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GENERAL ALPHABETICAL INDEX

*Illustrated; (P), (B. P.)—United States and British patents respectively; (S.)—Synopsis; (N.)—Papers read at society meetings but not printed in full.

- Brazil:**
 —Electric iron and steel plant. Paulson 1057
 —Alcohol as locomotive fuel in 148
 —Few purchases of heavy chemicals in 528
 Brick, Cinder cement. To be tested 345
 Brick, Paving. Standardization of 892
 —Excess varieties eliminated 980
 British chemical industry.... 48, 269, 860, 1038
 British Columbia:
 —Paper plant reopens 528
 —To make steel from magnetite 716
 Bromine extraction and apparatus. Dow. (P.) 208
Bronze:
 —Schwartz furnace atmosphere when melting complex. Anderson and Capps 103
 Budget, Chemical items in 1113
BUREAU OF CHEMISTRY:
 —Directorship unattractive to many .. 169
 —Acting chief named 255
 —Appointment of chief delayed 525
 —Report of chief of bureau 1113
BUREAU OF MINES:
 —Alloy work discussed 980
 —Bureau of Mines to study light alloys. 625
 —Ceramic work being expanded 256
 —Chemical staff increased 1155
 —Co-operative agreements 761
 —Non-metallic investigations 527
 —Petroleum Experiment Station seeks technical men 123
 Bureau of Standards:
 —New standard samples 257
 Burns from calcium saccharate. Sherrill. 4
 Burton, William M., Perkin medalist ... 848
- C**
- Cadmium in 1920. Siebenthal and Stoll.. 29
 Cadmium-copper wire. Smith *1178
 Calcium carbonate:
 —Notes on metallurgy of. Brace *105
 Calcium acetate, Mfr. 238
 Calcium-barium-lead alloys. Electrolytic. Cowan, Simpkins and Hiers *1181
 Calcium bisulphate, Mfr. of. Richter. (P.) 208
 Calcium carbonate:
 —Forms of 149
 Calcium chloride solutions:
 —Vapor pressures of. Baker and Waite. *1174
 Calcium nitrate, Mfr. (B. P.) 340
 Camphor, Synthetic:
 —DuPont plant may resume 1156
 —Bernyl esters for (B. P.) 715
 Cam shafts, Tempering, Wandersee. (P.).. 208
CANADA:
 —Brass and copper industry 650
 —Business papers. Tribute to 1067
 —Ceramic school in Saskatoon 209
 —Chemical and allied industries. Statistics 822
 —Directory of chemical industries 672
 —Glass industry in 1918 115
 —Linseed oil in 1918 694
 —Soap industry statistics 506
 —Soap industry, 1918 751
 —Water-power resources 691
 Canadian Chicago Bridge & Iron Co. changes name 211
 Canis variegatus. Heterogeneity in. Seyt... 92
 Capital Increases, etc. 44, 87, 131, 176, 220, 264, 308, 352, 492, 579, 635, 679, 724, 768, 812, 855, 899, 944, 988, 1076, 1120, 1164, 1204
 Carbon:
 —Activation of. Ardagh. (N.) 500
CARBON BLACK:
 —From natural gas in 1920. Sievers. 333
 —Supreme Court decision on Wyoming industry. Dannerth 104
 —Ruling on 672
 Carbon monoxide, Catalytic oxidation of. Frazer. (N.) 1128
 Carboys. Regulations for transportation of. Carelessness. Wastes caused by. De Wolf. 433
 Casein cements, Mfr. of. (B. P.) 523
 Casein composition. (B. P.) 340
 Casein glues durable in damp places 607
 Cellulose:
 —Action of thiocyanates on. Clayton. (N.) 499
 Cellulose esters:
 —Solvents for. Willkie *1186
 Cellulose ethers:
 —Mfr. of. (B. P.) 340
 —Mfr. of. Dreyfus (B. P.) 714, 1021
 —Celluloid from. Dreyfus (B. P.) ... 715
 Cellulose Section, A. C. S.:
 —Fall meeting: 34
 —Plans 551
 —Report 551
CEMENT:
 —Potash recovery from cement kilns. Krarup *316
 —Chemical engineering needed. Dean.. 439
 —Wet process. Critical review of. Meade. (S.) 295
 —Foreign specifications 612
 —Foreign specifications charted 1020
 —Output increases in August 626
 —October output 1061
 —Philippine industry 735
 Census of Manufactures, 1919:
 —Preliminary summaries of 465
 Central Steel Co. Merger 717
CERAMICS:
 —Glimpses of Ohio ceramic industries. Jones I *562, II *619
 —Production wastes in. Minton 440
 —Ceramics as byproduct of coal mining in Sweden. Beckman 882
- CERAMICS—Continued:**
 —Bureau of Mines begins work on heavy clay products 77
 —Bureau of Mines ceramic work expanded 256
 —Ceramic engineering course at Illinois. 1112
 —Ceramic school at Univ. of Saskatchewan 209
 —Ceramic Station investigates burning. 527
 —Chemical stoneware: (see Acid-Resisting Materials).
 —Clay drying. New method 753
 —French porcelain industry. Growth of 124
 —Gas-fired kiln to be demonstrated .. 979
 —Laboratory car for brick kiln tests.. 978
 —Lead poisoning in pottery trade 78
 —Lecture course on burning of clay... 717
 —Pottery expositions being arranged.. 1067
 —Pottery products. Lower freight rates sought for 893
 —Pottery workers accept wage reduction 299
 Chamber of Commerce of the United States:
 —Natural resources reportment 893
 Charts:
 —Hamor's chart of aims of purposeful study of problems of chemical and physical technology *422
 —Measuring gases containing water vapor *329
 —Volumes of air required in air drying 1088
 Chemical and allied industrial markets... 38,
 81, 126, 170, 214, 258, 302, 346, 486,
 529, 573, 629, 673, 718, 762, 806, 850,
 894, 938, 982, 1026, 1070, 1114, 1158,
 1198.
 Chemical companies. New 212,
 299, 629, 805, 980, 1154
 Chemical engineering ideals. Wesson. (N.). 7
 Chemical industry:
 —Power and fuel data. Goodwin.... 708
 —Unemployment decreases in 716
 —Employment increases 1066
 Chemical market review 628
 Chemicals:
 —Waste due to lack of standardization. Cohoe 383
 —Census report for 1919 465
 —List of research chemicals in preparation 569, 892
 —Wholesale prices lower 672
 —Exports and imports:
 —May, 1921 37
 —Fiscal year 278
 —October 1069
 —Exports, Fiscal year 328
 Chemical stoneware: (see Acid-Resisting Materials).
 Chemical tonnage on railroads..... 77, 716
 Chemical warfare:
 —Alabama tests 626, 670
 —Consideration at disarmament conference 978, 1024, 1069, 1114
 —Weeks favors gas development..... 1113
 —Spread of war gases subject to control 1156
 —Anti-chemical propaganda rife..... 1193
CHEMICAL WARFARE SERVICE:
 —Moves offices 78
 —New proving ground ready..... 124
 —Service school course completed 124
 —Needs \$4,000,000 next year..... 213
 —Training plan outlined 298
 —Appropriation increased 1066
 —Survey shows gas leaves no permanent injury 1193
 Chemical welfare of America. Hendrick. (N.) 803
 Chemists' clubs exchange greetings..... 934
 Chicago Section, A. Cer. Soc.:
 —November meeting 1069
 Chicago Section, A. C. S.:
 —September meeting 670
 —October meeting 849
 —December meeting 1195
 Chicago's relation to future American steel industry. de Geer 325
 Chilean nitrate:
 —Declining importance of 717
 —New discoveries of 1185
 —Situation 1112
 China:
 —Vegetable tallow industry 522
 —Bibliography available 925
 Chlorine:
 —Electrolytic chlorine: caustic cells: Hooker. (P.) *1152
 Chlorine industry. Key position of. Brooks. (N.) 1127
 Chromium:
 —Electrolytic. (B. P.) 802
 Cincinnati needs river terminals..... 1157
 Civil service examinations 79,
 626, 670, 762, 1070, 1110
 Clay, Drying. New method 753
COAL:
 —Cleaning by use of oil. Trent process. Perrott and Kinney *182
 —Destructive distillation of mixtures of oil and. Davis, Place and Scott... *1131
 —Consumption by uses 648
 —Low-temperature carbonization. Beilby 228
 —Pulverized:
 —In iron and steel industry. Coffin.. *971
 —Volatile matter. Determination of. Wilkinson 925
 Coal ash. Fusing temperatures of coke ash and. Rose 141
 Coal tar:
 —Separating water from. (B. P.) *340
 Coconut oil:
 —Philippine exports of 323
 Coffee extracts, Mfr. of. Challas. (B. P.) 76
 Coke:
 —Coking mid-continent coals *710
 —Monthly statistical summary established 210
- COKE—Continued:**
 —Studies at Ohio State 571
 Coke ash, Fusing temperature of coal ash and. Rose 141
 Coke ovens:
 —Piette ovens to be introduced..... 342
 Colloids:
 —Colloid chemistry of petroleum. Padgett 189
 Color measurement in industry. Pfund. (N.) 849
 Colorado clays to be studied 1157
 Colorado Industrial Exposition 1069
 Commerce, Department of:
 —Annual report of secretary 1111
 —Additional commodity divisions 1112
 Concrete:
 —Use in construction of salt plants. (S.) 75
 Congress of Industrial Chemistry at Paris. 893
 Connecticut Valley Section, A. C. S.:
 —Officers elected 1025
 Construction and operation 43,
 86, 131, 175, 219, 263, 307, 351, 491,
 534, 578, 634, 678, 723, 767, 811, 855,
 899, 943, 987, 1031, 1075, 1119, 1163,
 1203.
 Construction wastes, Elimination of. Burpee 394
 Co-operation between University and industry. Johnston. (N.)..... 1195
COPPER:
 —Electrodeposition of alternate layers of nickel and. Blum and Slattery.. 320
 —Structure and properties of. Blum. 961
 —Electrolytic solution and deposition. Briggs. (N.) 689
 —Standards approved by A. E. S. C... 36
 Copper alloys:
 —Heat-treatment of. Isabellen Hütten Ges. (B. P.)..... 33
 Copper: aluminum alloys. Anderson. (N.). 688
 Copper-cadmium wire. Smith *1178
 Copper shingle production 759
 Copper sulphate:
 —Mfr. of pure. Mackay. (B. P.) ... 251
 Cordite, Artificial leather from 528
 Cores:
 —Air required in baking cores made with linseed oil. Grubb and Jamison 793
 —Comment. Olsen 948
 Cost methods:
 —Disclosing waste through better. Wessen 389
 Cottonseed products, Fundamental research program for 1067
 Cottrell precipitator: (see Electrical Precipitators).
 Crane, General purpose crawling tractor.. *712
 Crankshaft, Metallurgical examination of broken 14
 Credulochemistry. Comment. Frary 773
 Crushing:
 —Symposium at chemical exposition .. 587
 Crystal structure:
 —Studies with X-rays. Bain *657
 Crystallization. Impurities retard. Walton. (N.) 1025
 Current Events 34,
 77, 121, 165, 209, 253, 297, 341, 483,
 525, 569, 625, 670, 716, 759, 803, 847,
 892, 934, 978, 1022, 1066, 1109, 1154,
 1194.
 Cyanamide:
 —Electrolysis of. Kameyama. (N.).. 686
 Cyanure azide. Ott. (P.)..... 1192
 Czechoslovakia:
 —Radium production 1050
 —Restricts exports 934
- D**
- Dartmouth College dedicates Steele Chemistry Building 936
 Decolorizing carbon:
 —Mfr. DeBruyn. (B. P.) 296
 De-inking process. Chemical control of. Joyce 248
 Delaware Section, A. C. S.:
 —October meeting 849
 Dental amalgams. Gray. (N.)..... 1112
 Deoxidizers:
 —Alloys. Vos. (P.) 482
 Detinning processes:
 —Oleum. Mackay. (B. P.)..... 251
 Detonator, New. Ott. (P.) 1191
 Deutsche Chemische Gesellschaft:
 —November meeting 1156
 Dialkylaminoalkyl compounds. (B. P.)... 1064
 Diethyl sulphate, Properties. Curme 957
 Distillation:
 —Separating organic substances by. (B. P.) 1064
DRYING:
 —Air drying. Volumes of air required in. Mitchell *1088
 —Symposium at chemical exposition... 588
 —Air conditioning in. Lissauer. (N.).. 589
 —Atmospheric. Stern. (N.) 589
 —Moist air. Stonex. (N.)..... 588
 —Selection of driers. Landell. (N.)... 588
 —Vacuum. Chen. (N.) 589
 DuPont Fibersilk Co. plant in operation.. 36
 Dye Division, A. C. S.:
 —New York meeting:
 —Plans 168
 —Report 544
DYE LEGISLATION: (see also Tariff).
 —Investigation of dye industry demanded 121
 —Dye embargo eliminated as tariff passes House 165
 —Another Moses amendment 168
 —Dye vote surprises Congress 209
 —Dye embargo extended 297
- *Illustrated; (P.) (B. P.)—United States and British patents respectively; (S.)—Synopsis; (N.)—Papers read at society meetings but not printed in full.

INDEX

DYE LEGISLATION—Continued:

—Dye embargo argued at Senate hearings	297
—Senator Ladd's plea	342
—Joint dye committee named	344
—Extension of temporary dye control	345, 485
—Special duties continued	525
—Plea for protection, Hendrick, (N.)	803
—Dye and chemical control extended	805
—Dye investigation not ordered	1022
—Dye investigation ordered	1109
—Senate sub-committee appointed ..	1193

DYES:

—Is there an American dye monopoly? Breithut	*594
—Census of dyes and coal-tar chemicals, 1920	*166
—Natural dyes and extracts, Census report on	466
—Anthracene, (B. P.)	1021
—Germany advances prices	525
—Indigoid vat, (B. P.)	933
—Industry lacks business knowledge ..	434
—Monoazo, Morgan, (B. P.)	33
—(B. P.)	933
—National Lime Association urges protection	123

E

Earthenware, Embossed, Reduced duty for ..	717
Edible oils:	
—Basic technical information needed, Ingram	438

EDITORIAL:

—Act! but think first	726
—Administrative and business opinions on tariff policy	1077
—Agricultural support for the chemical industry	901
—Alcohol dyes and industrial supremacy ..	221
—And again, what is a chemist?	451
—And now the question: "What is the chemical engineer?"	683
—An old fake persists	903
—Anent peace with Germany	637
—Apropos of getting a job	946
—Are colleges over-supplying chemists? ..	1165
—Armistice Day and a new epoch	901
—The arms conference and chemical warfare	857
—A. S. T. M. unable to join Federation ..	46
—Athletics and chemistry	310
—The banker and research	991
—Better business methods needed	179
—The blight of finance on technical enterprises	857
—The bottom of the chemical market ..	133
—Business revival and our export trade ..	178
—Canada and the tariff	989
—Can mild steel have 750,000 lb. ultimate strength?	989
—Ceramic engineers develop clay industries	1078
—The chemical exposition	581
—Chemical exposition for 1921 to excel its predecessors	355
—Chemical supremacy with English-speaking people	356
—Chemists and time clocks	1123
—Chicago business men clearing labor situation	1122
—Chicago chemists show progress	1123
—Chicago citizens support Landis award ..	947
—Classification of research	945
—Coal, and the rocky road to normalcy ..	725
—Coke byproduct output misinterpreted ..	1166
—College degrees for the credulous	1035
—Concerning the threefold state	91
—Conferences and publicity on unemployment	637
—The conference on unemployment	583
—Congress fears cupidity in the chemical industry	859
—The cover of this number	353
—Culture in technical education	89
—Defenseless in war and laggards in peace	449
—Denying a pernicious rumor	583
—Deterrents for methanol consumption ..	902
—Development of transportation	771
—The dunce and the devil	902
—The dye industry and modern warfare ..	639
—Earnings in the steel industry	815
—The electric furnace and sound castings of pure silver	450
—Electrochemists at Lake Placid	682
—Elimination of waste in industry	353
—Engineers honor Marshal Foch	1123
—An era of construction in prospect ..	223
—Expecting arrest or protection?	2
—The facts about American dyes	493
—Facts and fancies about the Oppau explosion	814
—Fair dealing with Washington	221
—Finding the effect of American valuation	681
—Five years of legislative waste	355
—Fluctuations and drifts in prices	135
—Ford and Edison inspect Muscle Shoals	1079
—Mr. Ford's offer for Muscle Shoals ..	538
—Ford proposes to buy Government nitrate plant	89
—For the edification of readers and advertisers	265
—Foundations of trade unionism	859
—Fundamental conceptions underlying metallurgical advance	494
—Further defense of the selective embargo	538
—Haber, Nernst and the amenities of life	1079
—Helium demonstrates commercial utility	1078

EDITORIAL—Continued:

—How may research be fostered?	681
—How to reduce taxes	813
—Industrial menace of tax-exempt securities	47
—Internal strain versus amorphous metal	725
—Iron industry as a barometer	727
—Is it dyes, dyers, ignorance or cupid-ity?	537
—Land armaments and business recovery	1033
—A leaf out of the past	177
—Limiting the activities of trade associations	1166
—The long, long road to results	309
—Long-time forest policy	1
—Looking forward to fall meetings	46
—A loss to the cause of leather chemistry	1123
—The man on the firing line	356
—Mechanical engineering in chemical production	310
—Metallurgical literature	134
—A misleading advertisement	990
—National income and its distribution ..	1078
—Need of better association machinery ..	2
—New propaganda for old	1034
—Newspaper electrochemistry	267
—News value or nuisance value?	178
—Nobody to blame	769
—"Normalcy" and extrapolation	639
—A notable movement in metallurgical education	858
—Now he's bossing dad	45
—The Oppau explosion	583
—Organization as a factor in research ..	1122
—Other views on the mineral tariffs	2
—Patent litigation of unusual interest ..	266
—Peace-time uses of gas bombs	1122
—The permanent tariff revision	1
—Pitiable end of a Russian scientist	947
—Pointing the way to industrial peace ..	945
—Prevention of tuberculosis a means of increasing business	1033
—Princeton in the saddle	134
—Progress in the dye industry	46
—Prohibition and industrial alcohol	177
—The psychology of business	582
—Quality pays in the long run	223
—The railroad "problem"	947
—Railroad rates and business activity ..	682
—Railroad service and railroad buying ..	539
—Railroad strike is called off	813
—Readjustment or economy?	90
—Recognizing our organic chemical industry	813
—Relations in wage rates	495
—The return of industrial activity	3
—The rubber industry and the planters ..	582
—Russian chemists and organic chemis-try	495
—Russian chemists sorely need help	771
—Salvage for the wise ones	495
—Seen through friendly eyes	90
—Senate to investigate the dye industry ..	1077
—A serious economic problem	133
—The shoemaker and his last	581
—Signs of promise	770
—Signposts of metallurgical progress ..	946
—A silk purse from a sow's ear	311
—Simultaneous discoveries in science ..	222
—Sixty-second meeting of the American Chemical Society	537
—Social stepping a business necessity ..	815
—Soft-pedaling the curtailment of re-search	222
—Speeding the business revival	1035
—Steadier prices mean business expan-sion	311
—The Steel Corporation's quarterly report	179
—Steel prices and wages	47
—Student chapters for the A. I. C. E. ..	638
—Suggesting a new branch of chemistry ..	494
—A survey of special libraries	901
—Talking and working	1121
—Talking in large figures	3
—Time to change doctors	134
—The threatened railroad strike	769
—Tinkering with scientific bureaus	727
—Underdevelopment and overdevelop-ment	991
—Unemployment and the cost of pro-duction	1165
—Unemployment among engineers	683
—The ups and downs of steel	267
—Wastes in the iron and steel industry ..	450
—Water power development shows im-petus under new law	1079
—We congratulate Mr. Dawes	1121
—When is a research a mere inquiry? ..	638
—Who knows about internal strain?	266
—Wildcats in Western Texas	1167
—Wisdom in managing an educational institution	309
—Work and employment in 1920	1167
—Would the ZR-2 have been saved by helium?	451

EDUCATION:

—Educational waste in industry, God-frey	378
—Training glass works chemist, Silver-man	332
—Metallurgical, Notable movement in, Comment, Gilligan	993
—Culture in technical education, Com-ment, Hart	452
Elastic limit, Dalby (S.)	*623

ELECTRIC FURNACES:

—For silver, gold and metals of low melting point, Herlenius	*455
—Arc and resistance, Rennerfelt, (B. P.)	*669
—Baily furnace, Baily, (N.)	687
—Electrode arrangement, (B. P.)	296
—Glass-annealing lehrs, Collins	119

ELECTRIC FURNACES—Continued:

—Internal resistance type, (B. P.)	*73
—Muffled arc type, Wunne, (N.)	655
—Rebel Arc furnace	*1109
—Resistance type for sheet heating	*567
—Resistance type for steel melting	*667
—Turret furnace for heat treating	*713
—Vitreous enamel furnace	*296
Electric heating directory planned	844
Electric power stations shown on new series of maps	1014

ELECTRICAL PRECIPITATORS:

—Eliminating smoke, fume and gas nuisances and wastes with, (Land-olt)	*425
—Installation at Santa Cruz Portland Cement Co.	*318
—Use for separating fog in wood gas ..	195
—Process, Welch, (P.)	*670
Electrochemical developments auxiliary to hydro electric plants, Benson	1004
Electrochemical products:	
—Power requirements and cost, Seele, (S.)	32

Electrodeposition:

—A. E. S. symposium	659
Electrolytic cell, Williams, (P.)	298
Electrolytic processes, Graphic control, Worth, (N.)	657
Electrometallurgy, Non-ferrous:	
—A. E. S. symposium	657
Elyria Enamelled Products Co. plant, Jones ..	*927
—Research Laboratory, Poste	*974

Emulsions:

—Petroleum, Padgett	189
---------------------------	-----

ENAMELED EQUIPMENT:

—Enamelled steel manufacture, Jones	*853
—Enamel-lined apparatus, Jones	*927
—Enamelled products research labora-tory, Poste	*974
—Uses for industrial enamelled equip-ment, Donauer	*1015

Enamels:

—Electric furnace for vitreous enamels ..	*206
—Fish scaling of, Co-operative factory investigation	123
Energy, Source and future of, Little, (N.)	542
Engineering societies' delegates, Dinner to ..	739

ENGLAND:

—Ammonium sulphate embargo lifted	572
—British chemical industry, 48,269,860, 1038	
—British chemical workers to strike	343
—Dispute settled	527
—Brunner Mond dividend	1067
—Chemical imports affected by act	484
—Denatured alcohol plan	1025
—Disposal of government surplus chemicals	847
—Labor disputes and wage reductions in chemical plants	483
—Steel-works practice, Coulson, (S.)	1190

Ethyl acetate:

—Anhydrous, Properties of	1186
---------------------------------	------

Ethylene:

—Sources and uses, Curme	907
Ethylene chlorhydrin, Properties, Curme and Young	1091
Ethylene dichloride, Properties, Curme ..	999
Ethylene oxide, Properties, Curme and Young	1091

EVAPORATION:

—Studies in evaporator design, V Badger	*459
—Multiple effect evaporation, Dung-linson	*110
—Comment, Mellor	453
—Vapor compression, Dunglinson	*246
—Regenerative or vapor compression, Badger, (N.)	1129
—Symposium at chemical exposition ..	588
—Criss-Cross evaporator, Cook, (N.)	*589
—Enamelled evaporators, Donauer, (N.) ..	588
—Evaporation, Austin, (N.)	589

Explosions:

—Use of inert gas for prevention of, White	*513
—Comment, Bell	729
Extensometer calibrating device, Templin ..	*248

F

Fats:

—Statistics, Fats and oils, First quar-ter, 1921	148
--	-----

Fatty Acids:

—Distillation plants, Operation of, Wurster	*651
—Mfr. of triglycerides of, (B. P.)	*524
—Polymerizing, (B. P.)	1021

Federal Power Commission:

—First report	1110
---------------------	------

Federal Trade Commission:

—Issues order against Royal Baking Powder Co.	211
—Gypsum Industries' Association cited ..	570
—Procter & Gamble Co. cited	1025
—Complaint against Steel Corporation amended	1111

Federated American Engineering Societies:

—Dean Cooley discusses problems fac-ing	847
—To review progress at annual meeting ..	1023

Fermentation process, Continuous, (B. P.)

	76
--	----

Fermogas promoter sent to prison

	169
--	-----

Fertilizer Division, A. C. S.:

—New York meeting, Report	605
---------------------------------	-----

FERTILIZERS:

—Science and the coming agriculture, MacDowell	785
—Census report for 1919	466
—Farmers to demand free	571
—Freight rates discussed	892
—Hungarians organize company	528

- FERTILIZER—Continued:**
 —Movement during fiscal year..... 526
 —National Fertilizer Association co-
 operating with Bureau of Census... 484
 —Peninsula manufacturers organize... 1157
 —Sweden lifts export embargo..... 670
Filters:
 —Filter press, Improved type of. Bur-
 chenal..... *476
 —A. C. S. symposium. (N.)..... 545
**Fireproof protection of extra-hazardous
 risks in manufactories.** Patterson... *887
Fire waste, Some considerations of. Rich-
 ardson..... 397
**Fixed Nitrogen Research Laboratory (see under
 Nitrogen Fixation)**
**Foch made honorary member of engineering
 societies**..... 1153
Food-preservation industries:
 —Technically trained men needed.
 Cruess..... 435
Food products:
 —Industrial waste of..... 435
Forest Products Laboratory:
 —Plans for 1921-22..... *27
 —Wood Waste Exchange transferred to
 123
Formaldehyde, Mfr. of. Bailey. (P.)... 668
FRANCE:
 —American Field Service Fellowships for
 French Universities..... 892
 —Beet-sugar industry in northern
 France..... 188
 —Coal production in devastated regions
 792
 —Congress of Industrial Chemistry at
 Paris..... 893
 —Foreign trade in first four months,
 1921..... 152
 —Industrial reconstruction of devas-
 tated region..... 1101
 —Porcelain industry, Growth of..... 124
 —Reforestation of..... 1014
 —Sugar production, 1920-21 season... 148
Fray metal, Electrolytic. Cowan, Simp-
 kins and Hiers..... *1181
Freight movement increases...... 671
**Fritz medal for 1922 presented to Eugene
 Schneider**..... 121
Fuel gases, Purifying. Ramsburg. (P.)... 1191
Fuels:
 —A. C. S. symposium..... 546
 —Fuel and power data, Chemical in-
 dustry. Goodwin..... 708
 —Selection for industrial heating..... *116
Fuller's earth:
 —Production, 1920..... 16
Fumigation with HCN, Safeguarding...... 1155
**Furfural, Condensation with aniline in
 water.** Montgomery and Ernst..... 335
G
Gas and Gases:
 —Blast-furnace, Design of cleaners for.
 Gellert..... 287
 —Inert gas, Use in prevention of explo-
 sions. White..... *513
 —Comment. Bell..... 729
 —Measuring gases containing water
 vapor. Estep..... *329
 —A. C. S. symposium. (N.)..... 546
 —Census report for 1919..... 467
 —Combustion of gaseous fuels. Grebel.
 (S.)..... 75
 —Rare. Moureu. (N.)..... 1197
 —Complete gasification process. (B.
 P.)..... *339
 —Flow of, Device for measuring. Re-
 ply to comment. Hayward..... 5
 —Fuel gases, Purifying. Ramsburg.
 (P.)..... 1191
 —Medicinal properties to be studied... 804
 —Statistics on development of industry
 916
Gas analysis:
 —Apparatus for. (B. P.)..... *33
Gas mask for ammonia approved...... 125
Gas purification:
 —Process. (B. P.)..... 715
GASOLINE:
 —Peat process:
 —Court demonstration fails..... 1109
 —Declared fraud..... 1154
 —Quality of motor gasoline..... 324
 —Vapor pressure..... *752
Gelatin:
 —Data wanted on..... 77
 —Vegetable gelatine, Mfr. of. (B. P.)
 76
Genclite, a new bearing metal..... *207
General Bakedite Co. wins patent suit.
 Georgia, Industrial conditions improve in.
 Georgia white clays and bauxites to be
 studied..... 672
GERMANY:
 —Oppan disaster:
 —Cause..... 672
 —Further data..... 760
 —Impressions of and comments on.
 Comment. Kendall..... *818
 —B. A. S. F. to resume nitrogen fixation
 849
 —Chemical industry, Developments in... 163
 —Chemical industries in..... 1189
 —Dye prices advance..... 525
 —Explosion in salt-peter works..... 670
 —Fertilizer syndicate to market ammo-
 nia..... 935
 —Foreign trade in 1920..... 888
 —Kalisyndikat officials to visit U. S... 345
 —Labor situation..... 1196
 —Labor troubles in chemical industry.
 Leather industry, Status..... 914
 —Plants close down..... 671
 —Potash sales..... 278
 —Potash statistics..... 828
 —Taxation of American enterprises in... 828
 —Trade with Santiago de Cuba..... 656
 —Wages in metal industry..... 160
**Gilchrist, Colonel Harry L., receives D. S.
 M.**..... 124
GLASS:
 —As construction material in chemical
 industry. Marshall. (N.)..... 1128
 —Heat-intercepting. Alleman. (N.)... 499
 —Lehrs, Electrically heated. Collins... *119
 —Training glass-works chemist. Silver-
 man..... 332
 —Waste in. Tillotson..... 437
 —Belgian plate-glass costs..... 618
 —Canadian industry in 1918..... 115
 —Improved conditions..... 671
 —Operations in West Virginia..... 528
 —Research to be done on..... 672
 —Standardization conference..... 805
 —Wage reduction..... 527
GLUE:
 —Wastes in glue industry:
 —Causes of. Bogue..... 443
 —Efforts to eliminate. Tennant... 443
 —Casein glues durable in damp places.
 Data wanted on..... 607
 —Use of magnesium carbonate in... 77
 —Glue stains, Removal of..... 508
 Glycerine..... 241
 —Alcoholic fermentation as source of.
 Schweizer. (S.)..... 891
 —Fermentation process. (B. P.)..... 669
Gold:
 —Melting in electric furnaces..... *457
 Grease, waste, distilling. (B. P.)... *524
 Greensand as source of potash. Shreve... 1056
Grinding:
 —Economy of modern methods. Hard-
 inge..... 229
 —Symposium at chemical exposition... 587
**Gypsum Industries' Association cited for
 unfair competition**..... 570
H
Hardwood distillation (see Wood distillation)
HELIUM:
 —Petrolia plant shut down..... 212
 —Government to study..... 525
 —Successful flight with..... 1068
 —Practical use demonstrated..... *1111
 Hexane, Vapor pressure..... *752
**Highway engineering, Chemical engineer
 and.** Blanchard. (N.)..... 8
Humidity table for psychrometer readings.
 Hydrocarbons..... 746
 —Pyrolysis of. Denig..... *751
 —Halogenating. Loomis. (P.)..... 668
Hydrochloric Acid:
 —Electrolytic oxidation to perchloric
 acid. Goodwin and Walker..... 1093
 —New salt cake and hydrochloric acid
 furnace. Laury..... *834
 —Use by industries during war. Bailey.
 (S.)..... 481
**Hydro-electric inspection by Buffalo engi-
 neers**..... 629
Hydrogenation:
 —Catalyst for. Bolton. (B. P.)..... 296
Hydrogen-ion concentration:
 —In natural waters. Wolman and Han-
 nan..... *502
 —Practical applications of electrometric
 control. Klopsteg. (N.)..... 876
Hydrogen peroxide, Pure, Properties of.
 Maass. (N.)..... 499
Hydrolysis of salts, Gradual. Tian. (S.)
 32
Hygrometer, Care and use of...... 192
I
India:
 —Chemical research in. Watson. (S.) 338
 —Lac tax..... 526
 —Leather industry in. Ledgard..... 481
**Industrial and Engineering Chemistry Divi-
 sion, A. C. S.:**
 —New York meeting..... 545
Industrial Cost Association:
 —Pittsburgh meeting:
 —Program..... 804
 —Report..... 935
Industrial management:
 —Symposium at Industrial Relations
 Association..... 959
Industrial notes,
 44, 87, 352, 536, 635, 900, 944, 1076,
 1164, 1204
Industrial relations:
 —Pennsylvania conference..... 77
Industrial Relations Association:
 —New York meeting:
 —Program..... 625
 —Report..... 959
Industrial safety:
 —Engineer's part in. Tolman..... 203
**Insecticide and Disinfectant Manufacturers'
 Association:**
 —Atlantic City meeting..... 36
Institut de Beauté, Oxygen research at.
 Seyt..... 224
Internal Revenue:
 —Collections..... 528
 —Work of chemical division..... 1197
International Labor Conference:
 —Discusses white lead and anthrax... 980
 —To adopt convention on..... 1024
**International Union of Pure and Applied
 Chemistry:**
 —Brussels meeting:
 —Report..... 344
Interstate Commerce Commission:
 —Dates set for rate reduction argu-
 ments..... 1193
 —Inventors are active..... 224
Iodine:
 —Chilean industry..... 788
 —Iowa University of:
 —New chemistry building for..... 956
Iron:
 —Solid solutions of oxygen in. Stead
 and Whiteley. (N.)..... *960
 —Electrodeposition of. Hughes. (N.) 689
 —Electrolytic. (B. P.)..... 802
 —Electrolytic cleaning process. (B. P.) 296
IRON AND STEEL:
 —Analysis:
 —Sulphur in malleable cast iron.
 Crome..... 247
 —Corrosion (see Metal protection and
 corrosion)
 —Defects:
 —Internal service-strains in steel.
 Howard..... 275
 —Fatigue under repeated stress..... *1141
 —Effects of surface scratches. Coker.
 (S.)..... 714
 —Squaring a circle. Patterson... *1063
Effect of Various Elements:
 —Nitrogen in carburized steels.
 Ruder and Brophy..... *867
 —Comment..... 1036
 —Sulphur in malleable cast iron.
 Crome..... 247
Foundry Practice:
 —British view on steel foundry fur-
 naces..... 755
Furnaces:
 —Causes of high top heat in blast
 furnace. Imhoff..... 737
 —Heat balance of a blast-furnace
 stove. Wilson..... 200
 —Open-hearth ports. Kagarise. (N.) 952
 —Resistance type furnace tested... *667
 —Turret furnace for heat-treating... *712
General:
 —Chicago's relation to future Amer-
 ican steel industry. de Geer... 325
 —Pulverized coal in. Coffin..... *971
 —Surface of liquid steel. Johns.
 (S.)..... 714
 —Composite articles of iron and
 steel. Longmuir. (S.)..... 1108
 —Pig iron, Census report for 1919... 470
 —British steel-works practice. Coul-
 son. (S.)..... 1190
 —Independent steel merger contem-
 plated..... 1069
 —Proposed Western merger..... 1068
 —Industry at Buffalo resuming... 528
 —Imports from Europe..... 970
 —Italian production..... 822
 —Japanese production..... 515
 —Swedish industry..... 952
Heat Treatment:
 —Artificial seasoning of steels.
 French..... 155
 —Equilibrium between iron, carbon
 and oxygen. Comment. Giolitti... *312
 —Hardening high-speed steel. Vari-
 ous methods. d'Arcambal... 1150
 —Hardness of high-speed steel. d'Ar-
 cambal..... *1168
 —Influence of mass in. Janitzky... *783
 —Of high-speed steel cutting tools of
 intricate design. Langhammer... *30
 —Oxidation of carbon tool steel on
 heating in air. Scott..... *72
 —Case-hardening. Aitchison. (S.)... 164
 —Hardening tool steel. Brayshaw.
 (S.)..... 891
 —A. S. T. M. committee notes on... 14
 —Case-hardening symposium, A. S.
 S. T. 642
 —Hardening tool steel, A. S. S. T.
 papers. (N.)..... 645
 —Heat treatment of ordnance. (N.) 644
 —Regenerative furnace for..... 800
 —Turret furnace for..... *712
 —Hardening tools. Tate. (B. P.)... 33
Ingots:
 —Sound ingots and rails as a matter
 of course. Hadfield..... *772
 —Comment. Gathmann..... 1080
 —Gas-free ingots..... 1024
Metallography (see also Heat treatment):
 —Constitution of martensite and
 troostite. McAdam..... *613
 —Contrast etching. Rawdon and
 Lorentz..... *915
 —Electrolytic etching. Improved.
 Velguth..... *567
 —Etching agent for chromium and
 tungsten steels. Daevs. (S.)... 1151
 —Macroscopic examination..... 334
 —Microscopic examination..... 471
**Physical Properties (see also Heat treat-
 ment):**
 —Endurance under repeated stresses.
 McAdam..... *1081
 —Hardness variations in heat-treated
 steel. Hayward..... 695
 —Comment. Woodward. Reply.
 Hayward..... 905
 —Impact properties of various steels.
 Langenberg..... *910
 —Internal service-strains in steel.
 Howard..... 275
 —Fatigue under repeated stress..... *1141
 —Instrument to measure elongation
 of broken tensile specimens.
 Woodward..... *756
 —Elastic limit. Dalby. (S.)..... *623
 —Elastic properties after overstrain.
 Greaves. (S.)..... 667
 —Impact strength of carbon steel... 163
Processes:
 —Basset process. (S.)..... 568
 —Bessemer:
 —Spectroscopic examination of
 converter flame. Campbell... 618
 —Direct process for steel. Bour-
 coud. (N.)..... 951
 —Electric pig:
 —Electric reduction of iron ores.
 deFries..... 193

*Illustrated; (P), (B. P.)—United States and British patents respectively; (S.)—Synopsis;
 (N.)—Papers read at society meetings but not printed in full.

IRON AND STEEL—Continued:

Brazilian electric iron and steel plant. Paulsson	1057
Electric smelting. Hodson.....	881
Electric steel:	
Brazilian electric iron and steel plant. Paulsson	1057
Open hearth:	
Recarburizing. (B. P.)	340
Pig iron:	
Action of titanium in blast-furnace slags. (S.).....	801
Process. (B. P.).....	669
Desulphurizing. Koppers. (B. P.)..	296
Special Steels:	
Chromium steels:	
Bibliography and abstracts. Zimmerli	837
Etching reagent for. Daevs. (S.)	1151
Haber ammonia process steel. French. (N.)	647
High-speed steel:	
American manufacturing practice. d'Arcambal	1097
Hardening. Various methods. d'Arcambal	1150
Hardness of. d'Arcambal.....	1168
Magnet steel. New	1129
Molybdenum steel:	
Physical properties of. Hunter.	21
Properties. French. (S.).....	713
Mushet steel. Note on. d'Arcambal ..	1055
Non-magnetic, flame-, acid- and rust-resisting steel	797
Correction. Johnson	905
Stainless steel	717, 1108
Tool steel:	
Carbon. Oxidation on heating in air. Scott	72
A. S. S. T. papers. (N.).....	645
Hardening. Brayshaw. (S.).....	891
Tungsten steel. Etching reagent for. Daevs. (S.)	1151
Uranium steels. Foote.....	789
Iron and Steel Market.	
40, 83, 128, 172, 215, 260, 303, 347, 488, 530, 575, 630, 674, 719, 764, 807, 851, 896, 940, 983, 1027, 1072, 1116, 1159, 1199	
Iron ores, Magnetic separation. (B. P.)..	340
Isopropanol, Properties. Curme and Reid.	1049
Italian Chemical Industries.	
136, 315, 585, 817, 993	
ITALY:	
Italian chemical industries.	
136, 315, 585, 817, 993	
Iron and steel production.....	822
Imports and exports, 1920.....	136
Olive oil industry.....	1020

J

JAPAN:	
Bibliography available	925
Chemical industry status	344
Edible oils and bean cake in	192
Extension of government steel works.	1004
Iron and steel industry in	515
Paper industry, 1920	242
Japans:	
Water japan installations. (S.)	1190
Jute, Protest against duty on	77

K

Kerosene, Vapor pressure	752
Knight, Maurice A., chemical stoneware plant	289

L

Laboratories:	
Enamelled products research laboratory. Poste	974
Lactose, Mfr. of. (B. P.).....	76
Lead:	
Production. Classified	100
From lead-zinc ores. Elmore. (B. P.) ..	252
Lead-antimony alloys:	
Properties of. Gurevich and Hromatko	62
Lead pigments marketed 1919-20	286
Lead poisoning in pottery trades.....	78
Lead-thallium alloys. Corrosion. Fink. (N.)	685
Lead-tin alloys, Electrodeposition. Blum. (N.)	690
LEATHER:	
Flayed skins, Physiological and histological studies. Seymour-Jones... 1051	
Indian industry. Ledgard. (S.).....	481
British standard leather-measuring regulations	202
Census report for 1919	467
Hides and skins, 1920	916
Inefficiency in leather industry. Wilson ..	436
Mfrs. vote against cod oil tax.....	848
Status of German industry	914
Leather, Artificial:	
Pyroxylin type. Given. (N.).....	7
From cordite	528
Leather Chemistry Division, A. C. S.:	
New York meeting, Report	549
Legal Notes	31, 68, 159, 324, 464, 512, 795, 872, 926, 1054
LEGAL NOTES:	
Air pollution and wastefulness. Danerth	104
By Wellington Gustin.	
Chemical company obtains reversal of decree under workmen's compensation act in Maine	160
Churchward patents held no invention—Prior art and history of vanadium alloys	159

LEGAL NOTES—Continued:

Company held not responsible for injury to employee by explosion in gas pipe line	68
Condition in offer prevents contract agreement	796
The Conrad patents, the noiseless gear, using Bakelite mica, void for lack of invention	795
Cyanide pond owners liable for death of live stock	464
The Gaulin patent, Claim 7, held valid, but not infringed	1054
George patent for cooling bed held an advance in art and valid.....	321
Laboratory tests cannot outweigh the test of practical use	926
Nitric acid with sulphuric acid added to prevent corrosion not subject to duty	461
Non-delivery under installment contract not justified by non-payment for past delivery	31
Nuisance in storage of crude petroleum	464
Only attempt to sell goods as another's is unfair competition.....	69
Pearse patent held anticipated and void by District Court	872
Sale of goods before organization of company	872
Tank agitation patent held invalid as not being invention	926
Trader may announce in advance circumstances under which he will refuse to sell.....	872
Utzma patents for gypsum plaster board held valid	512
When mechanical equipment does and when it does not become fixtures..	31
Lehigh Valley Section, A. C. S.:	
September meeting.....	670
Officers elected	1157
Lenses, Microscope	115
Libraries, Special, Directory of.....	909
Lighting, Poor, Elimination of waste due to. Harrison	407
Lightning. Acid tank struck by. Wolf... 336	
Lignite:	
Briquetting. Thomson. (N.)	500
LIME:	
Dependence of lime industry upon nature and science. Little	149
Fine art of lime burning. Wood	705
Available lime in quicklime and hydrated lime. Whitson	740
Separation from dolomite. Schurecht. (S.)	891
Linseed oil:	
Canadian industry, 1918	694
Boiling with electric heat	844
Lithium minerals in 1920	21
Lithopone:	
Production costs	1196
Sales in 1920	346
Litigation wastes. Gustin	423
Location as a factor in eliminating waste.	
Kelsey	401
Lubricants:	
Mfr. (B. P.)	1021
Lumber industry:	
Waste in. Clapp	446
Chemical dips prevent blue stain....	286
Dry kilns, Progressive and compartment	746
Luxembourg iron industry	1102

M

Machinery, Automatic, Eliminating waste with. Hires	410
Magnesium carbonate:	
Use in glue	508
Magnesium chloride:	
Anhydrous, Mfr. of. Goldschmidt. (B. P.)	33
Magnesium-manganese alloy. Veazney. (P.)	339
Magnesium oxychloride cements:	
Plastic calcined magnesite and oxychloride cements. Seaton	233
Action of lime in. Seaton, Hill and Stewart	270
Magnet steel, New	1129
Maine:	
Notes on industrial activities in....	1157
Maine, University of:	
Summer pulp and paper course.....	78
Malachite green. Electrolytic oxidation of leuco-base. Lowy and Haux. (N.) ..	686
Manganese-magnesium alloy. Veazney. (P.)	339
Manufactures, Census of:	
Preliminary summaries of	465
Manufacturers' Catalogs	88
131, 535, 579, 636, 679, 768, 856, 899, 939, 1027, 1115, 1199	
Market, Chicago	1159
303, 630, 719, 807, 895, 983, 1071, 1159	
Market, St. Louis. S2, 170, 259, 347, 487, 574, 674, 763, 851, 939, 1027, 1115, 1199	
Market Reports. Current. 38, 81, 126, 170, 214, 258, 302, 346, 486, 529, 573, 629, 673, 718, 762, 806, 850, 894, 938, 982, 1026, 1070, 1114, 1158, 1198	
Material handling as factor in eliminating industrial waste. Coes	1096
Meat-packing industry:	
Contributes too much to fertilizer. Tolman	437
Meetings and Events. Coming. 44, 88, 131, 176, 220, 264, 308, 352, 492, 536, 580, 636, 680, 724, 768, 812, 856, 900, 944, 988, 1032, 1076, 1120, 1164, 1204	
Mercury compounds, Organic:	
Mfr. of. (B. P.)	252

METAL PROTECTION AND CORROSION:

Protective action of certain colloidal solutions. Huff	866
Corrosion in tile	1027
A. E. S. papers	684
Blushing. Styri. (N.)	685
Theory of corrosion. Friend. (N.)	686
Metal statistics, Duplication to be avoided in collection of	1157
Metallurgical reactions. Calculation of equilibrium in. Mexico	895
Metallurgy:	
Non ferrous. Problems in. Ransom. (N.)	523
METALS:	
Alternately electrodeposited structure and properties of. Blum	461
Amorphous metal hypothesis. J. J. J. and Archer	607
Mixed orientation developed in crystals of ductile metals by plastic deformation. Bain and Jeffries	775
Unusual grain growth due to critical strain. Knight	429
Slip interference theory of hardening. Comment. Hayward	181
Comment. Styri.....	313
Comment. Bain	729
Discussion. Sauveur	509
Comment. Belatew	554
Comment. Westgren	641
Comment. Heyn	728
Discussion. Honda	1001
What causes slip to halt? Knight	1036
Hardness of solid solutions. Rownham	243
Theory of hardening. Harder. (N.)	617
Strengthening by cold work	735
Extracting and separating. (B. P.)..	523
Meters for ammonia liquors. Than	1062
Methanol:	
Mfr in hardwood distillation industry ..	230
Treated wood gives increased yield of.	566
From methane. Riesenfeld. (P.).....	205
Metric System Bill:	
Asks hearing on	210
Hearings to be held	528
Mexico to increase tariffs	1193
Microscope. Comment on a book review. Holz	968
Milwaukee Section, A. C. S.:	
November meeting	1025
Minerals:	
Tariff on. Comments. Brown, Burdick	5
Bill to stimulate production of raw materials for chemical industry....	341
Non-metallic investigations. Bur. of Mines	527
MINERALS SEPARATION LITIGATION:	
Comment. Biesterfeld	4
Motion to fix standard of comparison ..	34
Decision on standard of comparison ..	481
Minerals Separation North American Corp. a party to Miami suit.....	168
M. S. claims 12 millions	1024
Mississippi, University of:	
Chemistry building	1157
Missouri, University of:	
Fellowships in metallurgy at.....	35
Monel metal:	
Properties and uses. Corse. (N.).....	7
Latent heat of fusion of. White.....	17
Notched bar impact tests and toughness of. Waltenberg	322
Comment. Comstock	816
Morocco:	
Phosphate shipments	278, 325
Motor fuel:	
Situation. Lesh. (N.)	9
More miles per gallon. Berry	64
Mushet steel. Note on. d'Arcambal	1055
Mustard gas. Pope. (N.)	541

N

Naphtha. Explosion of agitator charged with. Pape	919
National Conference of Business Paper Editors:	
Chicago meeting with A. B. P.	848
NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES:	
European interest in	77
Plans	121
Notes. 169, 212, 255, 299, 343	
Program	253
Exhibitors at	380
American Ceramic Society to meet at ..	484
Report	586
Side-lights on	590
National Lime Association:	
Urges protection for dye industry....	123
National Research Council:	
Division of Chemistry and Chemical Technology:	
Executive committee to meet	1023
Information service. Yerkes. (N.) ..	1128
To advise where to buy	1193
List of research chemicals	569, 592
National Safety Council:	
Boston meeting	570
Program	570
National Tube Co's hammer-welded pipe plant. Thum	921
NAVAL STORES:	
From dead wood of Southern pines ..	994
Sherwood	440
Wasteful methods. Crosswell	524
Movement during fiscal year	1140
Production, 1920-21 season	526
Navy Department:	
New wage scale	981
Status of chemists in	981

New Companies.	
44, 87, 131, 176, 220, 264, 308, 352, 492, 535, 579, 635, 679, 724, 767, 811, 856, 900, 944, 988, 1032, 1076, 1120, 1164, 1204.	
New Jersey Chemical Society:	
—October meeting	760
New Jersey Clayworkers Association:	
—To hold annual meeting	1024
—Report	*1194
NICKEL:	
—Latent heat of fusion of. White ..	*17
—Electrodeposition of alternate layers of copper and. Blum and Slattery.	320
—Structure and properties of. Blum.	*961
—Concentrated HCl etching reagent for. Rawdon and Lorentz	*955
Nickel-chromium alloys:	
—In heat-treating furnaces. Gatward. (N.)	10
Nickel silver. Physical tests on sheet. Price and Davidson	*141
—Electric melting. Thompson. (N.) ..	688
Nitrocellulose:	
—Chemistry, mfr. and uses. Schlatter.	*281
NITRIC ACID:	
—Superconcentration of. Galle	*741
—Distillation studies of nitric acid and sulphuric-nitric mixtures. Pascal. I.	*1103
II.	*1145
NITROGEN FIXATION:	
—European developments	299
—Fixed Nitrogen Research Laboratory:	
—Transferred to Dept. of Agriculture	167
—Government plants:	
—Ford offers to buy	124
—Hoover comments on Ford's offer ..	168
—Muscle Shoals on tapis again	209
—Muscle Shoals situation	342
—Ford invited to Washington	526
—Another Muscle Shoals offer	625
—Confer on Muscle Shoals	849
—Weeks and Ford to confer	936
—Deal likely to go through	1023
—Ford and Edison inspect	1069
—Supplement to Nitrogen Products report. (S.)	568
—Synthetic ammonia: (see under Ammonia)	
Nitrogen Products Committee report supplement. (S.)	568
Nitrogen purifying equipment	*74
Nitroglycerine:	
—Manufacture of. Symmes	*831
Nitrostarch explosives. Snelling. (P.) ..	846
Nitrous gases:	
—Absorption by sulphuric acid. Sanfourche. (S.)	623
—Absorption of. (B. P.)	*482
—Drying and liquefying. (B. P.) ..	802
—Separating from mixtures. (B. P.) ..	933
O	
Obituary:	
125, 214, 301, 485, 529, 573, 627, 673, 762, 806, 850, 894, 937, 982, 1025, 1114, 1158, 1198.	
—Abbott, Dr. Wallace Calvin	125, 301
—Borden, Colonel Spencer	806
—Ellis, George H.	301
—Chapman, Lloyd W.	573
—Dunlop, John Boyd	894
—Fischer, Louis A.	214
—Foote, Charles H.	529
—Gallun, Arthur H.	1158
—Gould, George L.	937
—Gray, Harry M.	301
—Greene, Benjamin F.	1114
—Hawley, Robert B.	1114
—Howitt, Peter Cooper	485
—Kidder, Edward Hartness	214
—Lane, Frank A.	982
—Levor, Gustav	1114
—Linbarger, S. C.	762
—Lindstrom, Reuben L.	1198
—Lucas, Anthony F.	627
—Luke, John G.	806
—MacMichael, Ross F.	485
—Mc Kean, Robert H.	1198
—Peterson, Jesse	850
—Price, William H.	894
—Richards, Joseph William	730
—Smalley, Dr. Frank N.	485
—Stengel, William H.	1025
—Stevenson, George H.	937
—Thomas, George W.	485
—Thomas, Howard	1025
—Tschernoff, Dimitri Konstantinovich.	937
—Vogel, William	529
—Voorhees, Samuel Stockton	673
—Weil, Prof. Charles L.	301
—Whitley, Charles W.	850
—Woodland, Prof. J. Ernest	806
Oil burner, New type	*336
Oil companies, New 212, 299, 670, 805, 1025, 1154.	
Oilgear power transmission system	*841
OILS:	
—Use in cleaning coal by Trent process. Perrott and Kinney	*183
—Destructive distillation of mixtures of coal and. Davis, Place and Scott.	*1131
—Basic technical information needed by. Ingram	438
—Statistics, Fats and oils, First quarter, 1921	148
—Clarifying and decolorizing. Mumford. (P.)	208
OIL SHALES:	
—Studies in Colorado shale oils. Franks.	*49
—Comment, Matthews. Reply, Franks	452
—Comment, Hoofs	816
—Studies in Colorado shale oils. Franks	A. *731, B. *778

OIL SHALES—Continued:

—Apparatus for studying thermal decomposition of. McKee and Lyder.	*1100
—Selected bibliography issued.	758
Olefine gases and derivatives, importance of:	
I. Ethylene and propylene. Curme.	907
II. Diethyl sulphate. Curme and Curme.	957
III. Ethylene dichloride. Curme	999
IV. Isopropanol. Curme and Reid	1049
V. Ethylene chlorhydrin and ethylene oxide. Curme and Young	1091
OPPAU DISASTER:	
—Cause	672
—Further data	760
—Impressions of and comments on.	*818
—Comment. Kendall	949
Optical Society of America:	
—To meet in Rochester	343
Organic chemicals, Synthetic:	
—Defined by Treasury Dept.	256
—Preparation at Rochester. Mees. (N.)	499
Oxides, Allotropic varieties of. Veil. (S.)	*120
Oxyaldehydes, Mfr. of. (B. P.)	252
Oxyaldehydes. (B. P.)	802

P

PAINT:	
—Automobile finishes. Holley	*873
—Ideal specification. Ingalls	595
—Census report for 1919	468
—Symposium at chemical exposition ..	590
—Improving. Perry	444
—Laboratory control. Nemzek. (N.) ..	590
—Limitations of standardization. Kohr. (N.)	591
—Physical testing. Breyer. (N.)	591
—Reflection factors of. Gardner. (N.)	591
—White lead, Prohibition of use in painting	980, 1024
Paint oils, Wastes in. Eisenschiml	444
PAPER:	
—De-inking, Chemical control of. Joyce	242
—More pulp per cord. Rue	447
—Sodium silicate in. Vail	823
—Census report for 1919	467
—Antiseptic treatment for wood pulp.	205
—Experimental paper mill for Siam ..	528
—Fire changes paper company's water-power plans	761
—Holyoke mills busier	671
—Industry in Kalamazoo Valley district	213
—Japanese industry in 1920	242
—Laurentide high-speed news machine. Kilberry. (N.)	498
—Maine activities	1157
—Pennsylvania industry	648
—Preliminary impregnation of pulp-wood chips	463
—Volumetric measurements of pulpwood	*704
—Whalen Pulp & Paper Co. reopens ..	528
Patent Office bill:	
—Stanley bill goes over in Senate	34
—Stanley bill again delayed	168
—Early vote expected	936
Patent Office continues to degenerate ..	1068
Patent policy of War Department	125
Patent situation. Prindle	417
Patents, Recent Chem. & Met.	
33, 76, 208, 251, 296, 339, 482, 523, 623, 668, 714, 802, 846, 933, 1021, 1064, 1152, 1192.	
PEAT:	
—Air-drying of. Moore. (N.)	500
—Peat gasoline process:	
—Court demonstration fails	1109
—Declared a fraud	1154
Pennsylvania industrial relations conference	77
Perchloric acid from HCl by electrolytic oxidation of. Goodwin and Walker	1093
Permut patent declared infringed	207
Personal:	
37, 80, 125, 170, 213, 257, 301, 345, 485, 529, 573, 627, 673, 718, 762, 806, 850, 894, 937, 981, 1026, 1070, 1114, 1158, 1198.	
Personnel:	
—Industrial training and selection of. Dooley	692
—Problems. Hopkins	385
PETROLEUM:	
—Wastes in petroleum industry. Hamor	441
—Wastes in refining. Pogue	442
—New products from. James. (N.) ..	1128
—Census report for 1919	468
—Oil claims staked at Fort Norman ..	571
—Specifications, Standardization of ..	211
—Colloid chemistry of. Padgett	189
—Distillation of. Illing and Kelly. (B. P.)	*669
Petroleum Chemistry Section, A. C. S.:	
—New York meeting, Report	552
Pfaudler Co. plant. Jones	*883
Phenol-aldehyde condensation products:	
—Mfr. of. (B. P.)	933
Philadelphia Chemical Club anniversary ..	1068
Philippines:	
—Sugar exports	119
—Coconut oil export	323
—Cement industry	735
—Copra and coconut oil export, August, 1921	836
Phosphates:	
—Briquetting. Waggaman, Easterwood and Turley	517
—Census report, 1919	758
—Morocco shipments	278, 525
Phosphoric acid:	
—Briquetting phosphates for mfr. of ..	*517
—Bureau of Soils to continue investigations	345
—Large saving claimed for	569
Photography, industrial and technical, Data wanted on	761

Phthaleins, Mfr. of. Rispler. (P.)	482
Phthalic acid, Mfr. (B. P.)	933
Phthalic anhydride, Mfr. (B. P.)	933
Physical and Inorganic Chemistry Division, A. C. S.:	
—New York meeting, Report	547
Physical terms, Definitions of	70
Pickling bath. (B. P.)	669
Pine trees, Lumber value not affected by turpentine	648
Pipe, hammer-welded, Mfr. of	*921
Plant chemistry:	
—Recent advances. Thatcher. (N.) ..	760
Plants resuming operations.	
803, 848, 893, 934, 978, 1022, 1066, 1110, 1154, 1197.	
Platinum:	
—Pure, Physical properties of	788
—Theft at Sierra Magnesite Co.	169
Platinum substitute. Fink. (Can. P.) ..	668
—Molybdenum-tantalum alloy. (P.) ..	846
Poland:	
—Alcohol production	53
Pollution legislation:	
—To oppose	761
—Hearings	849
—Further hearings to be held	980
—Legislation not imminent	1155
Postage, Extra zone, canceled	1111
Potash:	
—Successful recovery from cement kilns. Krarup	*316
—From greensand. Shreve	1056
—Quantitative determination by spectrum. Rogers	161
—United States industry during 1920.	
Nourse	1101
—Alsation production	629
—Alsation production increases	716
—Alsation mines return to France ..	876
—Domestic industry marking time ..	570
—French imports of German potash cause concern	849
—German sales of	278
—German Kalisynikat officials to visit U. S.	345
—Contract for German potash signed ..	761
—German statistics	828
—German potash syndicate captures American market	1109
—Texas deposits:	
—On discovery of potash in west Texas. Udden	1179
—Uncertainty	527
—Stock promotion warning	572
Potassium, Quantitative determination by spectrum. Rogers	161
Potassium nitrate from greensand. Shreve	1056
Power and fuel data, Chemical industry.	
Goodwin	708
Power plant in chemical industries:	
—Symposium at chemical exposition ..	592
Power plants, Elimination of waste in. Myers	413
Power transmission, New variable speed ..	*844
Priestley portrait presented to National Museum	847
Price lists,	
42, 83, 128, 172, 216, 260, 304, 348, 488, 531, 575, 631, 675, 720, 764, 808, 852, 896, 940, 984, 1028, 1072, 1116, 1160, 1201.	
Printing plates, Electrolytic reproduction of. Blum and Slattery	320
Procter & Gamble Co. cited	1025
Propylene:	
—Sources and uses. Curme	907
Publications, New.	
88, 220, 536, 580, 636, 856, 988, 1032	
Pulverizing:	
—Symposium at chemical exposition ..	587
Pumps:	
—Displacement pump for elevating acid by compressed air	*757
—Jennings steam-turbine-driven return-line heating pump	*337
—Magma pump	*801
Pyrites:	
—Spanish export tax protested	525, 1157
Pyrometry:	
—Brown cold junction compensated	*757
—Setting recording pyrometer for cold junction temperature. Comment.	
Hopkins	180
—Reply. Marsh	180
Pyrotip, Local heating with	*251
Pyroxylin plastics:	
—From cellulose ethers. Dreyfus. (B. P.)	715
R	
Radium:	
—Production in America. d'Aguiar. I.	*825
II.	877
—Plants merge	527
—Czechoslovakian industry	1050
Rails, Wheel-burnt. Sandberg. (S.) ..	568
Rare gases. Moureu. (N.)	1197
Refractories:	
—Laboratory furnace for deformation temperature of. Office	*162
—Electric furnace, Thompson. Hartmann. (N.)	688
—Firebrick. Hull. (N.)	951
—Bibliography available	1156
Refuse consuming furnace. Breuille. (B. P.)	*339
RESEARCH:	
—Role in waste elimination. Howe	379
—University researchers should patent discoveries in their own names. Hale	913
—Classification of research activities. Hyde	*948
—Canadian industrial research. Ruttan. (N.)	541
—Industrial research laboratories bulletin to be revised	36
—Program for cottonseed products	1067

- Research chemicals:
—List in preparation.....35, 569, 892
Resin esters and hardened rosin. Murray. 473
—Correction. Murray.....905
Revenue act (see Tax bill)
Rezistal.....*797
—Correction. Johnson.....905
Rhodium for rodents. Comment. Bridges 4
Richards, Joseph William, In memoriam...*730
—Electrochemical Society honors mem-
ory.....981
Rochester Section, A. C. S.:
—October meeting.....760
—December meeting.....1112
Rockland & Rockport Lime Corp. plant...*705
Rope, Formula for strength of.....888
Rosin (see Naval stores)
Rosin, Hardened, and resin esters. Mur-
ray.....473
—Correction. Murray.....905
Royal Baking Powder Co. ordered to cease
unfair methods.....211
- RUBBER:**
—Aging of rubber. King.....1039
—Industry learns its lesson. King.....434
—Observations on chemistry of. Whit-
by. (N.).....499
—Census report for 1919.....469
—Rubber used first 6 months, 1921...960
—Trenton mills at capacity.....671
—Spongy, Mfr. of. Marshall. (B. P.) *252
—Use of hot solutions. Gare. (B. P.) 251
—Vulcanizing oven. Bynoe. (B. P.) *76
—Waste, Utilizing. (B. P.) *1064
Rubber Division, A. C. S.:
—New York meeting, Report.....605
Rubber Manufacturers' Association of N. J.:
—Organized.....718
Rubber tires (see Tires, Pneumatic)
Rumania:
—Abolishes some chemical export duties 278
Russian chemists:
—Communications with. Krynitzky...992
—Scientific relief for. Minevitch....1037
- S**
Salesmen's Association of American Chem-
ical Industry:
—Organization.....342
—Meeting.....980
Salt:
—Boiling point of salt solutions under
varying pressures. Baker and
Waite.....*1137
—Technically trained men needed.
Badger.....442
—Use of concrete in salt plants. (S.) 75
—Electrolysis of salt solutions. Hook-
er. (P.).....*1152
Salt cake furnace. Laury.....*834
Sauveur, Albert, honorary member of steel
treaters.....*15
Sawdust, Destructive distillation of.....240
Schneider, Eugene, receives John Fritz
medal.....121, *906
Schwartz furnace atmosphere, Notes on.
Anderson and Capps.....103
Science and the coming agriculture. Mac-
Dowell.....785
Scientific bureaus, Tinkering with.....1025
Scleroscope, Improved.....*1107
Selenium oxychloride:
—Mfr. of. Lenher. (P.).....623
Shale oils (see Oil shales)
Sharpless, Frederick F., Secretary, A. I.
M. E.*101
Shellac:
—Handbook on Indian industry.....278
—Indian tax on.....526
Siam:
—Experimental paper mill for.....528
Silica gel, Catalytic oxidation with. Mc-
Kee. (P.).....1191
Silicates, Soluble alkali, Mfr. (B. P.)...524
Silk, Artificial:
—DuPont Fibersilk Co. plant in opera-
tion.....36
—Preparing threads. Bouffe. (B.
P.).....*33
—Treatment of. (B. P.).....802
Silver:
—Melting in electric furnaces. Her-
lenius.....*454
—Comment. Northrup.....904
—Melting fine and sterling silver by
electricity. DeFries.....*507
Slag, Converter, Granulating. Garr. (P.) 208
Slate industry utilizing waste.....167
Slip interference theory (see under Metals)
Smoke nuisance:
—Elimination of. Landolt.....*428
—Pyrites Co., Ltd., exonerated.....37
- SOAP:**
—Waste in mfr. of. Chester.....445
—Census report for 1919.....469
—Canadian industry 1918.....751
—Canadian industry statistics.....506
—Conference on specifications planned. 803
Société de Chimie Industrielle:
—Paris meeting.....484
—Announcement.....484
—Subdivision in sections. Kestner.
(S.).....164
Society of Chemical Industry:
—Montreal and New York meetings: 79, 256
—Plans.....*357
—Officers and visitors at.....*496
—Report of Canadian meeting.....
Society of Industrial Engineers:
—Springfield meeting.....527
Sodium cyanide, Mfr. (B. P.).....802
Sodium formate, Mfr. (B. P.).....933
Sodium hydrosulphide, Reduction by.
Lapworth. (S.).....338
Sodium naphtholate, Chebotaref. (P.)...482
Sodium nitrate sold by War Dept.1109
Sodium perborate, Electrolytic production.
Alsgaard. (N.).....686
Sodium peroxide causes fire.....1156
Sodium silicate:
—Relation of structure to free alkali
in. Stericker.....*61
—In papermaking. Vail.....823
Sodium telluride. Liddell.....453
Soil, Corrosive action on pipes to be
studied.....1014
Solvent extraction in vegetable oil indus-
try. Schrader.....*94
Solar cooker on Mount Wilson. (S.)...481
Solid solutions, Hardness of. Rosenhain.
Solutions, Diluting, Convenient formula
for. McMillan.....206
- SOLVENTS, VOLATILE, RECOVERY OF:**
—Bregat process. Comment. Law-
rence.....93
—Reply. Rouleux and Dort.....181
—Comment. Austin.....816
—Comment. Blair, Campbell & Mc-
Lean.....904
—Reply. Lawrence.....904
Southern pine waste, Complete utilization
of.....345
South Sea Islands:
—Commercial possibilities.....561
Spain:
—Proposed export tax on pyrites pro-
tested.....525, 1157
—Hydro-electric projects in.....830
Spotted dog. Martin Seyt.....92
Special Libraries Association:
—Directory.....909
Specifications, A. S. T. M., French edition
Spectroscope, Examining converter flames
with. Campbell.....618
Squaring a circle. Patterson.....*1063
Stainless steel.....717, 1108
- SUGAR:**
—Improvements needed in cane sugar
industry. Coates.....438
—Beet sugar crop forecast.....672
—Beet-sugar industry in northern
France.....188
—Color value of solutions.....792
—French production, 1920-21 season..148
—Philippine sugar exports.....119
Sugar Chemistry Division, A. C. S.:
—New York meeting, Report.....551
Sulphites, Sulphate-free. Shenefield, Vil-
brandt and Withrow.....953
- SULPHUR:**
—Mexican deposits to be developed...571
—Refining. Bacon and Wenrich. (P.) 339
- SULPHURIC ACID:**
—Recent developments in sulphuric
acid industry. Fairlie.....*861
—.....II. *917
—.....III. *964
—.....IV. *1005
—Distillation studies of nitric acid and
sulphuric-nitric mixtures. Pascal.
I. *1103
II. *1145
—Use by industries during war. Bailey.
(S.).....481
—Selenium process. Haeseler. (N.)...547
—Cascade pan, New type. Thiele.
(P.).....*623
Superpower survey:
—Chemical power and fuel data. Good-
win.....708
—Industrial power and fuel used in
zone.....470
—Report almost ready.....625
—Summary of report.....889
Surface tension, Measurement of. Fahren-
wald. (S.).....*295
Sweden:
—Ceramics as by-product of coal min-
ing in. Beckman.....882
—Fertilizer export embargo lifted...670
—Iron industry conditions in.....952
Switzerland:
—As market for American goods.....882
Synopsis of Recent Chem. & Met. Litera-
ture,
32, 75, 120, 164, 295, 338, 481, 568, 623,
667, 713, 801, 891, 1108, 1151, 1191
Synthetic Organic Chemical Manufacturers'
Association:
—Organization.....847
—Meeting.....1024
- T**
Tanning:
—Fish skins. (B. P.).....802
—Vacuum-pressure process. (B. P.)...1064
Tanning extracts:
—Extracting catechin and catechu-tan-
nic acid. (B. P.).....76
- TARIFF:**
—Minerals. Comments. Brown. Bur-
dick.....5
—Chemical schedule of Fordney bill...11
—Protest duty on jute.....77
—Tea waste duty opposed.....122
—Potash duty faces hard fight.....124
—Dye embargo eliminated in House...165
—Another Moses amendment.....168
—Dye vote surprises Congress.....209
—Manufacturing chemists make plea
for protection.....210
—Senate committee busy on.....254
—Dye embargo extended.....297
—Dye embargo argued at Senate hear-
ings.....297
—Chemical schedule considered.....341
—Extension of temporary dye control.
345, 485
- Ask embargo on chemical stores are 525
—Data on chemicals asked.....528
—Interest urged.....571
—Farmers to demand free list zero...571
—Tariff to free iron.....582
—Emergency tariff act extended.....582
—Postmaster General Hays.....979
—Summary of tariff information to be
revealed.....1025
- Tax bill:**
—Some business aspects of 1921
revenue act. Hays.....1120
—Finally approved.....1043
Technical Association of Pulp and Paper
Industry:
—Notes.....210, 299, 354, 572, 626
Tellurium white metal alloys. Notes on.
Ransom and Thiem.....*102
—Comments. Luddell.....453
Textile chemists' society: (see American
Association of Textile Chemists and
Colorists)
Textile industry:
—Causes of waste in.....445
Thallium lead alloys, Corrosion Peak (N.) 645
Tin-lead alloys, Electrodeposition Baum
(N.).....690
Tin scrap, Detinning: (see Detinning
Process)
Tires, Pneumatic:
—Determining factors for life of. Nel-
son.....153
—Comment. Pickering.....263
Titanium:
—Action in blast-furnace slags. (S.)...891
—Contribution to study of. B. Ry. (S.) 1190
TNT for road building.....331
Trade associations:
—Proper functions to be defined.....1113
Transformer oil sludge. Rodman. (N.)...685
Trent process:
—Laboratory studies of.....183
—Distillation of mixtures produced in 1131
Tropine derivatives. (E. P.).....602
Trucks, Electric storage battery, vs.
wheelbarrows.....74
Tungsten:
—Developments in mfr. of. Lohmann.
(S.).....129
—Tungsten wire, Mfr. (B. P.).....349
Turpentine: (see Naval stores)
- U**
Ultra-violet light, Uses of. Wood. (N.)...1128
Unemployment diminishing.....981
United States Potters Association:
—To meet in Washington.....935
United States Smelting, Refining & Mining
Co.:
—New stack at Midvale plant.....37
- V**
Vapor pressure of system calcium chloride-
water. Baker and Waite.....*1174
VARNISH:
—Automobile finishes. Holley.....*573
—Hardened rosin and resin esters. Mur-
ray.....473
—Ideal specification. Ingalls.....595
—Waste control. Perry. (N.).....591
—Census report for 1919.....468
—Symposium at chemical exposition...590
—Improving. Perry.....444
—Laboratory control. Nemzek. (N.) 590
—Limitations of standardization. Kohr.
(N.).....591
Varnish oils, Wastes in. Eisenschmidt...444
Vaseline, Vapor pressure.....*752
Vegetable gelatine. (B. P.).....76
Vegetable oil industry:
—Solvent extraction in. Schrader.....*94
Vegetable tallow:
—Chinese industry.....523
Viscosimeter, Air bubble. Abrams, Kava-
nagh and Osmond.....*665
- W**
War minerals relief act modified.....1066
Washington Chapter, A. S. S. T.:
—December meeting.....1197
Washington Section, A. C. S.:
—Officers elected.....979
WASTE IN INDUSTRY:
—Accident prevention reduces. DeBlois. *403
—Construction wastes, Elimination of.
Burpee.....394
—Cost methods should disclose. Wessen 389
—Educational. Godfrey.....378
—Engineering and management. Poor.
Kimball.....375
—Fire waste. Richardson.....397
—Human waste. Mock.....*369
—Lighting. Poor, Elimination of. Har-
rison.....*407
—Litigation. Gustin.....423
—Location as a factor in eliminating.
Kelsey.....401
—Machinery for eliminating manufac-
turing wastes. Hires.....410
—Marketing waste, Eliminating. Eas-
et.....420
—Patent situation. Prindle.....417
—Personnel problem. Hopkins.....385
—Power plants. Myers.....413
—Research. Role of. Howe.....379
—Smoke, fume and gas nuisance.
Landolt.....*428
—Standardization of chemicals. Lack
of. Cohoe.....383
—Waste and inefficiency in the in-
dustries.....433
—Cement. Dean.....439

WASTE IN INDUSTRY—Continued:

—Ceramics. Minton	440
—Dyes	434
—Edible oils. Ingram	438
—Fertilizers. MacDowell	445
—Food preservation. Cruess	435
—Food products. Menge	435
—Glass. Tillotson	437
—Glue. Tennant. Bogue	443
—Leather. Wilson	436
—Lumber. Clapp	446
—Meat packing. Tolman	437
—Naval stores. Croswell	440
—Paint and varnish. Perry	444
—Paint and varnish oils. Eisen-	
—schimi	444
—Paper. Rue	447
—Petroleum. Hamor	441
—Petroleum refining. Pogue	442
—Rubber. King	434
—Salt. Badger	442
—Soap. Chester	445
—Sugar. Coates	438
—Textiles	436
—Wood distillation. Root	448
—Wastes caused by carelessness.	
—De Wolf	433
—Extracts from F. A. E. S. committee	
—report:	
—Loss in production due to ill	
—health	374
—Waste due to interrupted produc-	
—tion	382
—Performance standardization	384
—Waste due to restricted produc-	
—tion	388
—Opportunity for governmental as-	
—sistance	393
—Responsibility of owners	406
—Some causes of low production..	
—412	
—Estimated savings with superpower	
—system	416
—Hamor's chart of aims	*422

WASTE IN INDUSTRY—Continued:

—Material handling as factor in elim-	
—inating. Coes	1096
—Role of libraries in eliminating.	
—Walker	904
—Water. Removing dissolved oxygen from.	
—(B. P.)	669
—Water power. World reserves	1048
—Water purification:	
—Effect of hydrogen-ion concentration	
—on. Wolman and Hannan	*502
—Water softening:	
—Boiler feed water purification. Ap-	
—plebaum	23
—Comment. Taylor	640
—Reply. Applebaum	992
—Permutit patent found infringed..	207
—Weidlein, Edward R.	*774

WELDING:

—Welding; Particularly hammer weld-	
—ing. Thum	*553
—Hammer-welding plant of Blaw-Knox	
—Co. Thum	*747
—National Tube Co.'s hammer-welded	
—pipe plant. Thum	*921
—Metallography of oxyacetylene weld	
—as affected by enameling. Poste	
—(S.)	801
—Fusion welding. Miller. (N.) ...	950
—Eliminating blow-holes in Thermit	
—welds	523
—Hammer-welded penstock joints with-	
—stand bursting pressures	*805
—Electric. (B. P.)	*524
—Wire drawing. Elongated structure, Hoff-	
—man. (N.)	1197
—Wood:	
—Air-seasoning. Reducing time and	
—cost of	515
—Blue stain prevented by chemical	
—dips	286
—Wood acids	696

Wood distillation:

—Hardwood distillation industry. Haw-	
—ley	I *137. II *195. III *237
—Waste in. Root	448
—Treated wood gives more methanol.	566
—Wood Waste Exchange transferred to For-	
—est Products Laboratory	123

X

—X-Rays:	
—Studies of crystal structure with.	
—Bain	*657

Y

—Yale University, Sterling Chemical Lab-	
—oratory	301, 892

Z

ZINC:

—Belgian conditions	103
—Electrolysis vs. retort smelting. Laist	754
—Electrolytic:	
—Electro metallurgy. Ingalls. (N.)	689
—From zinc cyanide solution. Wern-	
—lund. (N.)	690
—Plant capacities	607
—Purifying solutions for. Field.	
—(B. P.)	252
—From lead-zinc ores. Elmore. (B. P.)	252
—Production, First half, 1921	622
—Strengthening by compression	1180
—Zinc alloys, Strengthening by compres-	
—sion	1180
—Zinc-aluminum alloys:	
—Casting. Livermore	516
—Zinc chloride:	
—Mfr. of. Danckwardt. (P.)	208
—Zinc cyanide plating solutions	977
—Zinc dust, Production 1919-20	301
—Zinc pigments marketed 1919-20	286
—Zirkite, Purification in electric furnace.	
—Thompson. (N.)	688

*Illustrated; (P), (B. P.)—United States and British patents respectively; (S.)—Synopsis;
(N.)—Papers read at society meetings but not printed in full.

AUTHOR INDEX

- ABRAMS, VICTOR R.**, Joseph T. Kavanagh and Charles H. Osmond. Air bubble viscosimeter. 665
- Anderson, Robert J.**, and J. H. Capps. Constitution of gas atmospheres in aluminum-alloy melting furnaces. 54
- Note on Schwarz furnace atmosphere when melting complex bronzes. 103
- Applebaum, S. B.** Boiler feed water purification. 23, 992
- Archer, R. S.**, and Zay Jeffries. The amorphous metal hypothesis. 697
- Austin, H.** Recovery of volatile solvents by the Bregat process. 816
- BADGER, W. L.** Need of technically trained men in salt manufacture. 442
- Studies in evaporator design—V. 459
- Bain, Edgar C.** Studies of crystal structure with X-rays. 657
- What the X-ray spectrometer tells about the structure of solid solutions. 729
- Bain, Edgar C.**, and Zay Jeffries. Mixed orientation developed in crystals of ductile metals by plastic deformation. 775
- Baker, E. M.**, and V. H. Waite. Boiling point of salt solutions under varying pressures. 1137
- Vapor pressure of the system calcium chloride-water. 1174
- Basset, William R.** The elimination of waste in marketing. 420
- Beckman, J. W.** Ceramics as a byproduct of coal mining in Sweden. 882
- Beilby, Sir George.** Low-temperature carbamazation. 228
- Belaiew, Col. Nickolas T.** The slip interference theory. 584
- Bell, Kenneth E.** The use of inert gas for the prevention of explosions. 729
- Benson, H. K.** Auxiliary electrochemical developments for hydro-electric plants. 1004
- Berry, O. C.** More miles per gallon. 64
- Biesterfeld, Chester H.** Chemical patent claims. 4
- Blair, Campbell & McLean, Ltd.** Regarding solvent recovery process. 904
- Blue, A. A.** On the heat-treatment of aluminum bronze. 1043
- Blum, William**, and Thomas F. Slattery. The electrolytic reproduction of engraved printing plates. 320
- Blum, William.** Structure and properties of alternately electrodeposited metals. 961
- Bogue, R. H.** Outstanding causes of waste in the glue industry. 443
- Brace, P. H.** Notes on the metallurgy of calcium. 105
- Breithut, Frederick E.** Is there an American dye monopoly? 594
- Bridges, Thomas C.** Rhodium for rodents. 4
- Brophy, G. R.**, and W. E. Ruder. Nitrogen in carburized steels. 867, 1036
- Brown, Frederick W.** The tariff on minerals. 5
- Burchenal, Charles D.** An improved type of filter press. 476
- Burdick, Charles A.** The tariff on minerals. 5
- Burpee, George W.** The elimination of construction wastes. 394
- CAMPBELL, W. J.** Spectroscopic examination of converter flame. 618
- Capps, J. H.**, and Robert J. Anderson. Constitution of gas atmospheres in aluminum-alloy melting furnaces. 54
- Note on Schwarz furnace atmosphere when melting complex bronzes. 103
- Chester, J. H.** The waste of the soap industry. 445
- Clapp, Earle H.** The lumber industry—A flagrant waster. 446
- Coates, C. E.** Improvements to be realized in the cane sugar industry. 438
- Coes, H. V.** Material handling as a factor in eliminating industrial waste. 1096
- Coffin, F. P.** Pulverized coal in the iron and steel industry. 971
- Cohoe, Wallace P.** Waste due to lack of standardization of chemicals. 383
- Collins, E. F.** Electrically heated glass-annealing lehrs. 119
- Commentz, Dr. Ing. Carl.** First-hand impressions of the Oppau disaster. 818
- Comstock, George F.** Impact strength of monel metal and aluminum bronze. 816
- Cowan, William A.**, L. D. Simpkins and G. A. Hiers. The electrolytically produced calcium-barium-lead alloys comprising Frary metal. 1181
- Crome, Lester C.** Sulphur in malleable cast iron. 247
- Croswell, V. R.** Wasteful methods of the naval stores industry. 440
- Cruess, W. V.** Technically trained men, the need of the food-preservation industries. 435
- Curme, George O., Jr.** Importance of the olefine gases and their derivatives I. Sources and uses of ethylene and propylene. 907
- Curme, G. O., Jr.**, and H. R. Curme. Importance of the olefine gases and their derivatives II. Diethyl sulphate. 957
- Curme, George O., Jr.** Importance of the olefine gases and their derivatives III. Ethylene dichloride. 999
- Curme, George O., Jr.**, and E. W. Reid. Importance of the olefine gases and their derivatives IV. Isopropanol (isopropyl alcohol). 1049
- Curme, G. O., Jr.**, and C. O. Young. Importance of the olefine gases and their derivatives V. Ethylene chlorhydrin and ethylene oxide. 1091
- Curme, H. R.**, and G. O. Curme, Jr. Importance of the olefine gases and their derivatives II. Diethyl sulphate. 957
- D'AGUIAR, H. D.** Radium production in America. 825
- I. 877
- II. 877
- Dannerth, Frederic.** Air pollution and wastefulness. 104
- d'Arcambal, A. H.** American practice in high-speed steel manufacture. 1097
- Hardness of high-speed steel. 1168
- Note on Mushet steel. 1055
- Various methods for hardening high-speed steel. 1150
- Darling, Elton R.** Refining Chinese bismuth concentrates. 181
- Davidson, Philip**, and William B. Price. Physical tests on sheet nickel silver. 141
- Davis, Joseph D.**, Palmer B. Place and G. S. Scott. Destructive distillation of mixtures of oil and coal. 1131
- Dean, John Godfrey.** Cement industry needs more chemical engineering. 439
- deBlois, L. A.** Reduction of waste through accident prevention. 403
- deFries, H. A.** Electric reduction of iron ores. 193
- Melting fine and sterling silver by electricity. 507
- deGeer, Gerard.** Chicago's relation to the future American steel industry. 325
- Denig, Fred.** The pyrolysis of some hydrocarbons. 751
- deWolf, Philip.** Effect of lightning striking an acid tank. 336
- The wastes caused by carelessness. 433
- Diehlman, George.** Refining Chinese bismuth concentrates. 181
- Donauer, Max.** Uses of industrial enameled equipment. 1015
- Dooley, C. R.** Industrial training and selection of personnel. 692
- Dort, Robert G.** Recovery of volatile solvents by Bregat process. 181
- Dunglinson, Burton.** Evaporation by vapor compression. 246
- Multiple effect evaporation. 110
- EASTERWOOD, H. W.**, William H. Wagaman and T. B. Turley. Briquetting mineral phosphates. 517
- Eisenschiml, Otto.** Wastes in paint and varnish oils. 444
- Ernst, E. S.**, and Jack P. Montgomery. The condensation of water solutions of turtural with aniline. 335
- Estep, Thomas G.** Measuring gases containing water vapor. 329
- FOOTE, HUGH S.** Uranium steels. 789
- Fairlie, Andrew M.** Recent developments in the sulphuric-acid industry. 861
- I. 917
- II. 917
- III. 964
- IV. 1005
- Franks, Arthur J.** Studies in Colorado shale oils. 49, 452, 731, 778
- Frary, Francis C.** Credulochemistry. 773
- French, H. J.** Artificial seasoning of steels. 155
- GALLE, ERNST.** Elements of the super-concentration of nitric acid. 741
- Gathman, Emil.** Sound ingots and rails as a matter of course. 1080
- Gellert, N. H.** Some points in the design of blast-furnace gas cleaners. 287
- Gilligan, F. P.** A notable movement in metallurgical education. 992
- Giolitti, Federico.** Case hardening and oxidation of steel. 312
- Godfrey, Hollis.** The educational waste in industry. 378
- Goodwin, H., Jr.** Chemical industry power and fuel data. 708
- Goodwin, H. M.**, and E. C. Walker, 3rd. The electrolytic oxidation of HCl to perchloric acid. 1093
- Grubb, A. A.**, and U. S. Jamison. Air required in baking cores made with linseed oil. 793
- Guillet, Leon.** Heat-treatment of brass and brasses containing tin. 1009
- Gurevich, Louis J.**, and Jane S. Hromatko. Note on the properties of antimonomial lead. 62
- Gustlin, Wellington.** Legal Notes, 31, 68, 159, 324, 464, 512, 795, 872, 926, 1054
- Wastes in litigation. 423
- HADFIELD, ROBERT S.** Sound ingots and rails as a matter of course. 772
- Hag, Robert Murray.** Some losses as points of the 1921 revenue act. 1139
- Hale, William J.** University research should patent discoveries in their own names. 913
- Hamor, W. A.** Wastes and inefficient practices in the petroleum industry. 441
- Hannan, Frank**, and Abel Woman. Further observations on H in natural waters. 283
- Hardinge, Hawlowe.** The economy of modern grinding methods. 529
- Harrison, Ward.** Elimination of waste in industry due to poor lighting. 497
- Hart, Edward.** Culture in technical education. 452
- Hawley, L. F.** Hardwood distillation in industry. 137
- I. 195
- II. 237
- III. 237
- Hayward, Carle R.** Device for measuring the flow of gases. 5
- Hardness variations in heat-treated steel. 693
- The slip interference theory of the hardening of metals. 181
- Variation of hardness in quenched specimens. 905
- Herlenius, Jonas.** Electric furnaces for silver, gold and metals of low melting point. 454
- Heyn, E.** The slip interference theory of the hardening of metals. 728
- Hiers, G. A.**, William A. Cowan and L. D. Simpkins. The electrolytically produced calcium-barium-lead alloys comprising Frary metal. 1181
- Hill, Claude R.**, Max Y. Seaton and L. C. Stewart. Action of lime in magnesium oxychloride cements. 270
- Hires, J. E.** Eliminating manufacturing wastes with machinery. 410
- Hodson, Frank.** Electric smelting of iron ore. 881
- Holley, C. D.** The relation of the chemical engineer to the manufacture and application of automobile finishes. 573
- Holmes, Edward O., Jr.** Industrial alcohol and prohibition. 93
- Holz, Herman A.** The microscope; its design, construction and applications. 268
- Honda, Kotaro.** On the theory of the hardening of metals. 1001
- Hoots, Paul F.** Studies in Colorado shale oils. 816
- Hopkins, L. B.** The personnel problem: To eliminate the waste of human effort. 385
- Hopkins, L. W.** Setting a recording pyrometer for cold junction temperature. 180
- Howard, James E.** Internal service-strains in steel. 275
- Howe, Harrison E.** The role of research in waste elimination. 379
- Hromatko, Jane S.**, and Louis J. Gurevich. Note on the properties of antimonomial lead. 62
- Huff, Wilbert J.** Corrosion protective action of certain colloidal solutions. 865
- Hunter, Arthur H.** Physical properties of molybdenum steel. 21
- Hyde, Edward P.** Classification of research activities. 948
- IMHOFF, WALLACE G.** Causes of high top heat in the blast furnace. 737
- Ingalls, F. P.** The ideal paint or varnish specification. 395
- Ingram, John C.** Basic technical information needed by the edible oil industry. 438
- JAMISON, U. S.**, and A. A. Grubb. Air required in baking cores made with linseed oil. 793
- Janitzky, E. J.** Influence of mass in heat-treatment. 783
- Jeffries, Zay**, and R. S. Archer. The amorphous metal hypothesis. 697
- Jeffries, Zay**, and Edgar C. Bain. Mixed orientation developed in crystals of ductile metals by plastic deformation. 775
- Johnson, C. M.** Non-magnetic, flame-, acid-, and rust-resisting steel. 905
- Jones, Chester H.** Chemical stoneware manufacture. 289
- Enamel-lined apparatus. 927
- Enamel steel manufacture. 883
- Glimpses of Ohio ceramic industries. 562
- I. 819
- II. 819
- Joyce, C. M.** Chemical control of the process for de-inking paper. 242
- KAVANAGH, JOSEPH T.**, Victor R. Abrams and Charles H. Osmond. Air bubble viscosimeter. 665
- Kelsey, Victor V.** Location as a factor in eliminating industrial waste. 401
- Kendall, James.** Facts and fancies about the Oppau explosion. 949
- Kimball, Dexter S.** Waste due to poor engineering and management. 375

- King, Andrew H. The aging of rubber... 1039
 —The rubber industry learns its lesson... 434
 Kinney, S. P., and G. St. J. Perrott. The use of oil in cleaning coal... 182
 Knight, A. P. Unusual grain growth due to critical strain... 829
 Knight, O. A. What causes slip to halt? 1036
 Krarup, Christian. The successful recovery of potash as a byproduct from cement kilns... 316
 Krynitzy, Col. A. I. Communications with Russian scientists... 992
- L** AIST, FREDERICK. Electrolysis vs. retort smelting for zinc... 754
 Landolt, P. E. Eliminating waste and nuisance in smoke, fume and gas... 428
 Langenberg, F. C. Impact properties of various steels... 910
 Langhammer, A. J. Heat-treatment of high-speed steel cutting tools of intricate design... 30
 Laury, N. A. A new salt cake and hydrochloric acid furnace... 834
 Lawrence, James C. Recovery of volatile solvents by Bregeat process... 93
 —Regarding solvent recovery process... 904
 Liddell, Donald M. More on the tellurides and selenides... 453
 —Note on alloying tellurium with some white metals... 268
 Little, Arthur D. The dependence of the lime industry upon nature and science... 149
 Livermore, F. A. Casting aluminum-zinc alloys... 516
 —Notes on aluminum die-castings... 664
 Lorentz, Marjorie G., and Henry S. Rawdon. Concentrated HCl as metallographic etching reagent for nickel... 955
 —Contrast etching for metallographic specimens... 915
 Lyder, E. E., and Ralph H. McKee. Apparatus for studying thermal decomposition of oil shales... 1100
- M**acDOWELL, CHARLES H. How the fertilizer industry can prevent wastes... 445
 —Science and the coming agriculture... 785
 McAdam, D. J., Jr. The constitution of martensite and troostite... 613
 —Endurance of steel under repeated stresses... 1081
 McKee, Ralph H., and E. E. Lyder. Apparatus for studying thermal decomposition of oil shales... 1100
 McMillan, E. J. A convenient formula for diluting solutions... 206
 Marsh, Kirtland. Setting a recording pyrometer for cold junction temperature... 180
 Matthews, Ralph R. Studies in Colorado shale oils... 452
 Mellor, Ralph. Multiple effect evaporation... 453
 Menge, G. A. Industrial waste of food products... 435
 Merica, Paul O. Calculation of equilibrium in metallurgical reactions... 608
 Minevitch, Joseph R. Scientific relief suggested for Russian chemists... 1037
 Minton, R. H. Production wastes in the ceramic industry... 440
 Mitchell, C. T. The volume of air required in air drying... 1088
 Mock, Harry E. Human waste in industry... 369
 Montgomery, Jack P., and E. S. Ernst. The condensation of water solutions of furfural with aniline... 335
 Murray, Alexander. Hardened rosin and resin esters... 473, 905
 Myers, David Moffat. Elimination of waste in industrial power plants... 413
- N**ELSON, WILLIAM G. Determining factors for the life of a pneumatic tire... 153
 Northrup, E. F. De-gasifying silver with iron block... 904
 Nourse, M. R. Potash in the United States during 1920... 1101
- O**FFICE, LEON R. Laboratory furnace for deformation temperature of refractories... 162
 Olsen, J. C. Air required in baking cores made with linseed oil... 948
 Osmond, Charles H., Victor R. Abrams and Joseph T. Kavanagh. Air bubble viscosimeter... 665
- P**ADGETT, FRED W. The colloid chemistry of petroleum... 189
 Pape, W. H. Explosion of agitator charged with naphtha... 949
 Pascal, Paul. Distillation studies of nitric acid and sulphuric-nitric acid mixtures
 I... 1103
 II... 1145
- Patterson, C. T. Squaring a circle... 1063
 Patterson, Duncan M. Firefoam protection of extra-hazardous risks in manufacturing... 887
 Paulsson, N. A. V. Electric iron and steel plant for Brazil... 1057
 Perrott, G. St. J., and S. P. Kinney. The use of oil in cleaning coal... 182
 Perry, Robert S. Improving the paint and varnish industry... 444
 Pickering, O. W. Determining factors for the life of a pneumatic tire... 268
 Place, Palmer B., Joseph D. Davis and G. S. Scott. Destructive distillation of mixtures of oil and coal... 1131
 Pogue, Joseph E. Preventable losses in petroleum refining... 442
 Poste, Emerson P. Enamelled products research laboratory... 974
 Price, William B., and Philip Davidson. Physical tests on sheet nickel silver... 141
 Prindle, Edwin J. The patent situation... 417
- R**ANSOM, J. H., and C. O. Thieme. Note on alloying tellurium with some white metals... 102
 Rawdon, Henry S., and Marjorie G. Lorentz. Concentrated HCl as metallographic etching reagent for nickel... 955
 —Contrast etching for metallographic specimens... 915
 Reid, E. W., and George O. Curme, Jr. Importance of the olefine gases and their derivatives IV—Isopropanol (isopropyl alcohol)... 1049
 Rhead, Frederick H. Exhibition for the American Ceramic Society... 4
 Richardson, Nicholas. Some considerations on fire waste... 397
 Rogers, D. Paul. Quantitative determination of potash by the spectrum... 161
 Root, Frank J. The lack of team work in the wood-distillation industry... 448
 Rose, Harold J. Comparison of the fusing temperature of coal and coke ash... 141
 Rosenhain, Walter. The hardness of solid solutions... 243
 Roulleux, M. Recovery of volatile solvents by Bregeat process... 181
 Ruder, W. E., and G. R. Brophy. Nitrogen in carburized steels... 867, 1036
 Rue, John D. More pulp per cord of wood —Why not?... 447
- S**T. JOHN, H. M. The constitution of gas atmospheres in aluminum alloy melting furnaces... 452
 Sauveur, Albert. A discussion of the slip interference theory of hardening... 509
 Schlatter, Hugo. The chemistry, manufacture and uses of nitrocellulose... 281
 Scott, G. S., Joseph D. Davis and Palmer B. Place. Destructive distillation of mixtures of oil and coal... 1131
 Scott, Howard. The oxidation of carbon tool steel on heating in air... 72
 Seaton, Max Y., Claude R. Hill and L. C. Stewart. Action of lime in magnesium oxychloride cements... 270
 Seaton, M. Y. Plastic calcined magnesite and oxychloride cements... 233
 Seymour-Jones, Alfred. Physiological and histological studies on flayed skins... 1051
 Seyt, Martin. Heterogeneity in *Canis variegatus*... 92
 —Oxygen research of the Institut de Beauté... 224
 Shenefield, S. Lantz, Frank C. Vilbrandt and James R. Withrow. Sulphate-free sulphites for standard sulphur dioxide solutions... 953
 Sherrill, M. Treatment of acid and alkali burns... 4
 Sherwood, C. M. The manufacture of naval stores from the dead wood of the Southern pines... 994
 Shrader, J. H. Solvent extraction in the vegetable oil industry... 94
 Shreve, R. Norris. Greensand as a source of fertilizer potash... 1056
 Siebenthal, C. E., and A. Stoll. Cadmium in 1920... 29
 Sievers, E. G. Carbon black from natural gas in 1920... 333
 Silverman, Alexander. The training of the glass-works chemist... 332
 Simpkins, L. D., William A. Cowan and G. A. Hiers. The electrolytically produced calcium-barium-lead alloys comprising Fray metal... 1181
 Slattey, Thomas F., and William Blum. The electrolytic reproduction of engraved printing plates... 320
 Smith, W. C. Copper-cadmium wire for electrical transmission... 1178
 Stericker, William. Relation of structure to free alkali in sodium silicate solutions... 61
- Stewart, L. C., Max Y. Seaton and Claude R. Hill. Action of lime in magnesium oxychloride cements... 270
 Stoll, A., and C. E. Siebenthal. Cadmium in 1920... 29
 Styri, Haakon. Slip interference theory of hardening... 313
 Symmes, E. M. The manufacture of nitroglycerine... 831
- T**AYLOR, WILLIAM M. Boiler feed water purification... 640
 Templin, R. L. An extensometer calibrating device... 248
 Tennant, T. R. Efforts to eliminate wastes in the glue industry... 443
 Thau, A. Meters for ammonia liquors... 1062
 Thieme, C. O., and J. H. Ransom. Note on alloying tellurium with some white metals... 102
 Thum, Ernest Edgar. Hammer-welding plant of the Blaw-Knox Co... 747
 —National Tube Co.'s new plant for hammer-welded pipe... 921
 —Welding: Particularly hammer welding... 553
 Tillotson, E. Ward, Jr. Waste in the glass industry... 437
 Tolman, C. P. The engineer's part in industrial safety... 203
 Tolman, L. M. Meat-packing industry contributes too much to fertilizer... 437
 Turley, T. B., William H. Waggaman and H. W. Easterwood. Briquetting mineral phosphates... 517
 Turner, Fred H. Athletics and chemistry... 584
- U**DDEN, J. A. On the discovery of potash in west Texas... 1179
- V**AIL, JAMES G. Silicate of soda in papermaking... 823
 Velguth, W. Improved method of electrolytic etching for microstructure... 567
 Vilbrandt, Frank C., S. Lantz Shenefield and James R. Withrow. Sulphate-free sulphites for standard sulphur dioxide solutions... 953
- W**AGGAMAN, WILLIAM H., H. W. Easterwood and T. B. Turley. Briquetting mineral phosphates... 517
 Waite, V. H., and E. M. Baker. Boiling point of salt solutions under varying pressures... 1137
 Waite, V. H., and E. M. Baker. Vapor pressure of the system calcium chloride-water... 1174
 Walker, E. C., 3rd., and H. M. Goodwin. The electrolytic oxidation of HCl to perchloric acid... 1093
 Walker, K. C. Role of libraries in elimination of waste... 904
 Waltenberg, R. G. Note on notched bar impact tests and toughness of monel metal... 322
 Wesson, Ernest J. Disclosing waste through better cost methods... 389
 Westgren, Dr. Arne. Slip interference theory of the hardening of metals... 641
 White, Edward F. The use of inert gas for the prevention of explosions... 513
 White, Walter P. The latent heats of fusion of nickel and monel metal... 17
 Whitson, Alice I. Determination of available lime in quicklime and hydrated lime... 740
 Wilkinson, H. P., Jr. Determination of volatile matter in coal... 925
 Willkie, H. F. Solvents for cellulose esters... 1186
 Wilson, D. W. Heat balance of a blast-furnace stove... 200
 Wilson, John Arthur. Inefficiency in the leather industry... 436
 Withrow, James R., S. Lantz Shenefield, and Frank C. Vilbrandt. Sulphate-free sulphites for standard sulphur dioxide solutions... 953
 Wolman, Abel, and Frank Hannan. Further observations on pH in natural waters... 502
 Wood, George B. The fine art of lime burning... 705
 Woodward, R. W. Instrument to measure elongation of broken tensile specimens... 756
 —Variation of hardness in quenched specimens... 905
 Wurster, Oscar H. Operation of fatty acid distillation plants... 651
- Y**OUNG, C. O., and G. O. Curme, Jr. Importance of the olefine gases and their derivatives V. Ethylene chlorhydrin and ethylene oxide... 1091
- Z**IMMERLI, F. P. A bibliography and abstracts of chromium steels... 837

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Long-Time Forest Policy

THE paper industry in the United States, covering as it does paper board, newsprint, book, wrapping and many other grades of product, represents a tremendous output both in tonnage and value. A very large percentage of this chemical industry is dependent upon wood-pulp supply as its raw material, and as a consequence is vitally concerned in the forest policy which the nation may adopt. It is estimated that the paper industry uses five and one-half million cords of wood a year, the equivalent of forty to eighty years' growth of timber on a half million acres of forest land. It is easy to see, therefore, why a long-time policy rather than any year-to-year planning is essential.

In this planning three major points require consideration: First, the problem of efficient utilization of the forests which are cut; second, the protection of forests against wasteful attack, either by commercial depredation or forest fire; and third, a reforestation policy that is adequate to the national need.

In many parts of the country there are today lumbering activities which from the chemical point of view are most wasteful. For example, in the neighborhood of Puget Sound the Forest Service believes that the cutting of lumber is accompanied by the waste of much more than enough pulp wood not useful for lumber than would be required for the supply of several good sized pulp mills. If in this territory market for this pulp wood were created by establishment of a modern mill, of say 100 tons per day capacity, it seems certain that more than an adequate supply of wood would be offered at once. This material would come from the forests being cut for lumbering operations where a considerable percentage of the trees is now wasted because they are unsuitable for the local lumber markets, though they are well suited to pulp production if such market were available.

In many other parts of the West there are other possibilities in development of chemical industry for pulp-wood production that are most attractive. For example, in the neighborhood of the forest reserves under the control of the Forest Service the investment for paper production is most effectively minimized by the generous plan which the Forest Service offers to any who require this type of forest supply. Under this scheme it is necessary only to make a deposit on a contract for pulp wood to permit extensive cutting. These deposits are usually \$10,000 each, which will allow cutting to any extent permitted under proper forester control up to the total of the deposit and at any rate that may suit the need of the purchaser. When the first deposit is thus used up it is necessary only to make a second deposit on the contract and thus continue

over a period of years with ample forest reserve assured at a minimum capital investment. Of course in any of these cases the economic factors of the situation must be considered in order to insure commercial success, but the prospects seem most attractive in many circumstances.

The destruction of forests by fire in the territory nearer paper markets is even more alarming than the waste of pulp wood in the West. It is estimated by the Forest Service that these losses amount to over four million acres valued in excess of thirty million dollars per year. The consequence of these forest losses upon the cost of pulp wood and paper is obvious. Adequate protection by co-operation of state and federal authorities is of greatest importance to the industry.

There are also many problems of permanence in this industry which are dependent upon reforestation and maintenance of national forests. These are the problems which require vision for long-time development, but they are just as vital to permanence of investment and adequacy of future supply as any of the others. It is high time that the chemical industries involved should concern themselves with these problems from a chemical point of view, for they have chemical need as well as broad economic significance.

The Permanent Tariff Revision

TARIFF legislation, difficult to frame even under normal conditions, has been complicated by many unusual factors. The domestic industry, suffering under severe depression, asked not only for the restriction of foreign competition, but for legislation which it thought would assist it in recovering and expanding our export trade. Our change from a debtor to a creditor nation and the tremendous obligations of foreign countries which can only be repaid with goods have resulted in an uncertain and unsettled international situation. The measure for the revision of the permanent tariff, which has just been reported by the Ways and Means Committee, must be regarded, therefore, only as the initial attempt at the solution of an extremely perplexing problem.

It is difficult to compare the new bill with former tariff legislation. It has been framed to meet an entirely different situation and it is only natural that its framers have been forced to resort to many new and unusual provisions. Home valuation, retaliatory duties, anti-dumping, and the principles of the bartering tariff, although more or less foreign to our customs practice, have apparently been warranted by the specific conditions confronting our industries.

The chemical schedule of the new bill, which has been given detailed study on other pages of this issue, also

contributes its share of innovations. The special protection demanded by the dye industry has resulted in the proposal of a new form of control, which presumably is calculated to meet the growing opposition to the original licensing scheme. Likewise, potash and the other so-called war minerals have called for unusual treatment.

The reporting of the new bill marks the opening engagement of the impending tariff battle, the outcome of which will be awarded with anxious concern. Rumors are already afloat to the effect that opposing elements are dissatisfied with many of the provisions and that new schedules will have to be written or new compromises effected. The metal schedule particularly was the subject of violent criticism as soon as its contents became known. The entire bill will necessarily be modified before it leaves the House, some of its provisions will be rewritten in the Senate, and, finally, the last minute changes will be made in conference.

Need of Better

Association Machinery

WHEN necessary to increase plant production a manager usually has the choice of installing more machines or removing the present equipment and putting in better machines. In technical association affairs we are nationally in just that situation today. And, unquestionably, *better* association methods and machinery are needed.

Recently in Washington a conference of engineering society representatives considered the problem of some sort of engineering association and engineering club. At once two problems arose: First, how to get cooperation and efficient working together, and, second, how to avoid neglect of the specialties within chemistry and engineering that fully justify separate associations or institutions.

Almost everyone can recall from pre-war days the old association "table of equivalents" jokingly cited in reference to German technical society affairs. This started out by making two persons an association, three associations a federation and so on up until the entire universe was affiliated. This reference to the system, which we might call "a much-machinery system," points clearly to the evil of creating a new organization or club every time there is some rather new function to perform. The result obviously is only more wheels and charts of relationships, all of which consume much time and energy and give but little in compensating results.

For local affiliations such as proposed in Washington there is one scheme which really has worked. This provides a local office with a secretary from which are sent out common notices to the mailing list of all the affiliated bodies. Thus all members of all societies are reached regularly with notice of every activity in which they may be interested. It is to be hoped that some similar scheme may be evolved for Washington and that it will succeed as well there as it has in Cleveland, Buffalo and elsewhere. In fact it is to be hoped that Washington will add new variations or create a new scheme of this sort that is even better than those yet reached. Engineers and chemists are much too busy persons to welcome more societies or more affiliations of societies if they do not replace rather than supplement the present. Better association machinery is certainly all we need, not more associations.

Other Views on

The Mineral Tariffs

MARC PAWL'S article on the mineral tariffs has elicited some comments from our readers, which we are pleased to print on another page of this issue. At the outset, however, we must admit that we are disappointed because our correspondents have, for the most part, ignored the broader questions of conservation and national policy and have confined their views to the purely tariff issues presented by the individual minerals in which they are interested. We are glad to learn, for instance, that with scientific methods our crucible makers can use Alabama graphite to better advantage than the Ceylonese product, although this does not exactly confirm the reported experience of the twelve manufacturers who opposed the tariff on graphite at the hearings last February. "Searles Lake would keep us going at the present rate of consumption [of potash] for 75 or 100 years and doubtless by that time our chemists will be making potash out of soda." We don't want to discourage our potash alchemists, but might they not better divert their energy toward finding a cheaper means of transporting the Searles Lake product to its South Atlantic market?

But all that this proves is that the tariff still is, and probably always will be, a fruitful source of controversy.

Expecting Arrest

Or Protection?

ONE of our most prominent citizens recently remarked that industry long has regarded the Government as a policeman rather than as a friend. No doubt much of industry has taken this attitude—to what extent because it had a guilty conscience is worth considering.

If you drive your automobile up to a street intersection at forty-five miles per hour, which is above speed limits even in New York City and Los Angeles, our two coast cities of greatest speed and size, what would you expect of the officer at the "Stop-Go" semaphore? For our part we should expect that you would get a summons in next day's mail, if you were not more promptly invited to join an officer in a ride to the nearest precinct station. On the other hand, driving up with the car under control, with cut-out closed and if necessary making a stop before reaching the sidewalk line, you properly expect, and you get, a courteous signal from the officer for a *protected* crossing of the intersecting street.

The Secretary of Commerce is calling group conferences from industry to meet with him and his principal assistants to discuss statistics, standardization and simplification, and other basic matters of commerce and industry. It is a question how he shall be approached by industrial representatives. It is economic traffic which he desires to protect and direct; and the economics of this traffic, therefore, must be considered.

Chemicals, iron and steel, non-ferrous metals, rubber, textiles and all the other groups of products from chemically-controlled industry will in time receive attention. If they approach the crossing within the economic speed limit, they will obtain from the worthy Secretary and the capable associates whom he is gathering about him economic signals invaluable to their traffic movement. It is not a blustering, red-faced, bull-necked officer that they are to deal with. It is a courteous guard of business movement who knows more in many cases than industry itself about how each part of industry should move for-

the safety and speed of all. An approach in this spirit by industry will facilitate getting of much-needed governmental advice.

The comparison must not be pressed too far, however. If we disobey the traffic officer at the corner, more than likely we shall be "pinched." Almost certainly the least we get is a publicly administered reproof. In dealing with the Department of Commerce, however, it will be only advice and guidance of the most friendly sort that will be furnished. The decision as to whether industry will "stop" or "go" will remain with the business executive, where it belongs under our system of government. On behalf of the Department of Commerce therefore, and in the interest of business itself, let us hope for and insist upon a relationship of co-operation; and let us put aside fear of the Government, the old-fashioned bogey of our national industrial childhood. Certainly it would seem that industry had long since outgrown it.

The Return of Industrial Activity

IT IS quite clear that for a return of industrial activity we require something more than removal of the causes that produced the depression. Roughly speaking, the case is analogous to a patient suffering from a germ disease. Complete recovery does not instantly follow disappearance of the germs. The patient must convalesce, or get over the results of the disease. On this account we must not pin too much faith to "deflation" or insist that when certain commodity prices have come down others must come down by similar amounts before business can be ready to go forward.

Perhaps, indeed, we have been a little too critical about prices. The idea is right, but almost anything can be carried too far. Some months ago a common thought was that prices would have to get down to a certain relation to pre-war levels, the chief question being what that relation should be. As certain commodities declined we were disposed to take them as standard and expect other commodities to do likewise. No longer can we hold to any such doctrine. There is zinc, for instance. It is not down to its pre-war average. It is 8 per cent below its lowest in the five years before the war.

Nor can we follow what might be called a corollary to the theory that price deflation by itself will remove the industrial depression, that the commodities that first get down to the proper price level will first become active, for in many cases it is an especially light demand that has forced one commodity or another to a particularly low price, relative to the general average.

Now that we have before us recovery from the influences of depression as well as from the causes of depression, demand or activity is not going to revive by commodities, but rather by classes of consumption. To illustrate concretely, both nails and lumber are used in dwelling house construction and in making boxes for the shipments of a wide variety of merchandise. If lumber came down and nails stayed up, we ought not to expect the demand for lumber to become heavy, with the demand for nails remaining light.

Throughout the country there has been underbuying for months. No doubt this started by "a strike of buyers," but it has gone beyond a voluntary act, for with so much unemployment and so much reduction in wages and salaries the power to buy has been greatly reduced. Few can now buy what they would like to have. What people will buy first will be the things they need most and, to an extent, what they think are the better invest-

ments, preference being given where possible to commodities that seem the cheapest. The things that wear out the most rapidly or are most useful will experience the first revival in demand.

Obviously the beginning of industrial revival will not be in construction work. That is something that can most readily be postponed. The common everyday commodities, things that have only a short life at best, will be bought first. Then there will be more employment, increased buying power and a further increase in buying. The steel industry, for instance, which is now running at 20 per cent or less of capacity, or at a lower rate than is necessary merely to take care of the country's wear and tear, will find its first revival in demand not in steel for construction work, but in steel for restoring the wear and tear on railroads, the replacement of tools and agricultural implements, and in channels of that general description. The most unlikely thing is that industrial revival will begin with a "building boom."

Talking in Large Figures

IN 1914 the Census of Manufactures reported the total value of manufactured products as 24 billion dollars. The preliminary summary of the 1919 census gives a corresponding figure for all industries of 60 billion dollars, an increase to 250 per cent of the previous value. These numbers are rather too big to digest as a whole, and therefore it is worth while to pick them to pieces and see what they really mean.

It would not be at all reasonable to assume that the American people were producing and using or exporting two and one-half times as much in manufactured commodities in 1919 as they did five years before. Everyone knows that the value of a dollar as measured by commodity in the later year was much less than in the earlier and that corresponding change in the so-called "value" of the manufactured products appears in these summaries. It is perhaps fair to assume that the index number for 1919 was 215 on a basis of 100 for 1914. In any event authorities on this subject disagree sufficiently so that this is as good an estimate as one can be sure of. If we divide 250 per cent by 215 per cent we get a result which is really representative of the ratio of commodity in the latter year to commodity in the former. By such division one can arrive at the conclusion that about 115 per cent as much of manufactured goods was produced in the country in 1919 as in 1914.

During the same period of five years we may assume that the population changed by about half as much as during the time between the census years 1910 and 1920, or in other words there was perhaps a 6 or 7 per cent increase in population. This change in population should be compared with the change in manufactured goods.

The standard of living of a country may be measured by the quantity of manufactured goods used per capita. This is by no means the only unit, but it is certainly one of significance. For such measurement it is necessary only to compare the 115 per cent in goods with 107 per cent in population. Thus we can safely conclude that there was by and large through the country an increase in the American standard of living. To say that it amounted to 6, 7 or 8 per cent according to just how one figures would be improper, for standards of this sort cannot be measured exactly in percentage.

Readers' Views and Comments

Chemical Patent Claims

To the Editor of Chemical & Metallurgical Engineering

SIR:—With reference to my article published in CHEMICAL & METALLURGICAL ENGINEERING May 18, 1921, pages 883-4, relating to the case of Miami Copper Co. vs. Minerals Separation Co., it has come to my attention that some readers have construed this paragraph as referring to the Callow cell. It was not intended to convey any such impression; the court found infringement in three previous steps of the process, including the Pachuca tank in which agitation was caused by the air-lift effect.

CHESTER H. BIESTERFELD.

Rhodium From Rodents

To the Editor of Chemical & Metallurgical Engineering

SIR:—Here is the claimant for your "Flor de Convolvulus Scoparius."

Do you know you gave me a very bad five minutes, being the interval between the time that I read your comment on my "rhodium" article and that required to get at the "Encyl. Britt." It was not that I was not well acquainted with oil of rhodium as a rat bait, but that a horrible suspicion seized me that I had spelled it wrong and that the plant might be rodium without the "h."

Your apology is most handsome so we will shake hands (across the sea) and part good friends.

Princetown, England.

THOMAS C. BRIDGES.

Exhibition for the American Ceramic Society

To the Editor of Chemical & Metallurgical Engineering

SIR:—Referring to the editorial in your May 25 issue, in which you suggest an exhibition for the American Ceramic Society, you might be interested to know that the Art Division is working on a program which will assure the periodical exhibition of ceramic wares under conditions most favorable to each class of product.

Many members of the American Ceramic Society are also members of other organizations such as the Architectural League, National Academy, the National Woman's Painters and Sculptors, etc., and ideas dealing with the development and exhibition of artistic wares are being given serious consideration by these bodies.

An exhibition embodying anything like a representative collection of present-day domestic ceramic wares will be a rather large undertaking, and it is not expected that the first exhibition will do more than demonstrate the possibilities of a comprehensive show to every interest and activity in the ceramic field.

Without taking into consideration the many types of utilitarian and ornamental wares produced in this country, all of which should be shown in their respective groups, we have three classes of productive work, each one a powerful influence and force especially when their activities are co-ordinated, which is unfortunately not the case at this time, although serious efforts are being made to bring these forces together.

These three classes are: Factory production, studio production and school production. As the American Ceramic Society exhibitions are intended to be primarily educational in character, every effort will be made to show typical examples of all three classes.

While, as stated, these three active interests are working independently, often unsympathetically, and rarely possessing an appreciation and understanding of the importance and value of the others, there is happily a greater general interest in the development of artistic pottery and architectural faience than is often admitted by those who are too close to their respective activities to possess a true perspective. The Apprentice Schools of Design, the Art Alliance of America and many other organizations are actively interested. The press is giving due recognition to the need for development in ceramic art work. Your own valuable publication has been most liberal in this respect.

All of this goes to show that rational co-operative action among the interests mentioned is all that is needed to bring results, and this is the end toward which the Art Division is working.

Zanesville, Ohio.

FREDERICK H. RHEAD,
Chairman Art Division.

Treatment of Acid and Alkali Burns

To the Editor of Chemical & Metallurgical Engineering

SIR:—In regard to question of acid and alkali burns, published in your April 27, 1921, issue, may I state that in the Steffens department of beet sugar mills a rather painful burn is often experienced due to calcium saccharate? It has been my experience and observation that this unstable substance does not attack healthy, unbroken skin at all; but let there be the least contusion, scratch or friction from coat cuff or shoe, and there is trouble. The first stage is a redness with itching, which unless stopped passes to a peeling of the skin at various minute points. In these two stages a not too dilute acid will stop all further action. The third stage, which generally takes thirty minutes or longer to appear, is a number of small discolored, painless spots which are a true burn with tissue destruction. Unless drastic treatment is used here these burns will spread, grow and may run together to a very painful, sickly gray, sunken sore by the next day. I have seen them grow over night from almost unnoticeable points to the size of quarters.

In sugar mills accident cases are cared for in the laboratory. In one such laboratory the custom is to pour on rather concentrated acetic acid and make the workman walk across the laboratory before being allowed to wash off the acid. He is then stuck up with surgeon's tape and the result is generally successful. I prefer the more drastic, more painful, but absolutely certain treatment of using commercial HCl direct from carboy and leaving it on the burn till all effervescence (from the CaO) ceases, then washing well with water and soda and wiping with oiled rags. Burns then heal up in short order.

When one gets the saccharate in the eye it should be washed copiously with water—if none is handy, use

spittle—treat with weak acetic acid at once, and put in a few drops of olive or other equivalent oil. This stuff often slakes with mild explosion when in presence of hot water.

I am told that the barium saccharate is even nastier to handle from standpoint of burns.

Fort Morgan, Col.

M. SHERRILL.

Device for Measuring the Flow of Gases

To the Editor of Chemical & Metallurgical Engineering

SIR:—I noted with interest the comments by Messrs. Knowland, Donaldson and McCollum in your June 1 issue in reference to my paper "A Device for Measuring the Flow of Gases," appearing in your May 4 issue. It is possibly true, as pointed out, that my paper was misleading because it did not mention the corrections which should be applied in using the instrument calibrated with air. The object of my paper was merely to suggest the use of pipe fittings for building a measuring device. I pointed out that the principle was well known and therefore did not discuss it in detail. I am accustomed to make the corrections suggested, which are, of course, obvious, and I am sorry if anyone has been led to believe that the apparatus could be used without correcting the air calibration curve. The molecular weights of the gases that I have used are known and the corrections easily applied; with some gases it might be more difficult.

CARLE R. HAYWARD.

Mass. Inst. of Technology,
Cambridge, Mass.

The Tariff on Minerals

To the Editor of Chemical & Metallurgical Engineering

SIR:—In the article "The Tariff on Minerals," by Marc Pawl, in the June 8 number of CHEMICAL & METALLURGICAL ENGINEERING is included a paragraph on potash. It is unfortunate that the author did not take the trouble to get the facts before committing himself in writing. But facts do not always fit satisfactorily into a preconceived argument.

For example: Mr. Pawl makes the statement, "There is no likelihood of our being able to supply our needs from these sources" (natural brines). On the contrary, nothing is more likely. If the future of the industry is secured by adequate tariff protection, it would be easily possible for us to supply our needs from Searles Lake or Salduro Marsh alone inside of, say, two years. The potash is there and the methods of recovery are known. All that is needed is the capital to finance the plants, and this will quickly be forthcoming as soon as the future of the industry is reasonably secure. Searles Lake would keep us going at the present rate of consumption for seventy-five or a hundred years, and doubtless before that time our chemists will be making potash out of soda or some other element. But if they haven't accomplished this yet, we can start in on Salduro Marsh and run along for another century.

It is unfortunately true, as Mr. Pawl says, that we are still dependent on the German and French deposits for a large part of our potash, but there is no more reason for it than there was for our dependence on Great Britain for our tin-plate thirty years ago. If we had lacked the sense to protect our tin-plate people for a time, we should still be importing tin-plate instead of underselling the British in their own markets.

Mr. Pawl makes the statement that the proposed

tariff will add 75 per cent to the cost of potash. He does not mention the base upon which he figures his 75 per cent. . . . By some arithmetical gymnastics it is possible to figure the increase all the way from 20 per cent to 66 $\frac{2}{3}$ per cent, but to get up to Mr. Pawl's 75 per cent one must abandon facts and imagine a price which never was.

Finally, Mr. Pawl calls attention pathetically to the fact that the farmer will pay the increase. He fails to show that the proposed tariff will lay the appalling burden on the cotton farmer of not to exceed 30c. per acre. It will increase the cost of tobacco growing by the terrifying sum of less than three-tenths of one cent per pound. It will inflict on the potato farmer the frightful load of two or three cents additional cost per bushel.

Laying aside sarcasm, it is perfectly true that the farmer has his troubles and always will have until weather is made to order, bugs and plant diseases sent the way of the dodo and the Tasmanian, and marketing made a dead certainty. One of the American farmer's chief troubles in recent years has been the fact that he was so largely dependent on European sources for his potash. A small tariff for a temporary period will relieve him of this burden and at the same time enable the country to develop a new and important source of wealth and prosperity. In these circumstances, Mr. Pawl should shunt his pathos into some other channel and make an effort to help the good work instead of hinder it.

U. S. POTASH PRODUCERS' ASSOCIATION.

BY FREDERICK W. BROWN, Secretary.

Washington, D. C.

To the Editor of Chemical & Metallurgical Engineering

SIR:—I feel that if Marc Pawl is as poorly informed concerning other minerals as he is regarding flake graphite he should not be allowed the space in your valuable journal for his propaganda.¹

Mr. Pawl probably does not know that American business men have invested approximately \$6,000,000 in the development of Alabama graphite deposits alone; that Alabama could supply all the crucible stock and other flake graphite products required in the United States for years; that the quality of Alabama graphite is so much superior to Madagascar that the Quenelda Graphite Corporation, Liveville, Ala., was able to sell No. 2 flake graphite (second grade flake) in the open market at the same price as the No. 1 Madagascar graphite sold at during October, 1920.

Furthermore, Mr. Pawl probably does not know that the Bureau of Mines, U. S. A., under the direction of Mr. Stull of Pittsburgh, has proved that Alabama graphite can be used to better advantage in the manufacture of crucibles than Ceylon lump graphite, provided the manufacturer uses scientific methods in selecting and mixing his fireclay.

While Mr. Pawl is trying to protect the foreign investments of Americans, let him not forget the investments of Americans in American industries, without which we would have lost the European war.

Imports and exports are so much discussed these days that few people realize that these are only a small fraction of the total business of the country.

New York City.

CHARLES A. BURDICK.

¹EDITOR'S NOTE.—We do not regard Mr. Pawl's paper as propaganda, but rather as an unusual and interesting viewpoint of our mineral industries.



GRAND CIRCUS PARK IN THE HEART OF THE BUSINESS DISTRICT OF DETROIT

The Detroit Meeting of the American Institute of Chemical Engineers

Relation of the Chemical Engineer to the Automotive Industries Is the Keynote of the Summer Meeting—Papers Stress Metallurgy, Automobile Tires, Paint and Fuel—Excursions to Ann Arbor and Salt Mines at St. Clair

THE American Institute of Chemical Engineers met in Detroit, June 20 to 25, for the thirtieth semi-annual meeting. An enterprising local committee under the leadership of Chairman C. T. Bragg provided a week of pleasant and profitable entertainment and extended to the Institute the gracious hospitality of their busy and beautiful city. The well-rounded program included such interesting diversions as boat rides, dinner dances, banquets and barbecues. In addition to the usual business sessions there were excursions to the University of Michigan at Ann Arbor, and to the great salt mines at St. Clair. Many of the famous automobile factories and important chemical plants in the vicinity of Detroit were also visited by the chemical engineers.

The entertainment of the wives and feminine guests of members of the Institute was in the hands of a special committee under the direction of Miss Sarah Burnham of Detroit. The ladies' program substituted afternoon teas and shopping tours for the business sessions and plant inspections, but fortunately the programs converged for the dances and similar festivities.

REPORT OF COMMITTEE ON EDUCATION

The New York members of the Institute and their friends arrived in Detroit Monday morning after a boat trip up the Hudson to Albany and across Lake Erie from Buffalo. Immediately following their arrival President David Wesson called to order the first business session. The Institute was officially welcomed to the city of Detroit in a brief talk by John C. McCabe, research engineer for the city and personal representative of the mayor. Reports of the Council, the secretary and treasurer were then read by the secretary, J. C. Olsen. Dr. A. D. Little, chairman of the committee on chemical engineering education, presented as a progress report of his committee the tabulated results of the survey of chemical engineering courses in the principal universities and colleges of the United States. These tables, which had been

printed in a previous issue¹ of CHEMICAL & METALLURGICAL ENGINEERING, were used as the basis of an interesting discussion.

Dr. Little called attention to the great diversity of subjects included in 278 different courses offered by the institutions and pointed out the evident need for a certain amount of standardization. Other features of the report were the difference in the weighting of the various courses and the tendencies toward specialized instruction by certain universities, such, for example, as the courses in sugar at Louisiana, pulp and paper at Maine, and coal and ceramics at Illinois.

An interesting tabulation made by the committee showed that in ten important institutions the time devoted to chemistry lectures varied from 240 to 1,288 hours, with an average of 650 hours. The laboratory work ranged between 482 and 2,144 hours and the average was 1,148. Similar differences in requirements were shown to exist for the courses in physics, mathematics, mechanics and engineering. Additional charts and summaries are to be printed in the final report of the committee and the hope was expressed by Dr. Little that his committee might have the continued co-operation of the Institute in its study of this important subject.

FAVORS WORKING CLAUSE IN PATENT LAW

A report from the chairman of the committee on patents was read by the secretary and led to a discussion of the recent proposals to incorporate a working clause in the patent law. Henry Howard, who spoke in favor of such legislation, declared that the dye industry in this country had been throttled by the absence of a requirement for compulsory working of patents. Following other discussion, both favoring and opposing the working clause, a committee was appointed, with Mr. Howard as chairman, and was instructed to draft resolutions to Congress. These resolutions, presented and passed in a later meeting

¹CHEM. & MET. ENG., vol. 24, pp. 1047-53, June 15, 1921.

of the Institute, recommended the passage of a law similar to the British compulsory working act of 1907.

CHEMICAL ENGINEERING IN PAINT INDUSTRY

Dr. C. D. Holley, director of research for the Acme White Lead & Color Works, presented the first technical paper, which was an interesting account of "the manufacture and application of automobile finishes." Notwithstanding the fact that less chemical engineering has been devoted to the paint and varnish industry than to any of the other modern industries of similar magnitude, there are nevertheless certain engineering features worthy of mention. In many instances these developments from an engineering standpoint are directly attributable to the influence of the automobile industry, especially as related to quantity production.

FUME COLLECTION

One problem in the manufacture of varnishes which the chemical engineer has helped to solve has been the efficient collection and recovery of fumes.

"From 10 to 25 per cent of the weight of the varnish gums used is driven off in the melting of the gums. These products of decomposition pass up the varnish stacks and are disseminated in the air in quantities that sometimes reach several thousand pounds daily.

"This has necessitated the installation of an efficient fume control system whereby these fumes can be condensed as they leave the kettles or can be made to enter into a chemical combination and thereby be eliminated. This has required some really ingenious chemical engineering practice, as the problem was not an easy one to solve because of the physical and chemical nature of the fumes and the fact that the gums are 'run' in the varnish kettles at nearly their flash point and any undue disturbance in the equilibrium of the gases in the kettle often means a bad fire. These installations have proved quite successful, affording usable byproducts and in several instances have permitted a 50 per cent reduction in insurance premiums in addition to allowing the varnish maker to continue manufacture undisturbed by the authorities."

PYROXYLIN ARTIFICIAL LEATHER

Dr. G. C. Given described the manufacture of pyroxylin artificial leather. He pointed out that the enormous requirements of the automobile and furniture industries have greatly stimulated the manufacture of leather substitutes. The production of adequate quantities of satisfactory upholstery material has resulted in an industry in which there are now fourteen factories with a total invested capital in excess of \$50,000,000.

Of the three general types of leather substitutes—viz., vulcanized oils, rubber and pyroxylin—the last named is probably used in the largest quantity. In the manufacture of artificial leather from pyroxylin, the fabric is dyed and properly dried, and is then coated with a "dope" composed of special nitrocellulose, oil, solvent and pigment. This is spread on the cloth in successive thin coats numbering from five to fifteen, according to the quality desired. After the fabric has received the requisite quantity of coating, the product is passed into embossing machines which impress on the pyroxylin compound a grain resembling that of high-grade leather. For the production of the best qualities of artificial leather the embossed goods are



SCENE ON THE RIVER AT BELLE ISLE

finished by hand in order to obtain the artistic effects of old Spanish leather.

MONEL METAL

William M. Corse presented a paper on the properties and uses of Monel metal. This comparatively new and valuable alloy was originated in 1905 and was named after the late president of the International Nickel Co., Ambrose Monell. It is obtained from a nickel-copper ore of the Sudbury district, Ontario, and the metals in the finished alloy are in approximately the same proportion to one another as when found in nature. A typical analysis of the matte shows 67 per cent of nickel, 25 per cent of copper and 5 per cent of other metals, principally iron, manganese and silicon.

Mr. Corse indicated the principal uses of Monel metal in the automobile industry. Its silvery-white color, resistance to wear and the ease with which it is polished have made it a valuable material for door and brake handles, and for various dash trimmings. It has also been used satisfactorily in exhaust valves, spark-plug electrodes, and in float and needle valves for carburetors.

ANN ARBOR EXCURSION

One of the outstanding features of the Detroit meeting was the day spent at Ann Arbor as the guests of the University of Michigan. The trip was made from Detroit in special electric cars which arrived at Ann Arbor about the middle of the forenoon. The remainder of the morning was occupied in the inspection of the laboratories and buildings of the university. A pleasant half hour was spent in Hill auditorium, where Prof. Earl R. Moore gave an excellent organ recital. Luncheon was served in the Michigan Union building, which is a magnificent clubhouse erected on the campus by student and alumni organizations. President M. L. Burton of the university, in a short talk after the luncheon, emphasized the value of the present dual system of education and declared that the tax-supported universities of the West should receive the same recognition accorded the privately-endowed institutions of the East.

SOME CHEMICAL ENGINEERING IDEALS

Dr. David Wesson, in his presidential address, stressed the important work with which the Institute is connected and indicated the possibilities for future accomplishments. Dr. Wesson chose for his subject "Some Chemical Engineering Ideals" and said, in part, as follows:

"Painted on the wall of the library of the National



HILL AUDITORIUM AT ANN ARBOR

Engineering Societies' Building in New York is the following definition:

Engineering — the art of organizing and directing men and controlling the forces and materials of nature for the benefit of the human race.

"This definition is a very broad one and seems particularly adapted to defining the activities of the chemical engineers. It is a definition which arouses pride in our profession, for it indicates that the object of our profession is service—service for the benefit of our fellow beings.

"A glance through the list of members of our Institute will show that they are engaged in producing thousands of products which go to improve living conditions and at the same time provide means of earning a livelihood for multitudes. As an example, take the cottonseed oil industry alone. I mention it because it is the one with which I am most familiar. It gives employment in this country to 20,000 factory hands and 5,000 officers and salaried men, and all based on chemical engineering in developing the oil of a once despised waste product into valuable human food.

"Similar results are happening daily in other industries where the chemical engineer has had the opportunity to apply his knowledge. We see them in the field of metallurgy, fuel, mineral oils, tar, coloring matters and dyes, fiber products and paper, alkali acids and salts, glass and ceramics, building materials, paints, varnishes, india rubber, leather, glue, fertilizers, sugars and starches, foods and all sorts of organic products, photographic materials and explosives.

"The choice of the automobile as the keynote for the papers at this meeting is a particularly happy one. It is hard to conceive of any human production which embodies so many materials in its make-up as does this distance-destroying instrument of transportation. The papers read at this meeting will point out fully the part which the chemical engineer plays in making possible this modern means of travel.

"The automobile might well be taken as a symbol of the Institute. The industry started in a small way, and in twenty years has grown to world-wide importance. In the same way our Institute, starting modestly thirteen years ago, is rapidly growing into a national factor of economic and industrial importance.

"The first automobiles were built for pleasure

vehicles, and the industry was built up chiefly along the line of replacing the horse-drawn carriage. Now we see motor trucks displacing the dray and delivery wagon and competing with the railroad in the moving of merchandise. In the same way the Institute started out largely on an excursion, if not a joy-ride basis, but the responsibilities of the world war and the difficult reconstruction period which we are passing through have brought home to us all the idea that the Institute fulfills its highest ideals when it is rendering service to the profession and taking its part in national activities."

CHEMISTRY OF ROAD BUILDING

The relation of the chemical engineer to highway engineering was the subject of an instructive lecture by Prof. A. H. Blanchard of the University of Michigan. He declared that the status of the chemistry of highway materials is in a chaotic condition notwithstanding the fact that some work has been accomplished by federal, state and municipal laboratories. There is a promising field for the chemical engineer who can co-operate with the highway engineer in studying the physical and chemical properties of highway materials. The application of tar on asphaltum is an example of the faulty use of materials due to lack of knowledge of the properties of the two constituents. On the other hand, certain combinations of these materials have been successfully applied, but the need here is for the chemical engineer to supply the explanation. Before these combinations can be bought on specifications the chemist must devise more satisfactory tests and methods of analysis.

PROBLEMS IN NON-FERROUS METALLURGY

J. H. Ransom of the Michigan Smelting & Refining Co. read a paper entitled "Some Problems in Non-Ferrous Metallurgy." He laid emphasis on the fact that commercial metals are by no means 100 per cent pure, and the so-called "impurities," which as a matter of fact are mostly normal constituents, are likely to affect the resulting properties profoundly. In some cases alloying and remelting add to the total beyond that limited by safety, with the result that the metal becomes worthless. A probable case in point is the intercrystalline brittleness of lead, due to impurities segregated between the metallic crystalline grains. A



MICHIGAN UNION BUILDING

recently studied alloy of copper with about 15 per cent of nickel is also prone to this defect.

Minute amounts of unusual constituents often have a wholly disproportionate influence on the color, luster or "set" of an ingot, with a corresponding effect on its market value; inherently the metal may be undamaged. This effect had been studied carefully by the speaker, who concludes that changes in surface colors and other physical properties caused by a single additional element are usually characteristic and easily recognized. A combination of two or more impurities often causes greater perturbations than the same quantity of a single one, but in a few cases it was found that one addition counteracted a previous one. In general non-metals are more harmful than metals.

THE MOTOR FUEL PROBLEM

Prof. E. H. Leslie had prepared an exhaustive treatise on "The Motor Fuel Situation," but because of limited time, the paper was read only by title. Some of its salient features are reproduced here, however, as being of general interest.

"The motor fuel problem is one of the great problems of the present day. The solution demands readjustment and development in the petroleum and related industries, and in the automotive industries. Many of the problems are distinctly within the province of the chemical engineer.

"The consumption of gasoline is now nearly five billion gallons annually, and may be expected to increase to seven billion gallons. The United States produces two-thirds of the world's crude oil, but uses four-fifths of it. Our reserve supply below ground is 5,800,000,000 bbl., which, at a rate of production equal to that of 1920, would last only thirteen years. We are now dependent upon foreign crude oils, and are importing more crude oil than our combined exports of petroleum and its products.

"We cannot expect a further rapid expansion of the natural gas gasoline industry, nor can the distillation range of gasoline be further materially increased. Chemical research must point the way toward success in utilization of the heavier distillates as motor fuels.

"The most important single technical problem is the cracking of the heavier 40 to 50 per cent of petroleum, known as fuel oil or residuum. Processes now in use handle only the middle distillates.

"The use of aromatic distillates as fuel will never be of great consequence. Development of an alcohol industry based on wood as a raw material, and of a shale-oil industry, may be expected. Both are tremendous undertakings, and should not be expected to develop rapidly.

CRITICAL STUDY OF BOILING POINTS

Prof. E. M. Baker reported the results of some of the work growing out of the investigations of evaporator design which are being conducted in the laboratories of the University of Michigan. These investigations have emphasized the importance of a knowledge of the boiling points of solutions under reduced pressures. Mr. Baker and his associates have developed an apparatus capable of maintaining a reduced pressure constant at within 0.1 to 0.2 mm., and with this apparatus it has been possible to increase the accuracy of the boiling-point determinations to a greater degree than is required for any technical purpose.

They have made a critical study of boiling-point data and have found a general law which apparently holds rigidly for both concentrated and dilute solutions of all types, provided these solutions are not saturated and provided the dissolved substance does not itself exert an appreciable vapor pressure. This law is expressed by

the equation $K = \frac{t_1 - t_2}{\theta_1 - \theta_2}$ where t_1 is the temperature

at which a certain solution would boil at some pressure p_1 , and θ_1 is the temperature at which water would boil at this same pressure. Likewise, t_2 and θ_2 are respectively the temperatures at which the same solution and water would boil at a different pressure, p_2 . K is a constant for any given solution. Graphically, if the temperature of the solution is plotted as ordinates and the temperature at which water boils under the same pressure is plotted as abscissæ, the points for each solution will be on a straight line. This line represents the data for each solution more closely than any other smooth curve that can be drawn.

To illustrate how the law may be of assistance to the engineer concerned with evaporation and similar problems, we may assume that the temperatures at which a given solution will boil at two different pressures are known. Then the rule can be used to interpolate or extrapolate these data to other pressures, and the results will be as accurate as the original determinations. Thus the labor of investigating the boiling points of solutions under various pressures will be materially shortened.

The second paper, by Prof. Baker and V. H. Waite, presented the results of a critical study of the values given in the literature for the boiling points of calcium chloride solutions, supplemented by determinations using the law discussed in the previous paper.

SYNTHETIC AMMONIA PLANTS

The German and American synthetic ammonia plants were compared in an able manner by R. S. Tour, chemical engineer for the Nitrate Division of the Ordnance Department. The speaker was a member of the U. S. Fixed Nitrogen Commission, which inspected the German installations during the summer of 1919, and his paper showed the results of a very thorough investigation. The German plants studied were those at Oppau and Merseburg. Both were designed and built by the Badische Anilin und Soda Fabrik; the Oppau plant had a rated annual capacity of 100,000 metric tons of ammonia and the capacity of the Merseburg plant was 200,000 tons per year. The American plant at Sheffield, Ala., was rated at 10,000 short tons of ammonia.

The methods of operation and the types of equipment were compared by Mr. Tour, who also explained the details of the manufacture of the hydrogen and nitrogen required for the synthesis. The many interesting engineering applications need not be described here, since the complete paper will be published in a later issue of this magazine.

COSTS OF PRODUCTION

The consideration of costs has an important bearing on the synthetic process. The investment in the Oppau plant figured on the actual pre-war cost was estimated at \$270 per annual short ton of ammonia capacity or, roughly, \$100,000 per daily ton. The Merseburg plant, started during 1916, cost at least 50

per cent more, and by 1918 the costs of its construction had increased 150 per cent over the 1914 figure. (Investment per annual short ton of ammonia: 1914, \$270; 1916, \$400; 1918, \$700.)

The total cost of producing ammonia at the Oppau plant in 1914 was estimated to be 5.364 cents per pound. This figure was made up of the following items:

	Per Short Ton
Labor and operating	\$10.27
Fuel	18.00
Plant upkeep	43.66
General works expense	10.80
Fixed charges (interest, insurance, etc.)	24.55
Total cost per ton.....	\$107.28
Total cost per pound, \$0.05364	

VIEWPOINTS ON THE NITROGEN SITUATION

In summarizing the nitrogen situation Mr. Tour said:

"The true aspects of the problem are beclouded by the difference in viewpoint of those following or aiding its development. The research chemist realizes that the chemical problems are of the simplest nature except for the final step of the catalysis of hydrogen and nitrogen to synthesize ammonia. The designing engineer, on the other hand, feels that the development of a catalyst is a specific laboratory problem with which the research chemist is properly equipped to cope, but that the design of dependable equipment to operate at high pressures with temperatures at times approaching a red heat and with gases or liquids sometimes corrosive on the materials of construction is the really serious obstacle to success. The industrial interests have still another viewpoint; while appreciating only to a small extent the problems of the research chemist, the designing engineer and the operating chemical engineer, they rightfully feel that the success of these men is for them a failure if the resulting investment, fixed charges and operating expenses make the cost of the product prohibitive.

"The successful development of the synthetic ammonia process can be attained only by a full appreciation of all of these viewpoints."

RESOLUTION ON ALCOHOL

The last business session of the convention was held on Thursday, June 23. Prof. A. H. White pointed out the imminent danger to the alcohol industry contained in certain proposed legislation and he introduced a resolution to Congress calling attention to the legitimate needs of the chemical industries and favoring proper legislation for industrial alcohol. This was passed unanimously.

STUDENT MEMBERSHIP APPROVED

The Council of the Institute, after a consideration of the question of student membership, reported the following resolution:

Resolved, That the following amendment to the constitution be approved by the Council and recommended for adoption:

(1) That the Institute admit to its membership recognized chapters formed by students in chemical engineering at accepted institutions provided that at least one member of the faculty of the institution shall be an active member of the Institute and provided he shall act in an advisory capacity to such chapter.

(2) The constitution of each such student branch shall be approved by the Council.

(3) The members of such chapters shall receive the publications of the Institute and pay therefor such sum as the Council may determine.

(4) Members of the student chapters shall have the privilege of attending all meetings of the Institute.

Following a brief discussion by Professors White and Smith, the resolution was approved and referred to a committee for final drafting.

NICKEL-CHROMIUM ALLOYS AND HEAT-TREATING

W. A. Gatward discussed the application of nickel-chromium alloys to the heat-treatment of steel. He described the four general methods of heat-treating—viz., (1) annealing of steel parts, (2) malleableizing of cast iron, (3) heating for hardening and (4) carbonization or case-hardening. The application of nickel-chromium alloys in heat-treating furnaces was formerly carried on only on an experimental scale or for the production of small and expensive tools and parts. During the war a number of large installations were made by munition manufacturers and since then there has been a promising development in this field. It was claimed that electrical heating can compete with the fuel-fired furnace on a purely cost basis, but the strongest arguments in its favor are the improved working conditions and the higher grade product resulting from more carefully controlled temperatures.

AERONAUTIC DEVELOPMENTS

An informal talk on aeronautics was given by W. B. Stout. He discussed the recent developments in the aircraft industry, particularly the new all-metal type of plane which has largely been developed since the armistice.

The principal disadvantages of the wooden plane are the great waste in the selection of the spruce, the difficulty with which the wood can be tested, and finally the tendency of the plane to deteriorate due to the "letting up" of the glue and other causes. The metal plane, on the other hand, is constructed of material of very definite properties which can therefore be used with accuracy and precision.

OTHER PAPERS

Then followed two of the most interesting papers of the meeting. O. C. Berry of the Wheeler-Schebler Carburetor Co. spoke on the subject of "More Miles Per Gallon," and W. G. Nelson of Morgan & Wright discussed the determining factors in the life of a pneumatic tire. Both articles are to be published in early issues of this magazine.

Prof. James R. Withrow exhibited a new spray nozzle which was claimed to be very satisfactory for acid work. It was made of a high-silicon iron and is capable of giving a fine spray over a long period of operation.

A paper by Ludwig A. Thiele on the "Evolution of the Glue Industry and Grease Extraction" was read by title.

CONVENTION BANQUET

The closing event of the Institute's meeting in Detroit was the banquet at the Hotel Statler on Thursday evening. Following the bounteous repast and delightful musical entertainment, Toastmaster Alfred H. White called on Dr. O'sen, who spoke of some of the recent revelations of science. Responses were also given by Henry M. Leland, the father of the automobile industry, and Chester M. Culver of the Detroit Employers' Association. And finally the benediction was pronounced by President David Wesson in his pleasing and characteristic way and the convention adjourned until its winter meeting in Baltimore next December.

The Chemical Schedule of the Fordney Permanent Tariff Bill

An Analysis of the Proposed Provisions Affecting the Chemical Industries —Home Valuation of Imports and Restrictive Control of Dyes— Comparison of Rates in Previous Tariff Acts

THE Fordney bill for the revision of the permanent tariff, which was reported to the House of Representatives on June 29, represents the basis of what is perhaps the most important legislation to be passed by the present Congress. Its far-reaching effect on the future of industry and trade entitles it to the most serious consideration of all who are interested in our economic developments. The measure, framed along the well-known protective-tariff lines of the party in power, is the result of more than six months' work on the part of the Ways and Means Committee. It contains a great many unusual and untried provisions which make it difficult to compare it with previous tariff legislation or to render an accurate judgment on its probable operation.

The new tariff bill must be regarded as still in an experimental and tentative stage, for before its final enactment it will be the subject of many hours of heated debate and discussion, of political maneuvering and compromise. Some amendments will be accepted from the floor of the House, a more or less complete revision will probably be made by the Senate Finance Committee, and when, perhaps six months from now, it is signed by the President and finally becomes a law, it may bear but slight resemblance to its present form.

HOME VALUATION OF IMPORTS

One of the outstanding features of the proposed measure is the adoption of the domestic valuation of imports as the basis of assessing ad valorem duties. The change from the long-established use of the foreign market value has been made principally because of the instability of foreign exchange and the widely varying costs of production here and abroad. Section 402, which expresses "the legislative intention that duties ad valorem shall be assessed upon the fair market value of the merchandise *in the United States*" defines the dutiable value as:

* * * the price on the date of exportation of the imported merchandise at which comparable and competitive products of the United States were ordinarily sold or freely offered for sale in the usual wholesale quantities and in the customary wrappings, coverings, and containers, whether holding liquids or solids, to all purchasers in the ordinary course of trade, including all costs, charges, and expenses, in the principal market or markets of the United States; . . .

In cases where this value cannot be ascertained to the satisfaction of the appraising officer, certain alternatives are provided, based either on the foreign value of the imported goods with certain additional charges or on the costs of production plus shipping and selling expenses, duties and commissions.

The change to home valuation will have the obvious effect of increasing the amount of revenue to be obtained from a given ad valorem rate of duty, so for that reason a substantial increase in protection has been effected by an apparently slight advance in the ad valorem rates.

The Fordney bill presents many other innovations in

tariff legislation; a new scheme has been adopted for numbering the various schedules and the paragraphs within the schedules. There have been many changes in classification and phraseology and the administrative sections contain a number of new provisions giving the President the power, under circumstances warranted by the trade of the United States, to impose retaliatory duties or to adjust the rates along the principles of a bargaining tariff.

RATES IN THE CHEMICAL SCHEDULE

A critical examination of Schedule 1—Chemicals, Oils, and Paints—reveals comparatively few ad valorem duties higher than the general level of 25 per cent. The principal exceptions are in the cases of products of industries which have developed since the outbreak of the war, such for example as coal-tar dyes and medicinals, hydrosulphites and sulphonylates, synthetic organic chemicals, perfumery and toilet articles, and the products derived from acetylene and other hydrocarbon gases. The general rate of 25 per cent ad valorem is carried by the all-inclusive paragraph 5, under the general provisions of which have been included hundreds, if not thousands, of "chemical and medicinal compounds, preparations, mixtures and salts, not specially provided for." This rate is at least double the basic duty of 15 per cent on the foreign market value provided by the present law, and is a slight increase over the general level of the Payne-Aldrich tariff of 1909. Because of the change in the basis of valuation it is difficult to compare the rates between this and the earlier protective tariff, but of 100 duties in Schedule 1, 47 were found to be the same as in the Payne law, 27 are higher and 26 are lower. The rates in the Fordney bill on the principal chemicals are compared with those in the two preceding tariff laws in the accompanying table.

CONTROL OF DYE IMPORTS

By far the most significant feature of the chemical schedule is the special protection accorded to dyes and intermediates, pharmaceuticals and other products derived from coal tar. Not only are higher duties imposed, but for a period of three years these products cannot be imported unless the importer complies with certain very specific conditions. Dyes and other coal-tar chemicals which are manufactured in the United States and are obtainable on reasonable terms as to quality, price and delivery cannot be imported under any conditions. Products not being made here or for which the domestic supply fails to meet the requirements of satisfactory quality, price or delivery can be brought into the United States only by an importer registered with the United States Tariff Commission, and the total importation must not exceed a six months' supply for the actual consumer of the dyestuff.

This restrictive control of imports follows along lines somewhat similar to the "selective embargo" proposed

in the Senate during the last session as a substitute for the licensing scheme of the original Longworth bill. The section giving the Tariff Commission the power to determine reasonable terms as to quality, price and delivery is practically identical with the corresponding sections of the earlier bill. The new provisions, however, definitely establish the procedure by which the United States Tariff Commission is to administer the control. All of the articles in the paragraphs covering intermediates and finished coal-tar products are to be divided into two classes. Class A, which includes the non-importable products, is published in the form of a list, and this list may be revised, from time to time, at the discretion of the commission as the result of its investigations or following hearing of complaints. The commission is also required to publish a list of persons who have registered with the commission and are therefore permitted to import dyes under the above regulations.

The limitation in regard to the quantity of imports is accomplished by requiring the importer (or the actual consumer if the importer is acting as an agent) to furnish the collector of customs with an affidavit stating that "the quantity to be delivered will not place him in possession or control of more than a six months'

supply." Exception is made in the case of those goods which are sold in small packages through the retail trade, for which it would obviously be impossible to ascertain consumption during any limited period. Other sections of the dye schedule provide for the transfer to the Tariff Commission of the former War Trade Board Section, and also establish penalties for failure to comply with the regulations for administering the act.

Objections will probably be raised to this or any other form of restrictive control, on the familiar grounds of "less government in business," but the supporters of the bill point out the important relation of the dye industry to the national defense, and as a proof of their contention that a high tariff alone is inadequate, they cite the example set by England and France, which have already protected their dye industries by embargoes or similar measures. The coal-tar provisions include, in addition to dyes and intermediates, such materials as color lakes, pharmaceuticals, photographic chemicals, synthetic perfumes and flavoring materials, synthetic tanning materials, synthetic phenolic resins, explosives and all other products "when obtained, derived or manufactured in whole or in part" from coal tar.

RATES OF DUTY ON IMPORTANT CHEMICALS IN FORDNEY BILL COMPARED WITH THOSE IN PAYNE-ALDRICH AND UNDERWOOD-SIMMONS TARIFF LAWS

Specific duties on per pound basis unless otherwise noted							
Commodity	Payne- Aldrich Act of 1909	Underwood- Simmons Act of 1913	Fordney Bill of 1921	Commodity	Payne- Aldrich Act of 1909	Underwood- Simmons Act of 1913	Fordney Bill of 1921
Acetic acid, 65% and less.....	3c.	Free	3c.	Buchu leaves.....	1c. + 10%	10c.	10c.
Acetic acid, over 65%.....	2c.	Free	2c.	Coca leaves.....	5c.	10c.	10c.
Acetic anhydride.....	2½c.	2½c.	8c.	Gentian.....	1c. + 10%	½c.	½c.
Boric acid.....	3c.	3c.	2c.	Licorice root.....	Free	½c.	½c.
Chloroacetic acid.....	25% n.s.p.f.*	15% n.s.p.f.	5c.	Sarsaparilla root.....	1c. + 10%	1c.	1c.
Citric acid.....	7c.	5c.	10c.	Belladonna.....	1c. + 10%	10%	25%
Lactic acid.....	2c.-3c.†	1½c.	1½c.-3c.†	Digitalis.....	1c. + 10%	10%	25%
Tannic acid and tannin.....	35c.	5c.	4c.-20c.†	Henbane.....	1c. + 10%	10%	25%
Tartaric acid.....	5c.	3½c.	6c.	Stramonium.....	1c. + 10%	10%	25%
Arsenic and arsenious acids.....	Free	Free	25%	Ergot.....	Free	10c.	10c.
Formic acid.....	25% n.s.p.f.	1½c.	25%	Diethyl sulphate.....	25% n.s.p.f.	15% n.s.p.f.	25%
Gallic acid.....	8c.	6c.	25%	Dimethyl sulphate.....	25% n.s.p.f.	15% n.s.p.f.	25%
Oleic acid.....	25% n.s.p.f.	15% n.s.p.f.	25%	Ethyl acetate.....	25% n.s.p.f.	5c.	4c.
Oxalic acid.....	2c.	1½c.	25%	Ethyl chloride.....	30%	20%	15c.
Phosphoric acid.....	Free	Free	25%	Ethyl ether.....	8c.	4c.	6c.
Pyrogallol acid.....	25% n.s.p.f.	12c.	25%	Extracts for dyeing and tanning... Flavoring extracts, non-alcoholic..	1c. + 10%	3c. 20%	12½% 25%
Stearic acid.....	25% n.s.p.f.	15% n.s.p.f.	25%	Formaldehyde.....	25% n.s.p.f.	1c.	25%
Acetaldehyde.....	25% n.s.p.f.	15% n.s.p.f.	6c. + 30%	Hexamethylenetetramine.....	25% n.s.p.f.	15% n.s.p.f.	25%
Acetone.....	25% n.s.p.f.	1c. per lb.	25%	Glycerine, crude.....	1c.	1c.	1c.
Alcohol, amyl.....	1c.	1c.	6c.	Glycerine, refined.....	3c.	2c.	3c.
Alcohol, butyl.....	25% n.s.p.f.	1c.	6c.	Ink and ink powders.....	25%	15%	20%
Alcohol, isopropyl and fusel oil... Alcohol, methyl.....	1c. 25% n.s.p.f.	1c. Free	6c. 15c. per gal.	Iodine, resublimed.....	20c.	Free	20c.
Alcohol, ethyl.....	\$2.60 per pr. gal.	\$2.60 per pr. gal.	15c. per gal.	Lead acetate, white.....	3c.	1½c.	3½c.
Aluminum hydroxide.....	1½-2c.	15%	3c.	Lead acetate, brown.....	2c.	1c.	2½c.
Alum.....	1½c.†	15%	1½c.†	Lead nitrate.....	2½c.	1½c.	2½c.
Ammonium carbonate.....	1½c.	1½c.	1½c.	Lime, citrate of.....	Free	1c.	2½c.
Ammonium chloride.....	1c.	1c.	1½c.	Magnesium carbonate.....	3c.	1½c.	1½c.
Ammonium nitrate.....	25% n.s.p.f.	Free	25%	Magnesium chloride.....	25% n.s.p.f.	15% n.s.p.f.	1c.
Ammonium sulphate.....	Free	Free	8c.	Magnesium sulphate.....	1/5c.	1/10c.	½c.
Anhydrous ammonia.....	5c.	2½c.	2½c.	Magnesium oxide.....	7c.	3½c.	7c.
Antimony oxide.....	1½c.	25%	2c.	Magnesite, calcined.....	Free	Free	1c.
Tartar emetic.....	25% n.s.p.f.	15% n.s.p.f.	5c.	Magnesia, crude.....	Free	Free	1c.
Argols and wine lees.....	5%	5%	5%	Menthol.....	25% n.s.p.f.	50c.	25%
Cream of tartar.....	5c.	2½c.	5c.	Camphor, crude.....	Free	1c.	25%
Rochelle salts.....	3c.	2½c.	5c.	Camphor, refined.....	6c.	5c.	20%
Balsams, crude.....	Free	10%	10%	Oils, animal, n.s.p.f.....	25%	15%	20%
Balsams, refined.....	1c. + 10%	15%	10%	Oils, fish, n.s.p.f.....	8c. per gal.	3c. per gal.	20%
Barium carbonate.....	25% n.s.p.f.	15%	1c.	Oils, expressed, n.s.p.f.....	25%	15%	25%
Barium chloride.....	25% n.s.p.f.	1c.	1½c.	Castor oil.....	35c. per gal.	12c. per gal.	4½c.
Barium dioxide.....	25% n.s.p.f.	1½c.	4c.	Cottonseed oil.....	Free	Free	2c.
Barium nitrate.....	25% n.s.p.f.	15% n.s.p.f.	2c.	Coconut oil, crude.....	Free	Free	2c.
Bleaching powder.....	1c.	1c.	8c.	Soya-bean oil.....	Free	Free	2c.
Caffeine.....	25% n.s.p.f.	\$1	\$1.50	Hempseed oil.....	10c. per gal.	3c. per gal.	1½c.
Tea waste.....	1c.	1c.	1c.	Linseed oil.....	15c. per gal.	10c. per gal.	2½c.
Calcium carbide.....	25% n.s.p.f.	Free	1c.	Olive oil, less than 5 gal.....	50c. per gal.	30c. per gal.	7½c.
Calomel.....	35%	15%	30%	Olive oil, more than 5 gal.....	40c. per gal.	20c. per gal.	6½c.
Carbon tetrachloride.....	25% n.s.p.f.	1c.	2½c.	Peanut oil.....	Free	6c. per gal.	2½c.
Chloroform.....	10c.	2c.	8c.	Poppyseed oil.....	15c. per gal.	6c. per gal.	2c.
Chalk, precipitated.....	1c.	25%	15%	Rapeseed oil.....	Free	6c. per gal.	1½c.
Chicle, crude.....	10c.	15c.	15c.	Turkey-red oils.....	15-30c. per gal.	25%	25%
Chicle, refined.....	25%	20c.	20c.	Oils, essential, n.s.p.f.....	25%	20%	25%
Chloral hydrate.....	25% n.s.p.f.	25%	25%	Orange and lemon oils.....	Free	10%	20%
Terpin hydrate.....	25% n.s.p.f.	25%	25%	Peppermint oil.....	25c.	25c.	25c.
Thymol.....	25% n.s.p.f.	25%	25%	Opium, crude.....	\$1.50	\$3	\$3
Urea.....	25% n.s.p.f.	25%	25%	Opium, manufactured.....	\$2	\$4	\$4
Glycerophosphoric acid.....	25% n.s.p.f.	25%	25%	Morphine.....	\$1.50 per oz.	\$3 per oz.	\$3 per oz.
Coal-tar intermediates.....	Free	10%	7c. + 30%	Cocaine.....	\$1.50 per oz.	\$2 per oz.	\$2 per oz.
Coal-tar dyes, medicinals, etc.....	30%	30%	7c. + 35%	Perfume materials, synthetic.....	Free	20%	35%
Cobalt oxide.....	25c.	10c.	20c.	Perfumery, alcoholic.....	60c. + 50%	40c. + 60%	40c. + 60%
Collodion.....	40c.	15%	35c.	Perfumery, non-alcoholic.....	60%	60%	60%
Pyroxylin, unfinished.....	45c.	25%	40c.	Floral waters.....	20%	20%	20%
Pyroxylin, finished.....	65c. + 30%	40%	65c. + 25%	Bay rum.....	\$1.75 per pr. gal.	\$1.75 per pr. gal.	40c. + 60%
Drugs, crude.....	Free	Free	Free	Paris green.....	15%	Free	15%
Drugs, advanced.....	1c. + 10%	10%	10%				

Commodity	Payne-Aldrich Act of 1909	Underwood-Simmons Act of 1913	Fordney Bill of 1921
Phosphorus.....	18c.	Free	15c.
Paints, artists'.....	30%	20%	25c.
Paints and pigments, n.s.p.f.....	30%	20%	25%
Barytes, crude.....	\$1.50 per ton	15%	\$4 per ton
Barytes, ground.....	\$5.25 per ton	20%	\$7.50 per ton
Prussian blue.....	8c.	20%	12c.
Ultramarine.....	3c.	15%	3c.
Bone black.....	25%	15%	20%
Chrome colors.....	4½c.	20%	25%
Gas black.....	25%	15%	20%
Litharge.....	2½c.	25%	2½c.
Orange mineral.....	3½c.	25%	2½c.
Red lead.....	2½c.	25%	2½c.
White lead.....	2½c.	25%	2½c.
Ochers, siennas, umbers.....	1-½c.	5%	1-½c.
Satin white.....	1c.	20%	1c.
Spirit varnishes, denat'd.....	35c. per gal. + 35%	10%	25%
Spirit varnishes, not denat'd.....	\$1.32 per gal. + 35%	\$1.32 per gal. + 35%	\$2.20 per gal.
Vermilion reds.....	10c.	15%	10c.
Zinc oxides.....	1c.	10%	1½c.
Zinc oxides, in oil.....	1½	15%	2c.
Lithopone.....	1½c.	15%	1½c.
Potassium chromate.....	2½c.	1c.	2½c.
Potassium dichromate.....	2½c.	1c.	2½c. + 15%
Potassium chlorate.....	2c.	½c.	2c. + 15%
Potassium ferricyanide.....	8c.	2c.	7c. + 15%
Potassium ferrocyanide.....	4c.	1½c.	4c. + 15%
Potassium iodide.....	25c.	15c.	25c. + 15%
Potassium bicarbonate.....	25% n.s.p.f.	½c.	40%
Potassium bromide.....	25% n.s.p.f.	15% n.s.p.f.	40%
Potassium carbonate.....	Free	Free	40%
Potassium hydroxide.....	1c.	Free	40%
Potassium nitrate.....	½c.	.35c.	40%
Potassium permanganate.....	25% n.s.p.f.	1c.	40%
Santonin.....	50c.	Free	75c.
Soap, Castile.....	1½c.	10%	15%
Soap, toilet.....	50%	30%	30%
Soap, all others.....	20%	5%	20%
Sodium arsenate.....	1c.	Free	1c.
Sodium bicarbonate.....	1c.	½c.	½c.
Sodium borate.....	2c.	½c.	½c.
Sodium bromide.....	25% n.s.p.f.	15% n.s.p.f.	25%
Sodium carbonates.....	½c.	Free or ½c.	½c.
Sodium chlorate.....	1½c.	½c.	1½c.
Sodium chloride, bags.....	.11c.	Free	.11c.
Sodium chloride, bulk.....	.07c.	Free	.07c.
Sodium chromates.....	1½c.	½c.	1½c.
Sodium formate.....	25% n.s.p.f.	15% n.s.p.f.	25%
Sodium ferricyanide.....	2c.	½c.	2c.
Sodium hydroxide.....	½c.	½c.	½c.
Sodium nitrite.....	2c.	½c.	3c.
Sodium phosphate.....	½c.	½c.	½c.
Sodium sulphate, crystals.....	.05c.	Free	.05c.
Sodium sulphate, anhydrous.....	.05c.	Free	.10c.

Commodity	Payne-Aldrich Act of 1909	Underwood-Simmons Act of 1913	Fordney Bill of 1921
Sodium sulphide.....	1-½c. †	3c.	1-½c. †
Sodium silicate.....	1c.	Free	1c.
Sodium sulphites.....	1c.	1c.	1c.
Sodium hydrosulphite.....	25% n.s.p.f.	15% n.s.p.f.	35%
Sulphoxylates.....	25% n.s.p.f.	15% n.s.p.f.	35%
Starch, potato.....	1½c.	1c.	1½
Starch, all other.....	1c.	½c.	1c.
Dextrine, potato.....	1½c.	1½c.	1½
Dextrine, all other.....	1½c.	½c.	1½c.
Strontium salts.....	25% n.s.p.f.	15% n.s.p.f.	25%
Strychnine.....	15c. per oz.	Free	15c. per oz.
Thorium nitrate.....	40%	25%	25%
Tin compounds.....	25% n.s.p.f.	10%	20%
Titanium compounds.....	25% n.s.p.f.	15% n.s.p.f.	25%
Vanilla beans.....	30c.	30c.	30c.
Tonka beans.....	Free	25c.	25c.
Zinc chloride.....	1c.	½c.	1½c.
Zinc sulphate.....	1c.	½c.	½c.
Zinc sulphide.....	1½c.	15%	1½c.
Petroleum, crude.....	Free	Free	35c. per bbl
Fuel oil.....	Free	Free	25c. per bbl

CHEMICALS ON THE FREE LIST

Chromic acid.....	2c.	Free	Free
Hydrofluoric acid.....	Free	Free	Free
Hydrochloric acid.....	Free	Free	Free
Nitric acid.....	Free	Free	Free
Cinchona bark.....	Free	Free	Free
Azides and fulminates.....	20%	Free	Free
Calcium acetate.....	25% n.s.p.f.	Free	Free
Calcium chloride.....	25% n.s.p.f.	Free	Free
Calcium nitrate.....	25% n.s.p.f.	Free	Free
Calcium cyanamid.....	Free	Free	Free
Coal-tar crudes.....	Free	Free	Free
Copper sulphate.....	½c.	Free	Free
Copper acetate.....	Free	Free	Free
Crude drugs.....	Free	Free	Free
Enfleurage grease.....	Free	20%	Free
Floral essences.....	Free	20%	Free
Ferrous sulphate.....	.15c.	Free	Free
Iodine, crude.....	Free	Free	Free
Monazite sand.....	4c.	25%	Free
Oils, essential.....	Free	20%	Free
Potash salts, crude.....	Free	Free	2½c.
Potassium cyanide.....	12½%	Free	Free
Quinine.....	Free	Free	Free
Sodium cyanide.....	12½%	Free	Free
Sodium nitrate.....	Free	Free	Free
Sodium sulphate, crude.....	0.05c.	Free	Free
Sulphur.....	½c.	Free	Free
Pyrites.....	Free	Free	Free
Tapioca flour.....	Free	Free	Free
Sago flour.....	Free	Free	Free

* Not specially provided for.

† Depending on strength.

‡ For two years; 2c. for third, 1½c. for fourth, 1c. for fifth, thereafter free

FERTILIZER MATERIALS BECOME DUTIABLE

For the first time in tariff history imported fertilizer materials are to be taxed. A duty of three-fifths of a cent per pound is imposed on ammonium sulphate, presumably to encourage the development of byproduct coke ovens and to protect the domestic industry from possible competition of Germany's nitrogen fixation plants. These plants, built under the stress of military necessity, are reported to have the capacity to produce almost double the entire world's pre-war requirements of ammonium sulphate. The development of the by-products industry in our own country has reached the stage where it now supplies the domestic consumption, with a small exportable surplus, so it is not likely that the duty imposed will materially affect the ammonia trade. An additional factor of safety is the stabilizing influence of the competition with Chilean nitrate.

THE DUTY ON POTASH

The bill also provides a duty on crude potash salts, which will probably be felt somewhat more seriously, since, for the present at least, it will be necessary to import more than three-quarters of the country's requirements. The domestic producers, whose output in 1920 supplied only about one-fifth of our normal consumption, maintain that with the five years of protection afforded by this bill they can increase their production to the extent that the country will be practically independent of the German and Alsatian supplies. Whether or not this can be accomplished will depend to some extent upon the solution of the transportation problem, and possibly, in the case of the Searles Lake

producers, to the development of a water route through the Panama Canal. The duty on potash salts is to be on a declining scale. Starting with a maximum of 2½c. per lb. of actual potash for the first two years, the duty is reduced to 2c. for the third year, 1½c. for the fourth, 1c. for the fifth, and thereafter the imports are to be free of duty. For a period of five years a compensating duty of 15 per cent ad valorem is added to the regular rates on the refined potassium salts included in paragraph 75 of the chemical schedule.

OTHER INDUSTRIES RECEIVING PROTECTION

Other industries to be recognized by the new tariff are barytes and barium chemicals, magnesite, crude botanical drugs, synthetic camphor, and hydrogenated, vulcanized and other chemically treated oils. Chemical manufacturers will be interested in knowing that pyrites is to remain on the free list. The duty of \$4 per ton on crude barytes may be regarded as a compromise between the demands of the consumers along the Atlantic seaboard and those of the inland producers. With present freight rates the duty provided is not sufficient to permit the Missouri barytes to compete in the New York market, but it is questionable whether or not this could have been accomplished without giving undue advantage to the Georgian producers, who are more strategically located. Barium carbonate, chloride, dioxide and nitrate are given slightly higher rates than in previous tariffs in order to compensate for the duty on the raw material.

Another war mineral to become dutiable for the first time is magnesite, which is an essential material for

the manufacture of refractories and certain cements and stucco. Here too the fixing of the exact rate of duty involves the serious problem of transportation. The centers of production and consumption for this comparatively cheap material are separated by the width of the continent.

CRUDE BOTANICAL DRUGS AND SYNTHETIC CAMPHOR RECEIVE PREFERENTIAL TREATMENT

When the late war cut off the supply of certain indispensable botanical drugs their cultivation was attempted in the United States, and, in certain instances, with conspicuous success. The most important of these products, belladonna, digitalis, stramonium and henbane, have been given preferential treatment in the drug provisions of the new tariff.

Tariff laws in the past have generally imposed a duty on camphor for the purpose of raising revenue. A slight differential has sometimes been allowed between the crude and refined camphor and this has resulted in developing some refining in this country. The bulk of our large requirements, however, is purchased from the Japanese monopoly in the form of crude camphor. An ad valorem duty of 25 per cent on all forms of camphor is imposed presumably to encourage the manufacture of synthetic camphor, since the development of this new industry is apparently the only way that this country can become independent of the great foreign monopoly.

RECLASSIFICATION OF CHEMICALS

Most of the changes in the phraseology of the new tariff law are those suggested by the Tariff Commission in its report on reclassification. For example, the duties on acetic, lactic and tannic acids are based on standards of strength in order to avoid the unsatisfactory operation of the single specific duties imposed by the present law. By combining all of the dyeing and tanning materials of vegetable origin in a single provision, the customs officials are relieved of the difficulties of separate classifications based on use. A more logical and scientific classification of the oil provisions separates the animal oils, the expressed vegetable oils and the essential oils, and new paragraphs have been added for sulphonated oils and soluble greases, for hydrogenated, vulcanized, chlorinated and other chemically treated oils, and for the mixtures and combinations of animal, vegetable, and mineral oils. Radical changes have been made in the provisions dealing with perfume materials and perfumery. The principal raw materials such as the flower oils and floral products, and musk and other animal perfumes, have been transferred to the free list, although under the present law these articles are taxed for revenue purposes. The synthetic perfumes derived from coal tar are included in the provision for coal-tar products; those derived from the essential oils and non-coal-tar sources are given a protective duty of 35 per cent ad valorem. A more significant reclassification is found in the provision for mixtures and combinations of the various perfumery materials, which become dutiable at the comparatively high rate of 40c. per lb. and 40 per cent ad valorem. By imposing this higher duty the Congress evidently intended to develop the manufacture of perfumery from the primary raw materials and to prevent the practical evasion of the duties on finished perfumery by the importing of semi-finished and carefully compounded preparations.

The proposed duty of 35c. per bbl. on crude petroleum oil and 25c. on fuel oil is perhaps not to be regarded too seriously. Its transfer to the chemical schedule from the free list was accomplished at the last session of the committee and the corresponding correction had not been made in the printed copy of the reported bill. It is interesting to note, however, that gasoline, benzine, kerosene and other refined petroleum products remain on the free list, notwithstanding the duty on the raw material.

It has been possible here to comment upon only a few of the many features of the new tariff, but the importance of the measure merits the careful study of all who are interested in the development of our chemical industries.

Avoid Temperature Shocks in Heat-Treatment

The A.S.T.M. committee on heat-treatment of iron and steel submitted the following notes to the recent convention at Asbury Park, N. J., as covering helpful information:

The advantage of alloy steels over simple steels lies in the fact that they are more sensitive to heat-treatment and capable of giving higher properties when properly handled. The increased sensitiveness to treatment unfortunately is accompanied by a proportionate sensitiveness to failure during treatment, which requires greater care in all treatment operations and necessitates the elimination of abrupt changes in section. The following suggestions are made to overcome this difficulty:

1. Heavy solid alloy forgings should not be allowed to cool, but should immediately be put in an annealing furnace and normalized.

2. High nickel-chrome, chrome-vanadium or any other alloy steel bars and small forgings liable to shattering should be cooled slowly after rolling by burying in warm ashes or lime to retard the cooling. High carbon, even with a moderate alloy content, increases the risk of cracking.

3. A thorough annealing or normalizing above the upper critical point after rolling or forging eliminates much danger of later troubles due to cracks and strains and leaves the metal in a better condition to secure the maximum effect of the quench.

4. Annealing only does not develop high physical properties, but leaves the metal soft, uniform and ductile. To break up forging and rolling structures which are detrimental the piece should be double annealed, first at 100 to 200 deg. F. above the critical range followed by an anneal slightly above the critical range.

5. In heating for either annealing or quenching, the piece should be slowly and uniformly brought to temperature, the rate depending on grade and section, especially through the brittle range, which is up to 800 deg. F.

6. For quenching, the piece should be uniformly heated above the critical range and introduced into the quenching medium with no delay after leaving the furnace.

7. Quenching is the most drastic treatment operation, and therefore the most dangerous. Alloys or sections subject to water cracks should be quenched in circulating oil.

8. In drawing after quenching the piece must be slowly and uniformly heated to the proper temperature, but may be cooled slowly or rapidly as desired.

Albert Sauveur, Honorary Member of Steel Treaters

ALBERT SAUVEUR, professor of metallurgy at Harvard University, Officer of the French Academy, Elliott Cresson Medalist, was notified of his election to honorary membership in the American Society for Steel Treating on the occasion of his address before the Cleveland Section of that society on the "Dendritic Structure of Steel." In accepting the honor he honored the donors, who have thus added to their notables a leader in metallurgical thought and writing among technologists both here and abroad.

Coming to America fresh from the School of Mines at Liège, Belgium, Albert Sauveur matriculated in the Massachusetts Institute of Technology and received there the degree of Bachelor of Science in Mining and Metallurgy in 1889. Thereafter for eight years he served his novitiate as chemist and metallurgist—and in those days metallurgists were far more rare than chemists—for the Pennsylvania Steel Co. and the Illinois Steel Co.

W. R. Walker, manager of the South Works of the latter company, asked young Sauveur to take up the microscopical examination of iron and steel, which had received some attention both in England and in France. There was an old microscope available, and he was given an empty room in the laboratory. While waiting for table, desks and other equipment, a barrel served as a metallographic bench, and diffused sunlight replaced a better illuminator. From this hurried beginning he created that early work which was destined to have such a wide influence on the manufacture and heat-treatment of steel. The first application of microscopic evidence was to throw light upon apparently unexplainable variations in the quality of steel rails. A close examination of metallic structure seemed so pregnant with possibilities that the subject has since been followed keenly by him, his interest never flagging, and as a result it is no exaggeration to say that he has done as much as any other man, if not more than any other man, to bring metallurgy to its present important place as a method of routine testing and fundamental research.

That early work at Chicago extended into an investigation on crystallization in steel, and some of his results were read before the 1893 Chicago meeting of the American Institute of Mining Engineers. He had already set for himself the concrete problem, "What heat-treatment will best suit a given chemical composition so as to get a certain desirable structure, and

with it certain other desirable physical properties?"—a problem which is as important now as then, and even yet capable of solution only in special cases.

This first contribution to the literature showed that Sauveur had already diagnosed the relative effect of temperature, degree of work, rate of cooling and chemical composition on grain size of steel products. He had devised and used a method of measuring grain size without the necessity of photographing the specimen, and constructed curves showing its relation to the tensile properties and ductility of bessemer rails. His paper clearly shows, and in a way which then was unique in technical literature, that the finishing temperature and size of section has a great effect on the structural heterogeneity in a steel rail.

Such pioneer work on the industrial applications of metallography may be appraised only in the light of the amount of information regarding the science then available. To illustrate: At the same meeting, Osmond, the French savant, presented a paper on "Microscopic Metallography" covering such subjects as methods of illumination (now considered very elementary), and presenting micrographs of typical commercial steels, concluding briefly that "it is difficult to offer, even hypothetically, a satisfactory solution" of the reasons for difference in structures.

A worker of the Sauveur type could not long dodge the question, "What causes hardening?" and in 1896 he wrote another paper for the American Institute of Mining Engineers on "Microstructure of Steel and the Current Theories of Hardening," which summarizes to that date the ideas of various metallurgists on the reason for

the hardening of steel, and presents data of his own bearing upon the subject. This provoked such a discussion both in America and abroad that the paper marks an epoch in the history of heat-treatment. It was critically discussed by such men as Howe, Arnold, LeChatelier and Osmond, the latter presenting in a long contribution one of his first contributions to scientific information on the allotropy of iron, a new conception which has been widely accepted and has had such a strong influence on the theory and practice of heat-treatment of iron and steel.

At that time austenite had not been established as the solid solution of carbon in gamma iron—in fact martensite was thought to be the constituent stable at a high temperature, and on cooling it first precipitated excess ferrite (in low-carbon steels) and finally the residual portions transformed into pearlite. After marshaling the main evidences in favor of the various



ALBERT SAUVEUR

theories of hardening he writes in this article: "Martensite is the constituent which confers hardness upon suddenly cooled steel. If we knew its composition, the mist which now surrounds the phenomenon of hardening would be cleared away." With a truly remarkable clearness of judgment he presents his own conclusion from the evidence—namely, that martensite is carbon dissolved in iron—and proposes the idea that the hardness of martensite is essentially due to the distribution of carbide in the mass! This paper was written twenty-five years ago, and in his later writings Prof. Sauveur favors the view that hardness of martensite is due to beta iron with carbide in solution, yet does not the earlier conclusion remind one of the "critical dispersion" hypothesis of hardening lately supported by our friends the colloid chemists?

A KEEN AND WITTY EXPERT WITNESS

As the senior member of the firm of Sauveur & Boylston, such keen insight has in later years brought him great repute as an expert in important patent litigation. Sauveur always goes straight to the heart of a matter, and is always able and ready to clear up difficult points in the minds of attorneys and judges. This, without losing patience with legal obtuseness, without forgetting to temper the caution of the trained expert with common sense. After all a lawyer is only a human being, and wit often brings a laughing understanding with even a metallurgist.

In 1899 he was called to Harvard University as instructor and was assistant professor in metallurgy and metallography from 1900 to 1905. He lectured on metallography at the Massachusetts Institute of Technology until 1903. Since 1905 he had been professor of metallurgy at Harvard. He found time to edit the *Metallographist* (1898-1903) and its successor the *Iron and Steel Magazine* from 1903 to 1906. The latter magazine in turn was merged with CHEMICAL & METALLURGICAL ENGINEERING, then called *Electrochemical and Metallurgical Industry*.

Naturally his publications have been many. He is best known to metallurgical students for his wholly admirable "Metallography and Heat-Treatment of Iron and Steel," published in 1912 and since passing through several editions. Its information is contained in simple language, written in a clear style, arranged in a very orderly manner and illustrated not only with well-chosen micrographs but with a number of very original graphic diagrams.

As a teacher he is beloved by his students for his fairness, never failing courtesy and his clear explanation of difficult points, his quick sense of humor and ready wit driving home each principle or detail to the pupil. Dignified, yet alert to discern the fallacy in an argument of student or associate, he is nevertheless able to set either one right without offending. Prof. Sauveur is always patient with errors of students and employees, and gives his orders chiefly by means of suggestions which nevertheless convey his desires, leaving no doubt in the mind of the hearer as to the importance of the work in hand.

Despite the many duties of his post at Harvard, he has always been generous with time and thought for the good of our Government and the profession. In 1917-19 he was metallurgist of the American Aviation Commission in France and later director of research for the Metallurgical Division, Air Service, A.E.F., stationed in Paris, France.

Large Production of Fullers Earth in 1920

The production of fullers earth in 1920, according to a statement made public by the United States Geological Survey, was 128,487 short tons, valued at \$2,506,189, or \$19.51 per ton. These amounts represent the largest output, the largest value and the largest average price ever recorded. The output was 21 per cent greater than in 1919; it was more than three times as great as in 1913 and nearly nineteen times as great as in 1895, the first year of production. The value in 1920 was 25 per cent greater than that in 1919, nearly seven times as great as that in 1913, and sixty times as great as that in 1895. The average price per ton in 1920 increased only 4 per cent over that in 1919.

Fullers earth was produced in eight states in 1920; named in the order of their rank in output they were Florida, Georgia, Texas, Alabama, Nevada, Arkansas, California and Massachusetts. Promising deposits of fullers earth have been discovered also in Pennsylvania and Virginia. The Southern States reported 99 per cent of the output, Florida alone reporting about 85 per cent of the total.

The imports of fullers earth, which for many years constituted the entire source of supply, also increased in quantity and value in 1920. During the war these imports naturally decreased in quantity, and with the cessation of hostilities they just as naturally increased. The imports in 1918 were about 50 per cent of the maximum (24,977 short tons in 1914); in 1920 they were 77 per cent of the maximum. During the war some refiners of edible oils and fats—by whom the imported fullers earth is probably used exclusively—were unable to obtain a sufficient supply of foreign earth and were compelled to adapt domestic earth to their needs, and it may be that imports of this material will never again be so essential to the American industry.

The imports of fullers earth in 1920 were 19,235 short tons, valued at \$221,893, or \$11.54 a ton. These amounts represent an increase of 39 per cent in quantity and of 17 per cent in value.

The average price at the markets of the country from which the material was imported decreased \$2.13 a ton.

Production of Bauxite in 1920

According to figures collected by the United States Geological Survey, 521,308 long tons of bauxite, valued at \$3,247,345, was produced in the United States in 1920, as compared with 376,566 long tons, valued at \$2,201,747, in 1919.

The mines in Saline and Pulaski counties, Arkansas, produced 481,279 long tons, or 92 per cent of the total output in 1920. The production from these mines in 1919 was 333,490 long tons.

Georgia ranked second, Alabama third and Tennessee fourth in production, and the combined output of these three states was 40,029 long tons in 1920, as compared with 43,076 long tons in 1919. In Georgia the bauxite-producing counties, arranged in order of quantity produced, were Sumter, Wilkinson, Floyd, Randolph, Meriwether, Macon and Bartow. A number of the mines in Bartow and Wilkinson counties that were worked in former years have been abandoned, but new deposits in Randolph County were opened in 1920.

The bauxite imported in 1920, most of it from South America and France, amounted to 42,895 long tons, as compared with 6,082 long tons in 1919.

The Latent Heats of Fusion of Nickel and Monel Metal

Description of Apparatus and Manipulation for Precise Determinations of Specific Heat of Solid or Liquid Metals—Results Found Indicate That Formerly Published Figures Are in Error by 30 Per Cent

By WALTER P. WHITE

THE present paper deals with the two important metals nickel and copper. The work was done with considerable care; hence it is hoped that the results obtained will, besides being of value themselves, also prove useful as a check on other series of determinations in which these two metals are included.

Latent heat determinations of any sort above 1,000 deg. have not been numerous. The 1913 edition of Landolt and Börnstein contains latent heats of only four metals melting above 1,000 deg.—platinum, palladium, cast iron and copper—and none of these is really modern.

In 1918 Wüst, Meuthen and Durrer published¹ specific and latent heats, obtained by a very bold and interesting method, of numerous metals, including nickel, iron, cobalt, manganese, copper, gold and silver. This extensive research is thus our main source of knowledge of metallic latent heats above 1,000 deg.

The value for the latent heat of nickel obtained in the present work, 73 calories per gram, is very different from Wüst's value, 56 calories. There is evidently a large error somewhere; hence the probable error of the present work will be considered very carefully.

GENERAL METHOD

The method employed was the familiar one of heating the specimens of metal and then dropping them into a water calorimeter. Some special features of the particular arrangement used will be described at the end of this paper. The arrangements concerned in the temperature measurement in the furnace are of first importance, since this measurement presents the greatest uncertainties and therefore mainly determines the probable precision attained. The other errors, in weighing, in the dropping process and in the calorimeter, are negligible in view of the precision sought, which was from 3 to 10 per mille, and all that the purity of the metal samples warranted.

The metal specimens, about 27 g. in weight, were used in closed silica glass tubes, which protected them from oxidation and supported them while melted. To avoid bursting at the high temperatures the tubes were nearly exhausted before sealing. This necessitated first drawing out a thick-walled capillary. I am greatly indebted to Dr. E. G. Zies of this laboratory for this difficult work on the silica glass. The tubes sometimes collapsed, which did no harm. Before exhaustion they were filled with nitrogen, but the trace of gas left would have been negligible if it had been pure oxygen. If the nitrogen did any good, it was in protecting the metal during the inclosing process.

The furnace cavity was vertical, 2.8 cm. wide by 25 cm. high. Three platinum-faced partitions at each

end shut off, in part, the heat loss at the ends, and left an inner working chamber about 16 cm. high. In the center of this hung the silica glass tube containing the metal cylinder. The tubes were 13 mm. in diameter outside, and about 6 cm. high. In the 6 mm. annular space around the tube was the platinum-rhodium thermocouple which served as a thermometer. This couple agreed throughout, within 1 deg., with a carefully-kept standard, which had been calibrated against the original "Element G" of the Day-Sosman high-temperature scale determination, confirmed by gold, silver and palladium meltings. The only remaining uncertainty in the temperature of the metal specimen lies in the difference of metal and thermometer, and since the temperature measurement in the furnace is the only appreciable source of error, this difference mainly determines the precision attained. This difference was directly observed by combining with the regular couple a differential couple of fine wire (0.2 mm.) running to a heavy-walled platinum cylinder in an unsealed silica tube. This platinum cylinder took the place of the nickel or Monel cylinder, which could not well be used in a tube left open for the passage of the wire. The results of two series of observations on two successive days are shown in Table I. There is a

TABLE I. TEMPERATURE DIFFERENCES BETWEEN THERMOMETER AND TEST METAL IN THE FURNACE

Nov. 12, 1920			Nov. 13, 1920		
Time, minutes	Difference		Time, minutes	Difference	
after reaching temp.	Microvolts	Degrees	after reaching temp.	Microvolts	Degrees
Temperature * from 1256° to 1262°			Temperature from 1253° to 1256°		
7	220	18	7	220	18
10	206		10	206	
15	191		15	191	
18	185	15	18	185	15
25	167	14	25	167	14
30	158		30	158	
34	148		35	149	12
41	137		40	139	
47	129	11	50	125	
52	121	10	..	..	
56	118		..	..	
Moved specimen and thermometer 4 mm.					
toward thermometer side of tube					
63	101	8	60	114	
Returned specimen and thermometer 2 mm.					
66	108				
70	106		70	106	
80	99	8	80	99	8
95	92		95	92	
120	81		120	81	
Temperature 1394° to 1399°					
3	101	8			
10	97				
18	92				
Moved specimen and thermometer toward					
thermometer side of furnace tube					
25	52				
33	46				
Moved specimen and thermometer 4 mm					
away from thermometer side of tube					
34	64	5			
41	54				
44	51				
Replaced them and opened top of furnace					
48	61				
54	49				
61	34	3			

About 12 microvolts = 1

* The time when 1,256 deg. was reached on Nov. 12 was not noted, since its importance was realized only as a result of the experiment of this day. This time is therefore inferred by comparison with the curve for the next day, and is doubtless affected by a small, unimportant error.

¹F. Wüst, A. Meuthen and R. Durrer, "Thermal Constants of Technical Metals," *Ver. deutsch. Ing. Forschungsarbeiten*, No. 204, 1918.

change with time which is sometimes greater than the minimum value of the temperature difference. The direction of this change shows that it cannot be due to the lag of the tube or metal. It arises no doubt from a very protracted warming up of the ends of the furnace. After the first ten minutes an uncertainty of ten minutes in time evidently produces less than 2 deg. error.

Three degrees was the greatest change in the differential temperature reading produced by shifting the tube 4 mm. A greater change might conceivably occur in practice from a tilting of the tube in the furnace, but 10 mm. was the maximum possible displacement in this case, and 8 mm. is more than is probable. The greatest error from this source, then, is not likely to be over 6 deg. These errors in temperature are, for timing, 0.14 per cent of the specific heat, and for position, 0.4 per cent. The agreement of the results, to 0.6 per cent or better in all the metal drops but one, with errors

TABLE II. RECORD OF THE OBSERVATIONS

Silica glass containers, blank

Serial number.....	10	11	12	16	21
Time at upper temp., minutes.....	25	17	10	30	35
Blank-thermometer, deg.....	14	16	8	6	5
Temp. of blank, deg.....	1271	1272	1404	1403	1402
Temp. fall, blank, deg.....	1248	1249	1380	1380	1379
Thermal leakage correction, deg.....	0.02	0.014	0.020	0.026	0.025
Corrected temp. rise, calorimeter.....	1.019	1.282	1.417	1.392	1.415
Total calories.....	2868	3609	3977	3919	3983
Calories calc. for Pt.....	992	994	1112	1094	1115
Total for glass blank.....	1876	2615	2865	2825	2868
Wt. of glass blank.....	5.822	8.076	7.868	7.710	7.835
Calories per g. glass.....	321.8	324.8	364.1	366.9	366.1
Calories per g. per deg.....	0.258	0.260	0.264	0.2653	0.2654

from every source included, confirms in an entirely independent way the estimates just made of the magnitude of the errors. It is clear that this applies to the systematic as well as the accidental error, since the only way for a systematic error to enter would be in case the temperature difference from thermojunction to metal were different during the initial test from its value at all other times. Any large variation of this sort is very improbable in view of the small magnitude of the observed discrepancies throughout the work.

EXPERIMENTAL RESULTS

In order to correct for the heat given out by the silica tube, trial tubes, loaded with the platinum cylinder, were dropped at two temperatures, 1,260 deg. and 1,400 deg. In this way the mean heat loss in the drop was also corrected for, and only the irregularity of this heat loss remained to affect the results, since this loss was not affected by having the metal inside the container. These tube determinations appear in Table II.

TABLE III. METAL TEST SPECIMENS

	—Monel Solid—			—Monel Melted—		—Nickel Solid—		—Nickel Melted—		—Nickel Poured—	
Serial number.....	8	9	20	14	15	13	15	18	19	6	7
Time at upper temp., minutes.....	45	15	30	25	25	23	30	27	17	.....	.....
Test-thermometer diff., deg.....	11	17	13	7	7	9	8	5	6	.....	.....
Temp. of test, deg.....	1267	1273	1270	1404	1403	1360	1359	1469	1469	1448	1448
Temp. fall test, deg.....	1244	1250	1246	1379	1378	1336	1335	1444	1443	.....	.....
Thermal leakage corr'n, deg.....	0.030	0.024	0.040	0.038	0.047	0.036	0.038	*	0.060	0.060	0.041
Temp. rise, calorimeter, deg.....	2.266	2.358	2.583	3.096	3.777	2.681	3.045	*	3.806	5.751	5.852
Total cal.....	6377	6641	7271	8725	10632	7547	8571	*	10713	16189	16474
Calc. for Pt.....	145	145	148	178	165	172	159	177	177	.....	.....
Calc. for glass.....	2185	1901	2828	3000	3515	2075	3464	3258	3305	.....	.....
Cals. metal.....	4048	4595	4293	5547	6952	5300	4948	*	7231	.....	.....
Wt. metal.....	25.330	29.075	27.112	22.892	28.527	29.591	27.508	26.972	27.114	60.27	62.15
Wt. glass.....	6.783	5.872	8.755	8.214	9.630	5.905	9.866	8.445	8.572	.....	.....
Cals. metal per g.....	159.8	158.0	158.3	242.3	243.7	179.1	179.9	*	266.7	268.6	264.8
Cals. per g. per deg.....	128.4	126.4	127.2	.....	.....	134.2	134.7	.....	.....	.....	.....
Total heat, solid calc. to upper temp.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Latent heat, mean.....	.....	.....	.....	175	68	.....	.....	194.0	73	191.3	77

*An accident stopped the stirring, but late enough in the experiment so that the uncertainty was only a part of the leakage correction, or about 1 per cent. Since the est. estimate proved to coincide almost exactly with 19, a repetition would have added little to the probable accuracy of the result as now given.

The results of all complete determinations, with the magnitude of all the important quantities concerned, are given in Table III.

The latent heats are found as the difference of total heat of fused metal and total heat of solid metal at the same temperature. It is well known that impurities cause an incipient melting which may falsify the observed specific heat of substances over a temperature interval of many degrees below the melting point. For this reason the observations on solid metal were taken at temperatures nearly 100 deg. below the melting point or interval, and these values were used to calculate the total heat up to the assigned temperatures of melting. The values of specific heat assumed over the calculated interval were taken, somewhat arbitrarily, as the mean specific heat up to the temperature of observation and were, for nickel, 0.134; for Monel metal, 0.128. Since the specific heats of these metals do not vary rapidly in this region, the assumption cannot involve appreciable error. The difference between the specific heat of solid and liquid metal, also, is small enough so that a variation of 20 deg. or so in the assigned melting temperature makes little difference in the heat of fusion of nickel, and the assigning to Monel of a latent heat at a single temperature, instead of over an interval, leads to a value for this latent heat which has nearly the precision of the observations and is positively defined. It seems impossible to do any better until we have more reliable values for the various specific heats concerned.

RESULTS FROM POURING MOLTEN METAL

Before the work in silica inclosures was undertaken, the total heat of melted nickel was found by pouring the metal directly from crucibles into the calorimeter, using the first appearance of solidification to indicate the temperature, which was therefore the melting point. About 60 g. was taken, and the rate of cooling of the charge was necessarily very rapid, perhaps over 100 deg. a minute. Some practice was required in catching the right moment for pouring; the last two samples left some solid metal behind in the crucible. These results are also given in Table III. The method, at the stage to which we carried it, was still somewhat subjective, and the excellent agreement with the electric furnace determinations does not so much add to these as show something of the excellence of the pouring method. These pouring results do, however, furnish a very convincing and largely independent confirmation of the others in so far as they indicate that Wüst's result for the total heat of melted nickel is too low by an amount corresponding to a temperature difference of about 120 deg. For two things show that the poured nickel in the two cases can hardly have been 120 deg. high, and probably

not 20 deg.: the fact that solid metal was left behind, and the fact that the measured gas furnace temperature was only 50 deg. above the melting point when the crucible was removed, to be cooled some seconds in the air before pouring. In a third pouring there was doubt about the weight of the metal, hence this is not reported. Thanks are due to A. F. Buddington, then of this laboratory, who attended to the furnace and the pouring while the temperatures were being read electrically in the room above, and to C. M. Saeger, Jr., of the Bureau of Standards, who furnished a number of small zircite crucibles which stood excellently the rather severe treatment involved in the manipulation. This pouring method is evidently not so well adapted to an alloy like Monel, which has a melting interval.

Analyses of specimen metals after the determinations, kindly furnished by the International Nickel Co., are given in Table IV. They seem to show quite clearly that appreciable oxidation, either of metal or impurities, did not occur in any case, and hence that no appreciable heat from this source falsified the determinations. There was, moreover, no opportunity for oxidation during the drop of the inclosed specimens, since the silica tube was usually heard to crack, under water, about a minute after it was dropped. The metal cylinders, weighed after the experiment, showed no change as great as

TABLE IV. COMPOSITION OF THE METAL SPECIMENS

	Specimen		Specimen	
	Before	After	Before	After
Copper	0.16	0.17	28.0	26.39
Nickel	99.1	99.62	63.0	69.83
Iron	0.35	0.40	2.0	2.53
Sulphur	0.02	0.020	0.03	0.47
Silicon	0.25	0.17	0.10	0.18
Carbon	0.10	0.10	0.18	0.15
Manganese		0.10	1.50	1.74

1 mg. for the unmelted specimens; after melting there were negligible changes of 10 mg. or less, and even these were probably due to reaction with the silica glass, of which there were clear indications.

WÜST'S METHODS

For comparison it seems desirable to review, briefly, Wüst's methods. His furnace was in a highly exhausted tube, which extended down into an ice calorimeter. The solid metals were ordinarily used bare, but were inclosed in silica glass when they were to be melted. Comparisons with the three solid metals silver, gold, copper up to 900 or 1,000 deg. showed no difference, due to inclosure, in the specific heat so observed. The furnace thermel—i.e., thermoelectric thermometer—which was, as in our work, alongside the specimen, was found to be at the same temperature. In these special tests, as in most of the regular observations, the agreement was usually to 1 per cent. The tests and agreements reported are thus entirely favorable.

The furnace, however, was entirely open at the bottom, which presumably caused much greater temperature differences through radiation than there were in our carefully partitioned furnace. The high vacuum should have greatly diminished conduction and convection of heat, leaving heat transfer dependent on radiation. This evidently has a tendency to make the temperatures of inclosed bodies depend more on that of distant objects and on possibly variable radiating power. In Wüst's calorimeter the specimen fell into a metal box with a sheet nickel lid, which, still surrounded by vacuum, rested in a glass tube. The heat transfer was thus probably almost entirely by solid contact and radiation, and would therefore tend to vary with slight changes in the lie of the specimens or in the character of their surfaces, causing variations in the amount of heat escaping upward. In our case the specimen was dropped at once under water, and most of the heat transfer was over in the first minute. Wüst's agreement with the work of others is not very good. For the six metals aluminum, chromium, cobalt, copper, nickel and silver he differs in every case by from 4 per cent to 8 per cent at 100 deg. from Tilden or Schübel, who usually agree with each other to 1 per cent.² At 500 deg. Wüst's discrepancy is less, but compared with specially accurate determinations in the Geophysical Laboratory, his value for silica glass, though high at 100 deg., is 5 per cent too low at 900 deg. He agrees to 2 per cent or better with our value for platinum from 200 to 1,400 deg.

EXPERIMENTAL DETAILS

Several features of the present apparatus and procedure were the same as used in 1908 and later,³ and are

²For a convenient tabulation of their data I am indebted to a valuable résumé of other work given by Wüst himself. In this, however, he compares indiscriminately his own and other results for silica glass ("quartz" glass) with results for crystalline quartz.

³Walter P. White, "Specific Heats of Silicates and Platinum," *Am. J. Sci.*, vol. 28, p. 331 (1909); "Some Calorimetric Apparatus," *Phys. Rev.*, vol. 31, p. 670 (1910); "Specific Heat Determination at Higher Temperatures," *Am. J. Sci.*, vol. 47, p. 44 (1919).

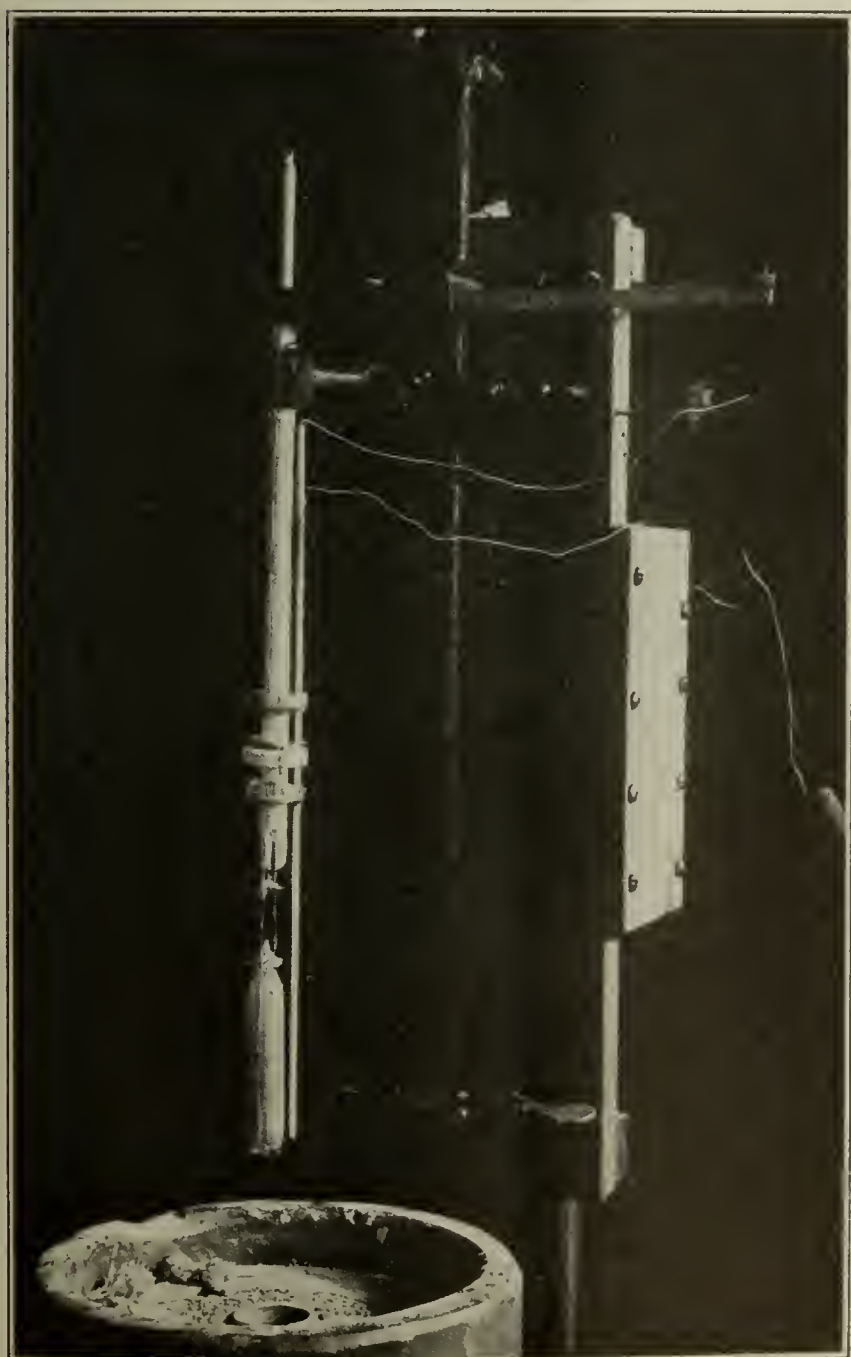


FIG. 1

Dropping mechanism, upper partitions, thermel and test objects inclosed in silica glass and suspended by platinum wires. The junction is a little too low in this view. The diameter of the larger Marquardt tube is 1 cm.

already published. Thus: (1) the dropping of the specimen was performed by a mechanical arrangement. (2) The lower partitions were first dropped into a box, the "swinging shield," which was then swung aside by hand to open the path to the calorimeter, and immediately returned to close it against radiation from the furnace. Thus neither furnace nor calorimeter needed to be moved. The motion of the shield operated the dropping mechanism. (3) The use of partitions has been mentioned, and so has (4) the method of eliminating the effect of the heat loss during the drop by subtracting the heat given to the calorimeter by the empty container. (5) The calorimeter temperature was read by a thermel (thermoelectric thermometer) to 0.0003 or 0.00025 deg.;

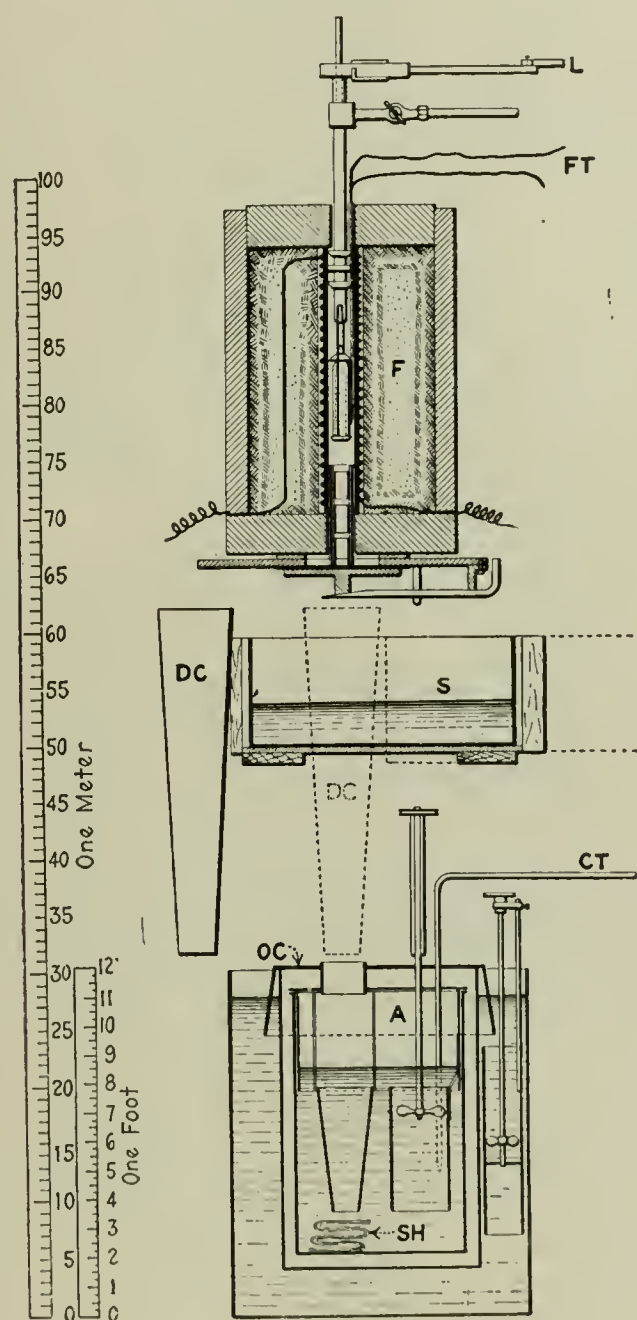


FIG. 2

Furnace *F*, with partitions, swinging shield *S* and calorimeter with jacket. *FT*, furnace thermel, one platinum-rhodium couple; *CT*, calorimeter thermel, 10 copper-constantan couples; *DC*, cone for directing the falling object also shown, dotted, in position for the drop; *L*, lever for rotating the inner rod in the dropping mechanism; *A*, air space above the water inside the calorimeter; *OC*, jacket cover of sheet copper 0.77 mm. thick; *SH*, cushion. Some supports are not shown. To scale, except that the furnace was 23 mm. higher than here represented.

(6) the thermal head (temperature difference of jacket and calorimeter) was measured directly. This facilitated the use of a calorimetric method which is especially advantageous where the calorimeter is opened to the air at the beginning of the experimental period.

Important differences from the earlier work were:

(1) The furnace chamber was narrower (2.8 cm.), which made for uniformity, though (2) this advantage was neutralized by the fact that the furnace coil was not concentrated at the ends. (3) The falling container was guided by a cone of coarse wire gauze, so that misdirected drops, a great detriment in the earlier work, were entirely avoided, while a smaller opening into the calorimeter could also be used. This cone was attached to the swinging shield and brought into place by it, being out of the way except when the shield was near the position for the drop. Wire gauze was used instead of sheet metal to prevent the reflection of radiant energy from the furnace down the cone into the calorimeter; its use also tended to diminish the amount of cold material touching the hot container in its fall. (4) The calorimeter top was arranged so as largely to prevent loss of heat as the container went into the water. In our earlier work there was merely a device for returning to the calorimeter the bulk of the water thrown up in the splash; the amount of steam produced was slight, and was expected to be fairly constant for a given temperature of the container; such constancy was all that was necessary in the method used. The results obtained with the older arrangement, however, indicated very strongly⁵ that inconstancy in the heat loss at the water surface was the main source of error, sometimes reaching 1 per mille. The manipulation of the splash-restraining device also delayed the closing of the calorimeter. In the present set-up the calorimeter cover, Fig. 2, comes 7 cm. above the water, so that under it is a space of about 1,100 c.c. from which little steam or splash water escapes through the narrow opening which admits the test specimen. This cover is of heavy copper 0.77 mm. thick, so that in temperature it is always practically a part of the calorimeter surface.

The dropping mechanism (Figs. 1 and 2) was simpler and much more compact than that described in 1918, and contained no platinum.⁶ It consisted of a tube of Marquardt mixture 10 mm. in diameter slotted after the plan of a bayonet joint, so as to hold the horizontal platinum wire which was the top of the container hanger, but so as to let this drop when it was rotated into the vertical part of the slot. The rotation was accomplished by a Marquardt rod, slotted at the bottom to take the wire.⁷ Of a number of test drops made outside the furnace, all landed within 2 cm. of the perpendicular after falling 50 cm.

DETAILS OF CONSTRUCTION

The furnace tube, platinum winding and alundum cement used to hold this, all formed a compact tube only 6 mm. in wall thickness. Outside this was calcined magnesia. At the ends were Buffalo fireclay disks

⁵Walter P. White, "Specific Heat Determination at Higher Temperatures," *Am. J. Sci.*, vol. 47, p. 55 (1919).

⁶Marquardt mixture is a remarkably valuable material for structures such as these dropping mechanisms. It keeps its form and enough of its strength indefinitely at high temperatures, probably as high as 1,500 deg.; and when in the form of tubes 2 mm. thick and 10 mm. in diameter can be repeatedly withdrawn from the furnace at 900 deg. without injury. Platinum, however, becomes soft and tends to stretch or loosen at high temperatures, enough so that structures fastened with it rapidly become disarranged and need frequent overhauling.

⁷This mechanism proved the most satisfactory of three that were tried. It was suggested by H. S. Roberts of this laboratory. It could not well have been constructed without a diamond saw. The two others were easier to make. Each had about half of the outer tube ground away for a centimeter or so from the lower end, leaving a projecting lip. In one an inner tube or rod had a notch for the wire; as this rod was rotated the projecting lip pushed the wire free. In the other mechanism the wire rested in notches in the exposed edges of the lip and was pushed out by forcing a Marquardt wedge down the tube. The wedge frequently stuck. A stop is also necessary in front of the notches to keep the wire from leaving one, turning on the other as a pivot, in which case it may drop prematurely or not at all.

⁸Walter P. White, "Some Calorimetric Methods," *Phys. Rev.*, vol. 31, p. 547 (1910).

3 cm. thick. Once when the upper one of these was removed neither furnace temperature (1,394 deg.) nor temperature distribution showed any change exceeding 2 deg. for fifteen minutes. Apparently the disk was a heat distributor as much as a heat insulator. Advantageous modifications of the end construction could doubtless be made.

The furnace stood on an iron plate, which had a hole under the furnace opening. A removable plate closed this hole till the time of the drop. All joints between and above the plates were carefully sealed with asbestos paper or rope, since a very slight upward current of air through the furnace may seriously affect the temperature distribution.

The silica containers were supported by a platinum wire loop passing under the bottom. Small, nearly horizontal, platinum disks at top and bottom still further cut off radiation to the colder furnace ends. The two wires, each 0.6 mm. in diameter, supported over 35 g. for nearly an hour at 1,460 deg. without perceptible stretching.

In order to minimize strain on the somewhat delicate dropping mechanism, the following precautionary features were introduced:

(1) The supporting surfaces along which the wire slid when rotated were not horizontal, but inclined so as to favor turning without causing it.

(2) The rotating force was applied at the end of a rather long (12 cm.) lever, by means of a string passing over a pulley to a weight which fell as a loose piston through a cylinder of water; thus giving a very even motion with little side pressure on the rotating rod.

(3) In preventing rotation during the preliminary manipulations no clamp was applied to lever or tube, but the far end of a rod was fastened whose other end was loosely pivoted to the lever. A suitable stop would probably have been still better.

SUMMARY

By the common method of dropping from a furnace into a calorimeter, the latent heats of nickel and of Monel metal have been determined, and their specific heats for the intervals to 1,360 and 1,260 deg., respectively. The metals were protected against appreciable oxidation by sealing into silica glass containers. The precision of the temperature measurement was studied, and the results indicate a final accuracy of better than 1 per cent. This indication tends to be confirmed by the agreement of all the determinations but one, which was 1.3 per cent divergent. Several determinations were made by pouring directly into the calorimeter nickel just ready to solidify, giving agreement to about 2 per cent with the furnace results. The latent heat of nickel, 73 calories per gram, is 17 calories greater than the recent determination of Wüst. The latent heat of Monel, 68 calories, is in excellent agreement with that of nickel.

The International Nickel Co. furnished material and analyses for this study, and bore part of the direct expense.

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Lithium Minerals in 1920

According to the Geological Survey, 11,696 short tons of lithium minerals valued at \$173,002 was produced in 1920. Lepidolite from the Stewart mine at Pala, Cal., was used in glass manufacture, while spodumene from the Etta and Swanzey mines, near Keystone, S. D., was used in the manufacture of various chemicals.

Physical Properties of Molybdenum Steel*

BY ARTHUR H. HUNTER

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MOLYBDENUM steels, as a class, when compared with other alloy steels which are in the same category from a commercial standpoint, treated to the same tensile strength, show:

1. A slightly higher elastic limit, hence a somewhat higher elastic ratio.
2. A higher elongation, hence greater ductility.
3. A much higher reduction of area, hence appreciably greater toughness.

This latter property is probably the most pronounced individual physical result of the addition of molybdenum to steel. From a great deal of data covering these three points, the writer has chosen the following tests, made under the supervision of Dr. J. S. Unger of the Carnegie Steel Co., as exemplifying them in the simplest manner.

Five steels, embracing only the accepted commercial tonnage types, analyzing as shown in Table I, were all heat-treated to give the same tensile strength—i.e.,

TABLE I. ANALYSES

Type of Steel	C	Mn	Ni	Cr	Mo
1. Carbon.....	0.62	0.45			
2. Chrome.....	0.49	0.53		0.60	
3. Nickel.....	0.40	0.65	3.61		
4. Chrome-nickel.....	0.43	0.57	1.60	0.46	
5. Chrome-molybdenum.....	0.32	0.72		0.80	0.27

approximately 125,000 lb. per sq.in. The results were as shown in Table II.

Compared with the carbon steel, the chrome-molybdenum showed 33 per cent increase in elastic ratio, 16½ per cent increase in elongation and 56 per cent

TABLE II. PHYSICAL PROPERTIES

Type	Tensile Strength, lb. per sq. in.	Elastic Limit, lb. per sq. in.	Elastic Ratio	Per Cent Elong. in 2 in.	Reduction of Area, per cent	Red Foot-Lb.
1. Carbon.....	126,175	84,380	66.9	18.0	43.6	5.0
2. Chrome.....	125,300	107,225	85.6	18.0	56.5	66.5
3. Nickel.....	127,975	112,525	87.9	18.8	51.4	54.5
4. Chrome-nickel.....	127,975	111,025	86.8	19.8	60.3	54.0
5. Chrome-molybdenum.....	125,650	112,250	89.3	21.0	68.0	90.0

increase in reduction of area. Compared with the nearest alloy steel, the chrome-molybdenum showed 1.7 per cent increase in elastic ratio, a little over 6 per cent increase in elongation and 12.8 per cent increase in reduction of area. The tensile strength of all these steels having purposely been made the same, the only possible variables were these three.

In direct relation to the foregoing it should be noted that tests by the Izod machine on these steels showed chrome-molybdenum to possess a resistance to impact of eighteen times that of the carbon steel and 34 per cent greater than the nearest alloy steel. As the impact test merely measures the work of rupture under a suddenly applied load, these results, which have been amply corroborated, clearly show the cumulative effect of the higher elastic ratio, elongation and reduction of area for a given tensile strength possessed by the

*Portions of a paper read before the American Iron and Steel Institute, May 27, 1921.

molybdenum steels. Bending tests further bear this out.

In order to give an idea of how the chrome-molybdenum series of alloy steels compares with chrome-vanadium steels, a comparison of two types of each follows. The data on both of the chrome-vanadium steels are taken from a recent booklet published by the Vanadium Corporation of America presenting charts plotted by the metallurgical department of the United Alloy Steel Corporation. The data on both of the chrome-molybdenum steels were furnished the writer by the metallurgical department of the same company. Both series of tests were made on steels manufactured in the open hearth.

TYPE 1—0.40 TO 0.50 CARBON						
Type	C	Mn	Cr	V	Mo	
Chrome-vanadium.....	0.47	0.85	1.19	0.15	.....	
Chrome-molybdenum.....	0.41	0.68	0.95	.....	0.24	
Sections $\frac{1}{2}$ in. round, quenched in oil from 1,560 deg. F. (V) and 1,500 deg. F. (Mo). Drawn to show tensile strengths indicated.						
Type	250,000 lb. T. S.			225,000 lb. T. S.		
	E. L.	El. %	R/A.	E. L.	El. %	R/A.
Cr-V.....	215,400	11.0	38.5	201,000	12.3	42.3
Cr-Mo.....	222,000	9.0	43.5	201,000	10.3	47.9
	175,000 lb. T. S.			150,000 lb. T. S.		
	E. L.	El. %	R/A.	E. L.	El. %	R/A.
Cr-V.....	157,300	15.0	60.5	137,500	17.7	62.8
Cr-Mo.....	163,400	15.5	59.3	141,200	18.7	63.4

It should be noted that the molybdenum content of both of these types of the chrome-molybdenum steel is extremely low. For a comparison on a purely commercial basis steels containing double the above content of molybdenum and showing higher physical properties might well have been used. Considering the lower manganese, chromium and molybdenum contents of the last-mentioned molybdenum steel, a comparison between its properties and those given in the table of Dr. Unger is interesting.

It has been stated above that the physical properties of molybdenum steel were progressively better as the molybdenum content is increased up to 1 per cent, and the table of properties below is presented to illustrate this point:

Sections from which the test-pieces were cut were $1\frac{1}{2}$ in. round or $1\frac{1}{2}$ in. square, quenched in water from 1,550 deg. F. to 1,600 deg. F., drawn to show a tensile strength of 175,000 lb. per sq. in.

ANALYSIS RANGE			
C	Mn	Cr	
0.28 to 0.36	0.44 to 0.64	0.70 to 1.04	
PROGRESSIVE EFFECT			
	Mo 0.20	Mo 0.40	Mo 0.76
Elastic limit.....	167,000	164,000	162,000
Elongation, per cent in 2 in.....	13.5	16.6	19.5
Reduction of area, per cent.....	52.0	58.4	61.0

For a constant tensile strength and very nearly constant elastic limit the ductility of the steel is greatly increased by the addition of molybdenum from 0.20 up to 0.76. Conversely, of course, by employing suitable drawback temperatures, for a given ductility the elastic limit and tensile strength will show an increase in like manner.

The comparative effect of increased section on chrome-molybdenum and chrome-vanadium steels is shown by the following average results on different

sizes of both, taken from test-bars cut from commercial stock:

ANALYSIS RANGE					
	C	Mn	Cr	V	Mo
Chrome-vanadium.....	0.23 to 0.30	0.60 to 0.80	0.70 to 1.00	0.15 to 0.20	.....
Chrome-molybdenum.....	0.23 to 0.30	0.60 to 0.80	0.70 to 1.00	.....	0.25 to 0.35

EFFECT OF SECTION									
Size	Elastic Cr-V	Limit Cr-Mo	Tensile Cr-V	Strength Cr-Mo	Elastic Ratio Cr-V	Elastic Ratio Cr-Mo	Elongation Per Cent Cr-V	Elongation Per Cent Cr-Mo	Reduction of Area Cr-V
$1\frac{1}{2}$ -in.	134,200	134,800	153,200	156,200	87.6	86.2	16.8	16.8	57.1
$1\frac{1}{4}$ -in.	123,100	132,300	145,500	153,700	84.7	86.3	15.8	16.3	55.8
$1\frac{3}{8}$ -in.	116,900	133,500	150,300	153,200	77.7	87.1	15.1	16.8	53.2
$1\frac{1}{2}$ -in.	103,200	124,600	137,500	152,200	75.3	81.9	14.0	16.3	46.3

The more complex quaternary alloy steels containing molybdenum show extremely high characteristics, as will be seen by reference to the following tables. Both of these steels can be drawn back to better than 1,000 deg. F. before the tensile strength falls below 200,000, and to 900 deg. F. before the elastic limit falls below this figure. The steel containing nickel exhibits remarkable physical properties at low drawing temperatures such as are employed in the production of oil-hardened gears, whereas the steel containing vanadium possesses greater possibilities at the higher drawing temperatures:

	C	Mn	Cr	Ni	V	Mo
Chrome-nickel-molybdenum (1).....	0.44	0.42	0.99	2.04	.....	0.36
Chrome-vanadium-molybdenum (2).....	0.38	0.60	1.00	.....	0.18	0.80
Sections, $\frac{1}{2}$ -in. round (1), quenched in oil from 1,450 deg. F., and $1\frac{1}{2}$ -in. round (2), quenched in oil from 1,600 deg. F., both drawn as indicated.						

RESULTS OF TESTS ON (1) CHROME-NICKEL-MOLYBDENUM STEEL				
Drawing Temp., Deg. F.	Tensile Strength	Elastic Limit	Elongation, Per Cent in 2 In.	Reduction of Area, Per Cent
400	336,600*	302,000*	10.0*	22.4*
600	275,000	241,000	11.3	43.0
800	240,000	220,000	12.0	46.0
1,000	204,000	185,000	15.0	51.0
1,200	152,000	134,000	20.5	61.0

* Section treated 0.505 in. round.

RESULTS OF TESTS ON (2) CHROME-VANADIUM-MOLYBDENUM STEEL				
Drawing Temp., Deg. F.	Tensile Strength	Elastic Limit	Elongation, Per Cent in 2 In.	Reduction of Area, Per Cent
600	243,000	217,000	9.0	38.2
800	225,000	207,000	10.8	45.4
1,000	210,000	197,000	14.0	52.5
1,200	186,000	174,000	18.2	59.7

A low-carbon steel to which about $\frac{1}{4}$ per cent molybdenum is added possesses extreme ductility, which makes it particularly adapted in sheet form to the manufacture of pressed steel parts and at the same time when heat-treated is capable of showing fairly high physical properties. Tests made on such a sheet steel test-piece $1\frac{1}{2}$ in. wide by 9 in. long follow. The quenched specimen was cooled in water from 1,600 deg. F. and then drawn to 900 deg. F.

ANALYSIS			
C	Mn	Mo	
0.164	0.45	0.226	
Thickness of Sheet, In.	Condition	Elastic Limit, Lb. per Sq. In.	Per Cent Elongation in 2 In.
$\frac{1}{8}$	As rolled	45,640	44.5
$\frac{1}{8}$	Quenched	120,470	7.5

Molybdenum steels also have the property of deep hardening, especially noticeable in the chrome-molybdenum series. Their properties are developed at higher drawing temperatures than employed with other steels, a fact directly related to their greater toughness and resistance to fatigue.

Dunkirk, N. Y.

Boiler Feed Water Purification

An Outline of the Respective Merits of the Various Methods Used for Boiler Feed Water Treatment, With Special Reference to the Advantages of the Zeolite Water-Softening Process

BY S. B. APPLEBAUM

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THE present-day means used for purifying boiler feed water can be grouped into three distinct classes—namely, boiler compounds, precipitation apparatus and zeolite apparatus. Each of these means has its advocates, and the following outlines the advantages and disadvantages of each and points out which is relatively important and which unimportant, especially from the practical operating viewpoint.

BOILER COMPOUNDS

The use of boiler compounds means the treatment of the water inside the boiler as differentiated from the use of water-softening apparatus which completes the treatment before the water enters the boiler. A great variety of substances have been employed for this internal treatment. Among them may be mentioned soda ash, caustic soda, barium compounds, graphite, tannin, kerosene, slippery elm, glucose, etc. Proprietary secret compounds are usually made up of a mixture of one or more of these substances.

In general, the action of boiler compounds may be divided into two classes:

1. The reduction of hardness by chemical reactions which is exemplified by the use of soda ash and caustic soda.

2. The mechanical action on the scale with the intention of coating the grains to interfere with their close cementation. This is typified by the use of tannin, graphite, slippery elm.

The claims that the action of the second class of compounds was mechanical rather than chemical had a certain appeal to the operating engineer, to whom chemistry has been and still is somewhat of a mystery. The general failure of such compounds to fulfill the fantastic claims made for them has imparted an unscientific atmosphere to the field of internal boiler treatment.

The nature of the chemical reactions with the feed water, however, when boiler compounds of the first class are used is in the same general class with those involved in a precipitation water-softening plant. The important difference is that the precipitates formed by the reactions with the boiler compounds enter the boilers, whereas in the case of the precipitation water-softening plants the precipitates are removed from the water by settling and filtration, only the clear softened water entering the boilers.

The boiler compound advocate makes three claims: First, that the resultant precipitates form a sludge inside the boilers less compact than the scale formed by the hard water and that therefore the first cost or investment in settling tanks and filters may be saved by using the boiler itself as a settling basin. Second, more accurate proportioning of the chemicals is accomplished than in precipitation plants. Third, boiler com-

pounds save the loss of water wasted in washing filters and sludging off settling tanks of precipitation plants.

In answer to these claims the following considerations must be taken into account:

Sludge in a boiler will accumulate and will bake together into a hard layer and the reagents added in general increase the amounts of deposits and the burden of solid content which the boiler has to bear. To maintain the high boiler efficiency to which modern power plant practice has attained, it is essential to maintain the heating surface absolutely clean both inside and outside. It is just as necessary to prevent sludge accumulating on the wet side of the heating surface as it is to keep soot off the dry side. If efficiency is not a consideration, if labor for cleaning is negligibly cheap and if fuel be plentiful and extremely low in price, then the use of boiler compounds may be permitted, but these conditions, although they may have been found formerly, no longer exist today.

Regarding the second claim, of greater accuracy of proportioning, this is difficult to substantiate. The same problem exists in both cases of adding definite amounts of certain chemicals in accordance with the composition of the incoming water and also to proportion the volume of chemical solution to the volume of water to be treated. A general inspection of the usual boiler compound feeding devices and of the precipitation plant chemical feed controls will disclose a contrast in favor of the latter from the point of view of refinement, mechanical ingenuity and reliability of action. Furthermore, it is possible to check up the results of treating a water in precipitation water softeners by analyzing the effluent before it enters the boiler and so adjust the treatment until the desired results are obtained. By using boiler compounds it is possible to check up on the efficacy of the dosage only by inspecting the boilers after they are taken "off the line."

The third claim is correct, but offsetting it is the loss of heat in the water blown off from the boiler. If the boiler is to receive the precipitates, and the sludge formed by the boiler compound is not to accumulate, it must be blown off. The heat lost in the blowoff water above 250 deg. F. required to sludge off the boiler is one of the most serious penalties incurred by the use of the boiler itself as the precipitation tank.

PRECIPITATION WATER SOFTENERS

Precipitation water softeners embody the main principle of adding prescribed amounts of definite soluble chemicals, usually lime and soda ash, to react with the hardening compounds of the raw water.

There are two main divisions of precipitation plants—namely, intermittent and continuous. The former consists of two or more settling tanks, one filling and receiving its charge of chemicals while the other is

being used to deliver treated water to service. In this way each tank goes through a cycle of operations—filling, charging, agitating, quiescent settling and finally emptying. The continuous plants usually have one settling basin, and the water flows continuously from inlet to outlet, receiving the charge at the inlet, settling as it flows and after filtering leaves at the outlet completely treated.

Intermittent plants are preferred for the treatment of waters which vary in composition between wide limits because the average composition of a tankful of water can be determined irrespective of the variations that may have taken place as the tank was being filled.

Some continuous plants have heaters ahead of the settling tanks and permit the reactions and settling to take place at boiling temperature. Although this gives a resulting effluent of lower hardness and a smaller settling tank is permissible because of more rapid reactions, the loss of heat by radiation from the settling tanks and filters and also by losing hot water in sludging off and washing of filters must be considered.

ZEOLITE WATER SOFTENERS

Zeolite plants accomplish the removal of the hardness by percolation of the water through a bed of zeolite material suitably supported and distributed in a closed or open container with piping and valves attached to the container properly to distribute and control the flow of water. The hardness is removed from the water by the well-known zeolite exchange principle, the zeolite exchanging its sodium base for the calcium and magnesium bases in the water. A meter is provided to indicate when the softener has passed the quantity of water it was designed to soften. The zeolite bed is then automatically regenerated or revived by passing a solution of salt (common brine) through the softener. The brine, by a reversed exchange reaction, gives its sodium base to the zeolite, and as it leaves the softener it carries with it in a clear solution the calcium and magnesium extracted from the zeolite. Where 24-hr. operation is required, one softener treats the water while the other is regenerated and they are consequently switched at proper intervals to provide continuity of operation. A tank is provided to make the brine and its flow to and from the softeners is automatically accomplished by properly designed equipment which forms an integral part of the modern zeolite softener. The zeolite is then rinsed free of brine and the softener is again thrown into service by opening the necessary valves.

SPACE REQUIRED FOR WATER SOFTENERS

For cold-precipitation plants it is customary to allow a minimum of four hours for the reactions to take place and the precipitates to settle. This means a tank or basin holding four hours' supply of water. For a capacity of 10,000 gal. per hour a 40,000-gal. tank would be required, say 15 ft. in diameter by 32 ft. high. This is generally too large to be accommodated in existing buildings. It must be located outside and thus involves extra land, foundations and housing, all of which should be added to the cost of the apparatus when making comparisons.

Zeolite plants accomplish complete removal of the hardness in several minutes; for example, a water of 10 grains of hardness per gallon is softened to zero hardness in approximately ten minutes. For a capacity of 10,000 gal. per hour and for an average water of 10

grains per gallon of hardness a zeolite softener 10 ft. in diameter by 10 ft. high would be required. This can usually be housed in an existing room, thus saving land, special foundations and extra housing.

Precipitation settling tanks or basins are open, and it is therefore generally necessary to install additional pumping equipment.

Zeolite plants can be and generally are built to withstand existing water pressures and the water passes through the softeners to service without the need for additional pumps. This not only saves initial investment but saves an appreciable operating charge.

OPERATION OF PRECIPITATION WATER-SOFTENER PLANTS

In the operation of precipitation plants, it is necessary to make a chemical analysis of the raw water and a determination of the purity of the chemicals in order to calculate the correct charge of lime and soda ash or other reagents to react with the varying composition of the raw water. Many water supplies are drawn from surface sources such as rivers or ponds. The volume of water in these supplies varies with the seasons and with the rainfall. Sudden storms have been known to change the mineral content of a stream completely in a few minutes. If too little chemical is added to the water the hardness is incompletely reduced and if too much chemical is added an objectionable amount of the excess of chemicals is left in the treated water. The addition of too great an excess of lime may even form a harder water than the original supply, since lime, besides being caustic, is also a form of hardness. The writer has analyzed samples before and after several precipitation plants where this condition was found to exist. The operator must therefore be alert and skilled to control the treatment properly.

Besides the need for skilled supervision to apportion the chemical dosage to suit the composition of the raw water, there are various mechanical problems to solve. Sludge disposal from the settling tanks frequently clogs sewers and some city ordinances prohibit dumping sludge into sewers on this account. This frequently entails sludge collection in pits and removal by digging out periodically and carting away to disposal dumps. The mechanical problem also exists of feeding the chemicals at a rate in proportion to the rate of the raw water flow. This involves a form of meter for the water and a meter for the chemicals. Since the chemicals are usually fed in the form of a suspension of particles or a milk, the meter itself may become coated with the particles, with a resultant change in the rate of chemical dosage. The complexity of this chemical feed problem from the mechanical point of view is evidenced by the many hundreds of devices that have been developed and patented to date.

OPERATION OF ZEOLITE WATER-SOFTENER PLANTS

The operation of zeolite water softeners marks a radical departure from the precipitation process. The water is distributed uniformly through the bed contained in the zeolite apparatus and in its passage through the bed of zeolite the hardness is completely removed, the calcium and magnesium entering the grains of the zeolite by chemical exchange for the sodium which the grains give up to the water. No sludge is formed and no problem of sludge disposal exists. No chemicals are added and the mechanical problem of controlling the feed of chemicals is avoided. The zeolite, an insoluble reagent, reacts completely with the relatively

small quantity of the salts of calcium and magnesium in the water.

This zeolite exchange principle or reaction is of universal occurrence in the fertilization of soils where the soil absorbs the potassium salts from the fertilizer by a similar chemical exchange.

The fact that the zeolite is insoluble makes possible this complete removal of the hardness from the water without the possibility of there being an excess of reagent in the softened water. The volume of the zeolite used is greatly in excess of the theoretical quantity required for the reaction and thus by mass action drives the chemical exchange—i.e., the softening action—to the end point of zero hardness water.

Slight amounts of hardness in the effluent of some zeolite softeners have been noticed in some cases;¹ but this can mean only that the particular zeolite softeners examined were improperly designed and that the volume of a proper grade of zeolite used was not in sufficient excess so that the softener was seriously overloaded.

If a zeolite softener is greatly overloaded it acts exactly as most mechanisms and structures used in engineering work under excess load. If precipitation water-softening plants are overloaded, the reactions are not completed in the settling tank and the resulting precipitates collect in the outgoing pipe lines, heaters, boilers, etc. A zeolite softener has a definite duty to perform, and if that duty is seriously exceeded the worst possible effect that can result is the production of a water with a slight residual hardness. If the size of the zeolite softener is correctly selected to take care of the required volume of water containing a known hardness, the effluent of the softener is always of zero hardness.

The capacity of a zeolite softener plant varies approximately in inverse proportion with the hardness of the raw water. If the zeolite apparatus is properly designed to take care of the owner's requirements of volume of water and hardness of raw water this is the most notable of advantages.

RELATIVE RESULTS OBTAINED IN PRECIPITATION AND ZEOLITE WATER-SOFTENER PLANTS

Precipitation plants reduce the hardness of the water to 4 to 5 grains per gallon in the cold, and 2½ to 3 grains at boiling temperature. The reason for these limitations is to be found in the character of the reagents used and in the resulting reactions. In order to drive any chemical reaction to its limit an excess of the reagents is required. But since lime and soda ash are soluble reagents, this excess is found in solution in the treated water, and if too great, renders the treated water unfit for industrial or domestic use. Furthermore, some waters offer great resistance to the action of reagents. The resultant precipitates, calcium carbonate and magnesium hydroxide, sometimes form very slowly and remain in a colloidal condition and thus slip through the filters into the service lines. In the *Engineering News Record* of Jan. 13, 1920, this colloidal condition is reported in connection with the municipal precipitation plant of the City of Columbus, Ohio. A hardness of 100 p.p.m., or 6 grains per gallon, was found present in the softened water as a result of this colloidal condition. The precipitates themselves are also soluble to the extent of several grains per gallon,

so that it is theoretically and actually impossible, even if the reactions could be driven to completion, to produce zero hardness water by the precipitation process.

Zeolite plants produce zero hardness water because the zeolite is insoluble and a great excess may therefore be employed without appearing in the softened water.

COMPARATIVE COST OF OPERATION OF PRECIPITATION AND ZEOLITE WATER-SOFTENER PLANTS

The relative cost of the reagents used in the treatment by the precipitation and zeolite processes depends on the local market prices of hydrate of lime, soda ash and salt and also on the composition of the raw water.

The market prices today average about 1c. per lb. for hydrate of lime; 2½c. per lb. for soda ash and 1c. per lb. for salt. One pound of hydrate of lime added to 1,000 gal. will react with about 8 grains per gallon of temporary hardness. One pound of soda ash added to 1,000 gal. will react with about 6 grains per gallon of permanent hardness. One pound of salt will regenerate a volume of zeolite that has softened a thousand gallons of water containing about 2 grains per gallon of either temporary or permanent hardness. Therefore for temporary hardness: 1 lb. lime at 1c. reacts with 8 grains, or about 12c. per grain; 1 lb. salt at 1c. reacts with 2 grains, or about 6c. per grain. Lime treatment is therefore half as costly as zeolite softening for temporary hardness. For permanent hardness: 1 lb. soda ash at 2½c. reacts with 6 grains, or about 4c. per grain; 1 lb. salt at 1c. reacts with 2 grains, or about 2c. per grain. Soda ash treatment is therefore twice as costly as zeolite softening for permanent hardness. Waters therefore which contain equal amounts of temporary and permanent hardness can be treated at the same cost by either method. But as the permanent hardness rises in proportion to the temporary hardness present softening becomes more economical by the zeolite process.

In making the above calculations no account has been taken of the fact that softening with lime and soda ash leaves 4 to 5 grains of hardness in the treated water. For example, if the raw water has an average of 14 grains per gallon of hardness, of which 8 grains may be temporary and 6 permanent, the lime and soda ash cost of treatment is about 3½c. per thousand gallons. But if 4 grains are left in the soft water, only 10 grains have been removed, so that per grain of hardness removed the cost is 0.325c. The same water would be totally softened by the zeolite process for about 2.8c. per thousand gallons, which establishes a cost of 0.2c. per grain of hardness removed.

CASES WHEN THE COMBINATION OF THE PRECIPITATION AND ZEOLITE PROCESSES IS ECONOMICAL

Waters containing extremely high amounts of temporary hardness—for example, more than 25 grains per gallon—and at the same time containing relatively low amounts of permanent hardness—say, less than 10 grains per gallon—are economically treated as far as cost of chemicals are concerned by using lime and soda ash, but if in such cases the volume of water to be treated is fairly large the most economical treatment is obtained by combining the precipitation and zeolite processes, using the lime to reduce the temporary hardness and the zeolite to remove the permanent hardness and to finish the incomplete work of the lime. Thus one can select what is advantageous from both processes and at the same time produce a water of zero hardness.

¹"A Comparison of Various Methods of Water Purification," W. M. Taylor, CHEM. & MET. ENG., vol. 24, No. 3, Jan. 19, 1921, p. 123.

The precipitation plant reduces a portion of the hardness and the pretreated water then passes to the zeolite plant, where the work of softening is completed. This also insures the reduction of the total solids of the water by the precipitation and removal of the greater part of the bicarbonates or temporary hardness. A number of combined lime-zeolite plants of this nature have been in operation in the United States for years.

RELATIVE INFLUENCE OF VARIOUS FACTORS ON FOAMING

It is falsely claimed that zeolite softened water increases the tendency of boilers to foam, on the consideration that the sodium salts have a heavier molecular weight by about 5 per cent than the corresponding calcium or magnesium salts. This is a chemical super-refinement inasmuch as the blowoff from the boilers maintains concentrations of total solids in the boiler salines considerably below the foaming concentration limit so that variations of 5 per cent in the total solids of the feed water are negligible by comparison.

Offsetting this possible 5 per cent increase in total solids is the very important fact that the water in a boiler fed with zero water is clear and free from particles of suspended scale and sludge or mud. And experience proves that the tendency to foaming is greatly increased by the presence of such suspended matter. This is illustrated also by the fact that when scaled boilers are suddenly fed with softened water, the scale which is loosened by the action of the soft water forms just such a suspension of particles and for a short period foaming is experienced. As soon as the boilers are thoroughly clean, however, they remain clean thereafter and the water inside the boiler clears up and the foaming ceases. A regular blowoff schedule can then be worked out to suit the operating conditions of the boilers in question, taking cognizance of the steam disengaging velocity and design of the boiler, all of which influence the limiting concentration of the boiler salines. Testing blowoff water with standard hydrometers should also be made standard practice to check up on the blow-off schedule.

Oil, organic and saponifiable matters are especially provocative of foaming. This is illustrated by a plant in Ohio using zeolite softened water in Sterling boilers of 1,000 h.p. total at high ratings with a water containing 25 grains per gallon total solids. No foaming was experienced during the summer on 100 per cent makeup, but in winter, when returns of 50 per cent from a heating system were used, foaming was observed. The returns lowered the solids in solution, but contained oily sludge previously deposited. As the heating system cleared up, this winter foaming disappeared.

NEED OF ZERO HARDNESS BOILER-FEED WATER

It is sometimes claimed that a feed water containing as much as 4 to 5 grains of hardness per gallon does not form a sufficient deposit in boilers to warrant consideration. Practical experience, however, proves that such a water is not satisfactory for boiler-feed purposes. When the statement is made that boiler compounds are good enough, that statement is linked with the past when the United States was an agricultural and not an industrial nation. Our national power requirements demand the highest degree of power plant operating efficiency. The time has passed when coal and oil were cheap and could be wasted. The recent war has demonstrated the ever-growing scarcity of fuel and the importance of conserving our natural resources.

The tendency today is toward boilers of ever-increasing size up to 1,000-hp. units operating with automatic stokers, at 200 to 300 per cent of normal rating and at very high pressures and superheat. This has developed an entirely new set of conditions.

Higher temperatures are being produced in the furnaces and far greater quantities of heat are being transmitted through the heating surfaces. Therefore greater care must be exercised in keeping the heating surfaces as clean as possible to avoid all danger of overheating the metal. Such immense boilers cannot be thrown off the line for repairs with the ease of former days. They are expected to run continuously for considerable periods without shut-down. What was good enough ten years ago with small boilers at low ratings, low pressure and low efficiency can no longer be countenanced. A water containing 5 to 6 grains per gallon of hardness in a 1,000-hp. boiler running at 300 per cent rating deposits in one day 220 lb. of scale on the inside of the boiler. In ten days more than a ton of scale would coat the heating surfaces. This certainly is not "good enough." The limit of hardness in the feed water must obviously come down to zero.

The Association of Central Power Plant Operators gave its opinion on this point in *Power* for June, 1916, in describing the results obtained from a water softener in a large central power station in New York operating on New York City's supply of 2 to 3 grains per gallon:

The results obtained develop a fact that is of great interest—that scale will form where boilers are operated at such high rating as 200 per cent—if the water contains a hardness such as is usually obtained in the average water-softening plant. That is, boilers will not be free from scale if fed with a water of 4 grains hardness; therefore a greater refinement must be obtained to meet this condition. The demand for 200 per cent rating is growing as more and more plants are being built to operate at that rating and greater care will have to be taken to put into such boilers water containing the least possible hardness.

CONCLUSION

In conclusion, the use of boiler compounds for the treatment of boiler-feed water can no longer be recommended in view of the disadvantages resulting from this internal boiler water treatment. The recent demand for increased efficiency for boiler plants, the increase in the size of the boiler units being put into operation, and the tendency which has developed of increasing the rating at which the boilers are operated, make it especially necessary to keep the boilers free from any deposits. These same developments in boiler-operating practice have also created an unmistakable demand for a water as free from hardness as can be produced in order to maintain the heating surfaces perfectly clean.

The design of a water-softening plant to produce this zero hardness water depends on the composition of the raw water. If the hardness of the raw water is predominantly temporary in character and the amount of water to be treated is fairly large, the most economical type of treatment is the combination of lime-precipitation followed by zeolite water softening. If the proportion of the temporary hardness in the raw water is much below the proportion of permanent hardness present, straight zeolite treatment is to be preferred.

Frequently also, irrespective of the composition of the raw water, a preference has been clearly found to exist for the straight zeolite treatment due to its simplicity, certainty of action and freedom from the problem of sludge disposal, chemical feeding and after reactions common to precipitation water-softening plants.

Forest Products Laboratory Plans Work for the Year 1921-22

AS RECENTLY noted in the news columns of CHEMICAL & METALLURGICAL ENGINEERING, the appropriation for the coming year allotted to the Forest Products Laboratory, Madison, Wis., has been increased \$100,000 for the year 1921-22.¹ New activities have been planned in the carrying out of research along present lines as noted in the following paragraphs:

WOOD MANUFACTURING WASTES

Of new work greatest emphasis will be placed on investigations to reduce the waste of two-thirds which now occurs in manufacture between the standing tree and rough, seasoned lumber, and of the further waste of from 10 to 15 per cent or even more in the remanufacture of rough lumber into final products. This means that approximately 75 per cent of the volume of every tree cut is wasted in manufacture before the final product is reached. High lumber prices and shortages of many important species of wood have made the question particularly acute.

The first phase of the problem to be undertaken will be to determine the possibility of cutting what is called dimension material—i.e., the exact sizes to be used in manufacture—direct from the log for furniture makers, wood turners and many other industries rather than first into lumber. For example, it is reported that in the manufacture of hickory handles two tons of material in the form of lumber is sometimes required to produce 400 lb. of handles, and in the furniture industry from 40 to 60 per cent of the lumber purchased is lost in various stages of manufacture. It is believed that manufacture directly into dimension material will materially reduce this waste. A systematic survey of waste which occurs in wood-using industries as contrasted with requirements will be undertaken in order that a market may be found in some industries for the waste in others. This is an exceedingly complex problem with great opportunity for saving. The possibility of a uniform system of lumber grading to replace the present multiplicity of systems will be studied in the interest of greater simplicity for the consumer, and second, to make possible the effective application of strength data, particularly in connection with municipal building codes.

PULP AND PAPER

Pulp and paper investigations will also be extended. Present processes employed in producing chemical pulps, which now use nearly 4,000,000 cords annually, convert less than 50 per cent of the raw wood into paper. An attempt will be made through research to reduce this enormous waste. Preliminary experiments indicate that increased yields can be obtained and that the wood now wasted can be saved and valuable chemical constituents reclaimed. Other preliminary investigations indicate the possibility under a modification of the sulphate pulp process of producing book and other high-grade paper from such resinous woods as Southern pine. The high prices now being paid by publishers and the great economic importance of making possible the utilization of a large amount of material now wasted justify this work on an enlarged scale. Fully \$5,000,000 worth of pulp is now lost annually by decay and a still

greater value of pulpwood decays through improper methods of handling. Investigations already under way to reduce this decay should be enlarged and continued. Twenty-thousand dollars of the proposed increase is needed for these urgent pulp and paper problems.

TIMBER TESTING

In timber testing it is desired to take up the development of methods for built-up and laminated construction, which offer great possibilities of utilizing small sizes and material now waste or of little value. Success for such articles as wagon parts and structural members depends upon comparative strength and permanence as compared with solid pieces, the development of improved glues or other satisfactory methods of fastening and a general industrial modification of existing standards and practice. The work is of particular urgency at the present time because of high prices and scarcity of high-grade material, and the difficulty in securing many kinds of timber formerly common.

The testing of large-sized columns will be undertaken. No data are now available on the strength of such columns, and it is necessary for safety to use considerably larger sizes than would be required if accurate strength data were available. A large amount of additional testing is necessary on wooden boxes and crates and fiber containers. The \$55,000,000 paid by the railroad companies in 1918 in claims resulted largely from faulty containers, and this is only one phase of the loss from this cause for which the consumer pays. Tests are needed on a large number of containers representative of different classes of commodities. Also, the fundamental relationship of kind and thickness of wood, nailing and strapping of the container to the size and weight of the contents will be investigated. Such data will have an almost universal application in placing boxing, crating and packing on a sound technical basis.

WOOD DISTILLATION

Chemical utilization offers probably the greatest opportunity of utilizing wood waste. In addition to work on pulp and paper problems, that on the manufacture of ethyl or industrial alcohol should be enlarged. Several millions of gallons of ethyl alcohol is now manufactured annually from wood in two plants in the United States. Investigations by the Forest Service have reduced operating costs at the larger of the two plants by 9c. a gal., and were an important factor in its success. Ethyl alcohol manufacture is important as a possible means of utilizing sawdust in mill waste, and the process offers a possible substitute for gasoline as fuel if through research production costs can be sufficiently reduced and manufacture made possible at small plants with low assembling costs. Investigations of hardwood distillation have increased the number of species which can be utilized from three to eight, have shown how without increasing operating costs yields of acetic acid and methanol can be increased 15 per cent, and more recently have shown how yields of methanol can be increased on an experimental scale by 50 per cent through the addition of one chemical. Since methanol can be obtained only from the distillation of wood, is essential in many basic chemical industries and can be made to utilize low-grade wood unsuitable for other purposes, the enlargement of investigations of this character is exceedingly desirable.

¹See CHEM. & MET. ENG., March 30, 1921, p. 579.

Finally, much of the progress in all investigations of chemical utilization of wood will in the future depend upon a more advanced knowledge of the chemistry of wood. Additional work will therefore be undertaken into the fundamental chemistry of wood and its principal groups of constituents. The findings will be of immense value in pulp and paper making as well as in

all of the other chemical industries which use wood as a raw material.

DRYING RESEARCH

Improved methods of drying designed to reduce the largely unnecessary annual \$50,000,000 loss in the seasoning of lumber have been developed on thirty-five woods, including Douglas fir, Southern pine, spruce,

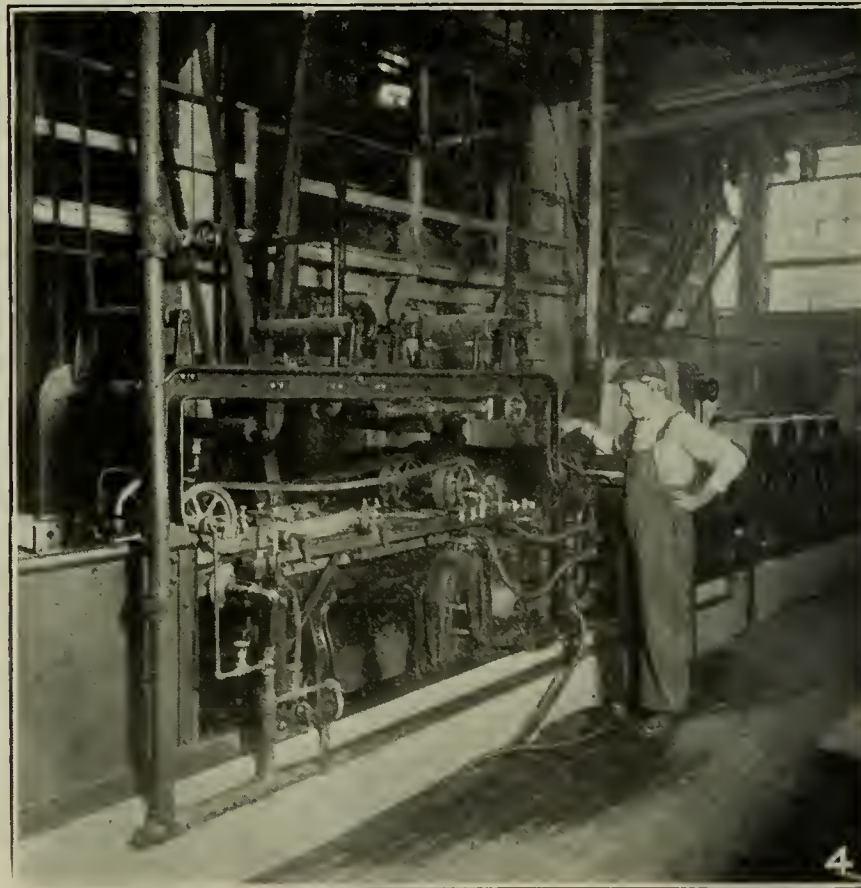
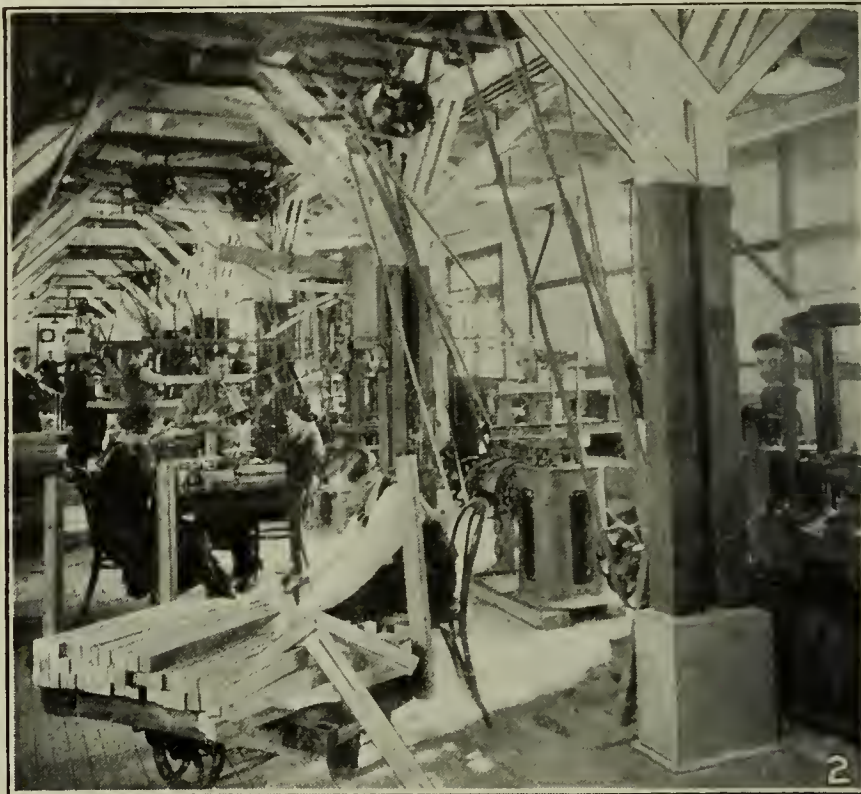


Fig. 1. Temporary quarters of timber testing department—The demands for information from the Forest Products Laboratory have been so great that this temporary building, formerly used as a war training barracks, was occupied. The tower in the foreground houses the 1,000,000-lb. universal testing machine recently installed. The double doors on either end can be opened to allow the testing of large members. Columns 30 ft. long and 12 in. square can be tested to destruction in this machine.

Fig. 2. Testing wood at a known moisture content—The strength of wood varies with the moisture content and the density (dry weight) of the piece. The importance of these two laws has been fully established by more than 500,000 separate tests of wood samples at the U. S. Forest Products Laboratory, Madison, Wis. From these tests and other data the density rules for grading Southern yellow pine and Douglas fir structural timbers were developed. This density rule provides a visual method of estimating the density of wood by relative proportions of springwood and summer wood (hard-growth rings and soft-growth rings) that shows on the end of a stick. The man in the foreground is marking a tested specimen for the moisture determination to be made by the girls in the immediate background. Moisture content is the difference between a given moisture condition and the oven-dry weight. The moisture content is dependent upon the atmospheric conditions of the place where the wood is stored.

Fig. 3. Erecting a million-pound testing machine—This million-pound capacity universal testing machine is to be used in studying full-size timbers. The influence of defects, such as knots, on strength is one of the important investigations contemplated. Columns 30 ft. long and 12 in. square can be tested to destruction in this machine. The part of the machine on which the man at the left is standing weighs 12 tons. The whole machine weighs 80 tons. The machine is of universal type, making tension and compression tests with equal facility.

Fig. 4. Experimental paper machine—This miniature machine can turn out a 16-in. strip of paper at the rate of 40 ft. a minute. It is equipped with both Fourdrinier and cylinder wet ends and it is used in determining the paper-making qualities of native woods. Such information is urgently needed at present on account of the rapidly diminishing supply of the woods commonly used for the manufacture of paper pulp.

gum and many of the oaks. Further improvement in methods must come through the determination of the limitations and possibilities of present types of dry kilns and their improvement, a wider knowledge of essential drying conditions for all our woods, and research into such fundamentals as the relation of moisture in the natural laws which govern the seasoning of wood. Present losses are an added production cost and also a wholly unnecessary drain on our forest resources, most of which can be eliminated by research.

WOOD PRESERVATIVES

Further work is also planned on the development of various classes of wood preservatives. There is a large loss of timber in wharves, docks, etc., caused by marine borers. It is now possible to study the activities of these borers and to attempt the development of the preservatives only in the San Francisco Bay region, where conditions are particularly acute. The study will soon be extended to cover other points on the Pacific, Atlantic and Gulf coasts.

Efforts will also be made to develop a cheap, odorless preservative against wood decay suitable for wood used in exposed situations in such structures as houses, which will take paint and which can be supplied in quantity.

The accompanying photographs and descriptions give some idea of the equipment at the laboratory available for this work.

Cadmium in 1920*

BY C. E. SIEBENTHAL AND A. STOLL

THE production of cadmium, either as the metal or as the sulphide, has been reported by the companies in the following list, which shows also the nature of the metallurgic plant in connection with which the cadmium plant is operated:

PRODUCERS OF CADMIUM IN THE UNITED STATES IN 1920

Company	Location of Plant	Associated Plant
American Smelting & Refining Co.	Denver, Col.	Lead smelter
Grasselli Chemical Co.	Cleveland, Ohio	Chemical works
Krebs Pigment & Chemical Co.	Newport, Del.	Lithopone plant
Midland Chemical Co.	Argo, Ill.	Lithopone plant
U. S. Smelting, Refining & Min. Co.	Kennett, Cal.	Electrolytic zinc plant
U. S. Smelting, Refining & Min. Co.	Midvale, Utah	Lead smelter

Of these the plant at Kennett, Cal., was reported to have made no output in 1920. The lead furnaces at the Globe plant of the American Smelting & Refining Co., at Denver, have been closed for some years, but stocks of cadmiferous residues remain from former operations and more has been shipped in from other plants of the company.

MANY PLANTS HAVE PROCESSES FOR RECOVERING THE METAL

Several other electrolytic zinc plants and lithopone plants save cadmium-bearing residues and have worked out processes for recovering the metal, so that an extension of the uses of cadmium and an increased demand for it would result in additions to the list of producers. Several companies that produce cadmium-bearing residues sell them to the producing companies named above.

In 1918 a canvass was made of lead smelters, electrolytic zinc reduction and refining plants, lithopone plants, and a few typical brass works, with the object

of ascertaining the yearly recovery of cadmium in fumes and residues, the accumulated stocks of such materials, and the maximum yearly capacity of the cadmium-reduction plants.

CADMIUM ACCUMULATING

According to the data obtained, cadmium is accumulating at lead smelters at the rate of 350 to 400 short tons annually, and the stocks of bag-house fumes contained more than 750 tons of cadmium. At electrolytic zinc plants about 200 tons is accumulating annually and the stocks of residues contained about 400 tons. At lithopone plants probably 50 tons is produced annually and about 25 tons was contained in stocks. In round numbers, then, 600 short tons accumulates annually, and there was on hand in 1918 approximately 1,200 tons in stocks of fumes and residues. Not all the stocks are rich enough for the cadmium to be commercially recovered, but perhaps material that carries 1,000 tons is suitable for treatment. The average recovery of cadmium is about 75 per cent. We may therefore estimate that 750 tons of recoverable cadmium in residues was in stock in 1918. At some electrolytic zinc plants the cadmium in the residues is wasted in recovering copper and lead.

CAPACITY FOR METALLIC CADMIUM

The maximum capacity for metallic cadmium reported by producers is 29,000 lb. a month, or about 175 tons a year. If the price of cadmium and the demand for it should justify expansion the producing capacity could no doubt be brought up with reasonable promptness to 500 short tons or more yearly. The price of cadmium will be the deciding factor also in determining what grade of cadmium fumes can be worked at a profit.

USES FOR CADMIUM

The alloys of cadmium most generally used are the easily fusible alloys used in the tips of automatic sprinklers, in safety plugs for boilers and in electric fuses; cadmium cliché metal for stereotype plates, and solders in which cadmium is substituted for part or all of the tin commonly used.

A fraction of 1 per cent of cadmium is used as a deoxidizer in making bronze telegraph and telephone wires and cables in France and Italy. The larger part of the cadmium exported from the United States goes to France. Cadmium is also used as a deoxidizer in making nickel alloys and may serve a like purpose in making brass.

A newer use for cadmium is in making small-arms ammunition. A cadmium band on the hard-jacketed cartridge ball takes the rifling with little wear on the barrel and thus prolongs the life of the gun.

ELECTROPLATING OFFERS PROMISING FIELD

Cadmium electroplating is a field that offers some promise of expansion. Cadmium is a better rust preventive than nickel, and at more nearly a parity in prices cadmium plating might be substituted for nickel plating on some articles. Or, as it has a greater tendency to tarnish than nickel, it might be used in combination with nickel, the first coat consisting of the rust-preventive cadmium and the second coat of the tarnish-proof nickel.

The Udyllite Process Co., of Kokomo, Ind., has developed a commercial method for electroplating iron and steel articles with cadmium and is prepared to grant licenses for its use.

*Advance sheets; Mineral Resources, 1920, Part I.

Heat-Treatment of High-Speed Steel Cutting Tools of Intricate Design

BY A. J. LANGHAMMER

MODERN manufacturing methods, especially where the principles of quantity production are applied, demand tools capable of continuous heavy duty performance. High-speed steel is the natural material from which such tools are made, and this article is limited thereto. Big production methods necessitate huge supplies of cutting tools. The specific type the writer has in mind is such cutting tools as taps, threading dies, hobs, broaches and special form cutters.

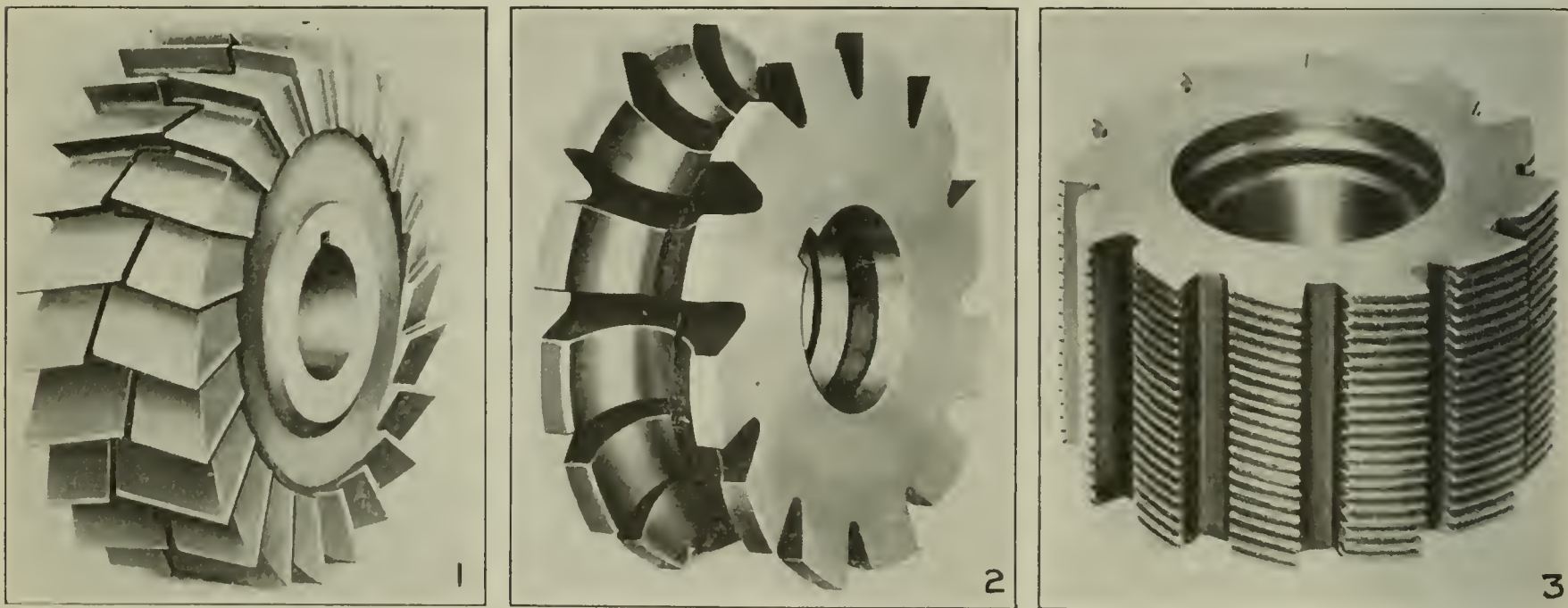
Attention is invited to the included photographs, Figs. 1, 2 and 3, of three special cutting tools. By an inspection of Fig. 2 it is at once obvious that any defect in the curved cutting edges greatly reduces the service of the tool, if it is not totally destroyed. In Fig. 1 this is not true to such a great extent. However, it is well known that no consumer will accept defective tools. Fig. 3, on the other hand, illustrates a type in which the tool hardener has little or no leeway. Such defects as pitting, deformation, dull or crushed edges absolutely incapacitate the tool. The importance of correctly heat-treating special cutting tools is therefore readily seen.

The machining of such special cutting tools offers no great difficulties—it is only in the hardening where trouble begins. In tool shops and large industrial

design made from the same brand of steel and even the same bar, where all precautions were taken to eliminate the variables affecting cutting speed and the only factor not a constant was that of the hardening method. Results have convinced him that the open-fire hardening method was undoubtedly the best, whenever the necessary care and skill was applied.

The reason for this is that in pack-hardening the temperature to which the tool is subjected is pure guesswork and is practically beyond control. Then, too, we have that important element—the time factor. When we consider that the heat-treatment of high-speed steel calls for a preheat of 1,450 deg. F. or thereabout, and then a *rapid heating* to exactly the "sweat point," the above statement is easily substantiated. Discoloration is somewhat under control by the tool hardener, and different brands of steel "clean up" better; however, pack-hardening generally gives a cleaner job, although with the open-fire method slight polishing, pickling, or sand blasting after quenching gives a superior product.

It should be noted, moreover, that the hardening of cutting tools of intricate design by the open-fire method is the acme of high-speed tool hardening. Only with the very best of care and closest attention are excellent results obtained. It is for this sole reason that the pack-hardening process was ever brought into practice. When the open-fire method is used, it is necessary to have a rich flame and all possibilities of oxidation must be eliminated. The temperature must be closely ob-



SPECIAL CUTTING TOOLS

plants one or both of two general hardening methods are used—i.e., "pack-hardening" or "open fire." By open fire is meant any method employing a muffle, or semi-muffle furnace, or a blacksmith's forge. Pack-hardening, of course, is used in the sense that is always understood, the packing material being carbonaceous material.

The following advantages are claimed for each method by their proponents, and it will be noted that they are practically identical:

PACK-HARDENING	OPEN-FIRE HARDENING
1-a—No scaling or pitting.	2-a—No scaling or pitting.
1-b—Little or no deformation.	2-b—Little or no deformation.
1-c—Absence of objectionable discoloration.	2-c—Maximum hardness (red-hardness).
1-d—Preserving of original sharp cutting edges.	2-d—Preserving of original sharp cutting edges.
1-e—Uniformity of product.	2-e—Uniformity of product.
1-f—Better cutting qualities.	2-f—Better cutting qualities.

For a number of years the writer has had occasion to observe the performance of cutting tools of intricate

served, and the tool quenched just before the "sweat point" is reached. The transfer of the tool from the furnace to quenching tank or lead pot must be quickly executed. Care must be exercised that no obstruction is met in the transfer, as the least impact will destroy the cutting edge. When this is done, the advantages listed as 2-a, 2-b, 2-d, 2-e and 2-f are obtained and in addition the most desirable one of maximum red-hardness. The writer has met one or two tool hardeners who regularly achieved good results with pack-hardening because of their uncanny skill. But this is the exception that merely proves the rule.

When an intricate cutting tool is correctly hardened by the open-fire method, it will permit greater cut speeds, longer periods between regrinds, produce a finer product, give a greater life, and therefore will yield a bigger production at reduced factory costs.

Detroit, Mich.

Legal Notes

BY WELLINGTON GUSTIN

Non-Delivery Under Installment Contract Not Justified by Non-Payment for Past Delivery

The liability of a manufacturer for failure to deliver agreed installments under a contract was the subject of an action before the Court of Appeals of Georgia, *Smith versus Harrison et al.*, 106 S. E., 191. The court's rulings and holdings were substantially as follows:

In a contract of sale an obligation by the seller to deliver to the buyer by a certain date a gross quantity of a certain product for a certain estimated price, as 1,000 gross of glass containers at some agreed rate per gross, but which must be delivered in certain stipulated quantities periodically at certain designated periods, is entire, and a failure by him to make any one of the deliveries at the time agreed upon amounts to a breach of the entire obligation and gives to the buyer the right to elect to bring suit before maturity for such damages as he may have sustained by reason of such breach. (*Phosphate Mining Co. vs. Atlantic Oil & Fertilizer Co.*, 93 S. E., 532.)

In such an action the buyer may recover such damages as he would have sustained by non-performance by the seller of his obligations upon their maturity—viz., the difference in the contract price and the market value at the time and place of delivery subject to a reduction (of damage) by any circumstances of which the buyer ought reasonably to have availed himself or did avail himself to reduce or mitigate his loss. And it is no defense to the seller and no ground for a reduction in the buyer's damage that the latter contracted for the product for a purpose not mentioned in the contract, and that he had no use for it, or that he failed to go into the market and buy elsewhere.

That where the seller defaulted in making a periodic delivery under the contract a demand by the buyer that the seller perform his obligation does not amount to a waiver by the buyer of his right to sue for the entire breach upon the seller's refusing to comply with such demand.

In the instant case the seller contended he had a right to refuse further deliveries under the contract because the buyer had failed to make payment for a past delivery. Assuming that the seller could so justify his refusal to make further deliveries, yet, says the court, since the parties to a contract may in the course of its execution depart from its terms and pay or receive money under such departure without any right in the other party to treat such departure as a violation or breach of the contract, in the absence of reasonable notice of his intention to do so given by the other party, the seller cannot, after having acquiesced in such departure and having failed to give such notice to the buyer, justify his refusal to comply with his obligation to deliver under the terms of the contract upon the ground that the buyer has failed to make payment for a past delivery.

Further it was claimed there was a tender of the product by the seller to the buyer. The contract provided that delivery was to be made at such place as the buyer may direct. Where no place is agreed on, under

the statute sold goods must be carried to the person entitled to them, if residing within the state. There being nothing in the nature of the product or in the contract from which another place of delivery could be inferred in the absence of any direction from the buyer as to the place of delivery, to constitute a valid tender the product should have been carried to the buyer in person, but the carriage to his place of business, in his absence and without his knowledge, did not constitute a valid tender under the contract.

Judgment against the seller was affirmed.

When Mechanical Equipment Does and When It Does Not Become Fixtures

The manufacturers of chemical machinery are often confronted with the question of whether title to machinery sold by them and installed in plants may be retained, and whether attempts to retain are defeated by installing of the machinery. The question is a big one with many angles, and facts in any particular case might remove it from the operation of the rules as generally laid down.

Some propositions of the law involved came up in the recent decision in the action by the Atlantic Refining Co. against H. Flinberg to recover a tank, pump and equipment. Defendant claimed possession and title to the property, because after it was placed upon the land it became fixtures, and title passed when he purchased the real estate upon which the chattels had been placed by the company, the purchase of the real estate being made without notice that the seller had consented that the chattels should not become fixtures at the time of installation. Therefore, for lack of notice to him when he purchased the real estate, the equipment passed to him with the title to the real estate.

The company contended that defendant had notice or knowledge that the equipment was its property and therefore was not an innocent purchaser and for this reason it did not pass to defendant when he purchased the real estate.

The company brought its action in replevin. The court stated that the action of replevin lies for the possession of goods and chattels unlawfully detained from the owner or the person entitled to the possession thereof. The primary object of the action is the recovery of the property itself with damages for the taking and detention thereof. Secondly, the object is the recovery of a sum of money equivalent to the value of the property.

THE LAW OF FIXTURES

In this case defendant claimed the equipment involved constituted what is known in the law as fixtures. The court says a fixture has been defined as a thing which, though originally a movable chattel, is, by reason of its annexation to land, regarded as a part of the land, partaking of its character and belonging, in the ordinary case at least, to the person owning the land. The owner of a chattel and the owner of land may agree that the annexation of the chattel to the land shall not change the legal character of the chattel or affect its ownership, and such an agreement is generally regarded as valid between the parties. Where, however, the land passes into the ownership of a third person, not a party to such an agreement and without notice or knowledge thereof, the purchaser of the land is not bound by such an agreement, but is entitled to the thing annexed to the land, as forming a part of the land. If any sub-

stantial part of the complete equipment necessary for the use of the chattels in question was fastened or attached to the freehold in a permanent manner, then all is to be considered as so attached and also everything used in working it.

Notice or knowledge on the part of the purchaser of real estate relative to an agreement respecting the title to fixtures on the premises purchased being in some person other than the owner of the real estate would be actual notice or knowledge of the fact or such information of a reliable character with respect to the ownership as would impose upon him the duty of making inquiry as to the actual ownership of the fixtures upon the land.

In the instant case the court said that if the purchaser, defendant herein, did not have notice, and was an innocent purchaser for value, then the title to the chattels would pass to him with the title to the land, but if he had notice and knowledge of the fact that the fixtures in question belonged to somebody other than the person from whom he purchased the land, then he would not be an innocent purchaser for value, and as between the true owner and himself the true owner would be entitled to the possession of the property.

Any notice, or knowledge of any fact, that would put him upon inquiry as to the ownership of the property would place a duty upon him to inquire and ascertain, if possible, the true owner; and the question of this notice or knowledge is ordinarily one of fact to be determined by a jury, where such fact is in dispute.

The court decided that defendant herein had such a notice and that therefore the equipment was not a fixture passing with the title upon the sale of the land.

Synopsis of Recent Chemical & Metallurgical Literature

A Theory on the Gradual Hydrolysis of Certain Salts.—The hydrolysis of salts being an ionic phenomenon, it would follow that such a reaction ought to be extremely rapid in all cases; but experience has proved that there are salt solutions whose hydrolysis is slow and may still continue even after many months. It has been found that all the salt solutions presenting this anomaly contain some of the acid or base in colloidal suspension; it would seem, therefore, that there is a relation of cause and effect between the presence of a colloid and the slow hydrolysis. A theory underlying this fact has been advanced by A. TIAN in a note presented before the French Academy of Sciences (*Comptes rendus*, May 9, 1921, pp. 1179-1181). He states that the extremely fine particles of the colloid unite to form grains of increasing sizes, which for a given mass present gradually decreasing surfaces, and that the hydrolysis of a salt is limited by two reactions, both of which reproduce the salt and the water with the acid or base freed during hydrolysis. The first reaction would take place in the aqueous phase between ions, this being exactly the reverse of hydrolysis. The second reaction, which he calls "supplementary retrogradation," takes place between the insoluble and liquid phases by the action of the other soluble element of the salt. The velocity of this reaction diminishes when the space between the two phases decreases and it follows that the hydrolysis slows down with the evolution of the colloidal solution. To prove this theory he has established experimentally that:

Slow hydrolysis is a function of the polymerization of the colloid and that there is effectively a regeneration of the salt by a reaction in which the colloid takes part. In the

first case he has utilized the very interesting properties of gels which hinder the displacement of colloidal particles, and by using gelose, animal gelatine or silica to produce a solidified state he stopped the hydrolysis. In the second case he was able to vary the rate of the hydrolysis by varying the amount of the colloid.

Electrochemical Industries.—The June, 1921, issue of *General Electric Review* contains an article by JOHN A. SEEDE in which there is an interesting summary of developments in the electrochemical industries. Electrothermic applications such as those used for smelting, melting and refining of various metals and alloys are of increasing importance. The first electric furnaces for melting and refining steel when introduced about 1904 were generally regarded as laboratory curiosities. Today we have furnaces with three electrodes normally rated at 40 tons holding capacity and capable of pouring 65 tons. During this period brass-melting furnaces have been developed and their adoption has far outstripped that of steel furnaces.

The author classifies the products of the principal electrochemical industries into electrothermic and electrolytic products. The electrothermic products are alundum, calcium carbide, calcium cyanamide, carbon bisulphide, ferro-alloys, graphite, iron, nitrates and nitrites, phosphorus and barium oxide. The electrolytic products include aluminum, caustic soda and potash, electrolytic iron, lead, magnesium, chlorine, chlorates and perchlorates, hydrogen and oxygen.

The following table lists these products with the approximate energy consumption required for their production. The author assumes the power to be furnished at \$20 per horsepower-year and from this he derives the percentage of the market price represented by the cost of power. This power cost, which is obviously obtainable in but a few localities, is used throughout the calculations in order to obtain comparable data.

ELECTROCHEMICAL PRODUCTION COST OF VARIOUS MATERIALS

Material	Kw.-Hr. per Ton	Present Market Price of Product	Cost of Power per Ton	Per Cent Cost of Power to Market Price
Aluminum.....	30,000	\$570	\$90.00	15.80
Alundum.....	2,000	60	6.00	10.00
Barium oxide.....	1,200	*	3.60	*
Cadmium.....	2,500	2,200	7.50	3.40
Calcium carbide.....	4,000	80	12.00	15.00
Calcium cyanamide.....	3,750	300	11.25	3.75
Carbon bisulphide.....	850	160	2.55	1.60
Carborundum.....	8,500	*	25.50	*
Caustic soda 2 000 lb. Chlorine, 1,760 lb. }	3,000	{ 72 } 220	90.00	30.80
Copper (electr ly ic ref.).....	300	240	.90	0.38
Copper (electroly ic).....	2,600	240	7.80	3.25
Ferrocromium (60%).....	8,000	180	24.00	13.30
Ferromanganese (76%).....	5,000	90	15.00	16.6
Ferromolybdenum (60%).....	8,400	3,000	25.20	0.84
Ferrosilicon (50%).....	5,000	80	18.00	22.50
Ferrosilicon (75%).....	10,000	135	30.00	22.20
Ferrotungsten (70%).....	7,600	700	22.80	3.25
Ferro-uranium (40%).....	8,600	4,800	24.00	0.50
Ferrovandium (35%).....	6,800	3,500	20.40	0.58
Graphite.....	7,800	200	23.40	11.70
Iron (elce rothermic).....	2,500	*	7.50	*
Iron (electroly ic).....	4,000	*	12.00	*
Lead.....	145	70	4.35	6.20
Magnesium.....	27,000	2,500	81.00	3.24
Nitric acid.....	17,500	*	52.50	*
Phosphorus.....	12,000	720	36.00	5.00
Potassium chlorate.....	1,350	150	4.05	2.70
Sodium.....	20,000	400	60.00	15.00
Sodium chlorate.....	7,000	170	21.00	12.30
Tin.....	175	570	0.525	0.09
Zinc.....	4,000	120	12.00	10.00

* Figures not available.

In like manner the second table compares the electrothermic melting and refining of a number of metals and alloys. The power cost is figured at 2c. per kw.-hr. throughout, and the percentages are, therefore, probably somewhat more in accord with actual practice.

ELECTROTHERMIC MELTING AND REFINING OF METALS

Material	Kw.-Hr. per Ton	Market Price per Ton		Power Cost at 2c.	Per Cent Cost of Product
		Raw Materials	Product		
Aluminum.....	500	\$570	\$1,200	\$10.00	0.80
Brass.....	300	200	600	6.00	1.00
Bronze.....	330	300	800	6.60	0.82
Cast iron.....	450	25	90	9.00	10.00
Cast steel.....	600	25	150	12.00	8.00
High-speed steel.....	750	400	1,500	15.00	1.00

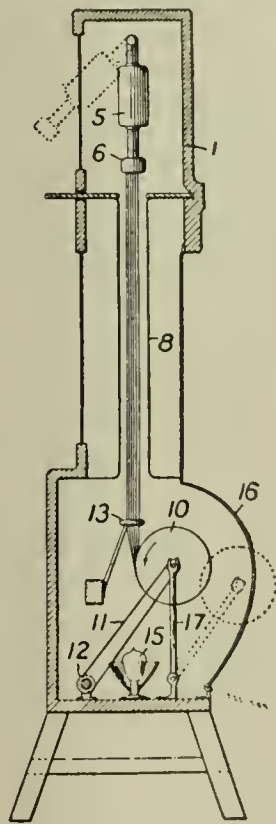
Recent Chemical & Metallurgical Patents

British Patents

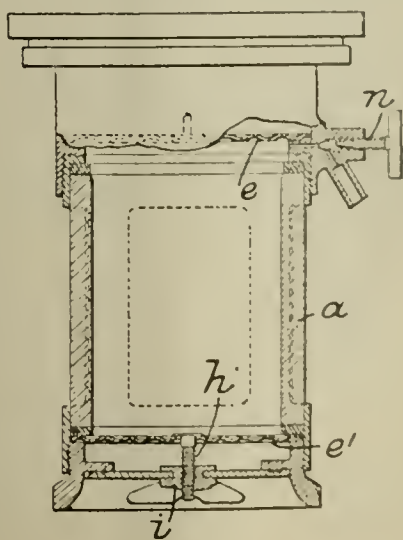
For complete specifications of any British patent apply to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Monoazo Dyes.—Monoazo dyes are obtained by coupling *o*-diazophenols, *o*-diazonaphthols, or their nitro, sulphonic, or carboxylic derivatives, with 4:6-diamino-1:3-xylene. According to examples, the diazo compound of picramic acid, and the diazo compound of 5-nitro-2-aminophenol, prepared by diazotizing 2:4-dinitraniline in sulphuric acid solution and pouring the product into ice-cold sodium carbonate solution, are employed; the resulting dyes give orange-brown and brown shades on wool with chrome mordants. (Br. Pat. 160,848; G. T. MORGAN, Birmingham, and BRITISH DYE-STUFFS CORP., LTD., London. May 19, 1921.)

Artificial Silk.—Artificial silk threads obtained by squirting a solution of cellulose acetate or other cellulose ester in a volatile solvent are prepared in a completely finished condition by passing the threads on leaving the squirting nozzle through gases or vapors such as sulphur dioxide, carbon dioxide or air which may be heated, or through an exhausted chamber, and then leading them directly to the winding or spooling apparatus. As shown, the parts of the apparatus are inclosed in a casing 1; in the top of the chamber is the combined squirting nozzle 6 and filter 5, arranged to swing outward, and the threads pass through a tube 8, then through a guide 13 traversed by the winding mechanism, or to a reel or spool 10 located in the lower part of the casing, mounted on a pivoted carrier 17, and driven by a belt 11, from a shaft 12; access to the reel is obtained by a door 16. In the lower part of the casing is an electric lamp 15 which causes a current of hot air to pass up the tube 8; and this tube may be warmed by a coil. The squirting nozzles may be located in the lower part of the casing, or the threads may be projected in a horizontal direction; and the threads may be stretched or twisted before reeling. (Br. Pat. 160,859; G. F. J. BOUFFE, Derby. May 19, 1921.)



Gas Analysis Apparatus.—An apparatus for analyzing gases comprises a receptacle *a* containing an absorbent for the constituent to be determined, the ends of the vessel being closed by diaphragms *e*, *e'*, the first connected to a pressure-indicating device and the other diaphragm designed to be adjusted in position as by a screw *h* and nut *i* so as to control the inlet and exit of gas through a valve *n*. In use, a negative pressure is produced in the vessel by distending the diaphragm *e'*, until the pointer makes a complete revolution; the valve *n* is then momentarily opened to admit a sample of gas; the final pressure shows the proportion of the sample absorbed by the reagent; the



valve *n* is then opened and the diaphragm *e'* pressed inward to discharge the residual gas. (Br. Pat. 160,930; R. H. DAVIS and C. ROSLING, both of Westminster. May 25, 1921.)

Distilling Ammonia.—In stills for treating ammoniacal liquor to separate ammonia, which is used to form ammonium sulphate, in which the liquor passes down a primary still for separation of sulphuretted hydrogen and carbon dioxide, then into a liming chamber, and through a final still, a portion of the vapor is withdrawn from the liming chamber and passed through a reflux condenser to separate water, and into an ordinary condenser to obtain a concentrated solution of ammonia, which may be used to neutralize free acid in ammonium sulphate. (Br. Pat. 161,244; R. P. DOUGLAS, Bolton. May 25, 1921.)

Magnesium Chloride.—Oxygen compounds of magnesium are converted in the presence of sulphur or its non-oxygenated derivatives—e.g., sulphur chloride—into anhydrous magnesium chloride by the action of a chlorine containing gas. Preferably magnesia is used as the starting material, but the carbonate and sulphate of magnesium and the double carbonate or silicate of calcium and magnesium may also be employed. The reacting materials must be dry and substances capable of forming water must be absent. Until the last stage is reached the process is carried out below 700 deg. C. so that the product does not fuse and thereby impede the reaction. A little carbon is added when the chlorination is conducted at about 300 deg. C. to convert the small quantity of magnesium sulphate which is also produced, into magnesia. The latter is readily separated from the fusible chloride. Any apparatus for treating solids with gases may be used—e.g., the raw materials may be fed into the top of a cylindrical vessel and chlorine passed in at the bottom; the sulphur chloride and other condensable products being cooled and returned to the reaction-zone. Advantageously the process may be worked in conjunction with the electrolysis of the magnesium chloride, the hot chlorine from the latter being used direct for the chlorination. (Br. Pat. 161,165; not yet accepted; V. M. GOLDSCHMIDT, Christiania. May 25, 1921.)

Hardening Tools.—In hardening tools the tool is heated and hammered to form a skin or casing, again heated and placed in a mixture of potassium ferrocyanide and bone ash, whereupon the container is placed in a furnace and heated to bright redness. After a short time a further quantity of the powered mixture may be added. The tools are finally quenched in water, and large tools may be clamped between metal plates during cooling. (Br. Pat. 161,446; W. TATE, South Hylton, near Sunderland. June 1, 1921.)

Heat-Treatment of Copper Alloys.—Relates to the heat-treatment of copper alloys and consists in subjecting alloys of copper, manganese and other metals such as aluminum, zinc, tin or silicon, after they have been cast, rolled or forged, to a prolonged heating at a temperature below red heat. In an example an alloy consisting of 10-15 per cent manganese, 10-15 per cent aluminum, the remainder being copper, which when rolled, annealed and cooled has a tensile strength of 66 kg. per sq.mm. and an extension of 21 per cent, after being subjected to a temperature of 220 deg. C. for twenty hours, showed a tensile strength of 96 kg. per sq.mm. and an extension of 0 per cent. The hardening is stated to render the metal suitable for the manufacture of knives. A marked hardening effect takes place in the case of brass alloys containing a high proportion of manganese. Such an alloy containing 51 per cent copper, 40 per cent zinc and 9 per cent manganese after rolling at a high temperature, forging and annealing at 600 deg. C. and cooling shows a tensile strength of 54 kg. per sq.mm., extension 11 per cent and a Brinell hardness of 166. After heating for thirty-six hours at 230 deg. C., the same alloy shows a tensile strength of 60 kg. per sq.mm., extension 2 per cent and a Brinell hardness of 260. Manganese, silicon and copper alloys hardened by this method at temperatures of 200 to 400 deg. C. may be used in place of tin alloys for bearing liners. Other examples are given in the specification. (Br. Pat. 161,537; not yet accepted; ISABELLEN HÜTTE GES., Dillenburg, Hessen-Nassau. June 1, 1921.)

Current Events

in the Chemical and Metallurgical Industries

Motion to Fix Standard of Comparison in M. S. Ltd., vs. Butte & Superior Co. Accounting Proceedings

On June 21 a motion of unusual nature was argued in this case before Judge Bourquin, U. S. District Court, sitting at Helena, Mont. By this motion, Minerals Separation, Ltd., seeks to have the court instruct the master, L. P. Donovan, who has recently been appointed in the Butte & Superior accounting, as to what shall constitute the standard of comparison for determining the amount of profits for which Butte & Superior company may be held liable as a result of the adjudged infringements.

In the case before the Supreme Court, Minerals Separation was not upheld in its contention that the process which Butte & Superior company had used (with oil in an amount in excess of 1 per cent upon the ore) was an infringement. Minerals Separation then claimed that petroleum was not "a frothing oil" upon defendant's ore, but the Supreme Court said that the patent made no disclosure as to "frothing oils" and held the plus 1 per cent process not to be infringing. Butte & Superior company took this plus 1 per cent process as a standard of comparison.

This motion, just argued, had as its announced object the prevention of extending the accounting proceedings beyond proper limits. Defendant sees in the motion an attempt to restrict it to water concentration as the sole standard of comparison.

Reference was made by plaintiff's counsel to the Miami accounting as being unduly prolonged, but it was explained by defendant's counsel that the Miami accounting—except for a brief period—had not been, thus far, an accounting at all, but that the time consumed had been almost entirely devoted to the examination of about eleven subsequent practices, in the use of which by the Miami company infringement was claimed by Minerals Separation.

Counsel for defendant, in argument, summarizes the contentions of the parties as follows:

The plaintiff sets forth in its hearing papers:

(1) That under the law, the only proper standard of comparison is a process or processes known and available at the date of the issuance of the patent in suit which would have given the best results with the defendant's ore if used by the defendant; and that in any event the standard of comparison must be a process or processes known and available prior to the commencement of infringement by the defendant.

* * * * *

(4) That for the infringing acts of the defendant during the few days in January, 1917, after January 9, 1917, and the greater part of February, 1917, during which defendant infringed the patent in suit, the proper standard of comparison is water concentration.

(5) That for the infringing acts of defendant from some time in May, 1917, to and including June 5, 1919, the proper standard of comparison is water concentration.

The defendant in its answer says:

(1) The statement of law contained in the first paragraph of plaintiff's motion is neither accurate nor complete. Anything free and open to be used at the time of infringement is a proper standard of comparison, and defendant has the right, if it desires, not only to set up alternate standards of comparison but to introduce evidence going to the question of reasonable or established royalty, so that the court, after hearing the evidence submitted, may determine what measure of damages or profits best fits the facts of the case and is most just.

* * * * *

(3) Defendant admits that all those forms of water concentration which were free and open to be used

during the infringing period are available standards of comparison, but it denies that they are the only proper standards of comparison.

(4) Defendant further says that there are several standards of comparison available in this case, one of which has already been presented provisionally by defendant in its statement of account and another of which is the electrolytic process, and defendant asserts that it has the right to introduce evidence as to each and every available standard of comparison upon which it desires to rely, as well as evidence looking to the question of determining a reasonable or established royalty, and all other evidence germane to the issues.

(5) Defendant further says that there is no evidence in the case as to what is the best standard of comparison, and that the present motion is an attempt to have the court rule on the admissibility of evidence, before it has been tendered by the defendant. Defendant avers that the questions arising on this accounting in this connection are complicated and cannot be justly determined until all the evidence is in and a complete case made out.

Plaintiff's counsel asked the court to instruct the master on the law, to the effect that the standard of comparison must be a process known at the date of the invention. Defendant contended that the proper rule was that the standard must be known at the date of the infringement.

Counsel for defense further stated that there was record of only one instance in which the court had given preliminary instructions at this stage of the accounting, and that these instructions had been of a very general character, not at all like those asked for here; and further that the instructions were so modified by the accompanying explanation as to quite relieve the master, to whom they are addressed, from being in any way hampered.

Both parties are preparing briefs upon submission of which decision will shortly be rendered.

Stanley Patent Bill Goes Over in Senate for Further Consideration

So that a further report may be submitted by the Secretary of War, the Stanley patent bill, providing that foreigners shall manufacture within two years any article they patent in this country, has been allowed by the Senate to go over for further consideration. Frederick P. Fish of Boston, a patent attorney of national reputation, takes the position that the legislation would set up a bad policy and establish a dangerous precedent. In view of the objections from such an authority, Senator Stanley expressed his willingness to wait until the Secretary of War could have opportunity to reply to Mr. Fish's arguments.

Senator Stanley declared, however, that he is thoroughly convinced of the necessity of the legislation. He thinks the only effect it can have is to protect the Ordnance Department in a great number of patents that have been perfected by American engineers upon American ordnance. These same inventions, Senator Stanley says, which the Americans used during the war and are now using but which they did not patent, have been patented by foreigners and sold to the Krupps or other foreign concerns, with the result that we cannot use our own patents for our own defense. Senator Stanley also pointed out that the United States is the only country in the world that has no such legislation.

In the course of his remarks, Senator Stanley said that he is strongly of the opinion that the junking of patents should be prevented. He declared that this is one of the most fecund sources of corruption and of monopoly. He called attention, however, to the fact that nothing of that kind was attempted in this bill.

Fall Meeting, Cellulose Section, A.C.S.

The president and secretary of the American Chemical Society have authorized another meeting of the Cellulose Section in connection with the fall meeting of the parent society in New York, Sept. 6 to 10, 1921. Prof. Harold Hibbert has been reappointed chairman and Gustavus J. Esselen, Jr., secretary. This will be the fourth consecutive session devoted to cellulose and its derivatives, a symposium on the subjects having been held in both St. Louis and Chicago and the first meeting of the Cellulose Section, as such, at Rochester last April. At this last meeting great interest was shown and there is no doubt that the Cellulose Section has made a place for itself in the activities of the American Chemical Society.

It is the plan this year to issue the preliminary program much earlier than on previous occasions, and accordingly those who plan to present papers before the Cellulose Section are urged to send the titles at once to G. J. Esselen, Jr., secretary of the section, 248 Boylston St., Boston, 17, Mass.

Program of the Summer Meeting of the American Ceramic Society

The midsummer meeting of the American Ceramic Society will be held at Canton, Alliance, Sebring and East Liverpool, Ohio, July 25, 26 and 27, inclusive, with headquarters at the Hotel Courtland, Canton, Ohio. The advance program for trips at this meeting is as follows:

MONDAY, JULY 25

10 a.m.—Leave Hotel Courtland on special cars for the Dueber Watch Case Manufacturing Co.

12 Noon.—Return to hotel for luncheon.

1:30 p.m.—Take special cars for the Bonnot Co., manufacturer of clay machinery.

3 p.m.—Visit the Canton Stamping & Enameling Co. or the Republic Stamping & Enameling Co. Due to the limited time available, it will be impossible for members to visit both enameling plants, therefore this portion of the trip will be left open to individual choice.

5 p.m.—Return to hotel.

7 p.m.—Leave Hotel Courtland in automobiles for Congress Lake.

7:30 p.m.—Banquet Congress Lake Country Club.

The drive from Canton to Congress Lake is a very fine one over about eighteen miles of perfect brick pavement. The country club is one of the best in the country and the cool, refreshing breezes from the lake, combined with a delicious and appetizing menu and exquisite service, make this an ideal place to dine during a hot July evening.

Besides a few short after-dinner speeches by speakers of national reputation, there will be several unique entertainment features.

TUESDAY, JULY 26, AT ALLIANCE AND SEBRING

9 a.m.—Leave on special cars of the Stark Electric for Alliance, arriving at 10:10 at Mahoning Ave., where the party will be met with automobiles and taken direct to the No. 2 plant of the Alliance Brick Co. Here the members will have the opportunity to see one of the most modern equipped brick plants in the country, the bricks being burned in a Richardson compartment kiln with producer gas.

1 p.m.—A complimentary luncheon will be given at the Alliance Country Club by the ceramic industries of Sebring.

2 p.m.—Party will leave by automobile for Sebring, where the Limoges China Co., the Sebring Pottery Co. and the Strong Enamel Co. will be visited. The Dressler tunnel kilns at the Limoges China Co. and the McFall oil-burning equipment at the Sebring Pottery Co. will be of special interest to members.

5:45 p.m.—Return to Canton on special cars of the Stark Electric.

9 p.m.—Theatre party, Myers Lake.

10:30 p.m.—Complimentary smoker, Myers Lake.

WEDNESDAY, JULY 27, AT EAST LIVERPOOL

7 a.m.—Leave Hotel Courtland for East Liverpool in automobiles, arriving at about 10 a.m. Visit R. Thomas & Sons Co., high-voltage electrical porcelain factory, oil-burning kilns, tunnel drier.

11:45 a.m.—Complimentary luncheon at Elks Club.

12:45 p.m.—Visit Homer Laughlin China Co., Newell, W. Va., and Knowles, Taylor & Knowles Co., East Liverpool, Ohio, both general ware plants. The visit to the factories in East Liverpool will be concluded in ample time for members to take the 5:40 train to Rochester, Pittsburgh and the East. At Rochester, connections can be made with Pennsylvania train 115 for Chicago and the West.

ENTERTAINMENT FOR LADIES

Special plans for the entertainment of the ladies have been made by the committee. In addition to the visit to the Dueber Watch Works on Monday morning, the banquet on Monday evening, the complimentary luncheons on Tuesday and Wednesday and the theatre party on Tuesday evening to which the ladies are cordially invited, there will be automobile trips on Monday afternoon, Tuesday and Wednesday to places of interest.

AUTOMOBILE TRIP CANTON TO EAST LIVERPOOL

The automobile trip from Canton to East Liverpool is of special interest, as it is a drive over nicely paved roads and through beautiful country. All members within a radius of 200 miles of Canton are urged to bring machines in order that members from a distance may enjoy this most delightful trip.

Fellowships in Metallurgy at University of Missouri

In co-operation with the United States Bureau of Mines and the State Mining Experiment Station, the School of Mines and Metallurgy of the University of Missouri offers four fellowships. These fellowships are open to graduates who have the equivalent of a Bachelor of Science degree and have had the proper training in mining, metallurgy or chemistry, and who are qualified to undertake research work. The income of each fellowship is \$800 per annum for the twelve months beginning July 1, 1921.

Fellows will register as students in the School of Mines and Metallurgy of the University of Missouri and become candidates for the degree of Master of Science in Mining or Metallurgy (unless this or an equivalent degree has been earned). Their class work will be directed by the heads of the departments of instruction, but the greater portion of their time will be spent in research work under the direction of the Bureau of Mines staff resident at the School of Mines. The purpose of this work is to undertake the solution of definite problems confronting the mining and metallurgical industries of the State of Missouri. For 1921-22 the four fellowships will be granted in the following subjects: Mining; ore dressing; physical metallurgy (heat-treatment of steel); electrometallurgy (zinc).

Applications, with a certified copy of collegiate record, statement of professional experience, and names and addresses of three references, will be received up to Sept. 1, 1921, by the Director, School of Mines and Metallurgy, University of Missouri, Rolla, Mo.

List of Research Chemicals in Preparation

Research chemicals and others not commonly available are to be listed in a forthcoming publication of the National Research Council. Dr. C. J. West, secretary of the committee, is sending out requests to every manufacturer of chemicals, stains, drugs and similar commodities asking them to furnish him with the list of products actually manufactured or products for which American companies are agents. This work will not include a listing of heavy chemicals or the more common chemical reagents, but it is intended to assist those doing research or occasionally using rare chemicals as raw materials to get in touch with all manufacturers of these products.

Special emphasis is being made by this committee on the importance of small orders. Where a company is willing to handle these, say in quantities less than 1 lb., this distinction will be indicated in the printed list.

Any manufacturers who have not already been reached by the committee should communicate with Dr. C. J. West, Committee on Research Chemicals, National Research Council, 1701 Massachusetts Ave., Washington, D. C.

Industrial Research Laboratories

Research facilities and the development activities of American industries are to be described in the forthcoming revision of bulletin of the National Research Council, No. 2, "Research Laboratories in Industrial Establishments of the United States of America." Only 300 such laboratories were listed in the first edition, but it is hoped that several hundred new names will appear in the revision and that a more nearly complete reference list will thus become available. The general demand for the first edition of the bulletin shows the wide interest in this subject and the importance of having every laboratory which devotes even a portion of its time to research properly listed.

The Council requests information from directors of research who have not already supplied it. The following data are wanted: Name and address of firm and address of laboratory; name of director of research; number on laboratory staff (classified as chemists, engineers, bacteriologists, etc.); approximate proportion of time spent on research; chief lines of research; unusual features of equipment; research laboratory space; date of organization of research laboratory and annual expenditure for research. Confidential information is not desired.

It is also requested that librarians in the service of the industries bring this notice to the attention of the proper officials in their organizations.

This material should be furnished as promptly as possible to the Research Information Service, National Research Council, 1701 Massachusetts Ave., Washington, D. C.

Dupont Fibersilk Co. Plant in Operation

Manufacture of artificial silk has been begun at the new plant of the DuPont Fibersilk Co. located on the Niagara River at Buffalo, N. Y. Operations are proceeding in a very satisfactory way and at the present time the plant is producing 1,000 lb. per day of 150 denier, which is one of the most widely used sizes of thread, but both the finer and coarser counts will be made in accordance with the demands of the trade. The product has already been tried out in several of the manufacturing industries using this size, such as those producing hosiery, fancy knitting, sweaters, neckties, broad silk weaving and others. The output of the plant will be increased from now on up to capacity, which will be in the neighborhood of 1,500,000 lb. of artificial silk per year. All of the product will be sold in the form of skeins and will go direct to manufacturers. When in full operation, the plant will employ approximately 600 operatives, about half of whom will be women.

The DuPont Fibersilk Co., which is a subsidiary of E. I. du Pont de Nemours & Co., owns 100 acres of ground on the Niagara River between Buffalo and Tonawanda and has installed its own facilities, including water supply, sewerage, etc. The DuPont Engineering Co. of Wilmington, Del., is the architect, engineer and designer for the plant and construction work was started in August, 1920. The buildings cover a total area of approximately 200,000 sq.ft. and are mostly one story in height. The main buildings are of brick, monitor type roof, glass sides and high head room, insuring ample light and proper ventilation. These main buildings are arranged so that the various processes of manufacture follow each other in proper sequence, thus insuring a minimum of handling. The balance of the buildings are concrete. The entire plant has been equipped with sprinkler system.

Power is supplied from a plant of 1,500 hp. which has been erected on the property and in addition to this, arrangements have been made to obtain electric power from one of the nearby electric power plants.

Special attention has been given to the comfort and convenience of employees and a modern cafeteria and girls' rest rooms have been provided. There are also medical and dental offices. Every effort has been made to insure the best of working and living conditions.

The DuPont Fibersilk Co. was incorporated in April, 1920, as a result of an agreement with the Comptoir des Textiles Artificiels of Paris, France. The latter company controls many of the large silk plants of Europe and has

been producing artificial silk for many years. The DuPont Co. has done extensive experimental work during the past six years and has developed a fund of knowledge and experience which will help to make the product of the finest possible grade.

The officers of the DuPont Fibersilk Co. are L. A. Yerkes, president; B. M. May, treasurer; M. du Pont Lee, production manager; George Rocker, chemical director; E. K. Gladding, plant superintendent; C. J. Bacon, chief engineer.

The executive and sales offices of this company are located at Buffalo.

Insecticide and Disinfectant Manufacturers' Association, Atlantic City Meeting

The seventh mid-summer meeting of the Insecticide and Disinfectant Manufacturers' Association was held at Hotel Traymore, Atlantic City, June 13 and 14. President H. W. Cole of The Barrett Co. presided, and the special guests of the occasion were Dr. J. K. Haywood, chairman of the Insecticide and Fungicide Board, U. S. Department of Agriculture; Prof. Thomas J. Hedlee, Entomologist, State of New Jersey; and William D. Hartley, representative of McDougall Bros., Ltd., Manchester, England.

The address of welcome was given by A. L. Bobrick, president of the Sanitary Products Corporation of New York, chairman of the committee on publicity and program, and the response was by A. S. Hickerson, vice-president of the Worrell Manufacturing Co. of St. Louis.

The president's address, which opened the business of the meeting, reviewed the progress of the association during the past six months, especially in committees, and he expressed the appreciation of officers and committee chairmen for the hearty co-operation of the membership at large.

W. H. Gesell, of the Lehn & Fink Co., Inc., reported for the committee on disinfectants, which was followed by the report of the committee on insecticides, prepared by the committee chairman, R. N. Chipman, president of the Chipman Chemical Engineering Co. of New York, and read by C. L. Weirich, chief chemist. Mr. Bobrick submitted the report for his committee on publicity and program, after which Dr. William Dreyfus, chief chemist of the West Disinfecting Co., as chairman of the committee on standardization of disinfectants, reported for his committee and this report as submitted and accepted included the recommendation by the committee on the adoption of the Hygienic Laboratory method of testing disinfectants as received from Dr. G. W. McCoy and about to be published by the Hygienic Laboratory of U. S. Public Health Service.

Following luncheon Prof. Hedlee gave a most interesting talk upon his work as State Entomologist and set forth the possibilities his field presented to the trade.

Mr. Hartley then addressed the association informally in regard to trade conditions in England, especially with respect to exportations. When questioned as to the effect of the coal strike upon market values of creosotes, cresylics, etc., Mr. Hartley expressed the opinion that such supplies of coal had been furnished to the essential industries, including the gas and coal oven plants, and that an advance in prices of these products was not expected.

The reports of the officers and committees, combined with the interesting addresses given by the guests of the occasion, contributed to make the meeting a most successful one, and those in attendance were deeply impressed with the work the association was doing and its future prospects.

Standards Recently Approved by the A. E. S. C.

Standards recently approved by the American Engineering Standards Committee include four copper specifications submitted by the American Society for Testing Materials as "Tentative American Standard," as follows:

- 9—1921—Soft or annealed copper wire.
- 10—1921—Lake copper wire, bars, cakes, slabs, billets, ingots, and ingot bars.
- 11—1921—Electrolytic copper wire bars, cakes, slabs, billets, ingots and ingot bars.
- 12—1921—Battery assay of copper.

Exports and Imports of Chemicals

A further decrease in imports of chemicals occurred during May. The total value of imports during that month was \$6,568,761. This is half the monthly average throughout the year preceding. The decrease is very marked when compared with imports in May, 1920, when their value aggregated \$21,021,162. A decrease also is shown over April of 1921, when the value of imports totaled \$7,416,478. The figures are those of the Bureau of Foreign and Domestic Commerce.

Colors and dyes formed the only item on the entire list of May's imports which showed an increase over the imports of May a year ago. Colors and dyes to the value of \$307,735 were imported during May of this year, whereas the value of imports during May of 1920 was \$263,281. Imports of coal-tar products, as a whole, decreased from \$634,840 to \$401,837. There was a decided slump in the gums imported. Imports in May of 1920 were valued at \$5,714,192. In May of 1921 imports of gums were valued at \$1,259,209. Outside the main groups, some of the chemicals imported during May, compared with the figures for the corresponding month of 1920, are as follows:

	May, 1920	May, 1921
Ammonia, muriate of.....	\$79,077	\$21,350
Glycerine	343,494	7,931
Lime, citrate of	761,277	676
Potash, nitrate of.....	122,748	15,341
Soda, cyanide of.....	41,935	12,392

Exports of chemicals were in small volume during May. The value of all chemicals exported during that month was \$4,366,119. This compares with \$4,525,852 in April, 1921, and with \$18,030,514 in May of 1920. The decrease was general, as compared with exports in May of last year. Exports of acids declined from \$840,282 to \$97,983. Dyes and dyestuffs to the value of \$3,437,885 were exported in May, 1920. In May of this year the value of exports was \$396,524. Extracts for tanning declined from \$260,118 to \$75,277. In May of 1920 the exports of sodas were valued at \$2,715,673. In May of this year the value of the soda exports was \$435,037.

There was one item on the list which showed a very decided increase. In May of this year, 18,102,679 lb. of benzene was exported from the United States. This compares with exports of 1,483,096 lb. in May of 1920. Exports of certain chemicals which move in smaller volume are shown in the following comparative table:

	May, 1920	May, 1921
Copper, sulphate of.....	\$38,619	\$7,851
Formaldehyde	230,053	33,937
Glycerine	29,406	11,357

Chemists Exonerate Pyrites Plant from Fume Damage

M. R. Lamkey, plant physiologist, and Thomas F. Mains, plant pathologist, State Agricultural Experiment Station, Newark, Del., have tendered a formal report to the City Council, Wilmington, following an inspection of property at South Wilmington, held to have been damaged by fumes from the plant of the Pyrites Co., Ltd., in this section. The report sets forth that there is no absolute evidence that the damage was done by fumes or smoke from this plant, and while without any positive conclusion, it is attributed to severe frosts in the early spring. Referring to the fact that a month had elapsed before the investigation was made, due to neglect in calling on the station chemists, the report says: "We wish to emphasize the fact that many natural conditions can produce injuries so nearly similar to fumes or smoke injury that no investigation, no matter how expert, can distinguish the two after an exposure of several days to weather conditions. The injuries must be seen as they are produced, and the conditions under which they are produced must be known before a conclusive statement can be made."

New Stack at Midvale, Utah, Smelting Plant

The United States Smelting, Refining & Mining Co. has begun the construction of a new stack at its smelting plant at Midvale, Utah, to be 450 ft. in height and estimated to cost about \$150,000.

Personal

PERCY E. BARBOUR, assistant secretary of the American Institute of Mining and Metallurgical Engineers, who has been seriously ill for some time past, is improving in health and expects to resume his duties before the end of July.

H. O. CHUTE, chemical engineer, of New York, is now associated with the Cannon-Swenson Co., Chicago, for work in wood distillation.

C. E. DAVIES has been appointed managing editor of *Mechanical Engineering*, the publication of the American Society of Mechanical Engineers, to succeed the late L. C. French.

Dr. LIVINGSTON FARRAND of the American Red Cross, Washington, D. C., has been elected president of Cornell University, Ithaca, N. Y.

ALEX. L. FEILD, who has been engaged in metallurgical investigations at the plant of the Electro Metallurgical Co., Niagara Falls, N. Y., has been recently transferred to the new research laboratory of the Union Carbide & Carbon Corporation, Thompson and Nelson Aves., Long Island City, N. Y. Mr. Feild was at one time assistant metallurgist in the U. S. Bureau of Mines, Pittsburgh, Pa., and later was research physical chemist with the National Carbon Co., Inc., Cleveland, Ohio.

H. O. HOFMAN, professor of metallurgy in the Massachusetts Institute of Technology, has been made an honorary member of the American Institute of Mining and Metallurgical Engineers.

A. G. MACGREGOR has returned from his inspection trip to the new Cerro de Pasco smelter in Peru. The plant will be ready to operate before next summer.

W. W. MURRAY, until recently manager at the plant of the Continental Can Co., Cannonburg, W. Va., has become connected with the staff of the same company at Chicago, Ill.

EMIL POHL, Hartford City, Ind., an expert in the manufacture of grease-proof glassine paper and for the past fifteen years superintendent of the super-calender department at the Hartford City Paper Mills, has resigned. He will occupy a similar position at a paper mill in Wisconsin.

CHARLES F. RAND, a director of the American Institute of Mining and Metallurgical Engineers, has been made an honorary member of the Iron and Steel Institute (London).

FRED F. SHARPLESS has been elected secretary of the American Institute of Mining and Metallurgical Engineers to succeed Bradley Stoughton, resigned.

L. B. SKINNER has recently severed his connection as chief of the research staff of the Mid-West Refining Co. to carry on a general consulting practice in Denver, Col.

Dr. E. R. WOLCOTT, of the Western Precipitation Co., Los Angeles, is on an extended Eastern trip on matters concerning electric precipitation.

Book Reviews

TREATISE ON GENERAL AND INDUSTRIAL ORGANIC CHEMISTRY. By Dr. Ettore Molinari. 456 pp. Philadelphia: P. Blakiston's Son & Co. Price \$8 net.

The new edition of the Treatise on Industrial Chemistry should perhaps be more properly termed a treatise on organic chemistry in which the various compounds mentioned are selected with a view to their industrial application. The author points out the fallacies of other writers who deem that it is unnecessary for the student to be made familiar with the practical phase of the subject, claiming that a knowledge of theory is all that is required.

This conception in past years has been taken too literally, for today, when industry has attained an adult stage, the

author is justified in claiming that the time of the young technician cannot be wasted in a protracted and often sterile consideration of the theories involved.

In order to produce rapidly and with increased certainty a sound, practical man it is necessary to have a good theorist and to acquaint him with both a theoretical and practical study of the most salient industrial problems. In this book the author has endeavored to show the application of a great many organic compounds and has purposely left out of consideration a study of the industries themselves, thus making the book a reference volume on practical organic compounds, but at the same time he has pointed out possibilities for their further application and opportunities for the theorist as well as the technician to benefit from the matter therein contained.

This volume is an improvement on the former editions, and it is felt that the author should be congratulated upon the reception which the book has received. It is also felt that the book will be of great service to both manufacturers and chemists as an authoritative compilation of the important chemical compounds, presented in a comprehensive and readable manner.

ALLEN ROGERS.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, July 1, 1921.

There were no pronounced marks of interest shown in the chemical line during the past week. Only at intervals was there any positive character to trading and when prices moved, they did so in a perfunctory way. Changes were apt to be wholly fractional and the movement was as often a decline as an advance. The continued inactivity led to opinions that the market has gone as far as it can easily go in one direction, while others asserted that the absence of big buying orders was a result of the vacation spirit in the current holidays. It must be admitted that prices which rise under consumptive buying usually falter when orders of the sort are no longer obtainable. Not only are these particular orders absent when large buyers pursue this policy but traders and dealers who follow such a lead stop their own activities. These are possibly trivial considerations in a discussion of the chemical situation, but it is on such considerations that the present market is built up. In general, the market gave no clue as to what is coming next.

There are many buying interests that express the opinion that soda ash prices should be revised downward. These ideas can be traced directly to the fact that English and French ash has been offered through dealers at prices below those named by American producers. It is understood that these latter interests have not seen their way clear to quote lower on account of the relatively high overhead, freight and labor costs. The trade does not expect much change in caustic soda. The contract price is well sustained by producers and the supply of resale standard stock has been materially reduced in second hands where spot requirements are handled. The bichromates have not changed to any noticeable degree. Bichromate of soda varied about a half cent on spot during dull periods, but was not offered freely and the market was sensitive to small buying operations. Heavy importations of caustic, chlorate and carbonate of potash from Germany had a tendency to ease prices of these chemicals. Nitrite of soda was not active enough to permit a real test of values. Offerings of imported oxalic acid made a slight dent in the late advance in prices, although the tone was steady throughout the week.

FOREIGN INQUIRIES

Foreign inquiries have been noted from Italy, South America and other important points. Canada has bought quite moderately, but the inquiries seemed to be from those who were trying to feel the market. Prominent authorities who have just returned from South American ports admit

that surplus stocks of chemicals are slowly but steadily decreasing. The establishment of a foreign credit system would give the necessary punch to export business and several large interests are confident that ways and means will be found to stimulate foreign commerce.

It seems to be the consensus among men occupying high places in business and finance in outside quarters that the tide is gradually turning for the better. It is generally agreed that sugar, copper, rubber, food and oil industries have seen their worst and are near the turning point. It may be said with a considerable degree of assurance that the cotton and leather industries are liquidated to the bone and are ready to recover. The woolen and textile trades are on the road to a general recovery. This is evidenced by reports of increasing business in mercantile lines throughout the country. Readjustments downward are expected to continue in labor, coal and steel and probably in the automotive trades. On the whole, it may be said that readjustment is now in its final stage. That which remains to be readjusted can undoubtedly be accomplished without disturbance to the general industrial fabric. It is well to consider that at the beginning of the year it did not seem possible that by this time prices for raw materials would have reached the point of approximate stabilization; that wage reductions would have been accepted by workers in widely diversified industries in the realization that they were just and necessary and finally that the banking position as a whole could have improved to the extent indicated by the substantial reduction in the borrowings of reporting member banks at the Federal Reserve banks. Borrowings, in general, have declined close to 50 per cent from the maximum reached last fall. Sentiment in regard to business will naturally fluctuate in times like these. The reaction from the spurt in spring business has caused profound disappointment. On the other hand, it is unwise to expect other than quiet business during the summer months.

CHEMICALS

An irregular weakness was noted in the market on *bichromate of soda* on spot, and a few small lots were disposed of below 8c. per lb. At the closing the feeling was somewhat steadier and prices ranged all the way from 8@8½c. per lb., with 8½c. the general quotation for standard goods ex-store. Trading has not shown much activity, and the slow inquiry inspired a keener state of competition among small holders in an effort to stimulate business. Quiet trading in spot *bichromate of potash* was reported by dealers during the past week at 11½@12¼c. per lb. Offerings continue limited on spot, but seem to be sufficient to cover the quiet extent of demand at present. There has been no material change in this chemical for several weeks. Imported *caustic potash*, 88-92 per cent, of German manufacture is on the market at prices ranging from 5@5½c. per lb., depending upon the quantity and seller. Dealers have placed an irregular business in this chemical and the price compares with 4½c. which was quoted just prior to the war when the market was recovering from one of the keenest trade wars ever experienced in this commodity. Foreign *chlorate of potash* has been offered in the local market on the basis of 7½@8c. per lb. and at 7c. per lb. for shipment from Germany, duty paid. At the close it was stated that this figure might be shaded on account of a decline in exchange rates. Prime American material continues unchanged at 12c. per lb. f.o.b. works. Resale *caustic soda* has been well sustained throughout the entire week at \$4.10 per 100 lb. and upward for standard brands. Offerings have not been so plentiful and there was enough inquiry noted to keep prices firm. Demand has involved the wants of both domestic and foreign consumers and some sales for export went through at 4½c. per lb. Producers are firm on contracts at 3½c. per lb., basis 60 per cent, f.o.b. works. Large dealers of *nitrite of soda* have quoted the market at 7½@8c. per lb. on spot during most of the week. Small lots have changed hands below the inside figure and irregular business has been reported down to 7½c. per lb. The market is being carefully watched and holders have not lost confidence in price prospects. It is asserted that any permanent improvement in demand will likely find response in the course of values. Dealers in im-

ported *prussiate of soda* have quoted 12½@12¾c. per lb. on spot during the week, but it is stated that very little business took place below the outside figure. At the close an isolated lot might have been purchased at 12¾c., but the market in most directions was quoted as steady at 12½c. per lb. Small-lot transactions were about the best that could be noted in this market. Resale *soda ash* in single bags has been well maintained at \$2.15 per 100 lb. and dealers have made sales at this figure and upward to \$2.20, depending on quantity. Barrels have sold as high as 2¾c. per lb. in less than carload lots and down to \$2.55 per 100 lb. in carlots. At the works prices held at \$1.60 per 100 lb. for single bags, basis 48 per cent, and \$1.95 per 100 lb. for barrels, basis 48 per cent.

COAL-TAR PRODUCTS

Reports from various quarters of the coal-tar products market during the past week show different degrees of improvement, but on the whole a more active interest is noted among consumers and moderate sized lots are moving to meet requirements of the present and near future. The consuming demand for *paranitraniline* was very light and prices ranged from 85c.@\$1 per lb., depending on seller and quantity. *Benzene* showed the same active conditions that have been noted for some time. Supplies seem to be quite limited and prices firm. The balance of the crude products were dull and only small quantities moved at irregular intervals. *Aniline oil* is moving in limited volume and prices are steady at 20@26c. per lb. *Beta naphthol* is firm at 38@40c. per lb. and fairly active. Supplies of dimethylaniline are limited, while the demand is fair and prices steady at 40@50c. per lb., depending on seller. *Meta-phenylenediamine* was in fair request and supplies were quotably unchanged at \$1.15@\$1.20 per lb. The market on *benzaldehyde* is reported dull with only a routine business of small volume. Prices have shown no recent change, with the technical quoted at 45@50c. per lb. and the U.S.P. at \$1.50 per lb. Reports from some quarters show an improvement in the consuming demand for *benzoic acid* with the U.S.P. moving on a basis of 60@65c. per lb. and the technical type at 50@60c. per lb. Available supplies are low. There has been very little change in the limited volume of business in *diphenylamine*, but the principal factors are steady in their views at 65c. per lb., while the low-priced resale lots are believed to be quite well absorbed. The past week has revealed little in *alphanaphthylamine* that could be construed as an improved outlook for an active market. There have been no changes in prices, however, which are quoted at 35@40c. per lb.

VEGETABLE OILS

Textile mills have been taking fair quantities of the technical grades of *castor oil*. Lubricant houses have not been active. In the U.S.P. grade the market was quiet but unchanged at 10c. per lb. Scattered parcels of *chinawood oil* sold in the past week at prices ranging from 14@15c. per lb. The offerings were comparatively light and quotations at all times were more or less nominal. Interest was noted in nearby stuff, but the ideas of buyers were somewhat below those of sellers. It was reported that 10¾c. might be done on July-August arrival at N. Y. For July-August shipment from the Orient 10¼c. could have been done. Closing prices in the market on *coconut oil* showed very little change compared with a week ago, yet the undertone in some directions was barely steady, due to a general lack of buying interest. Ceylon grade oil was unchanged on the spot at 10¼c. per lb. in barrels, with the Cochin type oil quoted at 11@11½c. per lb. There was a firmer market for crude *corn oil* in the West in sympathy with the strength in other competing oils. Demand, however, for immediate shipment remained quiet. At the close holders were asking 5¾@6c. per lb. for shipment. Crude oil in N. Y. held at 7½@7¾c. per lb. Further weakness in tallow did not help the *palm oil* situation. Exchange again was easier, but not so as to influence sellers, for closing prices showed little if any change compared with quotations of a week previous. *Lagos oil* for shipment was offered at 6½c. per lb. c.i.f. N. Y. *Lagos oil* on spot was regarded steady at 7c. per lb. Holders of crude *peanut oil* throughout the South were rather firm in their ideas,

yet a lack of important buying checked attempts to advance prices. At the close prime oil was available at 6c. per lb., buyers' tanks, f.o.b. mill with strictly prime material at 6¼c. It was reported that scattered business went through at 6c. per lb.

The Chicago Market

CHICAGO, Ill., June 29, 1921.

There was a noticeable improvement in the tone of the industrial chemical market during the past two weeks. All quarters reported an increased volume of business, and while the quantities ordered are not large, the buyers are demanding immediate delivery, showing that supplies in consumers' hands are getting low. Prices as a rule are firm, with holders showing little or no disposition to cut. The small lots of foreign material on the market have had little effect on the domestic manufacturers, who seem to be holding their own.

GENERAL CHEMICALS

A firm tone still ruled in the market for *caustic soda*, although business was quieter. Supplies among second hands are small, and 4c. for solid 76 per cent and 4¾c. for the ground were the prevailing quotations. *Soda ash* is still very firm, and supplies could not be obtained under \$2.60 per 100 lb. for material in barrels. *Sal soda* seems to be moving quite well at \$1.65@\$1.70 per 100 lb., although no large orders were reported. *Sal ammoniac* is unchanged as to price and is not moving so well. Prime white material, 98-100 per cent, is available at 8½c. per lb. in single casks. *Blue vitriol* is very firm, with prices ranging from 6c.@7c. per lb. according to the holder and the package. A fair movement of *carbon bisulphide* was noted in some quarters and supplies were available at 7½c.@8c. per lb. *Epsom salts* were in fair request and prices were firm at 3c.@3¼c. per lb. for the U.S.P. in barrels. *Formaldehyde* was very quiet and few sales were reported. Supplies are plentiful at 14c. per lb. for single barrels.

The *glycerine* market is very quiet, with little material moving. Offers as low as 15½c. per lb. were reported, but the prevailing price was 15¾c. for large drums. *Potassium bichromate* is quiet and steady, with a few small sales noted. Material of standard brand is offered at 14c.@14½c. per lb. according to the seller. *Sodium bichromate* is not moving so well and supplies are available at 9c.@9½c. for single casks. *Bicarbonate of soda* is in fair request, and dealers are asking \$2.65@\$2.75 per 100 lb. for a good grade of material. *Hyposulphite of soda* is moving very well and the price is firm at \$3.85 per 100 lb. *Sodium nitrite* is one of the firmest items on the list, and 9c. was the lowest offer noted.

ACIDS

As a rule the list of acids is quiet and unchanged. The demand for *citric acid* is rather disappointing for this time of year, and in some quarters supplies are heavy. Second hands are quoting as low as 45c. in some instances. *Oxalic acid* is quiet, and supplies are available at 18c.@20c. per lb. *Tartaric acid* is weak, and offerings at 32c. per lb. were heard. The heavy acids are quiet and unchanged as to price. *Sulphuric*, 66 deg., is quoted by makers at \$19@\$20 per ton in tank cars f.o.b. works.

VEGETABLE OILS

This market has shown more life during the past week than for several months. One dealer describes his business in *linseed oil* as fine, while several factors report a very good volume. In 10-bbl. lots or over the boiled oil is available at 80c. per gal., with a corresponding reduction for the raw.

NAVAL STORES

This branch of the trade has shown a decided change for the better and conditions are about all that could be expected. There is a good movement of turpentine and less than carlots are quoted at 60c. per gal., drum basis. The *rosins* are moving in a fair way, and prices are firm, with less than carlots quoted at \$6.60 per 280 lb. for the "G" grade. *Rosin oil* is also in fair request, and is offered at 45c. per gal. in barrels.

The Iron and Steel Market

PITTSBURGH, July 1, 1921.

The steel market has become still quieter, the absence of buying being almost complete, at least as regards the mills. There is more support to the theory that some of the buying is intercepted by manufacturing consumers reselling what stocks of steel they have remaining. There is evident a desire on the part of all consumers or distributors to reduce stocks not to the possible minimum but to absolute zero. The precise motive is not clearly understood, whether a fear that prices will decline greatly or a desire to be without stocks for an indefinite period. As in resales the mill market must be greatly undersold, the prospect of a further decline in steel prices is not necessarily a sufficient reason. Support to the theory that reselling is an important factor in reducing the demand on the mills is the fact that mills find demand for merchant steel bars especially light among steel products in general, and bars are a commodity that are normally stocked in considerable quantities, while stocks are mobile, since a consumer can generally be found for any ordinary section or size of bar.

DECLINING TENDENCY IN STEEL PRICES

There is a generally declining tendency in steel prices, but the fortuitous or occasional declines are of no great interest, while in the majority of commodities there is really no stable market price at any given time. There is so little business that while there is competition there is not enough to develop clear cut prices. The trade at large is not interested so much in current prices as in prospective prices, for it is generally understood that a definite price level will be furnished by the mills when they see that buying of any consequence is ready to occur and the buyer in his turn feels that he must be assured that he will not gain by deferring his purchase.

To illustrate the attitude, it is not uncommon for the buyer to ask the mill to guarantee a price to date of shipment of the steel, which is something the mills will not do, but if that is the mental attitude of the manufacturing consumer it is obvious that he thinks still more of the time that must elapse between the date of shipment of the steel and the date of sale of the goods he intends making from the steel, and at this time he cannot sell his product ahead. He does well if he makes sales out of stock already produced.

NEW STEEL CORPORATION PRICE SCHEDULE PREDICTED

In some quarters it is predicted that within a few weeks the United States Steel Corporation will announce a schedule of prices so low that it will be accepted as the minimum that buyers can expect, at least for a period of months, but this would be done only in case it seemed clear that there was a latent demand to be developed by price reduction. Up to this time the mills have claimed, with good show of reason, that buyers were not ready to take hold, no matter what prices were quoted.

The so-called "April prices" are down \$5 a ton in wire products and sheets, as noted in previous reports. Other steel commodities are being shaded more or less from the April schedule, but there is no formal announcement that the Steel Corporation has made departures other than in wire products and sheets. It is just learned that the corporation recently reduced the galvanizing differential in wire from 70c. to 50c. per 100 lb., so that with plain wire at 2.75c. galvanized wire is 3.25c., and with painted barb wire at 3.15c. galvanized barb wire is 3.65c. Nails are at \$3, as formerly announced.

PIG IRON AND COKE

Pig iron is practically nominal at last week's quotations: Bessemer, \$22.50; basic, \$20.50; foundry, \$31.50 f.o.b. valley furnaces, with \$1.96 freight to Pittsburgh. On an attractive inquiry these prices could be shaded, as with continued light absorption of stocks and prospects of the replacement cost decreasing furnaces are more anxious to liquidate.

Connellsville coke for spot shipment remains quotable at \$3 for furnace and \$4.25 to \$4.75 for foundry. On an attractive inquiry the furnace coke price could probably be shaded.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots	Less Carlots
Acetic anhydride.....lb.	\$0.12½ - \$0.12½	\$0.40 - \$0.45
Acetone.....lb.	1.13 - 1.13	1.13 - 1.13
Acid, acetic, 28 per cent.....100 lbs.	2.50 - 2.75	3.00 - 3.25
Acetic, 56 per cent.....100 lbs.	4.00 - 4.25	4.50 - 5.50
Acetic, glacial, 99½ per cent, carboys.....100 lbs.	9.75 - 10.00	10.25 - 10.50
Boric, crystals.....lb.	13½ - 14	14½ - 15
Boric, powder.....lb.	15 - 15½	16 - 16½
Citric.....lb.	1.50 - 1.65	1.75 - 2.00
Hydrochloric.....100 lb.	12½ - 12½	12½ - 13
Hydrofluoric, 52 per cent.....lb.	10 - 11	11½ - 12
Lactic, 44 per cent tech.....lb.	04½ - 05½	06 - 07
Lactic, 22 per cent tech.....lb.	4.00 - 4.50	4.50 - 5.00
Molybdic, C. P.....lb.	06½ - 06½	07 - 07½
Muriatic, 20 deg. (see hydrochloric).....lb.	07 - 07½	07½ - 07½
Nitric, 40 deg.....lb.	18 - 18½	19 - 20
Nitric, 42 deg.....lb.	13½ - 14	14½ - 18
Oxalic, crystals.....lb.	20 - 25	27 - 35
Phosphoric, 50 per cent solution.....lb.	1.90 - 2.15	2.15 - 2.15
Picric.....lb.	12.00 - 14.00	13.00 - 15.00
Pyrogallol, resublimed.....lb.	18.00 - 20.00	22.50 - 23.00
Sulphuric, 60 deg., tank cars.....ton	21.00 - 22.00	22.50 - 23.00
Sulphuric, 60 deg., drums.....ton	21.00 - 22.00	22.50 - 23.00
Sulphuric, 66 deg., tank cars.....ton	21.00 - 22.00	22.50 - 23.00
Sulphuric, 66 deg., drums.....ton	21.00 - 22.00	22.50 - 23.00
Sulphuric, 66 deg., carboys.....ton	21.00 - 22.00	22.50 - 23.00
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	21.00 - 22.00	22.50 - 23.00
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	23.00 - 23.50	24.00 - 24.50
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	31.00 - 32.00	33.00 - 34.00
Tannic, U. S. P.....lb.	90 - 1.00	90 - 1.00
Tannic (tech.).....lb.	45 - 48	50 - 55
Tartaric, crystals.....lb.	29 - 30	29 - 30
Tungstic, per lb. of WO.....lb.	1.30 - 1.40	1.30 - 1.40
Alcohol, Ethyl.....gal.	4.90 - 5.05	4.90 - 5.05
Alcohol, Methyl (see methanol).....gal.	31 - 36	31 - 36
Alcohol, denatur ed, 188 proof.....gal.	38 - 42	38 - 42
Alcohol, denatur ed, 190 proof.....gal.	03½ - 03½	04 - 04½
Alum, ammonia lump.....lb.	03½ - 04	04 - 04½
Alum, potash lump.....lb.	13 - 13½	14 - 14½
Alum, chrome lump.....lb.	01½ - 02	02 - 02½
Aluminum sulphate, commercial.....lb.	02½ - 02½	03 - 03½
Aluminum sulphate, iron free.....lb.	07 - 07½	07½ - 08
Aqua ammonia, 26 deg., drums (750 lb.).....lb.	30 - 32	33 - 35
Ammonia, anhydrous, cyl. (100-150 lb.).....lb.	08 - 08½	09 - 10
Ammonium carbonate, powder.....lb.	06½ - 06½	07 - 07½
Ammonium chloride, granular (white salamoniac).....lb.	07 - 07½	08 - 08½
Ammonium chloride, granular (gray salamoniac).....lb.	07 - 07½	07½ - 08½
Ammonium nitrate.....lb.	2.60 - 2.75	2.80 - 3.00
Ammonium sulphate.....100 lb.	4.00 - 4.25	4.00 - 4.25
Amylacetate.....gal.	2.50 - 3.00	2.50 - 3.00
Amylacetate tech.....gal.	06½ - 07	07½ - 08
Arsenic oxide, (white arsenic) powdered lb.....lb.	11 - 11½	12 - 13
Arsenic, sulphide, powdered (red arsenic) lb.....lb.	59.00 - 59.50	60.00 - 62.00
Barium chloride.....ton	20 - 21	22 - 23
Barium dioxide (peroxide).....lb.	07½ - 07½	08 - 08½
Barium nitrate.....lb.	04½ - 05	05½ - 06
Barium sulphate (precip.) (blanc fixe) lb.....lb.	07 - 07½	07½ - 08
Bleaching powder (see calc. hypochlorite).....lb.	07 - 07½	07½ - 08
Blue vitriol (see copper sulphate).....lb.	07 - 07½	07½ - 08
Borax (see sodium borate).....lb.	07 - 07½	07½ - 08
Brimstone (see sulphur, roll).....lb.	41 - 42	43 - 45
Bromine.....lb.	2.00 - 2.05	2.00 - 2.05
Calcium acetate.....100 lbs.	04½ - 04½	05 - 05½
Calcium carbide.....lb.	23.50 - 24.00	24.50 - 25.50
Calcium chloride, fused, lump.....ton	01½ - 02	02½ - 02½
Calcium chloride, granulated.....lb.	2.15 - 2.25	2.35 - 2.50
Calcium hypochlorite (bleach powder) 100 lb.....lb.	1.40 - 1.50	1.40 - 1.50
Calcium peroxide.....lb.	15 - 16	15 - 16
Calcium phosphate, tribasic.....lb.	75 - 78	75 - 78
Camphor.....lb.	06½ - 07	07½ - 08
Carbon bisulphide.....lb.	10½ - 10½	11 - 12
Carbon tetrachloride, drums.....lb.	60 - 75	60 - 75
Carbonyl chloride (phosgene).....lb.	07 - 07½	07½ - 08
Caustic potash (see potassium hydroxide).....lb.	07 - 07½	07½ - 08
Caustic soda (see sodium hydroxide).....lb.	07 - 07½	07½ - 08
Chlorine, gas, liquid-cylinders (100 lb.).....lb.	08 - 09	09 - 10
Chloroform.....lb.	40 - 43	40 - 43
Cobalt oxide.....lb.	3.00 - 3.10	3.00 - 3.10
Copperas (see iron sulphate).....lb.	20 - 21	22 - 23
Copper carbonate, green precipitate.....lb.	05½ - 06	06½ - 06½
Copper cyanide.....lb.	05½ - 06	06½ - 06½
Copper sulphate, crystals.....lb.	05½ - 06	06½ - 06½
Cream of tartar (see potassium bitartrate).....lb.	05½ - 06	06½ - 06½
Epsom salt (see magnesium sulphate).....lb.	05½ - 06	06½ - 06½
Ethyl Acetate Com. 85%.....gal.	05½ - 06	06½ - 06½
Ethyl Acetate pure (necetic ether 98% to 100%).....lb.	05½ - 06	06½ - 06½
Formaldehyde, 40 per cent.....lb.	13½ - 14	14 - 15
Fusel oil, ref.....gal.	3.00 - 3.25	3.00 - 3.25
Fusel oil, crude.....gal.	1.75 - 2.00	1.75 - 2.00
Glauber's salt (see sodium sulphate).....lb.	16 - 16½	16 - 16½
Glycerine, C. P. drums extra.....lb.	3.65 - 3.75	3.65 - 3.75
Iodine, resublimed.....lb.	10 - 20	10 - 20
Iron oxide, red.....lb.	19.00 - 20.00	21.00 - 22.00
Iron sulphate (copperas).....ton	11½ - 13½	11½ - 13½
Lead acetate.....lb.	09 - 09½	10 - 11
Lead arsenate, paste.....lb.	15 - 20	15 - 20
Lead nitrate.....lb.	08½ - 09	08½ - 09
Litharge.....lb.	1.30 - 1.40	1.30 - 1.40
Lithium carbonate.....lb.	09 - 09½	10 - 11
Magnesium carbonate, technical.....lb.	2.40 - 2.75	2.40 - 2.75
Magnesium sulphate, U. S. P.....100 lb.	1.20 - 1.75	1.20 - 1.75
Magnesium sulphate, technical.....100 lb.	07 - 80	07 - 80
Methanol, 95%.....gal.	80 - 85	80 - 85
Methanol, 97%.....gal.	14 - 14½	14 - 14½
Nickel salt, double.....lb.	15 - 15½	15 - 15½
Nickel salt, single.....lb.	15 - 15½	15 - 15½
Phosgene (see carbonyl chloride).....lb.	45 - 46	47 - 50
Phosphorus, red.....lb.	35 - 37	35 - 37
Phosphorus, yellow.....lb.	11½ - 12	12½ - 12
Potassium bichromate.....lb.	11½ - 12	12½ - 12

	Carlots	Less Carlots
Potassium bitartrate (cream of tartar)..... lb.	\$. . . - \$. . .	\$0.30 - \$0.31
Potassium bromide, granular..... lb.	.35 - .40	.16 - .25
Potassium carbonate, U. S. P..... lb.	.35 - .40	.45 - .50
Potassium carbonate, 80-85%..... lb.	.05 - .051	.06 - .07
Potassium chlorate, crystals..... lb.	.07 - .071	.08 - .12
Potassium cyanide..... lb.	.05 - .051	.26 - .28
Potassium hydroxide (caustic potash)..... lb.	.05 - .051	.051 - .06
Potassium muriate, 80% K.C.L..... ton	49.00 - 50.00	
Potassium iodide..... lb.		2.75 - 3.00
Potassium nitrate..... lb.	.091 - .091	.10 - .121
Potassium permanganate..... lb.	.29 - .30	.31 - .32
Potassium prussiate, red..... lb.	.35 - .37	.38 - .40
Potassium prussiate, yellow..... lb.	.241 - .25	.251 - .26
Potassium sulphate (powdered)..... per unit		1.50 - 1.75
Rochelle salts (see sodium potas tartrate).....		
Salammoniac (see ammonium chloride).....		
Sal soda (see sodium carbonate).....		
Salt cake..... ton		27.00 - 30.00
Silver cyanide..... oz.		1.35 - 1.38
Silver nitrate..... oz.		.40 - .41
Soda ash, light..... 100 lb.	2.15 - 2.20	2.30 - 2.70
Soda ash, dense..... 100 lb.	2.40 - 2.45	2.50 - 2.75
Sodium acetate..... lb.	.041 - .041	.041 - .051
Sodium bicarbonate..... 100 lb.	2.25 - 2.40	2.50 - 2.75
Sodium bichromate..... lb.	.08 - .081	.081 - .09
Sodium bisulphate (nitre cake)..... ton	5.00 - 5.25	5.50 - 6.50
Sodium bisulphite powdered, U.S.P..... lb.	.05 - .051	.051 - .06
Sodium borate (borax)..... lb.	.06 - .061	.061 - .07
Sodium carbonate (sal soda)..... 100 lb.	1.90 - 2.00	2.10 - 2.40
Sodium chlorate..... lb.	.071 - .071	.08 - .081
Sodium cyanide..... lb.	.191 - .21	.22 - .30
Sodium fluoride..... lb.	.111 - .12	.121 - .131
Sodium hydroxide (caustic soda)..... 100 lb.	4.15 - 4.25	4.30 - 4.80
Sodium hyposulphite..... lb.		.031 - .031
Sodium nitrate..... 100 lb.	2.80 - .	3.00 - .
Sodium nitrite..... lb.	.071 - .071	.071 - .08
Sodium peroxide, powdered..... lb.	.25 - .26	.27 - .30
Sodium phosphate, dibasic..... lb.	.041 - .041	.05 - .051
Sodium potassium tartrate (Rochelle salts) lb.		.26 - .27
Sodium prussiate, yellow..... lb.	.121 - .121	.13 - .131
Sodium silicate, solution (40 deg.)..... lb.	1.00 - 1.15	1.25 - 1.40
Sodium silicate, solution (60 deg.)..... lb.	.021 - .03	.031 - .031
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	1.50 - 1.75	2.00 - 2.25
Sodium sulphide, fused, 60-62 per cent (conc.) lb.	.051 - .051	.06 - .061
Sodium sulphite, crystals..... lb.	.031 - .04	.041 - .041
Strontium nitrate, powdered..... lb.	.15 - .151	.16 - .17
Sulphur chloride, red..... lb.	.07 - .071	.071 - .08
Sulphur, crude..... ton	20.00 - 22.00	
Sulphur dioxide, liquid, cylinders extra..... lb.	.08 - .081	.09 - .10
Sulphur (sublimed), flour..... 100 lb.		2.25 - 3.10
Sulphur, roll (brimstone)..... 100 lb.		2.00 - 2.75
Tin bichloride, 50 per cent..... lb.	.18 - .19	
Tin oxide..... lb.		.40 - .42
Zinc carbonate, precipitate..... lb.	.16 - .18	.19 - .20
Zinc chloride, gran..... lb.	.11 - .111	.111 - .12
Zinc cyanide..... lb.	.45 - .49	.50 - .60
Zinc dust..... lb.	.111 - .111	.111 - .121
Zinc oxide, XX..... lb.	.09 - .091	.091 - .10
Zinc sulphate..... 100 lb.	2.90 - 3.00	3.25 - 3.75

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude..... lb.	\$1.10 - \$1.15
Alpha-naphthol, refined..... lb.	1.25 - 1.30
Alpha-naphthylamine..... lb.	.35 - .40
Aniline oil, drums extra..... lb.	.20 - .27
Aniline salts..... lb.	.26 - .29
Anthracene, 80% in drums (100 lb.)..... lb.	.75 - 1.00
Benzaldehyde U.S.P..... lb.	1.50 - .
Benzidine, base..... lb.	.85 - 1.00
Benzidine sulphate..... lb.	.75 - .85
Benzoic acid, U.S.P..... lb.	.60 - .65
Benzoate of soda, U.S.P..... lb.	.55 - .60
Benzene, pure, water-white, in drums (100 gal.) gal.	.27 - .32
Benzene, 90%, in drums (100 gal.)..... gal.	.25 - .28
Benzyl chloride, 95-97%, refined..... lb.	.28 - .30
Benzyl chloride, tech..... lb.	.20 - .25
Beta-naphthol benzoate..... lb.	3.50 - 4.00
Beta-naphthol, sublimed..... lb.	.70 - .75
Beta-naphthol, tech..... lb.	.38 - .40
Beta-naphthylamine, sublimed..... lb.	1.75 - 1.80
Cresol, U. S. P., in drums (100 lb.)..... lb.	.16 - .18
Ortho-cresol, in drums (100 lb.)..... lb.	.25 - .27
Cresylic acid, 97-99%, straw color, in drums..... gal.	.70 - .80
Cresylic acid, 35-97%, dark, in drums..... gal.	.65 - .70
Cresylic acid, 50%, first quality, drums..... gal.	.45 - .50
Dichlorobenzene..... lb.	.06 - .09
Diethylaniline..... lb.	1.20 - 1.25
Dimethylaniline..... lb.	.40 - .50
Dinitrobenzene..... lb.	.26 - .28
Dinitrochlorobenzene..... lb.	.20 - .30
Dinitronaphthalene..... lb.	.30 - .40
Dinitrophenol..... lb.	.35 - .40
Dinitrotoluene..... lb.	.27 - .30
Dip oil, 25%, car lots, in drums..... gal.	.40 - .45
Diphenylamine..... lb.	.60 - .65
H-acid..... lb.	1.20 - 1.30
Meta-phenylenediamine..... lb.	1.15 - 1.20
Monochlorobenzene..... lb.	.12 - .14
Monoethylaniline..... lb.	1.75 - 1.85
Naphthalene crushed, in obls..... lb.	.07 - .081
Naphthalene, flake..... lb.	.07 - .081
Naphthalene, balls..... lb.	.081 - .091
Naphthionic acid, crude..... lb.	.70 - .75
Nitrobenzene..... lb.	.12 - .15
Nitro-naphthalene..... lb.	.30 - .35
Nitro-toluene..... lb.	.16 - .18
Ortho-amidophenol..... lb.	3.10 - 3.20
Ortho-dichlor-benzene..... lb.	.15 - .20
Ortho-nitro-phenol..... lb.	.80 - .85
Ortho-nitro-toluene..... lb.	.15 - .20
Ortho-toluidine..... lb.	.20 - .25
Para-amidophenol, base..... lb.	1.50 - 1.60
Para-amidophenol, HCl..... lb.	1.75 - 1.80

Para-dichlorobenzene..... lb.	.15 - .20
Paranitroniline..... lb.	.85 - 1.00
Para-nitrotoluene..... lb.	.85 - .95
Para-phenylenediamine..... lb.	1.75 - 2.00
Para-toluidine..... lb.	1.25 - 1.40
Phthalic anhydride..... lb.	.50 - .60
Phenol, U. S. P., drums..... lb.	.11 - .13
Pyridine..... gal.	2.00 - 3.50
Resorcinol, technical..... lb.	1.75 - 1.85
Resorcinol, pure..... lb.	2.25 - 2.30
Silicic acid, tech., in bbls..... lb.	.19 - .22
Salicylic acid, U. S. P..... lb.	.20 - .25
Salol..... lb.	.80 - .85
Solvent naphtha, water-white, in drums, 100 gal gal.	.25 - .28
Solvent naphtha, crude, heavy, in drums, 100 gal gal.	.14 - .16
Sulphanilic acid, crude..... lb.	.30 - .35
Toluidine..... lb.	1.25 - 1.35
Toluidine, mixed..... lb.	.40 - .45
Toluene, in tank cars..... gal.	.25 - .28
Toluene, in drums..... gal.	.28 - .31
Xylidines, drums, 100 gal..... lb.	.40 - .45
Xylene, pure, in drums..... gal.	.40 - .45
Xylene, pure, in tank cars..... gal.	.45 - .
Xylene, commercial, in drums, 100 gal..... gal.	.33 - .35
Xylene, commercial, in tank cars..... gal.	.30 - .

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark..... lb.	\$0.24 - \$0.25
Beeswax, refined, light..... lb.	.27 - .28
Beeswax, white pure..... lb.	.42 - .45
Carnauba, Florida..... lb.	.58 - .60
Carnauba, No. 2, North Country..... lb.	.25 - .26
Carnauba, No. 3, North Country..... lb.	.151 - .16
Japan..... lb.	.17 - .171
Montan, crude..... lb.	.061 - .061
Paraffine waxes, crude match wax (white) 105-110 m.p..... lb.	.031 - .031
Paraffine waxes, crude, scale 124-126 m.p..... lb.	.021 - .031
Paraffine waxes, refined, 118-120 m.p..... lb.	.031 - .031
Paraffine waxes, refined, 125 m.p..... lb.	.041 - .041
Paraffine waxes, refined, 128-130 m.p..... lb.	.041 - .05
Paraffine waxes, refined, 133-135 m.p..... lb.	.051 - .051
Paraffine waxes, refined, 135-137 m.p..... lb.	.051 - .06
Stearic acid, single pressed..... lb.	.09 - .
Stearic acid, double pressed..... lb.	.091 - .
Stearic acid, triple pressed..... lb.	.10 - .101

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl..... 280 lb.	\$5.00 - .
Rosin E-I..... 280 lb.	5.30 - 5.50
Rosin K-N..... 280 lb.	5.70 - 6.50
Rosin W. G. W. W..... 280 lb.	6.60 - .
Wood rosin, bbl..... 280 lb.	6.25 - .
Spirits of turpentine..... gal.	.581 - .
Wood turpentine, steam dist..... gal.	.50 - .
Wood turpentine, dest. dist..... gal.	.54 - .
Pine tar pitch, bbl..... 200 lb.	. - 6.75
Tar, kiln burned, bbl. (500 lb.)..... bbl.	. - 11.50
Retort tar, bbl..... 500 lb.	. - 11.50
Rosin oil, first run..... gal.	.35 - .
Rosin oil, second run..... gal.	.38 - .
Rosin oil, third run..... gal.	.43 - .
Pine oil, steam dist., sp.gr. 0.930-0.940..... gal.	\$1.80 - .
Pine oil, pure, dest. dist..... gal.	1.50 - .
Pine tar oil, ref., sp.gr. 1.025-1.035..... gal.	.46 - .
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla..... gal.	.35 - .
Pine tar oil, double ref., sp.gr. 0.965-0.990..... gal.	.75 - .
Pine tar, ref., thin, sp.gr. 1.080-1.960..... gal.	.35 - .
Turpentine, crude, sp. gr. 0.900-0.970..... gal.	1.20 - .
Hardwood oil, f.o.b. Mich., sp.gr. 0.960-0.990..... gal.	.35 - .
Pinewood creosote, ref..... gal.	.52 - .

Solvents

73-76 deg., steel bbls. (85 lb.)..... gal.	\$0.41 - .
70-72 deg., steel bbls. (85 lb.)..... gal.	.39 - .
68-70 deg., steel bbls. (85 lb.)..... gal.	.38 - .
V. M. and P. naphtha, steel bbls. (85 lb.)..... gal.	.30 - .

Crude Rubber

Para-Upriver fine..... lb.	\$0.16 - .17
Upriver coarse..... lb.	.09 - .091
Upriver caucho ball..... lb.	.111 - .12
Plantation—First latex crepe..... lb.	.141 - .
Ribbed smoked sheets..... lb.	.12 - .121
Brown crepe, thin, clean..... lb.	.15 - .
Amber crepe No. 1..... lb.	.17 - .

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls..... lb.	\$0.081 - \$0.09
Castor oil, AA, in bbls..... lb.	.10 - .101
China wood oil, in bbls. (f.o.b. Pac. coast)..... lb.	.141 - .15
Cocoonut oil, Ceylon grade, in bbls..... lb.	.101 - .101
Cocoonut oil, Cochín grade, in bbls..... lb.	.11 - .111
Corn oil, crude, in bbls..... lb.	.071 - .071
Cottonseed oil, crude (f. o. b. mill)..... lb.	.051 - .051
Cottonseed oil, summer yellow..... lb.	.071 - .08
Cottonseed oil, winter yellow..... lb.	.08 - .
Linseed oil, raw, car lots (domestic)..... gal.	.73 - .75
Linseed oil, raw, tank cars (domestic)..... gal.	.67 - .
Linseed oil, in 5-bbl. lots (domestic)..... gal.	.75 - .77

Olive oil, Denatured.....	gal	\$1.55	—	\$1.45
Palm, Lagos.....	lb.	.05	—	.07
Palm, Niger.....	lb.	.05 ¹ ₂	—	.05 ¹ ₂
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.06	—	.06 ¹ ₂
Peanut oil, refined, in bbls.....	lb.	.10	—	.10 ¹ ₂
Rapeseed oil, refined in bbls.....	gal.	.88	—	.90
Rapeseed oil, blown, in bbls.....	gal.	.94	—	.95
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.07 ³ ₄	—	—
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.05 ¹ ₄	—	—

FISII

Light pressed menhaden.....	gal.	\$0.42	—	....
Yellow bleached menhaden.....	gal.	.44	—	....
White bleached menhaden.....	gal.	.46	—	....
Brown menhaden.....	gal.	.50	—	....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	\$24.00	—	30.00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	22.00	—	26.00
Barytes, crude, 88% @ 94% ba., Kings Creek	net ton	10.00	—	12.00
Barytes, floated, f.o.b. St. Louis	net ton	26.50	—	28.00
Barytes, crude, first grade, Missouri	net ton	7.00	—	...
Blanc fixe, dry	lb.	.04 $\frac{1}{8}$	—	.04 $\frac{1}{8}$
Blanc fixe, pulp	net ton	45.00	—	55.00
Casein	lb.	.08	—	.10
Chalk, domestic, extra light	lb.	.04 $\frac{1}{2}$	—	.05
Chalk, domestic, light	lb.	.04	—	.04
Chalk, domestic, heavy	lb.	.03 $\frac{3}{4}$	—	.04
Chalk, English, extra light	lb.	.04 $\frac{1}{2}$	—	.05
Chalk, English, light	lb.	.04 $\frac{1}{2}$	—	.05
Chalk, English, dense	lb.	.04	—	.04 $\frac{1}{2}$
China clay (kaolin) crude, f.o.b. mines, Georgia	ret ton	8.00	—	10.00
China clay (kaolin) washed, f.o.b. Georgia	ret ton	12.00	—	15.00
China clay (kaolin) powdered, f.o.b. Georgia	ret ton	18.00	—	22.00
China clay (kaolin) crude f.o.b. Virginia points	ret ton	8.00	—	12.00
China clay (kaolin) grou d, f.o.b. Virginia points	ret ton	15.00	—	25.00
China clay (kaolin), imported, lump	ret ton	12.00	—	20.00
China clay (kaolin), imported, powdered	ret ton	20.00	—	25.00
Feldspar, crude, f.o.b. Maryland and North Carolina points	gross ton	8.00	—	14.00
Feldspar, crude, f.o.b. Maine	ret ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore	net ton	27.00	—	30.00
Fullers earth, f.o.b. Mines	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Pa.	net ton	15.00	—	18.00
Fullers earth, powdered, f.o.b. Fla.	net ton	18.00	—	...
Fullers earth, imported, powdered	net ton	24.00	—	27.00
Graphite, Ceylon lump, first quality	lb.	.07 $\frac{1}{2}$	—	.08
Graphite, Ceylon chip	lb.	.06	—	.06 $\frac{1}{2}$
Graphite, high grade amorphous crude	lb.	.02 $\frac{3}{4}$	—	.03
Pumice stone, imported, lump	lb.	.04	—	.50
Pumice stone, domestic lump	lb.	.05	—	.05 $\frac{1}{2}$
Pumice stone, ground	lb.	.06	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore	net ton	.....	—	10.00
Quartz (acid tower) 1 $\frac{1}{2}$ @2 in., f.o.b. Baltimore	net ton	.....	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore	net ton	.....	—	17.00
Quartz, lump, f.o.b. North Carolina	ret ton	5.00	—	7.50
Shellac, orange fine	lb.	.68	—	...
Shellac, orange superfine	lb.	.70	—	.71
Shellac, A. C. garnet	lb.	.53	—	.54
Shellac, T. N.	lb.	.65	—	.67
Soapstone	ton	12.00	—	15.00
Sodium chloride	long ton	12.50	—	13.00
Talc, paper-making grades, f.o.b. Vermont	ton	11.00	—	20.00
Talc, roofing grades, f.o.b. Vermont	ton	8.50	—	13.00
Talc, rubber grades, f.o.b. Vermont	ton	11.00	—	18.00
Talc, powdered, Southern, f.o.b. cars	ton	10.00	—	14.00
Talc, imported	ton	30.00	—	40.00
Talc, California talcum powder grade	ton	18.00	—	40.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	per ton	\$37.50-40.00
Carborundum refractory brick, 9-in.	{ less than earlot carload lots	1,000 1250.00
		1,000 1100.00
Chrome brick, f.o.b. Eastern shipping points.....	net ton	60 ..
Chrome cement, 40-45% Cr ₂ O ₃	net ton	30- 32
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in ear lots, f.o.b. Eastern shipping points.....	net ton	33- 35
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylv- ania, Ohio and Kentucky works.....	1,000	36- 40
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylv- ania, Ohio and Kentucky works.....	1,000	30- 35
Magnesite brick, 9-in. straight.....	net ton	70
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	77
Magnesite brick, soaps and splits.....	net ton	98
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	42- 45
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	46- 50
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	35- 38

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	\$200.00 —	\$225.00
Ferrochrome per lb. of Cr. contained, 6-8% carbon, carlots.	lb.	.14 —	....
Ferrochrome, per lb. of Cr. contained, 4-6% carbon, carlots.	lb.	.15 —	....
Ferromanganese, 76-80% Mn, domestic.	gross ton	70.00 —	75.00
Ferromanganese, 76-80% Mn, English.	gross ton	70.00 —	75.00
Spiegeleisen, 18-22% Mn.	gross ton	27.00 —	28.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo	lb.	2.50 —	....
Ferro-silicon, 10-15%.	gross ton	40.00 —	42.00
Ferro-silicon, 50%.	gross ton	68.00 —	70.00
Ferro-silicon, 75%.	gross ton	140.00 —	145.00
Ferrotungsten, 70-80%, per lb. of contained W	lb.	.45 —	50
Ferroumium, 35-50% of U, per lb. of U content	lb.	6.00 —	....
Ferrovandium, 30-40% per lb. of contained V	lb.	5.00 —	6.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content	gross ton	\$8.00	—	\$10.00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	unit	.35	—	.40
Chrome ore, 50% Cr_2O_3 , f.o.b. Atlantic seaboard	unit	.35	—	.40
Coke, foundry, f.o.b. ovens	net ton	4.00	—	4.50
Coke, furnace, f.o.b. ovens	net ton	3.00	—	3.25
Coke, petroleum, refinery, Atlantic seaboard	net ton	14.00	—	15.00
Fluorspar, lump, f.o.b. mines, New Mexico	net ton	12.50	—	.....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	18.00	—	20.00
Ilmenite, 52% TiO_2 , per lb. ore	lb.	.01 $\frac{1}{2}$	—	.01 $\frac{1}{2}$
Manganese ore, 50% Mn, c.i.f. Atlantic seaport	unit	.25	—	.....
Manganese ore, chemical (MnO_2)	gross ton	55.00	—	60.00
Molybdenite, 85% MoS_2 , per lb. of MoS_2 , N. Y.	lb.	.55	—	.60
Monazite, per unit of ThO_2 , c.i.f., Atlantic seaport	unit	30.00	—	.....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.14	—	.14
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport	unit	.14	—	.14
Pyrites, domestic, fines, f.o.b. mines, Ga.	unit	.12	—	.13
Rutile, 95% TiO_2 per lb. ore	lb.	.15	—	.....
Tungsten, scheelite, 60% WO_3 and over, per unit of WO_3 (nominal)	unit	2.75	—	3.00
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3 , N. Y. C.	unit	3.00	—	3.25
Uranium ore (carnotite) per lb. of U_3O_8	lb.	1.50	—	2.50
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.25	—	2.50
Vanadium pentoxide, 99%	lb.	12.00	—	14.00
Vanadium ore, per lb. of V_2O_5 contained	lb.	1.00	—	.....
Zirown, washed, iron free	lb.	.03	—	.....

Non-Ferrous Metals

New York Markets

Cents per Lb.

Copper, electrolytic.....	12.75
Aluminum, 98 to 99 per cent.....	28.00@28.5
Antimony, wholesale lots, Chinese and Japanese.....	4 $\frac{1}{2}$
Nickel, ordinary (ingot).....	41.00
Nickel, electrolytic.....	44.00
Monel metal, spot and blocks.....	35.00
Monel metal ingots.....	38.00
Monel metal, sheet bars.....	40.00
Tin, 5-ton lots, Straits.....	29.00
Lead, New York, spot.....	4.40
Lead, E. St. Louis, spot.....	4.12-4.25
Zinc, spot, New York.....	4.55
Zinc, spot, E. St. Louis.....	4.20-4.25

OTHER METALS

Silver (commercial).....	oz.	\$0.59
Cadmium.....	lb.	1.00-1.25
Bismuth (500 lb. lots).....	lb.	1.50@1.55
Cobalt.....	lb.	4.00
Magnesium (f.o.b. Philadelphia).....	lb.	1.25
Platinum.....	oz.	75.00
Iridium.....	oz.	160.00@180.00
Palladium.....	oz.	65.00-70.00
Mercury.....	75 lb.	46.00-47.00

FINISHED METAL PRODUCTS

Warehouse Price
Cents per Lb.

Copper sheets, hot rolled.....	21.25-21.50
Copper bottoms.....	28.75-29.00
Copper rods.....	20.00
High brass wire.....	17.25
High brass rods.....	14.25
Low brass wire.....	18.75
Low brass rods.....	18.75
Brazed brass tubing.....	27.50
Brazed bronze tubing.....	32.25
Seamless copper tubing.....	22.00
Seamless high brass tubing.....	20.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York	Cleveland	Chicago
	Current		
Copper, heavy and crucible.....	9.25@ 9 50	9.25	9.50
Copper, heavy and wire.....	8.25@ 8 50	8.50	8.50
Copper, light and bottoms.....	7.25@ 7 75	7.50	7.25
Lead, heavy.....	3.25@ 3 50	3.25	3.25
Lead, tea.....	2.25@ 2.35	2.25	2.25
Brass, heavy.....	4.25@ 4 50	4.50	5.00
Brass, light.....	3.25@ 3 50	3.25	3.50
No. 1 yellow brass turnings.....	4.25@ 4 50	4.25	4.50
Zinc.....	2.00@ 2.50	2.00	2.25

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by $\frac{1}{2}$ in. and larger, and plates $\frac{1}{2}$ in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes.....	\$2.60	\$3.23	\$3.23
Soft steel bars.....	2.50	3.00	3.13
Soft steel bar shapes.....	2.50	3.13	3.13
Soft steel bands.....	2.85	3.83	3.78
Plates, $\frac{1}{2}$ to 1 in. thick.....	2.50	3.30	3.23

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

PINEY POINT—The Florida Oil Refining Association, Tampa, Fla., has preliminary plans in preparation for the erection of a new refinery at Piney Point. A local tract, comprising about 1,100 acres of land, has been acquired as a site; the plant will be of two-unit type, with daily output of about 2,000 bbl. A storage capacity of 80,000 bbl. will be provided. The new plant is estimated to cost about \$250,000, including equipment.

Arkansas

EL DORADO—The Union Pipe Line & Refining Co. has completed a new local refinery and operations have been inaugurated. The plant is of 5,000-bbl. capacity and will handle crude oil from this district exclusively. The company has another refining plant under construction, and plans to have the unit ready for service early in August.

California

LOS ANGELES—The Bradley-Wise Paint Co., 650 Santa Fe Ave., has arranged for an increase in capital from \$50,000 to \$150,000, and has tentative plans under way for the establishment of a new plant. It is said that a number of local sites are being considered.

SAN JOSE—The plant of the Fred Cooke Oil Co. was partly destroyed by fire, June 11, with loss estimated at about \$30,000. The company is reported to be planning for early rebuilding.

LOS ANGELES—C. H. Winkelman, formerly president and general manager of the California Varnish Co., has organized a company to be known as C. H. Winkelman & Co., to operate a plant at 2416-26 San Leandro St., for the manufacture of paints, enamels, varnishes, etc. P. M. Waldron will act as factory superintendent.

SUMMERLAND—The Department of Agriculture, Washington, D. C., has taken bids for the sale of the Government kelp potash plant here. The highest bid received, totaling \$35,000, is said to be irregular and not in accord with conditions. The next highest bid, for \$25,000, was made by M. E. Saville, San Francisco.

LOS ANGELES—The Republic Steel Package Co., 7930 Jones Rd., has acquired property here for the erection of a new plant for Pacific Coast service. The initial plant unit will be 60 x 300 ft., and will be equipped to give employment to about 100 operatives. S. B. Merry is treasurer.

Idaho

BOISE—Edward Crassen, Baker, Ore., and associates are considering the erection of a new plant in the vicinity of Boise for the manufacture of paint, varnish, etc.

Illinois

CHICAGO—The Carbo Oxygen Co., affiliated with the Carbo Hydrogen Co., 10305 Torrence Ave., has construction under way on a new plant at 10329-41 Torrence Ave., to be 1-story, 55 x 140 ft., and estimated to cost about \$18,000. W. G. Langenheim, 333 South Dearborn St., is engineer.

Indiana

CHESTERTON—The United States China Co. will soon commence the erection of an addition to its local plant, to comprise a number of buildings. A new main 2-story structure, 100 x 300 ft., will be built, with adjoining building, 50 x 50 ft., to be equipped as a sagger manufacturing department. Five new kilns will be constructed, the work is estimated to cost close to \$100,000.

INDIANAPOLIS—The Standard Oil Co. of Indiana is completing negotiations for the purchase of the Midwest Refining Co., the acquisition to include all oil refineries and other property. The Standard company

recently increased its capital from \$100,000,000 to \$140,000,000. A large portion of the increase, it is said, will be used for the proposed purchase.

Louisiana

SHREVEPORT—The plant of the Henderson Cotton Oil Co. was destroyed by fire, June 22, with loss estimated at \$300,000, including machinery. A number of buildings sustained a large loss, including main mill and lint department.

Maryland

BALTIMORE—The Zirconium Co. of America, Monument and Eleventh Sts., recently organized to manufacture ferrozirconium and other products, will install an electrochemical plant at its new works for oxide production. George F. Dixon is president.

BEL AIR—The Maryland Flint & Feldspar Co. has perfected plans for the construction of a new plant near Bel Air, to replace its present works. It is estimated to cost about \$250,000, including machinery.

BALTIMORE—The Rasin-Monumental Co., National Marine Bldg., is arranging preliminary plans for the erection of its proposed new fertilizer manufacturing plant on Fairfield St., estimated to cost close to \$1,000,000 with machinery. The plant will be used as an extension to the company's works in the Curtis Bay section.

BALTIMORE—The International Chemical Products Co., 13 West Saratoga St., recently organized, has plans under way for the erection of a new plant for the manufacture of pulp and paper products, extracts, etc. Six buildings will be erected at a cost of about \$25,000, and machinery and equipment estimated to cost \$75,000 installed. The latter will include extracting, evaporating, refining and other apparatus. The company is capitalized at \$150,000. W. A. Gardner is president, and Frank L. La Motte secretary.

BALTIMORE—The Gwynns Falls Paper Co., 517 Calvert Bldg., has taken title to property in the Gwynns Falls section, comprising about 5 acres of land, as a site for the erection of its proposed new paper mill, estimated to cost about \$250,000 with machinery. Joseph H. Wallace & Co., 5 Beekman St., New York, are engineers. George W. Davis is head.

Massachusetts

SPRINGFIELD—The Springfield Bronze Foundry Co. has awarded a contract to the M. J. O'Connell Co., 23 Murray Hill St., for the erection of its proposed new foundry for the manufacture of brass and bronze castings, at 166 Charles St. It will be 40 x 50 ft.

Michigan

DETROIT—Parke, Davis & Co., 2951 Atwater St., manufacturer of chemicals, etc., has construction under way on a new 2-story building, 100 x 200 ft., to cost about \$60,000. Frank H. Davis, 1838 Penobscot Bldg., has the erection contract.

Missouri

ST. LOUIS—The Chester Iron & Foundry Co., 7800 Vulcan St., has taken bids for the erection of a new 1-story foundry and plant addition, 45 x 117 ft., to cost about \$40,000. A. J. Schaelich is president.

ST. LOUIS—The Fleischmann Yeast Co., 1535 Market St., has awarded a contract to Kremer & Voirol, St. Louis, for the erection of its proposed new 1-story plant on the Forest Park Blvd., near Bogle Ave., 75 x 170 ft., estimated to cost about \$50,000.

Montana

WINNET—The Southern Alberta Refineries, Ltd., Calgary, Alta., is planning for the erection of a new oil refinery at Winnett. A site has been acquired and the proposed plant is estimated to cost about \$100,000. William Livingston is president.

Nevada

TONOPAH—The West End Chemical Co., affiliated with the West End Consolidated Mines Co., headed by F. G. (Doc) Smith, San Francisco, Cal., is planning for the early operation of a new plant in southern Nevada for the production of refined borax. The company has an extensive colemanite deposit in this section and will develop the property on a large scale.

New Jersey

EDGEWATER—The Archer-Daniels-Lesseed Co., Twenty-ninth Ave., Minneapolis, Minn., is completing plans for the erection of its proposed new linseed oil works on property recently acquired at Edgewater. It is understood that bids for erection and equipment will be asked at an early date.

TRENTON—A creditors' committee, headed by Edgar W. Hunt, Trenton, has acquired the local plant of the Trent Rubber Co., Enterprise Ave., for a consideration said to be \$100,000, and will continue the plant in operation.

Ohio

DOVER—The Harbison-Walker Refractories Co., Pittsburgh, Pa., has disposed of its local clay properties to S. A. McCaskey, said to represent the Wayne Coal Co., which proposes to operate on the site. The property is located in the Strasburg section, and was sold for a consideration said to be \$40,000.

CLEVELAND—The Empire Rolling Mill Co., Bessemer Ave., and the Pennsylvania R.R., has commenced the erection of a new 1-story building at its plant, to be used as a steel-galvanizing works. With warehouse building to be constructed, it is estimated to cost about \$50,000. C. G. Berkwell is president.

Pennsylvania

ERIE—The Keystone Rubber Mfg. Co., 1413 East Eleventh St., manufacturer of mechanical rubber goods, is taking bids for the rebuilding of its plant, recently destroyed by fire with loss estimated in excess of \$100,000. It will be 3-story, 123 x 165 ft. J. M. Blake, Commercial Bldg., is engineer.

Tennessee

ANDERSON—The Robinson Lime Co., recently organized with a capital of \$250,000, has plans under way for the erection of a new lime-manufacturing plant on local site, with initial daily output of about 50 tons. Complete grinding and crushing departments will be installed. A. J. Robinson is president and M. H. Bates treasurer.

Texas

HOUSTON—James A. Harley, Houston, is organizing a local company to establish a new plant in the Bethany-Elvian gas field, Harrison Co., for the production of carbon black. The proposed works are estimated to cost in excess of \$500,000 with machinery.

BRIDGEPORT—The Edmonds Oil & Refining Co. has acquired the refinery of the Bridgeport Refining Co., and has plans under way for extensions and improvements for increased production.

COMMERCE—The Trinity Paper Mills Co., which recently commenced operations at a new local mill for the manufacture of paper pulp from cottonseed linters, is considering preliminary plans for the construction of branch mills for similar production at Fort Worth and McKinney, Tex.

BROWNWOOD—The Texas Oil & Gas Refineries Co., recently reorganized, is planning for the installation of additional equipment for gasoline production. Philip J. Baney is president and general manager.

Utah

SALT LAKE CITY—The Utah Oil Refining Co. is planning for the rebuilding of its plant, destroyed by fire, June 11, with loss reported in excess of \$500,000, including buildings and equipment.

Virginia

WINCHESTER—The Cornwell Lime-Marl Co. has plans in preparation for the erection of a new plant 25 x 68 ft. and 25 x 90 ft., with initial daily capacity of about 125 tons of lime marl. The plant will cost about \$25,000. C. J. Swank is general manager.

ROANOKE—The Viscose Co., Marcus Hook, Pa., manufacturer of artificial silk products, is reported to be planning for the erection of additions to its local plant, to double the present output.

New Companies

THE F. W. MUIR BOARD Co., Morristown, N. J., has been incorporated with a capital of \$100,000 to manufacture paperboard products. The incorporators are Franklin W. Muir, Robert H. McLeod and Oliver K. Day, Park Place, Morristown.

MARTIN-WALSH, INC., New York, N. Y., has been incorporated with a capital of \$70,000 to manufacture paper products. The incorporators are W. Martin, A. R. and J. C. Walsh, Jr. The company is represented by O. M. Bate, 26 Liberty St.

THE SPRINGFIELD WIRE & TINSEL Co., Springfield, Mass., has been incorporated with a capital of \$600,000 to manufacture wire products and kindred specialties. Gerald J. Callahan is president; and Edward S. Bradford, Springfield, treasurer.

THE MARK DELISSER CORP., New York City, has been incorporated with a capital of \$100,000 to manufacture chemicals and affiliated products. The incorporators are Mark Delisser, J. Dubow and M. B. Lesser, 132 Nassau St.

THE SERVICE PAINT & VARNISH WORKS, INC., Brooklyn, N. Y., has been incorporated with a capital of \$10,000 to manufacture paints, varnishes, etc. The incorporators are C. A. and J. C. Osterholm, W. D. MacNaughton, and J. A. Johnson, 91 Kenmore Pl., Brooklyn.

THE LUDINGTON NOVELTY MFG. Co., Ludington, Mich., has been incorporated with a capital of \$50,000 to manufacture steel needles and kindred products. The incorporators are Bernard Ostendorf, L. E. Vorse, and William C. Killen, Ludington.

THE SEPOY DYE PRODUCTS CORP., New York City, has been incorporated with a capital of \$150,000 to manufacture chemicals, dyestuffs, etc. G. Bothamley, 77 Pine St., is the principal incorporator.

THE UNITED STATES PORCELAIN Co., Trenton, N. J., has been incorporated with a capital of \$100,000, to manufacture porcelain wares and other ceramic products. The incorporators are John Janus and Carl Markau, 54 Seward Ave.

THE SOBOS OIL CORP., New York City, has been incorporated with a capital of \$16,000 to manufacture oil products. The incorporators are W. Davis, A. Conant, and W. C. Arnold, 120 B'way.

THE OZARK PETROLEUM Co., Willow Springs, Mo., has been incorporated with a capital of \$200,000 to manufacture petroleum products. L. O. Neider is president; and Dr. S. E. Haycraft, vice-president, both of Willow Springs.

THE CLARKSVILLE SEED Co., Clarksville, Tenn., has been incorporated with a capital of \$35,000 to manufacture cottonseed oil specialties. The incorporators are F. A. Antone and R. Isbell, Clarksville.

THE MOBILE PAINT MFG. Co., Mobile, Ala., has been incorporated with a capital of \$50,000 to manufacture paints, varnishes, etc. W. A. Benson is president; H. R. Luscher, treasurer; and Carter Luscher, secretary, all of Mobile.

DYAS & LEGRS, INC., 5514 West Lake St., Chicago, Ill., has been incorporated with a capital of \$15,000 to manufacture chemicals and chemical byproducts. The incorporators are Clair S. Dyas and Emil A. LeGros.

THE O. C. BARBER LIME Co., Room 48, 10 South St., Baltimore, Md., has been incorporated with a capital of \$600,000 to manufacture lime products. The incorporators are Clarence W. Perkins, Addison E. Hook and Mullin Wilson.

THE SHEPHERD CHEMICAL Co., New York City, has been incorporated with a capital of \$30,000 to manufacture chemicals, insecticides and kindred products. The incorporators are N. P. Cullom, F. B. Ryan and E. C. Dickinson. The company is represented by Cullom & Rinke, 165 B'way.

THE MONTVILLE PAPER Co., Montville, Conn., has been incorporated with a capital of \$50,000 to manufacture and deal in paper, paper boxes and affiliated specialties. The incorporators are R. C. Burchard, Montville; F. W. Mercer and F. L. McGuire, 64 Huntington St., New London, Conn.

THE SHAWMUT DRUG & CHEMICAL Co., Boston, Mass., has been incorporated with a capital of \$10,000 to manufacture chemical products. Joseph M. McManus, 496 Main St., Charlestown, Mass., is treasurer; Charles Costello and Dennis McCarthy are directors.

THE NEW JERSEY OIL REFINING Co., Keyport, N. J., has been incorporated with a capital of \$2,500,000 to manufacture refined oil products. The incorporators are Robert Thysem, Earl U. Bartholomew and Arthur L. Turner, Keyport.

THE PUENTE MID-CENTRAL OIL Co., Los Angeles, Cal., has been incorporated with a capital of \$1,000,000 to manufacture petroleum products. The incorporators are G. G. Russell, W. M. Miller and Walter F. Wilkinson. The company is represented by Walter H. Sprague, 811 H. W. Hellman Bldg.

THE G. & R. MFG. Co., Tampa, Fla., has been incorporated with a capital of \$25,000 to manufacture soap products. L. F. Goonrey is president and M. D. Reay secretary and treasurer, both of Tampa.

THE WOVEN LEATHER CORP., Brooklyn, N. Y., has been incorporated with a capital of \$100,000 to manufacture leather products. The incorporators are N. H. Dimon, M. P. Murphy and P. H. Loftus, 80 B'way.

THE ILLINOIS BARITE Co., Main St., Golconda, Ill., has been incorporated with a capital of \$150,000 to operate mineral properties with refining plant. The incorporators are Leslie Wardrop, James Wardrop and G. W. Casey.

THE FREDERICKSEN Co., Saginaw, Mich., has been incorporated with a capital of \$100,000 to manufacture brass, bronze, aluminum and other metal castings. The incorporators are Niels J. Fredericksen, 5740 Lorain Ave., Detroit, Mich.; Alexander M. Lemke and Otto Schrupp, Saginaw.

THE CORTEX CHEMICAL WORKS, Brooklyn, N. Y., has been incorporated with a capital of \$30,000 to manufacture chemicals and chemical byproducts. The incorporators are L. Kuhne, C. Zengerie and D. Spero. The company is represented by B. G. Greller, 299 B'way, New York.

THE JEWELERS' SMELTING Co., INC., Newark, N. J., has been incorporated with a capital of \$100,000 to operate a smelting and refining works for gold and other materials. The incorporators are Marcel Godefroy, Milton A. and Harry C. Helminger. The company is represented by Charles S. Smith, 207 Market St.

THE H. K. T. OIL Co., Los Angeles, Cal., has been incorporated with a capital of \$350,000 to manufacture petroleum products. The incorporators are Roy Lauman, J. A. Rasmussen and Theodore Wittler. The company is represented by Joseph Crail, Union Oil Bldg.

THE TRANSLOID PRODUCTS Co., New York City, has been incorporated with a capital of \$500,000 to manufacture translucent sheeting and other composition products. The incorporators are W. A. Scanlan, L. Meyers and L. Tyler, 51 Chambers St.

THE ORGANIC FERTILIZER Co., Lakeland, Fla., has been incorporated with a capital of \$500,000 to manufacture fertilizer products. The incorporators are W. T. Overstreet, Edwin Spencer, Jr., and W. B. Sewell, Lakeland.

THE ONONDAGA SALT Co., Syracuse, N. Y., has been incorporated with a nominal capital of \$5,000 to manufacture salt products. The incorporators are T. K. Gale, D. W. Peck and T. P. Murray. The company is represented by Daniel A. Pierce, Wieting Bldg.

THE OIL & CHEMICAL CORP., Chicago, Ill., has been incorporated under Delaware laws with a capital of \$335,000 to manufacture chemicals, oils, etc. The incorporators are Abraham Greenspan, A. L. Rittenberg and Lawrence A. Cohen, 11 South La Salle St., Chicago.

THE NATURAL OXIDE CORP., Ford City, Pa., has been incorporated with a capital of \$500,000 to manufacture oxides, purifying materials for gas plants and kindred products. The incorporators are Leroy John, Harry Butler, Ford City; and Guy Ross, Oakmont, Pa.

THE PEERLESS CORK Co., 26 Prospect St., Newark, N. J., has filed notice of organization to manufacture cork products. Charles A. Hauser, 61 Linden St., Irvington, Newark, heads the company.

THE CHARLES B. CHRYSTAL Co., New York City, has been incorporated with a capital of \$200,000 to manufacture waxes, chemicals, etc. The incorporators are C. B. and O. Chrystal, and J. Ormiston. The company is represented by F. J. Knorr, attorney, Albany, N. Y.

THE AUBURN PARK OIL Co., 7222 Green St., Chicago, Ill., has been incorporated with a capital of \$100,000 to manufacture and deal in oil products. The incorporators are Otto Miller, Hugh J. McHugh and W. Gottwold.

THE SOUTH SIDE OIL Co., Salamanca, N. Y., has been incorporated with a capital of \$35,000 to manufacture oil products. The incorporators are R. C. Cooney, T. Conlan and G. A. Adams, Salamanca.

SCHWITTER, CLOVER & STARKWEATHER, INC., Newark, N. J., has been incorporated with a capital of \$125,000 to operate a metal smelting and refining plant. The

incorporators are Martin Schwitter, Charles Clover and George W. Starkweather, 320 Passaic Ave.

THE CLAROTYPE Co., New York City, has been incorporated with a capital of \$100,000 to manufacture type-cleaning fluids and other chemical compounds. The incorporators are L. and E. Banov, A. Henderson and L. Mintz, 19 West 44th St.

Industrial Notes

THE CHEMICAL EQUIPMENT Co. announces the removal of its general offices from 910 Monadnock Bldg. to 2457-59 South Western Ave., Chicago, Ill.

HUGO SCHLATTER has resigned his position as manager of the chemical products division of the Hercules Powder Co. and plans a trip to Europe early in July. While abroad he will visit industrial centers and is prepared to undertake commissions for American manufacturers who desire special investigations and reports on conditions abroad. Mr. Schlatter may be addressed at P.O. Box 26, Wilmington, Del.

THE ELECTRIC HEATING APPARATUS Co. announces the removal of its general offices and factory to 18-34 Nesbitt St., Newark, N. J.

Capital Increases, Etc.

THE SINCLAIR & VALENTINE Co., 611 West 129th St., New York City, manufacturer of lithographing inks, etc., has filed notice of increase in capital from \$400,000 to \$1,600,000.

THE EAGLE LAKE BRICK & TILE WORKS, Eagle Lake, Ill., has filed notice of dissolution under state laws.

THE MAC SIM BAR PAPER Co., Otsego, Mich., has filed notice of increase in capital from \$1,200,000 to \$2,400,000.

THE GOODYEAR RUBBER Co., 787 B'way, New York City, has filed notice of increase in capital from \$500,000 to \$2,615,000.

THE ROOSEVELT DRUG & CHEMICAL Co., 117 Smith St., Perth Amboy, N. J., has been granted a certificate of dissolution under state laws.

THE BARTLES-SWEENEY OIL Co. of ILLINOIS, Peoria, Ill., has filed notice of increase in capital from \$15,000 to \$300,000, at the same time changing its name to the Sweeney Gasoline & Oil Co.

WILLIAM S. GRAY has been appointed receiver for RALPH L. FULLER & Co., 81 Fulton St., New York City, manufacturers of chemicals and paints, in bond of \$50,000. The company's liabilities are said to aggregate \$480,000, with assets in excess of this sum.

Coming Meetings and Events

AMERICAN CERAMIC SOCIETY's summer meeting will be held at Canton, Alliance, Sebring and East Liverpool, Ohio, July 25 to 27. Headquarters will be at the Hotel Courtland, Canton, Ohio.

AMERICAN CHEMICAL SOCIETY, THE SOCIETY OF CHEMICAL INDUSTRY and the American Section of the latter society will hold a joint meeting in New York, Sept. 6 to 10.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in Lake Placid, N. Y., Sept. 29 and 30, and Oct. 1.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its fall meeting at Wilkes-Barre, Pa., Sept. 12 to 17.

AMERICAN MINING CONGRESS AND NATIONAL EXPOSITION OF MINES AND MINING EQUIPMENT will hold its twenty-fourth annual convention in the Coliseum, Chicago, Oct. 17 to 22.

AMERICAN SOCIETY FOR STEEL TREATING will hold its third annual convention and exhibition Sept. 19 to 24 at Indianapolis.

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SEVENTH) will be held during the week of Sept. 12 in the Eighth Coast Artillery Armory, New York City.

NEW JERSEY CHEMICAL SOCIETY has discontinued meetings for the summer and will resume them in October.

SOCIETY OF CHEMICAL INDUSTRY (BRITISH) at the invitation of the Montreal section will hold its annual meeting in Montreal and other Canadian cities during the week of Aug. 29, 1921. Details will be printed in this magazine from time to time.

CHEMICAL & METALLURGICAL ENGINEERING

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A consolidation of
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R. S. McBRIDE
CHARLES N. HULBURT
Assistant Editors
CHESTER H. JONES
Industrial Editor
J. S. NEGRU
Managing Editor

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New York, July 13, 1921

Number 2

Now He's Bossing Dad

DOUBTLESS most of our readers and all of our metallurgical friends are acquainted with the *Iron Age*, so that no introductory remarks are necessary. To those of them who do not see it regularly, however, we take the liberty of reproducing the following copyrighted poem by L. G. FIRTH, of the Firth-Sterling Steel Co., which appeared in an ornamental border on one of its recent front covers:

"THE MAN AT THE FIRE"

There are some who forget what experience means,
(They are generally fellows just out of their 'teens)
And by using pyrometers seem to acquire
A lack of belief in—
 "The man at the fire."

They'll talk of "calescence" and "pearlite," and tell
You the value of "cementite":—(sounds very well!)
And the depth of their learning will make you perspire,
But they don't get *results*, like—
 "The man at the fire."

A pyrometer's good when it's kept in its place,
But sometimes you'll find there's a lie on its face,
And then when the heat's climbing higher and higher,
The man who can *tell*, is—
 "The man at the fire."

Now do not mistake me; I say, by all means
While you're lacking in skill, put your trust in machines;
But if to be really expert you aspire,
Then study, as well, with—
 "The man at the fire."

So when you are learning your job, never heed
Those who tell you that skill is a thing you don't need;
For skill and hard work you will surely require,
If you hope to compete with—
 "The man at the fire."

The question immediately arises: Is this an advertisement, or is it not? On first glance, it certainly appears like editorial matter—no product or material is described or bulletined in it. It contains an idea which might readily be treated in this manner in editorial pages. Nevertheless we hasten to affirm our belief that it is an advertisement, unfortunately not censored.

Assume for the instant, however, that it is matter selected for display by the editors. On this assumption one cannot help but speculate what class of readers this poem would attract. It appears to be addressed to the unseasoned technical student, cautioning him against allowing a pyrometer to remain too long without calibration, of using technical terms beyond everyday parlance (although doctors appear to get rich doing just that), and of neglecting the human element involved in all manufacturing operations. These points should

always be borne in mind, although we would judge that the emphasis in the quotation is rather misplaced. It would be a rather safe bet that for every error due to inaccurate electric pyrometers there exist a dozen due to the "human-eye" pyrometer. As a matter of fact, scientific control devotes most of its energies toward preventing errors by "The Man at the Fire."

But we have been told that the *Iron Age* circulates mostly among executives, superintendents and purchasing agents. The small number of immature students seeing this cover would not warrant its use for them. If the editors deliberately address the big men in the industry in this tone, this outside cover appears as a direct slur on applied science; as a reflection of the attitude which rock-ribbed conservatism has always had toward progress. From a reasonable familiarity with the editorial pages of the *Iron Age* and an acquaintance with the editors themselves we therefore decline to believe that they are responsible for this cover. Even the reading pages of the same issue carry in the place of honor, crowding out such important business information as "The Metal Schedule in the New Tariff Bill," an article not by a man at the fire on "An Occurrence of Nitrogen in Steel." We are therefore forced to the conclusion that a certain steel company is willing to pay a considerable sum to advertise (a) that one of its officials is a poet, (b) that its products are still made in the good old-fashioned way, (c) that its steel is immune from any hardening-room abuse, or (d) that the man at the fire is the best judge of excellence in alloy steel.

Such an appeal for a return to the happy-go-lucky methods of rule of thumb displayed so prominently, even in advertising, cannot pass without protest. No thoughtful man but marvels at the heights of metallurgical perfection—oftentimes yet unimproved—reached purely by cut-and-try methods; by groping in the dark. But he also understands how painfully slow was this progress. Iron has been known since man can remember, yet a lingering two thousand years crawled by between the invention of the first crude blowing bellows and its equipment with a simple flap valve! Civilization progresses with ever-increasing speed, however. It took only a short hundred years to change the blast furnace from a machine producing twenty-five or thirty tons of pig iron a week to as much an *hour*. But are we going to throw away our pyrometers, our microscopes, our equilibrium diagrams, our calescences and cementites because "they don't get *results*, like—the man at the fire"? Is the man at the fire a good yardstick to measure an X-ray spectrometer?

After humbly courting a reluctant muse, we submit the following poem (with our humble apologies to CARL SANDBERG) as a counter-irritant. In order that there may be no doubt in the casual reader's mind about its

status, we hereby certify that it contains the germ of CHEMICAL & METALLURGICAL ENGINEERING'S editorial policy.

"NOW HE'S BOSSING DAD."

Bill Jones, he
Was a treater skilled. He
Knew just why he
Put manure into his quenching tub.
But one day,
Ann, Bill's wife,
Said,
"Bill, you're stuck in the mud.
Bill, Jr., goes to Tech."
So Jr. went
And saw
All manner of strange things
On a blackboard
In a microscope
In books;
Then he came home and got a job in the factory.
* * * * *
Now he's bossing Dad.

Progress in The Dye Industry

AMAZING progress was made in the dye industry during 1920. Notwithstanding that for the last three months of the year the majority of the plants were closed or operated on a greatly reduced scale, the industry had an output, according to the recent report of the Tariff Commission, of 88,000,000 pounds of finished products valued at more than \$95,000,000. This is a tremendous increase over the production during 1919 and is practically double the total pre-war imports. That our consuming industries are now almost entirely independent of foreign dyes is shown by the fact that the imports during 1920 amounted to less than one twenty-fifth of the domestic production.

The production of indigo is an example of real progressive development. Since 1917 our output of this important color has increased from 275,000 pounds to over 18,000,000. The latter figure is at least twice the domestic consumption before the war, and indigo has been able therefore to play an important part in our export trade in dyes and chemicals. This production exceeds that of sulphur black, which has previously been produced in largest quantity.

There is still, however, a noticeable lack of variety among the important vat dyes other than indigo. A considerable portion of the imports during 1920 was of these so-called "specialties," which just before the war were beginning to replace many of the older and less satisfactory colors. Some of these, to be sure, were produced in ample quantity, but many other dyes of this faster type have not yet made their appearance.

One particularly significant fact shown by the commission's report is that more than 90 per cent of the total quantity of dyes was produced by three or more manufacturers. This statement would seem to indicate that monopolistic control of particular products has not as yet made great headway in the domestic industry. Perhaps this will to some extent allay the fears of those members of Congress who have opposed the dye legislation on the ground that it is an attempt "to grant exclusive rights to a recognized monopoly."

The dye industry is to be congratulated on the showing it has made, and it is hoped that with the general resumption of business it will not only continue to expand its output but through research and development will produce a wider range of dyes of newer type and better quality.

Looking Forward To Fall Meetings

BY A HAPPY conjunction of events American chemists will have an unusual opportunity for professional intercourse during the last week of August and the first two weeks of September. The headliner on the bill is the British Society of Chemical Industry, which will hold its fall meeting in Canada, and the supporting features are successively the regular fall meeting of the American Chemical Society and the National Exposition of Chemical Industries in New York. British, Canadian and American chemists will mingle at all these functions, which will afford three weeks of opportunity for renewing old acquaintances, making new ones, and incidentally fortifying that bond of fellowship between English-speaking peoples which we are all convinced will be a large factor in the solution of many world problems.

Chemistry should gain fresh impetus in England, Canada and the United States as a result of the meetings that will be held in Montreal and New York. The science and its application to industry have assumed a position of new importance in England just as they have in this country, and while we are showing our visitors something of the efforts we have made to establish a chemical industry in the United States undoubtedly we can learn many lessons from the problems they have encountered and solved. The Exposition will enable us to show our guests concrete evidence of the progress that chemistry has made on this side of the Atlantic. It should prove not only a source of entertainment to them but also a stimulus toward the edification of chemistry in England. It is not too early to begin to plan for a visit to New York from September 6 to 10, when the American Chemical Society will be in session with the Society of Chemical Industry as visitors, or from September 12 to 17, when the Chemical Exposition will be held in the Eighth Coast Artillery Armory. It will be years before a similar opportunity is again afforded.

A.S.T.M. Unable To Join Federation

IT IS to be regretted that the American Society for Testing Materials finds itself unable to join with the Federated American Engineering Societies. An invitation to become a charter member was issued after the Federation had been organized, and has been carefully considered by the executive board of the A.S.T.M. during the intervening months. Action was finally reported and approved by the recent meeting at Asbury Park.

In view of the society's principal utility—which seems to be a medium whereby divergent views of buyer and seller of materials of engineering construction can be harmonized into acceptable specifications—it might be questioned whether such an organization would have interests identified with commerce rather than with engineering. Acquaintance with the personnel of the committees and active men in the society dispels this notion. Even though powerful organizations like the Steel Corporation and the Pennsylvania Railroad are vitally interested in specifications, they are represented almost exclusively by engineers or engineering chemists. Independent consultants and instructors are also much in evidence, and presidents, vice-presidents and salesmen rather scarce. The

result naturally is to inject a pronouncedly engineering rather than commercial atmosphere into committee meeting and general assembly.

Therefore it was not a surprising event when the American Society for Testing Materials was the first society to join the founders of Engineering Council, and its representatives did their share of the work of launching the Federation. But now, after a year's consideration, the executive committee finds that its budget will not be able to furnish the necessary funds for this new affiliation without serious curtailment of its current activities. In view of the present public temper, it was thought inadvisable to increase the dues, a decision which was sustained by the general meeting, despite a motion to refer the whole matter to a letter ballot of the membership.

Knowing the history of the two bodies, there seems to be no reason to doubt the sincerity of the official resolution indorsing unreservedly the belief that the "objects for which the Federation is organized merit the support of engineering organizations and engineers in general," and the further resolution offered from the floor that the present action was not to be construed to prevent affiliation at a later date, when the financial conditions and prospects of the society warrant the step.

Industrial Menace of Tax-Exempt Securities

WHILE the subject of political economy is admittedly outside the editorial scope of this magazine, the matter of taxation is of such vital import to the chemical and related industries that we may be pardoned for calling attention briefly to the McFadden resolution, H. J. Res. 102, pertaining to tax-exempt securities. Students of taxation have for some time been directing public attention to the menace of the continued issuance of tax-exempt securities by the Government and its political subdivisions. It has been estimated by OTTO H. KAHN that up to January, 1921, such securities have been issued to the value of \$14,425,000,000, of which half represents the debts of states, cities, school districts and other political subdivisions and the remainder the obligations of the Government. Obviously individuals of wealth have accumulated these securities as rapidly as possible to such an extent that they are rapidly freeing themselves of the burden of taxation, which is forced onto those less fortunate. The extent to which tax-exempt securities have been segregated in the hands of the wealthy and the consequent effect on the taxable income of individual taxpayers under the federal income tax may be seen in the fact that taxable income of \$992,972,985 in 1916 decreased to \$731,372,053 in 1917 and to \$392,247,329 in 1918.

The effect of Mr. MCFADDEN'S resolution would be to amend the Constitution in such a manner as to place all forms of investment on an equitable basis of competition and to re-establish equality in the assumption of the tax burden by all the people. The former is of direct interest to the normal progress of industry and the latter is of personal interest to every federal tax payer. As nearly as we can ascertain competent opinion in the matter, legislation to abolish tax-exempt securities is highly desirable and we feel justified in bringing the matter to the attention of our readers with the suggestion that they take legitimate steps to encourage the passage of the McFadden resolution or similar legislation.

Steel Prices And Wages

THE American steel industry is displaying very plainly an anxious desire to play fair with its workmen and its customers. Steel prices have been declining. There having been at least two markets in 1920, the Steel Corporation holding its prices to the Industrial Board schedule of March 21, 1919, while the independents made large advances, the independent market has been declining for almost a twelvemonth, while the Steel Corporation's prices began their decline April 13 of this year. The decline has brought steel prices to a level between 50 and 60 per cent above the pre-war level, according as one takes as basis for comparison the ten years ended with 1913, the five years ended with 1913 or the average of 1913 alone.

The major portion of the steel-consuming trade has not desired that steel prices be cut ruthlessly. In most cases the manufacturing consumers have had stocks of steel or of their manufactures, made from steel, which they desired to liquidate. They wished to sell their goods, rather than buy steel, hence in many cases the steel mills would be rendering their customers a disservice by reducing prices. At the same time it was to the interest of the steel makers not to slash prices, as they would obtain little if any more business by doing so.

Last week the Bethlehem Steel Co., one of the most prominent of the independent producers, formally announced a schedule of price reductions, and the action was followed, formally or otherwise, by other independents, while a couple of days later the Steel Corporation made a formal announcement of the same tenor. To the layman it may have appeared that the steel market had been pegged at a certain point, that a new peg was inserted farther down and that the first peg was forthwith pulled out. That, however, was hardly the case. During the preceding week the open market had really sagged and the new prices were chiefly a formal recognition of prevailing prices.

The steel industry is gradually reducing its wages, and evidently one object of the formal announcement as to prices was to remove the appearance of the steel mills receiving higher prices for their product than they really were receiving.

The Steel Corporation now pays 37 cents an hour for common labor, as do a few of the independents. Others are paying 33 cents and 30 cents, down to 27 and 25 cents, in the case of certain Eastern mills. Contractors in the Central West pay 25 and 30 cents.

The mills are giving the workmen the better end of the bargain. The rate for common labor before the war—as a matter of fact from February 1, 1913, to February 1, 1916—was 19 cents. With steel prices 50 to 60 per cent higher, a corresponding rate would be 30 cents, and that probably will be the final objective, but not until steel prices have further declined.

At the end of 1914 steel prices had practically returned to their historic low level, made in 1897 and 1898, when the wage rate was 13 cents. The mills had absorbed a 50 per cent increase in wages, by making improvements in methods and appliances. They cannot absorb another 50 per cent wage increase, because they have not made corresponding improvements, nor have they anything from which to absorb the great increases in freight rates, but it is plainly the spirit of the industry to pay fair wages and have wages dictate the price of steel rather than allow steel prices to dictate wage rates.

British Chemical Industries

(FROM OUR LONDON CORRESPONDENT)

LONDON, June 17, 1921.

INDUSTRIAL troubles are still with us and prophets have either gone out of business or are utterly discredited. The end does not yet seem in sight either as regards coal or for many other industries in which the pendulum is swinging against the operatives. A state of affairs which, according to quite reasonable predictions on the pre-war basis, should mean the complete and utter ruin of this country has been borne by the general public with an uncanny apathy amounting almost to stoicism and by manufacturers with an uncrushable optimism of the "it might be even worse" variety. The undertone in chemical markets continues good, and in spite of the adverse conditions prices are well maintained.

GAS WORKS OPERATE UNDER DIFFICULTIES DURING THE COAL STOPPAGE

The public during the last two months has relied largely on the gas companies and the flexibility of modern plant is well illustrated by the manner in which all difficulties were overcome. French coal was chiefly used and a certain amount also arrived from Germany and Pittsburgh. On account of the somewhat heavy percentage of ash in the French coal and its smaller yield in residuals, costs in raw materials per "therm" were much greater than for British coal, while the heavy freightage militated against the extended use of American fuel. Sulphur in all cases was lower than for British coal, but in spite of all efforts the various gas companies are faced with heavy losses in operation which could only have been partly avoided by shutting down. Heavy petroleum distillates being now relatively cheap owing to the fall in oil prices, carburetted water gas was extensively used, and this as well as prompt supplies of French coal really saved the situation. The gas works engineers have had an anxious time technically and perhaps the chief lesson learned is that if and when the British coal-mining industry returns to sane conditions, it will hardly have lost any of its market among the gas works.

FUEL RESEARCH BOARD PUBLISHES GAS RETORT STEAMING TESTS

The Glover-West retort was selected as the most suitable for these tests because of the ease with which the temperature can be controlled, and a setting of four retorts was installed during 1919 at the Experimental Station at East Greenwich. Coal from Durham, Yorkshire and Lanarkshire was tested as being of widely different types, and while at first 5 per cent of steam was used as a starting point, it was later on realized that a steamless starting point was necessary. It was common knowledge that steaming would lead to an increased yield of "therms" in the form of soluble gas, but the probable effects of steaming on the other products obtained was not so clear. The tests have shown that steaming also leads to increases in the yields of tar and ammonia at some slight sacrifice in the quantity and perhaps quality of the coke. It is concluded that provisionally 20 per cent of steam represents the economic limit for the time being subject to definite determination for different coals; the total gains obtained at an expense of 10 therms in the form of steam and fuel are stated to

be 33 therms of gas, 34 lb. of tar and 6 lb. of sulphate of ammonia, all reckoned per ton of coal.

TRADERS HANDICAPPED IN GERMAN TRADE

The debate on the safeguarding of industries bill ultimately degenerated into a free trade versus tariff reform controversy and no suggestions of a practical kind were made as an alternative to the bill. As in the case of other bills of this type, the House of Lords is far more likely to bring forward constructive criticism and sound arguments for and against its various provisions. While Parliament is dabbling with a half-hearted scheme, real attention has been focused upon Mr. McKenna's views embodied in an address on international debts. It is argued that in order to enable Germany to meet her final liability of close on 1,600 millions a year her exports must amount to not less than 4,800 million dollars. Obviously German foreign trade could not be expanded to this extent unless wages are kept extremely low with a corresponding rigid cutting down of the standard of living. Attention is drawn to the fact that Great Britain's international trade would be gravely impaired if Germany is able to meet her obligations, and this could only be partly avoided by reparations exports of coal, timber, potash, sugar and the like, this being equivalent to a handicap on German industry. Otherwise the reparations are shown to be really a bonus in favor of Germany, and shipping is given as an example.

Meanwhile importation of goods from Germany can be carried on only under great difficulties and with considerable delay, owing to the absence of official German announcements in regard to the refund of the 26 per cent reparations and export duty. The chief free imports at the moment are patents and processes of all kinds, which have been developed in ex-enemy countries during the war and which are being freely absorbed by British firms in the traditional manner.

NEW PROCESSES AND GENERAL NOTES

Considerable attention has been attracted to Mr. Hayhurst's new method of electrical heating and drying, in which the liquid is at no time at a higher temperature than the highest to which the liquid is to be raised. Further details will shortly be available, but it may be stated that the current in the one case is passed direct through the liquid and in the case of driers induced currents and hysteresis effects are utilized. During the war, electrical heating was developed in countries such as Italy, where coal was obtainable only at prohibitive prices, but in those cases electrodes were usually used. The present process from all accounts is likely to have extended application and of course particularly in localities where electrical energy is obtainable at low rates. Another interesting process is Calvert's for the synthetic direct production of alcohol from water gas and producer gas by catalysis. It is stated that ethyl alcohol of 99.2 per cent purity had been obtained from ordinary water gas with a yield of 90 per cent.

The announcement of the election of Dr. Ruttan to the presidency of the Society of Chemical Industry was unaccountably delayed at this end, although it was common property through American and Canadian sources. One of the new vice-presidents, C. S. Garland, is managing director of Lighting Industries, Ltd., and is one of the delegates to the forthcoming annual meeting in Canada.

Studies in Colorado Shale Oils

Results of Investigations on Shale Oils and Their Fractions, With Special Reference to Their Content of Sulphur and Nitrogen and to the Increased Saturation by Cracking

By ARTHUR J. FRANKS

IN A previous preliminary paper¹ the author presented some fundamental data on a number of Colorado shale oils which indicated clearly the similarity between the different products from the same type of oil shale. It was also shown that the heavy fractions of these shale oils are rather easily cracked on distillation at atmospheric pressure, the resulting distillates having a much higher saturation than the original oil. The only plausible explanation suggested for this phenomenon was that the increase in saturation might be due to the formation of new saturated compounds from some of the heavy unsaturated material. The present communication represents the results of further investigation on some of the same oils and their fractions, and deals mainly with the distribution of sulphur and nitrogen.

The unstable, unsaturated substances in Colorado shale oils are very complex and it would be a hopeless task to attempt to isolate and identify even a few of them without first studying some of the prominent general properties of the fractions in which they occur. The work done thus far in this direction only raises further questions instead of answering previous ones. Therefore it was thought advisable to proceed further with the preliminary investigation of the same oils before undertaking any general study of different types of oils or of the specific compounds in any one. It was hoped that simple distillations and analyses of the fractions for sulphur and nitrogen, in connection with the results obtained for saturation, specific gravity and temperature, would reveal, or at least indicate, some of these fundamental properties, as well as shed a little light on the phenomenon of increased saturation by cracking. Obviously, then, the purpose which underlies these preliminary studies is to discover the hidden road that leads to the main highway of ultimate investigation.

PRESENCE OF SULPHUR COMPOUNDS IN SHALE OILS

The distribution of sulphur, aside from its importance in connection with refining problems, may yield valuable information on the possible composition and properties of some of the compounds present in Colorado shale oils. In the dry distillation of the heavy fractions of these oils a strong odor of hydrogen sulphide is always noted, indicating decomposition of sulphur compounds. Since all of the heavy compounds of sulphur decompose more or less on distillation, this would be expected, and does not give any indication of the possible forms in which the element might occur. Casual examination and tests fail to give much additional information, except to indicate that the usual compounds do not seem to be present in quantity. The

only sulphur compounds that have ever been found in oils and the characteristics of which are known fall into the following classes: (a) Hydrogen sulphide; (b) carbon bisulphide;² (c) alkyl sulphides,³ or thioethers; (d) thiophenes;⁴ (e) thiophanes,⁵ and (f) mercaptans.⁶ Most of the sulphur in the oils studied does not seem to be present in any of these forms, but rather in forms suggesting an asphaltic nature and a very complex structure. Whatever their real nature may be, a knowledge of the amount of sulphur present will be of value, especially as a basis for other researches.

The accurate determination of small amounts of sulphur in oils presents many difficulties, especially when a great number of analyses are to be made. While sufficiently precise for most practical purposes, the usual technical methods give results which are not at all exact, even though considerable care is used in their application. Some of them contain such a number of sources of possible error that correct values obtain only by chance. Others are either long and awkward or require the use of such expensive apparatus that a large number of determinations becomes prohibitive. Since it is beyond the scope of this paper to discuss the relative merits and defects of different methods for determining sulphur, only the two which were actually tried will be given consideration.

It was realized early in the investigation that the only methods which could be utilized in making many accurate analyses on shale oils were the modified nitric acid method of Waters⁷ and the sodium peroxide fusion method devised by Edinger⁸ and modified by Parr.⁹ Waters' method was tried first, and the sulphur in the crude oils¹⁰ was obtained thereby. A brief outline of the procedure is not out of place.

NITRIC ACID METHOD FOR THE DETERMINATION OF SULPHUR IN SHALE OILS

Two grams of oil was weighed into a 75-c.c. casserole and 7 c.c. of concentrated nitric acid (previously saturated with bromine) was immediately added and the casserole covered with a watch glass. After all violent action had ceased the mixture was heated on a steam bath for about three hours, the crucible being gently shaken from time to time to insure complete

²Chem. Zeit., vol. 21, p. 203.

³Mabery and Smith, *Ber.*, vol. 22, p. 3303 (1889).

⁴Meyer and Nahnsen, *ibid.*, vol. 18, p. 217 (1885); Charltschoff, *Chem. Zeit.*, vol. 30, p. 476 (1906), and Girard, *Petroleum*, vol. 2, No. 3 (1906).

⁵Mabery and Quayle, *Proc. Amer. Acad.*, vol. 41, p. 89 (1905); Mabery, *J. Soc. Chem. Ind.*, vol. 19, p. 508 (1900).

⁶Höfer, *Erdöl u. s. Verw.*, 2d ed. p. 82.

⁷*J. Ind. Eng. Chem.*, vol. 12, pp. 482 and 612 (1920); U. S. Bureau of Stand. Tech. Paper 177.

⁸*Z. anal. Chem.*, vol. 34, p. 362 (1895).

⁹*J. Am. Chem. Soc.*, vol. 30, p. 767 (1908).

¹⁰CHEM. & MET. ENG., vol. 24, No. 3, March 30, 1921, p. 561.

¹¹"Studies in Colorado Shale Oils," CHEM. & MET. ENG., vol. 24, No. 13, March 30, 1921, pp. 561-564.

attack by the acid. The casserole was then cooled and about 8 to 10 g. of dry, pure sodium carbonate was cautiously added and the mass stirred into a paste, a little water being added if necessary. The mixture was then dried thoroughly on a steam bath and carefully ignited to a white melt, which was later dissolved in water and the sulphur precipitated by barium chloride in the usual manner. Two blanks were run on each new lot of reagents, which are never pure.

The greatest difficulty encountered was that of too rapid combustion of the organic material when the mixture was fused, even with application of extreme care by the operator. The enormous heat developed often caused the volatilization of some of the salts, and in some cases considerable loss occurred by sputtering. However, careful duplicate determinations often checked fairly well, so that the reliability of the method was not questioned, in spite of the fact that results were occasionally obtained which varied widely. This was thought to be due to carelessness. Hence the publication of the best data for the sulphur in some of the crude oils was thought to be justified.

Recently, however, a large number of determinations has shown surprising vacillations in the amount of sulphur present in the different fractions. Since previous analyses gave no cause for anticipating such results the reliability of the method was finally suspected. Many redeterminations on the same oils proved that our suspicions were correct and that the results given are in error. The author does not attempt to advance any excuse for this unfortunate blunder, but takes the blame upon himself entirely. It is hoped that the present efforts will partly atone for this past mistake, as they bring to light the main failures in the method already mentioned, as well as those in the sodium peroxide fusion method which was eventually adopted. Since a complete discourse on this subject would be too long to be included here, only the main points will be considered briefly, a fuller and more detailed discussion being reserved for a later paper.

A careful study of the nitric acid method showed that the main defects were due to the use of too large a sample of oil (2 g.) and the use of an insufficient amount of sodium carbonate. When the sample of oil was reduced to 1 g., the volume of nitric acid (and bromine) to 5 c.c., and the weight of sodium carbonate increased to 12 g., concordant results were obtained, although they were still a trifle lower than those obtained by the fusion method. It has the additional disadvantage of being longer. In case Parr bombs are not available, however, the Waters method is to be recommended.

SODIUM PEROXIDE FUSION METHOD FOR THE DETERMINATION OF SULPHUR IN SHALE OILS

The peroxide fusion method does not give exact results unless a number of precautions are closely observed. Investigation has shown that with a good balance and extreme care it is possible to check determinations to within 1 per cent of the total sulphur present when this amounts to between 0.5 and 1.0 per cent of the oil. When more sulphur is present, the differences are, of course, proportionately smaller. Thus duplicate determinations on an oil containing 0.75 per cent of sulphur should agree as closely as 0.747 and 0.755. Frequently results have been obtained which check as closely as 0.748 and 0.752 per cent. These represent very accurate determinations when it is con-

sidered that those obtained by the usual methods seldom agree as closely as 0.74 and 0.76, which gives a difference of about 3 per cent of the total sulphur present. A brief description of the procedure eventually adopted is given in the following paragraph:

One measure of sodium peroxide, 1 g. of powdered potassium chlorate and 0.2 g. of benzoic acid are placed in a Parr bomb and well mixed by shaking. About 0.5 g. of the uniform sample is weighed into this mixture by means of a medicine dropper and a small weighing bottle. The whole mass is then thoroughly mixed over a piece of glazed paper with a thin glass rod, any solids adhering to the rod or falling upon the paper being subsequently returned to the bomb. After ignition in the usual manner the fusion is carefully dissolved in about 50 c.c. of water, the bomb thoroughly washed with water, the inside being finally rinsed with about 1 c.c. of concentrated HCl and a little more water, and the solution made acid with concentrated HCl. About 5 c.c. of saturated bromine water is then added to oxidize all the sulphur to sulphuric acid and the iron to the ferric condition. Ammonia is added until the liquid is alkaline and the solution brought to a vigorous boil to coagulate the ferric hydroxide and expel the excess ammonia. The former is then filtered off, a small wad of absorbent cotton being placed in the bottom of the filter to hasten the operation and facilitate washing. Four thorough washings with hot water are sufficient. The solution is acidified with 1 c.c. of concentrated HCl, made up to 225 c.c., brought

TABLE I. PERCENTAGE OF SULPHUR IN CRUDE OILS AND THEIR 10 PER CENT FRACTIONS

Oil No.....	3	3a	5	7	9	2
Fraction No.					1	
Crude Oil.....	0.64	0.61	0.77	0.61	0.75	0.75
1.....	.48	.46	.64	.30	.67	...
2.....	.65	.59	.70	.49	.77	.77
3.....	.63	.59	.69	.59	.77	.78
4.....	.61	.58	.68	.68	.76	...
5.....	.60	.58	.66	.69	.74	...
6.....	.57	.54	.66	.68	.71	...
7.....	.49	.50	.64	.62	.64	.65
8.....	.38	.41	.54	.57	.45	...
9.....	*	...	.39	.52	.30	...
10.....	...	...	...	*	...	...

* Not enough of sample left for analysis.

to a boil and 5 c.c. of 10 per cent barium chloride solution is added slowly from a pipette. The boiling is continued until the precipitate is well formed, which sometimes requires as much as twenty minutes. About 200 c.c. of liquid will remain. After standing over night the precipitate is filtered through a close 7-cm. filter paper (Munktell's No. 00 is preferred) and is carefully washed until free from chlorides. Ignition is made in a very small (about No. 000) porcelain crucible. The final precipitate will be pure and white. The sulphur is calculated from the barium sulphate weighed. A blank is run for each new lot of reagents and the gross result corrected accordingly.

The corrected results for the sulphur in the crude oils, together with those for the sulphur in the 10 per cent fractions, are given in Table I. The distribution of the sulphur is represented graphically by the curves in Fig. 1. The sulphur was not determined in the fractions of all the oils, because the results obtained are so similar that further analyses would be of no particular value. The corrected value for the sulphur in oil No. 1 is not given in the table, but is 0.72 per cent. A number of duplicate determinations are given for those fractions of oil No. 9 which furnish the turning points in the sulphur curve. The agreement is very

good. These results alone are indubitably not a sufficient basis for any conclusive generalizations; nor were they so intended. Yet, they serve to establish a few facts and bring forth a number of important questions.

A study of the curves reveals a striking regularity in the apportionment of the sulphur among the various fractions. Obviously the 20 to 30 per cent cut contains the greatest percentage in every case except that of oil No. 7, which is not a representative crude oil, but a fractional condensate consisting of a mixture of light and heavy oils. It seems rather surprising to find such relatively small differences in the amounts of sulphur present in the different fractions. The very light oils

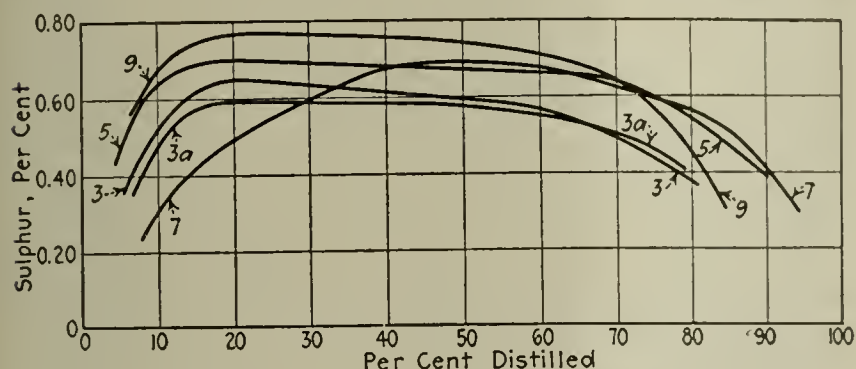


FIG. 1. SULPHUR CONTENTS OF SHALE OILS AND THEIR FRACTIONS

apparently contain the least sulphur, while there is but little variation between the percentages found in the middle cuts. It is very important to observe the decrease in the sulphur in the heavy oils, which is undoubtedly caused by cracking. This is evident if the sulphur curves are studied in connection with those for saturation, specific gravity and temperature." Whenever the temperature ceases to rise, then falls, the specific gravity of the distillate at the same time decreasing and its saturation increasing (these phenomena being the criteria for cracking), a lowering is to be observed in the percentage of sulphur; and this becomes more and more pronounced as the cracking progresses. The lowering is not so great as might be expected, however, and there does not seem to be any quantitative relationship between this and other changes in the oils.

ACTUAL LOSS OF SULPHUR IN THE FRACTIONATION OF CRUDE SHALE OILS

The strong odor of hydrogen sulphide noted during the cracking of the heavy oils was an early indication of a loss of sulphur through a decomposition of at least a part of the complex sulphur compounds. That there is a considerable loss is unquestionable, as calculations from the analyses show. In order to compute the actual loss correctly, the total sulphur in the distillate must be subtracted from that in the crude oil. The difference between the average of the sulphur in the fractions and the sulphur in the crude is not the true loss at all. Since the falseness of the latter process of computation is not always obvious, the correct method is here given. The total sulphur in the distillate is the sum of 100 times the products of volume, specific gravity and percentage of sulphur in each fraction. The total sulphur in the crude oil is 100 times the product of volume, specific gravity and percentage of sulphur. The difference is, of course, the actual loss in weight

of sulphur. If the sulphur in the distillate of oil No. 9 is calculated in this manner, it is found to be 2.47 g., while that in the crude oil amounts to 3.50 g. Hence the loss of sulphur is 1.03 g., or 29.3 per cent of the total amount present.

The total loss in weight of oil by the distillation is 21.3 per cent, of which 11.0 per cent is coke. Now, if all the material that decomposed contained sulphur, it would mean that 8 per cent of all the sulphur (or 37.5 per cent of the decomposed material) failed to recombine to oil, but either escaped as hydrogen sulphide or remained in the coke. Such losses as these would account for the slight difference between the sulphur in crude oil No. 3 and that in the distillate No. 3a, the high percentage of sulphur in the light oils, and suggests that it will be impossible to eliminate much of the sulphur by cracking distillations. The fact that the cracking was always accompanied by a loss of sulphur by no means proves that the sulphur compounds only suffered decomposition, in spite of the fact that the phenomena always seem to occur together and at about the same temperature in every case. The evidence merely points in that direction. There is no doubt, however, that practically all the material which cracked was unsaturated (regardless of whether or not it was composed entirely of sulphur compounds) and that most of the saturated compounds were formed from the decomposition of this material.

COMPOSITION OF SULPHUR COMPOUNDS IN SHALE OILS

The sulphur curves of shale oils are significant in connection with the composition of the sulphur compounds present. The fact that the percentage of sulphur in the middle oils tends to be constant indicates a series of isomers. The pronounced deflection of the first part of all the curves signifies the presence in the light oils of a different series of sulphur compounds from those found in the heavier fractions. The cracking of the heavy oils obscures the true distribution of the sulphur therein, but the writer is of the opinion that there would have been a regular decrease in the sulphur in these oils had the cracking been prevented, in which case the curves would have approached straight lines. This would indicate a third series of sulphur compounds—a homologous series—in which each individual member contained the same number of sulphur atoms. Still other series might, of course, occur in such proportions as to give the same apportionment of the sulphur as here observed. This is quite probable. Much more work will have to be done, however, before any of these suggestions can be established as facts. They are mentioned at present only for the purpose of pointing out the course of future investigations, and to stimulate further research.

PRESENCE OF NITROGEN COMPOUNDS IN SHALE OILS

It is a well-known fact that the products from the carbonization of most bituminous materials contain nitrogenous compounds, and researches on different shale oils have shown that they also contain such substances. Investigators have already isolated and identified a number of heterocyclic nitrogen compounds from Scotch shale oils and some have been detected in Green River oils. The most exhaustive research has, however, been done on petroleum.

The possible forms in which the nitrogen might occur in Colorado shale oils are numerous, but the most im-

portant may be classed under the following heads: (a) Pyridines; (b) pyrrols; (c) quinolines; (d) amines, and (e) very complex substances similar in their nature to asphalt. Preliminary tests seem to indicate the presence of all of these forms.

Williams¹² has long ago isolated and identified pyrrol, pyridine, methyl and dimethyl pyridines, and parvoline in a crude naphtha from a Dorsetshire shale oil. Morrell and Egloff¹³ have reported qualitative evidence of pyridine and its homologues in Green River oils. Beilby¹⁴ has done considerable work on the nitrogen in oils from Scotch shales, but he made no attempt to isolate or identify the individual compounds. In spite of the great importance of such knowledge, relatively little has been published and the literature is very meager.

Before making any attempt to determine the classes of compounds present in the oils studied or to identify the individual members of any series it was thought advisable to investigate first the distribution of the nitrogen among the different fractions, since this would yield preliminary information of importance. Three typical oils were chosen for this work—Nos. 5, 6 and 9. The results obtained were so characteristic that further analyses were deemed unnecessary. The nitrogen was determined in all cases by a slight modification of the Kjeldahl-Gunning method. A brief description will indicate its simplicity.

One gram of oil was weighed from a small bottle into a 500-c.c. Kjeldahl flask and immediately treated with 20 c.c. of concentrated sulphuric acid. Ten grams of

tion of sodium hydroxide run into the flask through the funnel until the solution turned to a deep blue, and an excess of about 10 c.c. of the alkali added. The ammonia was cautiously distilled into 50 c.c. of N/20 sulphuric acid into which the condenser tube dipped from the time the alkali was first introduced until water began to condense. The level of the acid was then lowered until it barely touched the tube of the condenser. When about 75 to 100 c.c. of water had distilled over, the distillation was discontinued, the condenser tube rinsed with water, and the excess acid titrated with N/20 sodium hydroxide solution, using a few drops of cochineal for an indicator. The end-point was always compared with that obtained by a fresh titration of equal volumes of the standard acid and alkali in order to eliminate possible error in judging when the proper color was reached. Each c.c. of sulphuric acid neutralized by the ammonia represents 0.0700 per cent of nitrogen in the oil. Blanks should always be run with each lot of reagents and the gross result corrected if any ammonia is found, which is seldom the case. The pipette (or burette) from which the standard acid is measured should, of course, be calibrated against the burette from which the alkali is measured.

The copper sulphate was used to accelerate the decomposition of the oil and to serve as an indicator in the addition of the strong alkali. Phenolphthalein could not be used for the latter purpose because it seemed to induce troublesome foaming during the distillation.

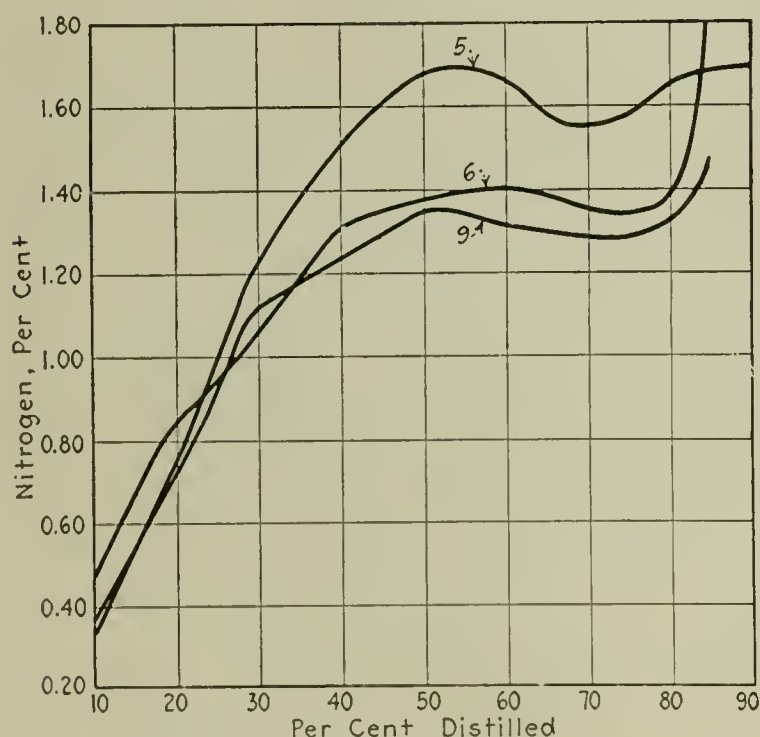


FIG. 2. NITROGEN CONTENTS OF SHALE OILS AND THEIR FRACTIONS

TABLE II. PERCENTAGE OF NITROGEN IN CRUDE OILS AND THEIR 10 PER CENT FRACTIONS

Oil No.....	5	6	9
Fraction No.			
Crude Oil.....	1.855	1.608	1.501
1.....	0.344	0.466	0.361
2.....	0.742	0.837	0.721
3.....	1.239	1.140	1.120
4.....	1.491	1.307	1.232
5.....	1.674	1.365	1.344
6.....	1.659	1.404	1.305
7.....	1.540	1.351	1.285
8.....	1.654	1.374	1.316
9.....	1.685	1.883	1.470

The use of copper sulphate permits the saving of about one hour in the decomposition of the oil, about three and one-half hours being required when it is absent. The alkali was introduced in the manner described, because slight losses of ammonia were sometimes obtained during neutralization of the solution in the usual way. The loss of ammonia could, of course, be prevented by greater dilution of the acid and the use of less concentrated alkali; but this would mean that the liquid would have to be transferred to a larger flask before distillation and that a greater amount of water would have to be distilled over to insure complete expulsion of the ammonia. This causes an unnecessary waste of time, especially when a great number of determinations are to be made.

No difficulties were encountered with this method and duplicate determinations checked very closely. Agreement to within one or two thousandths of one per cent are quite common and the difference never exceeds one hundredth of one per cent when analyses are carefully made. The results obtained for the crude oils and their 10 per cent fractions are given in Table II. The distribution of the nitrogen is represented graphically by the curves in Fig. 2.

The amount of nitrogen in these oils is comparatively large and exceeds that found in most petroleum, with

potassium acid sulphate and a small crystal (about 0.2 g.) of copper sulphate were then added and the mixture digested until a clear solution was obtained. This required about two and one-half hours. When completely cooled the contents of the flask were diluted with cold water to about 200 c.c., again cooled, a few glass beads introduced, and a small dropping funnel and a Kjeldahl connector were placed in the flask through holes in a tightly fitting rubber stopper. Connection was made with a water-cooled condenser, a strong solu-

¹²J. Chem. Soc., vol. 7, p. 97 (1854).

¹³CHEM. & MET. ENG., vol. 19, No. 2, July 15, 1918, p. 95.

¹⁴J. Soc. Chem. Ind., vol. 3, p. 216 (1884).

the exception of some from California, Japan and Algeria.¹⁵ Analyses of the fractions show that most of the nitrogen lies in the oils boiling above 225 deg. C., and that the amount tends to increase as the boiling point rises. A comparison of the nitrogen curves reveals a number of irregularities, but they all have the same general shape, which would be expected from the fact that the oils are very similar in other respects.

LOSS OF NITROGEN IN THE FRACTIONATION OF CRUDE SHALE OILS

As the curves (Fig. 2) indicate, the distribution of nitrogen in the oils is very much disturbed by the cracking, which causes a great loss in the total amount of nitrogen recovered in the distillates, the losses being proportional to the extent of the decomposition, as the results and calculations therefrom show. If this loss is computed in the same manner as that for sulphur, it will be found to be 41.2 per cent in the case of oil No. 9, 43.9 per cent for oil No. 6, and 35.9 per cent for oil No. 5. Hence the total percentage loss of nitrogen greatly exceeds that for sulphur under the same conditions. This might be explained in one of two ways: Either this nitrogen and sulphur are present in a series of compounds that decompose during the cracking in such a manner that most of the sulphur later recombines while the greater part of the nitrogen fails to do so, or they are present in separate classes of compounds, those containing the nitrogen being the more unstable. The first hypothesis seems by far the more plausible when the relative chemical reactivities of sulphur and nitrogen are considered and because it is a general rule that a loss in one is always accompanied by a loss in the other. The high percentage of nitrogen in the heavy fractions is evidence of the presence of one or more other classes of nitrogenous compounds which are quite stable. The data are, of course, too meager to permit the deduction of any more definite conclusions as to the possible character of the different kinds of compounds.

CONFIRMATION OF THE HYPOTHESIS THAT UNSATURATED COMPOUNDS ARE CHANGED BY CRACKING INTO SATURATED COMPOUNDS

The simultaneous loss of nitrogen and sulphur and gain in saturation forms interesting evidence in support of the hypothesis that unsaturated, unstable material is the source of the saturated compounds produced by cracking of the heavy fractions of Colorado and similar shale oils. That this unsaturated material is made up of a series of unstable compounds of high molecular weight and rich in nitrogen and sulphur (and perhaps oxygen), as the results suggest, seems very plausible. In spite of the strangeness of the phenomenon, it would not be difficult to conceive how, under suitable conditions, it would be possible for the molecules of such unstable substances to disintegrate completely and for the atoms or groups to recombine immediately to more stable series of compounds, such as paraffines, aromatics, alicyclics, olefines and their sulphur and nitrogen derivatives. It would certainly be unlikely, if not impossible, for the resulting products to be as unstable as the original material or less so. The results obtained are, therefore, not contrary to theory, but might almost be expected. An enormous amount of work will have to be done, however, before the suggested hypothesis can be conclusively proved.

¹⁵Engler-Höfer, "Das Erdöl," vol. I, 1913.

SUMMARY

The usual technical methods for determining sulphur in oils are found to be inexact. A slight modification of Parr's method gave accurate results and was used to determine the distribution of sulphur in five of the oils previously studied. The apportionment of the sulphur is quite uniform for all the oils that were investigated, and is such that there are comparatively only slight differences between the amounts present in the various 10 per cent fractions, the percentage being greater in the 20 to 30 per cent cut and tending to remain constant in the middle oils. The sulphur is less in the light and heavy oils, the amount being reduced in the latter by cracking, showing that at least part of the compounds which decompose contain sulphur. The total loss of sulphur during the distillation was about one-third of the amount present in the crude oil. In spite of this, the distillate contains about the same percentage as the original oil. The distribution of the sulphur as represented by the curves suggests the presence of at least three different series of sulphur compounds, two of which seem to be quite stable. The simultaneous loss of sulphur and gain in saturation by cracking indicate that the unsaturated material which is the source of the new saturated compounds contains sulphur.

Colorado shale oils and their fractions contain much nitrogen, which seems to be present as basic compounds, and complex, unstable, unsaturated substances of high specific gravity and molecular weight. The distribution of nitrogen is similar for each of the three oils studied, the heavier fractions containing by far the larger amounts. Cracking of the latter during distillation effects a great loss of nitrogen and masks its true distribution. The total loss observed was about 40 per cent of the nitrogen occurring in the crude oil, showing that one of the classes of nitrogenous substances is very unstable.

The simultaneous loss of nitrogen and sulphur and increase in saturation by cracking suggests the hypothesis that the saturated oils thus formed are produced from unsaturated compounds containing sulphur and nitrogen, which are easily decomposed under the conditions that obtain during a destructive distillation, yielding oils of a more stable and saturated nature. Work is now being done on the changes wrought by successive distillations of shale oils. The results should yield valuable evidence in support of this hypothesis.

ACKNOWLEDGMENT

The author takes this opportunity to express his indebtedness to C. P. Hackett, who helped to work out the method for determining nitrogen and who made the analyses, and to J. P. Bacca, who aided in developing the method for determining sulphur and made the determinations. The writer is also indebted to Prof. A. H. Low for his valuable criticisms and suggestions in the preparation of this paper.

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Production of Alcohol in Poland

This year's production of alcohol in Poland, according to the *Kurjer Polski*, a newspaper of Warsaw, will be about 40,000,000 liters, of which 30,000,000 liters will be exportable. Last year's alcohol production was only 10,000,000 liters (1 liter = 0.264 gal.).

Constitution of Gas Atmospheres in Aluminum-Alloy Melting Furnaces

Tabulated Analyses of Atmospheres of Various Types of Aluminum Furnaces, Sampled at Short Intervals During Operation, Furnishing Data Necessary for a Study of Dross and Metal Losses Due to Furnace Operation

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AS INDICATED in a previous contribution,¹ "Gases in Aluminum Furnaces and Their Analysis," the Bureau of Mines set out to determine by actual analysis the constitution of the gas atmospheres in industrial melting furnaces used for light aluminum alloys, under foundry operating conditions. A portable gas-sampling apparatus was devised, and a large number of samples taken and analyzed, the results of which are given below.

STATIONARY, OPEN, IRON-POT FURNACE

Gas samples were taken from the atmosphere above the metal in a stationary, oil-fired, iron-pot furnace, run without a cover, such as sketched in Fig. 1. The oil was injected by air under pressure, and steam was not employed for oil atomization in any of the furnaces which were sampled. The furnace was one of several units run as a battery in a bank, the waste gases from the combustion discharging into the air at one end of the bank. In furnaces of this type the iron pot is heated over its exterior surface, and there is practically

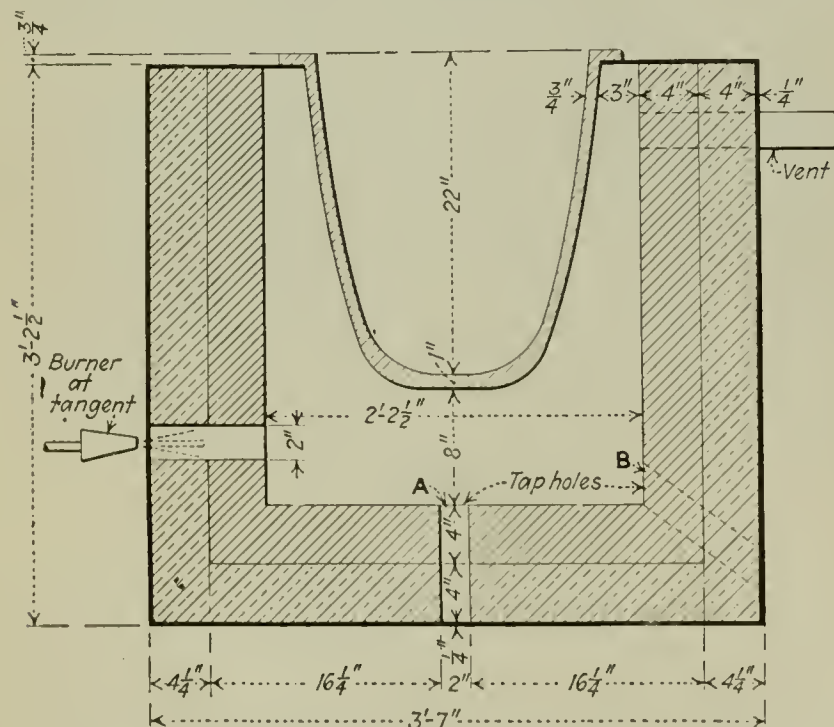


FIG. 1. CROSS-SECTION OF STATIONARY, OPEN, IRON-POT FURNACE

no opportunity for the products of combustion to come into contact with the metal during melting. The sampling tube was supported on a suitable stand, and the intake end was hung within 1 in. of the bath surface at about the center. The melting charge consisted of aluminum pig plus 50:50 copper-aluminum alloy, No. 12 alloy pig, and No. 12 alloy foundry scrap. There was

doubtless, no contaminating material in the charge which could have given rise to gases on heating.

As might be expected, the gas in contact with the surface of the liquid metal in an open iron-pot furnace would consist of practically unaltered air. Normally, however, owing to draughts or leakage from the combustion space, the gas contains either a small percentage of unburned hydrocarbons (from 0.0 to 0.4 per cent) or their combustion products (H_2 from 0.0 to 0.2; CO_2 from 0.0 to 0.2) or both, in addition to oxygen and nitrogen. Methane was tested for and not found. Since the gas in contact with the liquid metal in a furnace of this type is practically unaltered air, it is evident that dross formation is a direct function of the temperature. The higher the melting temperature the greater the loss by oxidation and nitridation.

STATIONARY, CLOSED, IRON-POT FURNACE

A number of gas samples were taken from the atmosphere above the metal in a stationary, gas-fired, iron-pot furnace, run with a dome-shaped cast-iron cover (Fig. 2). Natural gas was the fuel. The furnace was operated as a single unit, the waste products from the combustion discharging up a small stack connected to the side of the furnace wall. As in furnaces of the foregoing type, the iron pot is heated over its exterior surface, and there should be but little opportunity for the products of combustion to come into contact with the metal during melting. The furnace charge consists of No. 12 alloy scrap (castings, gates, and risers), 50:50 copper-aluminum alloy, and baled aluminum clippings made up so as to give a final alloy of approximately No. 12 composition.

Contrary to what might have been expected, the furnace atmosphere contained quite large percentages of carbon dioxide, and the oxygen and nitrogen contents were rather variable. The burning of oil on the clippings might be expected to show momentarily the presence of considerable carbon dioxide, but this constituent should not be expected to persist during the course of a melting period. The oxygen content of the atmosphere was increased when the cover was opened for charging metal. The high percentage of carbon dioxide may be due to burning out of the carbon in the cast-iron pot or cover since the oxygen is decreased and the nitrogen increased as compared with the percentage of these constituents in air. There may, of course, be some leakage of the products of combustion into the space above the metal which would account for the carbon dioxide content of the atmosphere. Omitting the figures obtained for samples taken after the cover was open, the range of composition for carbon dioxide, nitrogen

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²See CHEM. & MET. ENG., vol. 24, No. 23, June 8, 1921, p. 1019.

and oxygen was as follows: 7.2 to 9.8 per cent carbon dioxide, 84.7 to 86.6 per cent nitrogen, and 3.5 to 8.1 per cent oxygen. Fractional percentages of carbon monoxide, hydrogen and unsaturated hydrocarbons were found once. The atmosphere of this furnace may be considered to be oxidizing, and both oxidation and nitridation of the metal will take place on melting.

STATIONARY, CRUCIBLE FURNACE

Gas samples were taken from the atmosphere in the interior of the crucible in a stationary, gas-fired, crucible furnace run without a cover. Natural gas was the fuel. In this furnace, somewhat as shown in Fig. 3, the crucible was simply set in a round iron shell lined with firebrick, and the crucible was heated over its exterior surface by the combustion of the fuel. The waste gases were discharged through a large hole in the furnace cover. No cover was used on the crucible. In a furnace of this type there is ample opportunity for the products of combustion to come into contact with the metal during melting, since they are discharged with a rotating motion through the top of the furnace. The burner was set so that the flames were projected tangentially and with a rotating and upward motion around the crucible.

The sampling tube was admitted to the atmosphere in the crucible above the liquid metal through the large hole in the top of the furnace and the intake end was held at a point in the center of the crucible space about 1 in. from the surface of the alloy. Analyses of a number of samples from this furnace are given in Table I. The charge contained about 86.0 per cent aluminum,

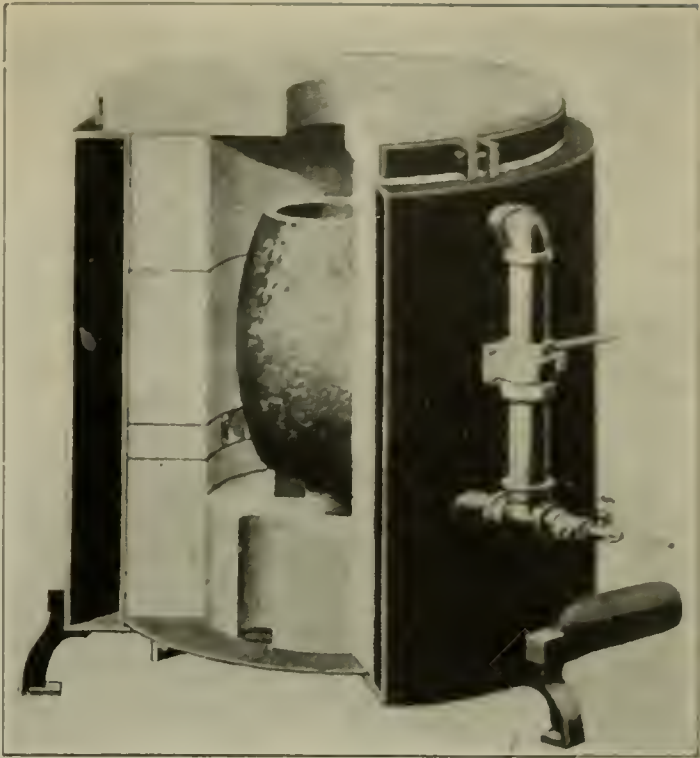


FIG. 3. SECTIONAL PERSPECTIVE OF STATIONARY CRUCIBLE FURNACE

7.0 per cent copper and 7.0 per cent tin (made up by adding tin to No. 12 alloy pig).

As might be expected, the gas in contact with the surface of the liquid metal in a furnace of this type depends intimately upon the fuel used and the operating details (air supply, etc.). The products of combustion are passing over the metal surface at a fairly rapid rate during melting. As will be noted from Table I, the gas

in contact with the liquid metal contained large amounts of nitrogen. It cannot be considered as oxidizing on the basis of the oxygen content of the gases. The variations in carbon dioxide, carbon monoxide, hydrogen and methane are traceable to variations in the air supply and in the speed of the combustion. It is entirely likely that variations in the constitution of the furnace atmosphere as large as those indicated in the table would be obtained by sampling different parts of the combustion space. Hence the analyses as given are useful only in so far as they indicate the variations in the composition of the atmosphere.



FIG. 2. BATTERY OF COVERED POT FURNACES. POTS REMOVED FROM FURNACES AT FAR END OF LINE

TABLE I. ANALYSES OF GASES IN CONTACT WITH METAL IN A STATIONARY, GAS-FIRED, CRUCIBLE FURNACE

Time Sample Drawn	Composition, Constituents Per Cent, by Volume						Oxygen, O ₂	Remarks
	Carbon Dioxide, CO ₂	Carbon Monoxide, CO	Hydrogen, H ₂	Methane, CH ₄	Unsaturated Hydrocarbons, C ₂ H ₄ , etc.	Nitrogen, N ₂ (by difference)		
2:47	7.3	3.9	2.5	4.1	1.3	78.5	2.4	Metal charged
2:53	7.4	4.1	3.3	3.3	0.4	79.7	1.8	Metal melting
2:57	6.9	5.5	4.4	3.5	0.6	77.6	1.5	Metal melting
3:01	6.7	5.1	3.5	2.9	0.0	79.4	2.4	Metal melting
3:07	8.2	4.8	4.0	2.1	0.4	80.1	0.4	Metal melting
3:12	7.7	5.5	4.7	2.2	0.4	79.3	0.2	Metal melting No 12 pig charged
3:16	7.7	4.1	3.1	1.1	0.2	81.7	2.1	Metal heating
3:20	7.5	5.9	4.5	2.3	0.0	79.3	0.5	Metal heating
3:25	7.6	5.7	4.5	1.8	0.0	79.8	0.6	Metal heating
3:35	9.6	3.3	2.4	0.5		83.2	1.0	Metal heating
3:39	7.4	6.3	6.2	1.6	0.4	77.8	0.3	Metal heating
3:43	7.8	6.2	6.0	1.1	0.4	78.5	0.0	Metal heating
3:48	7.6	5.5	5.3	1.0	0.6	79.3	0.7	Metal heating
3:53	7.8	5.2	4.6	0.8		81.1	0.5	Metal heating, temperature 790° C

TABLE II. ANALYSES OF GASES IN CONTACT WITH METAL IN A STATIONARY, OIL-FIRED, SEMI-PIT, CRUCIBLE FURNACE

Time Sample Drawn	Composition, Constituents Per Cent, by Volume—			Remarks
	Carbon Dioxide, CO ₂	Nitrogen, N ₂ (by difference)	Oxygen, O ₂	
11:12	12.8	83.1	4.1	Metal heating.
11:30	13.3	83.3	3.4	Metal heating; ready to pour.
12:12	14.5	83.5	2.0	New charge; metal melting.
12:26	14.1	83.6	2.3	Metal melting; flame smoky.
12:36	13.0	82.8	4.2	Metal melting; flame not smoky.
12:40	14.2	83.2	2.6	Metal melting; flame not smoky.
12:44	13.6	83.1	3.3	Metal melting; flame not smoky.
12:55	14.0	83.0	2.8	Metal melting; flame not smoky.

STATIONARY, SEMI-PIT, CRUCIBLE FURNACE

Gas samples were taken from the atmosphere in the interior of the crucible in a stationary, oil-fired, semi-pit, crucible furnace, run without a cover. Fuel oil of unknown composition was used. In this furnace the crucible for melting the alloy was set in a cylindrical iron shell lined with firebrick. The lower half of the shell was set down in a pit. The crucible was heated over its exterior surface by the combustion of the fuel. The waste gases were discharged through a large hole in the furnace cover. No cover was used on the crucible. In a furnace of this type there is also ample opportunity for the products of combustion to come into contact with the metal. The intake end of the sampling tube was held at a point in the center of the crucible space about 1 in. from the surface of the alloy. Analyses of a number of samples from this furnace are given in Table II. No. 12 alloy was melted, and the charge was made up of No. 12 foundry scrap, aluminum pig and 50:50 copper-aluminum alloy.

In the installation under discussion the gas in contact with the liquid alloy during melting was of fairly uniform composition. As will be noticed from Table II, the gas consisted largely of nitrogen and carbon dioxide, with smaller amounts of oxygen. No carbon monoxide or methane was found, and only 0.1 per cent of hydrogen and unsaturated hydrocarbons was detected in one of the samples. Both oxidation and nitridation of the metal would occur in the atmosphere of this furnace.

TILTING, CRUCIBLE FURNACE

Gas samples were taken from the atmosphere in the interior of the crucible in a tilting, crucible furnace of a special design using a good grade of metallurgical coke. In this furnace the crucible for melting the alloy was supported in the furnace shell and heated by the combustion of coke on a grate beneath. The waste gases passed up and around the uncovered crucible and were discharged through a large hole in the furnace cover. Both natural and forced drafts were employed on the

furnace. In this furnace there was ample opportunity for the products of combustion to come into contact with the metal during melting. Analyses of a number of samples from the furnace are given in Table III. No. 12 alloy was melted, and the charge was made up of No. 12 foundry scrap, aluminum pig and 50:50 copper-aluminum alloy.

For natural draft the gas in contact with the liquid alloy during melting was of fairly uniform composition, but the variations were more marked in the case of forced draft. The effect of forced draft upon the constitution of the gas atmosphere is plainly shown. The carbon dioxide content of the gas is higher and the oxygen content much lower, indicating more perfect combustion of the gases before egress from the furnace. When the draft was reduced the carbon dioxide was lowered and the oxygen raised. The high carbon monoxide content of sample taken at 2:17 may be due to several causes—for example, too rapid egress of the unburned gases. Unsaturated hydrocarbons were tested for but not found in any of these samples.

Both oxidation and nitridation of aluminum would occur in a furnace atmosphere of the compositions indicated. It would have been interesting to study the variations in the atmosphere of this furnace over a wide range of draft pressures, but this was impossible.

REVERBERATORY FURNACE

Gas samples were taken from the atmosphere in the interior of an open-flame, oil-fired reverberatory-type furnace. In this furnace the melting was done upon the furnace bottom; fuel was supplied through three burners at one end, and combustion took place in the space between hearth and roof. The products of combustion were discharged into a large stack.

The furnace was approximately 10.0 ft. long by 6.0 ft. wide by 4.0 ft. high inside. There were two large charging doors and a single tapping runner on each side. Considerable air was sucked into the furnace through cracks and holes in the walls and around the doors and burners.

The sampling tube was admitted into the interior of the furnace under the different charging doors, held at various points usually about equidistant from the opposite charging doors and close to the surface of the bath. Analyses of a number of samples taken are given in Table IV. No. 12 alloy was melted, and heavy foundry scrap was used exclusively in the charges.

By reference to the table, it will be seen that the composition of the gas atmosphere in this furnace was very variable, especially as regards carbon dioxide and oxygen. Omitting the figures which are traceable to

TABLE III. ANALYSES OF GASES IN CONTACT WITH METAL IN A TILTING, COKE-FIRED, CRUCIBLE FURNACE; NATURAL AND FORCED DRAFT

Time Sample Drawn	Composition, Constituents Per Cent, by Volume—						Remarks
	Carbon Dioxide, CO ₂	Carbon Monoxide, CO	Hydrogen, H ₂	Methane, CH ₄	Nitrogen, N ₂	Oxygen, O ₂	
1:00	6.1	0.1	0.0	0.2	79.2	14.4	Metal heating; natural draft.
1:09	9.2	0.4	0.2	0.0	79.7	10.5	Metal heating; natural draft.
1:15	2.4	0.3	0.0	0.0	79.4	17.9	Metal heating; natural draft.
1:20	5.8	0.0	0.0	0.0	79.5	14.7	Metal heating; natural draft.
1:25	3.2	0.3	0.0	0.0	79.0	17.5	Metal heating; natural draft.
1:30	3.1	0.0	0.0	0.0	79.4	17.5	Metal heating; natural draft.
1:35	5.8	0.0	0.0	0.0	79.4	14.8	Metal heating; natural draft.
2:17	13.3	11.2	0.8	0.1	74.4	0.2	Another charge; metal heating; forced draft.
2:23	16.7	6.0	0.3	0.1	76.7	0.2	Metal heating; forced draft.
2:28	13.2	3.8	0.1	0.1	77.5	5.3	Metal heating; forced draft; scrap charged.
2:32	19.1	0.4	0.0	0.0	79.3	1.2	Metal heating; forced draft.
2:37	13.3	0.2	0.0	0.0	79.7	6.8	Metal heating; forced draft; scrap charged.
2:42	3.6	0.0	0.0	0.0	79.8	16.6	Metal heating; draft much reduced.
2:48	3.1	0.0	0.0	0.0	79.1	17.8	Metal heating; draft much reduced.
2:52	13.9	0.3	0.0	0.0	79.1	6.7	Metal heating; strong forced draft.
2:56	12.8	0.0	0.0	0.0	80.9	6.3	Metal heating; strong forced draft.

definite operating conditions, it is evident that the atmosphere is oxidizing. Taking the last twelve samples, which cover a melting period when the operating conditions were fairly uniform, the composition of the atmosphere ranged about 4.5 per cent CO_2 , 14.5 per cent O_2 and 80.8 per cent N_2 . Both carbon monoxide and methane were found in small percentages in certain of the samples, but hydrogen was detected (0.1 per cent) in only one sample. Both oxidation and nitridation would occur in a furnace atmosphere of this type. Since the gases are passing over the metal at a rapid speed, the gross loss would be a function of the temperature, the composition of the atmosphere and the speed of passage of the gases.

Reverberatory practice is generally to run continuously—cold metal being added periodically to keep pace with the rate of pouring. Since the doors are opened

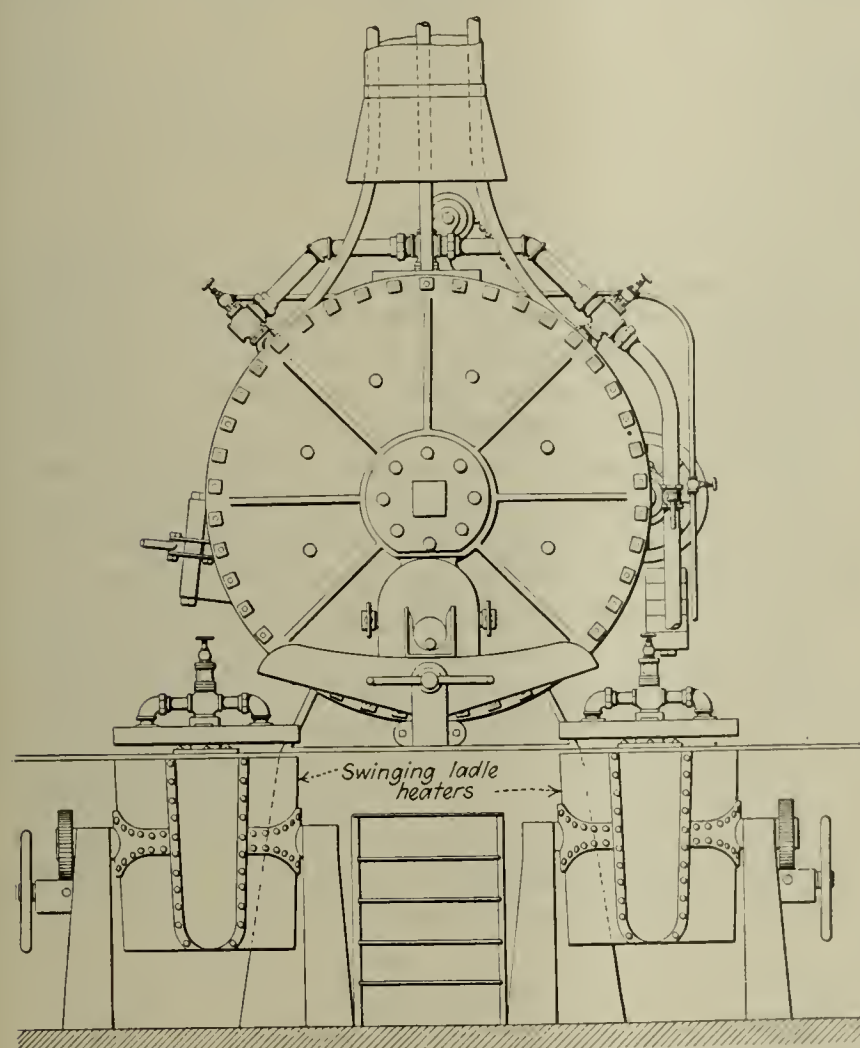


FIG. 4. END ELEVATION OF OPEN-FLAME STATIONARY FURNACE

from time to time, the atmosphere may be expected to change periodically for this reason if no other. But the atmosphere did not vary widely in different parts of the furnace, as shown by the last set of analyses.

OPEN-FLAME, STATIONARY, CYLINDRICAL FURNACE

Gas samples were taken from the atmosphere in the interior of the open-flame, oil-fired, stationary cylindrical furnace of the Schwartz type sketched in Fig. 4. In this furnace the melting was done upon a cylindrical bottom; the fuel was supplied through two burners on the side, and the combustion took place in the space between the surface of the metal and the cylindrical walls of the furnace. The products of combustion were discharged into the air through a hole in the top of the furnace. The furnace was about 10 ft. long by 5 ft. in diameter inside. There were two charging doors at the side and the end. In this furnace, as in other open-flame furnaces, there was ample opportunity for the products

TABLE IV. ANALYSES OF GASES IN CONTACT WITH METAL IN AN OPEN-FLAME, OIL-FIRED, REVERBERATORY-TYPE FURNACE

Time Sample Drawn	Composition, Constituents Per Cent, by Volume					Remark
	Carbon Diox- ide, CO ₂	Carbon Mon- oxide, CO	Methane, CH ₄	Nitrogen, N ₂ (by difference)	Oxygen, O ₂	
Tube supported in iron pipe; 3½ ft. in the furnace						
10:50 (F) *	4.15	0.0	0.02	82.65	13.18	Burners off, metal be- ing tapped
11:45 (F) †	5.48	0.0	0.04	81.34	13.14	Burners on, metal charged
11:50 (F)	8.86	0.0	0.03	83.43	7.68	Metal heating
12:45 (B)	6.17	0.0	0.33	87.62	5.88	Metal heating, metal charged
1:15 (B)	1.07	0.0	0.03	80.15	18.75	Metal heating, meta charged
1:25 (B)	0.8	0.0	0.1	88.4	10.7	Metal heating
Bare tube 10 in. in the furnace						
1:40 (F)	1.73	0.0	0.02	79.81	18.44	Metal heating
2:00 (F)	1.69	0.0	0.03	79.69	18.59	Metal heating
2:25 (F) ‡	2.28	0.0	0.02	79.92	17.78	Metal heating
2:35 (B)	0.10	0.0	0.03	79.18	20.69	Burners off, metal being tapped
3:10 (F)	1.26	0.0	0.09	79.50	19.15	One burner on, meta being tapped.
3:20 (F)	0.14	0.0	0.03	79.03	20.80	One burner on, meta being tapped
Bare tube 3 ft. in the furnace§						
12:00 (B)	10.6	0.1	0.0	83.9	5.3	New charge; burners on
12:10 (B)	4.2	0.4	0.1	80.2	15.1	Metal heating
12:18 (B)	11.7	0.3	0.0	84.4	3.6	Metal heating
12:27 (B)	7.9	0.7	0.0	82.1	9.3	Metal heating
12:35 (B)	12.1	0.4	0.0	84.6	2.9	Metal ready to pour
Bare tube, 14 in. above the bath						
10:36 (F)	5.6	0.4	0.3	81.5	12.2	Another charge, burn- ers on
10:42 (F)	6.3	0.7	0.0	81.0	12.0	Metal heating
10:47 (F)	5.2	0.6	0.0	80.7	13.5	Metal heating
10:52 (F)	4.8	0.7	0.0	80.2	14.3	Metal heating
Bare tube 3½ ft. in the furnace; 4 in. above the bath						
10:58 (F)	4.8	0.6	0.1	81.0	13.5	Metal heating
11:03 (F)	4.8	0.6	0.0	80.6	14.0	Metal heating
11:12 ()	6.0	0.0	0.0	82.0	12.0	Metal heating
11:32 ()	6.6	0.0	0.0	80.9	12.5	Metal charged
11:45 ()	5.9	0.0	0.0	81.0	13.1	Metal heating
11:49 ()	3.4	0.0	0.0	79.6	17.0	Metal heating
12:17 (B)	6.5	0.0	0.0	81.5	12.0	Metal heating
12:23 (B)	6.4	0.0	0.0	81.3	12.3	Metal heating

(F) Through door nearest the flue. (B) Through door nearest burners.

(M) Midway.

* Temperature of gas near the burners was 595 deg. C.; flue gases, 810 deg. C.; liquid metal, 905 deg. C.

† Temperature of gas near the burners was 1,165 deg. C.; flue gas, 1,090 deg. C.; and liquid alloy, 705 deg. C.

‡ Temperature of liquid alloy, 880 deg. C.

§ The heat softened the quartz sampling tube so that it sagged.

of combustion to come into intimate contact with the metal.

Owing to the fact that the incandescent gases were constantly in violent motion, it was not necessary to place the sampler very close to the bath. It was admitted through a hole in the end charging door and luted with clay. The end was held at a point about 3 ft. in the furnace from one end and midway between the opposite walls, several inches above the metal surface.

Analyses of a number of samples are given in Table V. No. 12 alloy was melted, the charge consisting of No. 12 alloy pig, aluminum pig plus 50:50 copper-aluminum alloy, and heavy foundry scrap.

The constitution of the gas atmosphere in a closed furnace of this type should remain fairly constant for a given set of operating conditions, and the constituents present in the gases, as shown by the table, vary within

TABLE V. ANALYSES OF GASES IN CONTACT WITH METAL IN A STATIONARY, OIL-FIRED, OPEN-FLAME, CYLINDRICAL FURNACE (SCHWARTZ TYPE)

Time Sample Drawn	Composition, Constituents Per Cent, by Volume					
	Carbon Dioxide, CO_2	Carbon Monoxide, CO	Hydrogen, H_2	Methane, CH_4	Nitrogen, N_2 (by difference)	Oxygen, O_2
3:00	13.7	1.7	0.8	0.3	82.8	0.7
3:04	12.8	2.9	1.7	0.2	82.2	0.2
3:09	13.9	0.4	0.3	0.0	84.1	1.3
3:13	14.1	1.2	0.2	0.5	83.8	0.2
3:17	14.1	1.0	0.5	0.1	84.1	0.2
3:25	13.4	2.2	0.9	0.1	83.3	0.1
3:36*	14.6	0.0	0.0	0.0	84.3	1.1
3:41	14.1	0.0	0.0	0.0	83.9	2.0
3:55	13.5	0.0	0.0	0.0	84.5	2.0

* Bath stirred and fluxed with ZnCl_2 .

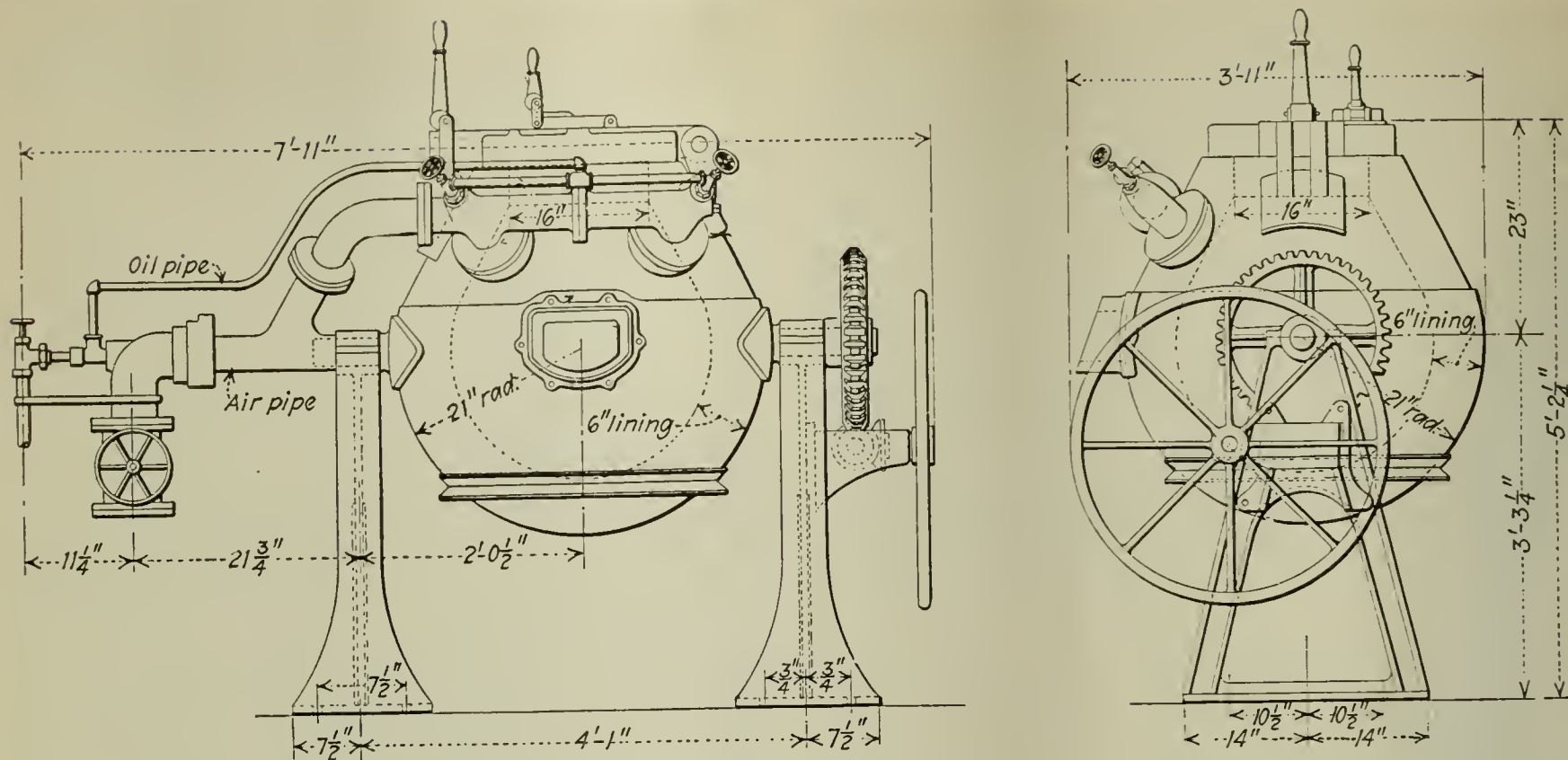


FIG. 5. SCHWARTZ FURNACE

small limits. The atmosphere as found would not be considered as oxidizing unless there is a reaction between carbon dioxide and aluminum at moderate temperatures (700-900 deg. C.).

OPEN-FLAME, TILTING, EGG-SHAPED FURNACE

Gas samples were taken from two different open-flame, oil-fired, tilting, egg-shaped furnaces. In the first furnace (No. 2 Hawley-Schwartz) the melting was done upon the bottom of the furnace; the fuel was supplied through two burners located at one side and near the top which projected the flames down upon the metal. Combustion took place over the metal bath, and the products of combustion were discharged into the air through the open pouring spout on one side of the furnace. This furnace was about 3.5 ft. in diameter. The charging door was at the top. The sampling tube was admitted into the interior of the furnace through a

hole in the charging door and luted in place with clay. The intake end of the tube was held at a point in the approximate center of the interior and several inches above the surface of the bath. Analyses of a number of samples are given in Table VI.

The constitution of the gas atmosphere in a closed furnace of this type should remain fairly constant for a given set of operating conditions. The variations in the percentages of the various constituents as shown in the table are undoubtedly due to burner adjustments.

Methane up to 2.0 per cent was found in some of the samples. The atmosphere is a difficult one to analyze from the melting standpoint, owing to the peculiar relative percentages of the various constituents in certain of the samples. At times it was plainly oxidizing, while at others the oxygen was low and the carbon monoxide quite appreciable. In a few samples both oxygen and carbon monoxide were present.

TABLE VI. ANALYSES OF GASES IN CONTACT WITH METAL IN A TILTING, OIL-FIRED, OPEN-FLAME, EGG-SHAPED FURNACE (SCHWARTZ TYPE)

Time Sample Drawn	Composition, Constituents Per Cent, by Volume						Remarks
	Carbon Dioxide, CO ₂	Carbon Monoxide, CO	Hydrogen, H ₂	Methane, CH ₄	Nitrogen, N ₂ (by Difference)	Oxygen, O ₂	
Melting 67:33 Aluminum : Zinc Alloy							
12:21	11.6	4.4	1.8	0.7	79.7	1.8	Metal heating; one charge
12:26	9.6	4.1	0.6	0.5	79.8	5.4	Metal heating; one charge
12:30	10.1	6.0	1.5	0.5	79.1	2.8	Metal heating; one charge
12:36	11.6	5.7	2.2	0.6	79.9	0.0	Metal heating; one charge
12:42	11.3	6.3	2.2	0.5	79.7	0.0	Metal ready to pour; temperature about 900° C.
2:16	13.1	0.4	0.0	0.0	83.1	3.4	Another charge; metal heating
2:25	14.0	0.3	0.0	0.5	82.7	2.5	Metal heating
2:30	12.3	0.0	0.0	0.2	83.0	4.5	Metal heating
2:35	11.9	0.0	0.0	0.0	82.4	5.7	Metal heating
2:40	12.6	0.0	0.0	0.0	83.1	4.3	Metal heating
2:45	12.6	0.0	0.0	0.0	83.1	4.3	Metal heating
Melting 95:5 Aluminum : Magnesium Alloy							
1:29	14.3	0.6	0.0	0.0	82.9	2.2	Another charge; metal heating
1:34	13.7	0.4	0.0	0.0	82.7	3.2	Metal heating
1:44	11.2	6.9	2.4	0.4	79.1	0.0	Metal ready to pour
3:06	13.0	0.3	0.0	0.0	83.1	3.6	Another charge; metal heating
3:11	14.7	1.8	0.0	0.0	83.4	0.1	Metal heating
3:16	12.5	2.0	0.2	0.4	82.4	2.5	Metal heating
3:24	12.8	3.9	0.7	0.3	82.2	0.1	Metal heating
Melting No. 12 Alloy							
12:24	13.3	0.0	0.0	0.0	83.4	3.3	Another charge; metal heating
13:30	14.5	1.9	0.7	0.0	82.9	0.0	Metal heating
12:34	13.7	3.1	1.1	0.1	81.9	0.1	Metal heating
12:38	12.4	3.4	1.0	0.2	81.9	1.1	Metal ready to pour
2:11	12.6	4.5	1.7	0.5*	80.0	0.3	Another charge; metal heating
2:15	13.3	3.5	1.5	0.3*	81.0	0.0	Metal heating
2:18	9.3	5.9	1.7	1.7	78.7	2.7	Metal heating
2:22	8.9	7.9	4.3	2.0	75.3	1.6	Metal heating
2:26	9.9	7.8	4.7	0.7*	76.3	0.2	Metal heating
2:30	7.2	7.3	2.5	0.3	77.0	5.7	Metal heating
2:34	7.8	11.0	7.1	0.8	73.3	0.0	Metal ready to pour.

* 0.4 per cent unsaturated hydrocarbons.

TABLE VII. ANALYSES OF GASES IN CONTACT WITH METAL IN AN INDIRECT-ARC, ROCKING, ELECTRIC FURNACE (DETROIT TYPE)

Time Sample Drawn, A.M. and P.M.	Composition, Constituents Per Cent, by Volume						Remarks
	Carbon Dioxide, CO ₂	Carbon Monoxide, CO	Hydrogen, H ₂	Methane, CH ₄	Nitrogen, N ₂ (by difference)	Oxygen, O ₂	
10:54	3.0	40.3	8.1	0.3	48.3	0.0	New charge, metal heating
10:59	3.0	42.8	6.6	0.4	47.2	0.0	Metal heating
11:07	3.6	40.0	5.7	0.6	50.1	0.0	Metal heating
11:18	3.6	35.2	4.5	0.7	55.8	0.2	Metal heating
11:24	0.8	30.4	5.2	0.8	62.5	0.3	Rocking started
11:29	0.7	27.4	4.2	0.5	67.2	0.0	Metal heating
11:34	0.4	24.3	2.8	0.8	71.6	0.1	Metal heating
11:39	1.5	21.5	2.2	0.9	73.4	0.5	Metal heating
11:45	4.3	11.5	0.5	0.9	82.6	0.2	Metal heating
11:50	3.0	5.9	0.0	0.9	87.8	2.4	Metal heating
11:55	6.4	5.2	0.0	1.1	87.1	0.2	Metal heating
12:00	0.2	15.8	3.0	0.4	80.6	0.0	Metal heating
12:12	0.3	5.9	3.4	0.1	90.3	0.0	Metal heating
12:18	0.6	3.0	3.3	0.0	92.8	0.3	Metal heating
12:23	0.7	1.5	2.5	0.4	94.9	0.0	Arc shut off
1:29	8.4	21.5	4.0	0.6	65.5	0.0	Metal soaking; ready to pour
1:35	7.8	22.4	4.2	0.4	65.2	0.0	Another charge; metal heating
1:41	4.6	22.7	3.7	0.5	68.3	0.2	Metal heating
1:46	2.4	22.0	3.8	0.6	71.2	0.0	Metal heating
1:53	0.4	25.4	4.0	0.6	69.6	0.0	Rocking started
1:59	0.5	27.6	3.5	0.6	67.4	0.4	Metal heating
2:04	0.7	23.7	3.9	0.6	71.1	0.0	Metal heating
2:10	1.5	16.0	2.8	0.8	78.8	0.1	Metal heating
2:15	0.6	18.8	3.4	0.2	76.7	0.3	Metal heating
2:20	0.3	19.9	3.5	0.5	75.6	0.2	Metal heating
2:26	0.5	16.0	3.4	0.2	79.9	0.0	Metal heating
2:30	1.1	16.5	1.9	0.8	79.2	0.5	Metal ready to pour

INDIRECT-ARC, ROCKING, ELECTRIC FURNACE

Gas samples were taken from an indirect-arc, rocking, electric furnace (Detroit type), of 2,000 lb. brass capacity (Fig. 6). The general features of this furnace as used for non-ferrous metal melting are well known and detailed description is not necessary here.² The charge is put in through a door at the side and melted by the heat of the arc from a pair of electrodes centered horizontally in the furnace. Any gases present in the interior of the furnace are in intimate contact with the metal, but the atmosphere is doubtless fairly uniform throughout, since ingress of air or egress of gases does not take place when the furnace is tight.

The sampling tube was projected 15 in. into the furnace through the pouring spout and luted in place with clay. It was not attempted to hold the intake end close to the liquid metal surface.

Analyses of a number of samples are given in Table VII. The furnace was run on No. 12 alloy, made up with aluminum pig plus 50:50 copper-aluminum alloy in most of the heats.

²"A Rocking Electric Brass Furnace," by H. W. Gillett and A. E. Rhoads, CHEM. & MET. ENG., vol. 18, p. 583 (June 1, 1918).

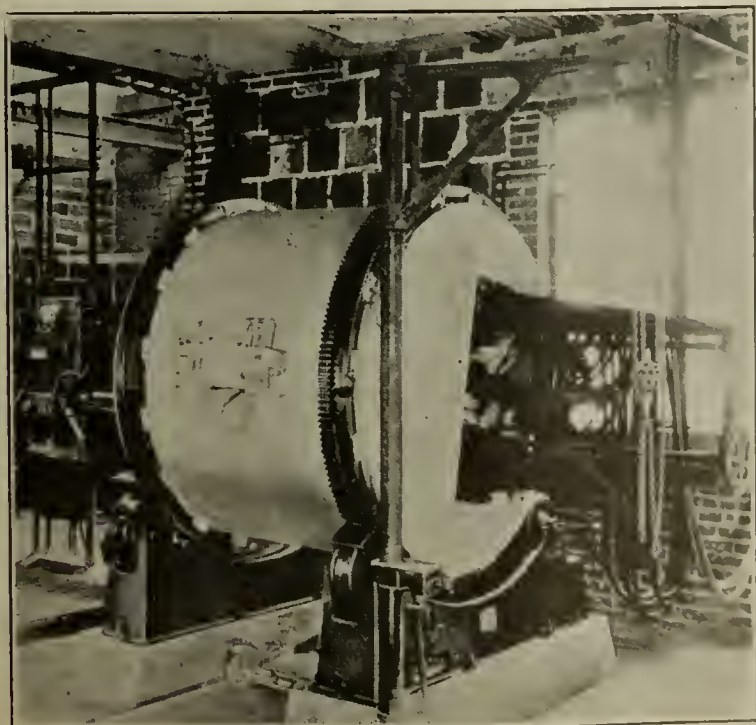
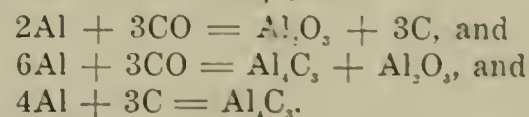


FIG. 6. DETROIT ROCKING FURNACE

The original atmosphere, immediately after charging, should consist of unaltered air. With the arc on and the furnace in operation, the oxygen will combine with the carbon of the electrodes with the formation of carbon dioxide. Then, with the oxygen used up, the carbon dioxide is reduced by the hot carbon with the formation of carbon monoxide. During the greater part of a melting period the furnace atmosphere may be expected to be high in carbon monoxide. Referring to the data given in the table, it will be seen that the carbon monoxide content of the atmosphere was generally quite high. For a short melting period between 11:08 and 12:20 (not included in the table) the range of composition was as follows: 21.0 to 39.3 per cent carbon monoxide, 0.0 to 2.7 per cent CO₂, 50.5 to 72.6 per cent nitrogen, 0.0 to 5.1 per cent oxygen; 0.1 to 3.0 of methane; 0.4 to 7.0 per cent of hydrogen, and 0.0 to 2.1 of cyanogen.

Over a long melting period, as covered by samples taken from 10:54 to 12:23 inclusive, changes in the constitution of the atmosphere were marked. Thus, carbon monoxide and hydrogen generally become less with longer duration of the melt. Carbon monoxide possibly reacts with aluminum, thus:



No analyses were made of the dross obtained on melting aluminum alloys in this furnace, but it should show aluminum oxide, aluminum nitride and aluminum carbide. Cyanogen was smelled throughout, but was not found on analysis. It is due to the direct union of carbon and nitrogen at the temperature of the electric arc. The source of the hydrogen is unknown, although a small part of it may be evolved from the aluminum on melting. Taken by and large, the atmosphere of this furnace after the arc has been on for a short time will be high in carbon monoxide and nitrogen and low in carbon dioxide and oxygen. Such an atmosphere appears to oxidize aluminum; it would, of course, be reducing to copper and zinc.

GRANULAR-RESISTOR ELECTRIC FURNACE

Gas samples were taken from a granular-resistor electric furnace (Baily type) with capacity of 1,500 lb. brass. (Fig. 7.) The general features of this furnace



FIG. 7. BAILY GRANULAR-RESISTOR FURNACE

as used for non-ferrous metal melting are well known.³ The charge is melted upon a bottom by the reflected heat from the granular carbon resistor placed in a circular trough above the hearth. If luted tightly, there should be no ingress of air. The actual atmosphere may vary at different points.

The sampling tube was admitted to the interior of the furnace through the pouring spout, and the intake end was held at a point about 1 in. above the metal surface and in about the center of the furnace. Analyses of a number of samples are given in Table VIII. The furnace was run on No. 12 alloy, the charge con-

further because the temperature is not so high as in an arc furnace, it might be expected that the carbon dioxide would be higher and the carbon monoxide lower in the granular-resistor than in the arc furnace.

The drosses obtained from the indirect-arc and the granular-resistor electric furnaces appear to be entirely different in character. No aluminum carbide is thought to be present in the dross from the latter, and evidently the temperature is not sufficiently high to cause interaction of aluminum and carbon monoxide.

DISCUSSION OF THE RESULTS; TOXICITY OF GASES

In considering the detailed analytical data given in the tables, it is of interest to note that the constitution of the gas atmosphere in a metal-melting furnace may be, and usually is, quite variable during a melting period. During a day's run in a foundry, the gas atmosphere in a furnace may be exceedingly variable. In oil- and gas-fired, open-flame furnaces, the firing conditions vitally affect the constitution. It is extremely speculative to attempt to state why a furnace atmosphere should contain certain percentages of the different constituents at a particular moment, and the authors will not attempt to present a detailed analysis of the data as set forth in the tables. As has been stated previously, the main object of the study was to determine the actual constitution of the gas atmospheres in contact with metal in typical industrial furnaces used for melting light aluminum alloys in foundry practice. The fact that the effects of most of the constituents of the gas atmospheres upon the properties of aluminum and its light alloys are largely unknown makes any discussion of this aspect of the subject speculative.

TABLE VIII. ANALYSES OF GASES IN CONTACT WITH METAL IN A GRANULAR-RESISTOR, ELECTRIC FURNACE (BAILY TYPE)

Time Sample Drawn	Composition, Constituents Per Cent, by Volume						Remarks
	Carbon Dioxide, CO ₂	Carbon Monoxide, CO	Hydrogen, H ₂	Methane, CH ₄	Nitrogen, N ₂	Oxygen, O ₂	
12:00	16.9	5.2	0.1	0.4	76.9	0.5	Metal heating
12:06	19.6	0.9	0.0	0.1	78.4	1.0	Metal heating
12:15	17.8	5.0	0.5	0.0	76.2	0.5	Metal heating
12:25	14.6	12.4	4.8	0.0	67.8	0.4	Metal heating
12:30	14.2	15.2	5.4	0.3	64.6	0.3	Metal heating
4:41	14.0	0.5	0.0	0.2	84.5	0.8	New charge
4:46	13.1	4.4	1.5	*	80.0	0.7	Metal heating
4:56	12.7	5.6	0.3	0.4	80.5	0.5	Metal heating
5:00	13.9	5.1	1.2	0.2	79.4	0.2	Metal heating
5:04	12.7	9.0	3.1	0.2	74.8	0.2	Metal heating
5:09	13.8	5.8	1.6	0.1	77.8	0.9	Metal heating
5:13	14.4	2.9	0.7	0.1	80.2	1.7	Metal ready to pour
12:03	19.9	2.9	0.3	0.1	76.4	0.4	New charge
12:08	19.9	4.3	0.1	0.1	75.2	0.4	Metal heating
12:30	13.9	13.6	4.9	0.0	66.9	0.7	Metal heating
12:36	14.2	16.6	4.7	0.1	64.2	0.2	Metal heating

* 0.3 per cent C₂H₄

sisting of No. 12 foundry scrap and aluminum pig plus 50:50 copper-aluminum alloy.

It would be expected that considerable carbon monoxide would be present in this furnace as well as in the Detroit furnace, provided the furnace is tightly closed and the melting period is sufficiently long. Referring to the data given in the table, it will be seen that the carbon dioxide content of the atmosphere was quite high, while the carbon monoxide content was variable. In a similar Baily furnace operating on brass, carbon monoxide up to 20.0 per cent was found, indicating that the reduction of carbon dioxide by carbon was more complete at the higher temperature obtaining. The oxygen content of the furnace was quite low, while hydrogen and methane were ordinarily present in small amounts. Owing to the fact that a large volume of air is contained in the furnace at the time of charging and

Some atmospheres prevailing in the melting furnaces contain carbon monoxide and cyanogen and are extremely toxic. No report of injury due to the inhalation of furnace gases in foundries have come to the attention of the authors, and no analyses of foundry melting-room atmospheres have been made in this investigation. Where the gases are discharged into the outside air through a stack, there is small possibility of contamination of the foundry atmosphere by toxic or non-toxic gases, but where the products of combustion are discharged directly from the furnace into the foundry atmosphere, it appears that a real danger exists. With good ventilation, an atmosphere containing high percentages of CO would be rapidly diluted.

Proper ventilation and suitable means for removing furnace gases to the outside air will probably prevent any serious cases of gas poisoning in melting rooms, but it is evident that even under these conditions, a man working too close may be injured.

³See CHEM. & MET. ENG., vol. 17, p. 92 (July 15, 1917); vol. 19, p. 324 (Sept. 15, 1918); vol. 21, p. 11 (July 1, 1919).

Relation of Structure to Free Alkali in Sodium Silicate Solutions*

BY WILLIAM STERICKER†

AMONG chemists there are a great many misconceptions about sodium silicate. The literature is full of contradictions and standard text-books contain many erroneous and misleading statements about it. Failure to specify the composition of the material is often the cause of the contradictions. The ratio of Na_2O to SiO_2 in sodium silicate solutions may vary from 1:1 to 1:4, although in commercial grades the limits extend only from 2:3 to 1:4.

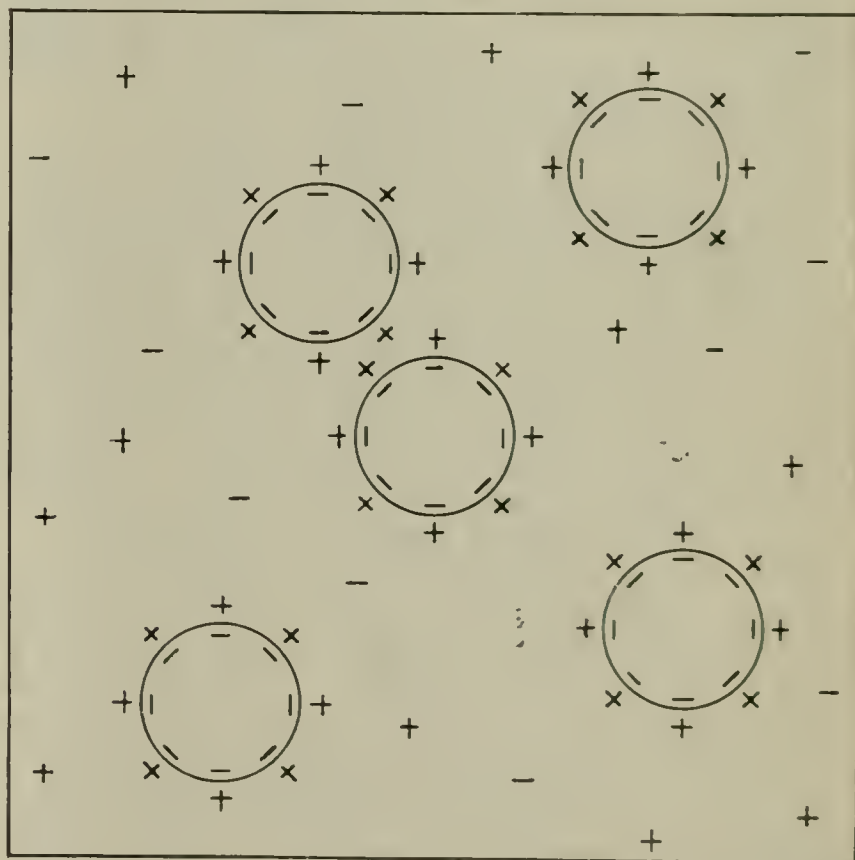
One question frequently asked is, "Do not sodium silicate solutions contain large quantities of free alkali?" The general opinion that such is the case is due to at least two reasons: (1) Sodium silicate solutions give an alkaline reaction with all common indicators. (2) Several investigators have stated that sodium silicate is completely hydrolyzed in dilute solutions.² Another possible reason is that some reference books³ give the composition of "water glass" as $\text{Na}_2\text{Si}_2\text{O}_5$. At least one chemist has calculated that the excess of sodium oxide over that required for this formula was present as free alkali.

These facts do not afford sufficient evidence on which to base the conclusion that concentrated solutions are always largely hydrolyzed. Indicators cannot be accepted as conclusive evidence regarding the amount of free alkali. Hildebrandt⁴ states that "the hydrogen ion concentration at which indicators change color may be very different from the values given by Salm and others when certain substances are present." His conclusions were based on experiments by himself⁵ and by Rosenstein⁶, which showed that the presence of other materials threw "the color change off whole powers of 10 from the tabulated values." Prideaux also calls attention to the fact that colloids and neutral salts affect the color changes of indicators.⁷ Cameron⁸ found that soils and absorbent cotton gave acid reactions with litmus even though the latter was neutral and the former yielded an alkaline extract. He concluded that the discrepancy was due to selective adsorption. These results show that the indicator method may give erroneous ideas as to the amount of free alkali present.

Furthermore, the conclusion that dilute solutions are completely hydrolyzed does not mean that the same is true of concentrated ones. In fact, it is known that salts of weak acids with strong bases are increasingly hydrolyzed on dilution.⁹ Convincing evidence of such decomposition in the case of sodium silicate was obtained by adding water to a concentrated solution. Thread-like lines immediately wriggled up through the clearly defined water layer. This showed that some material was being dissolved rapidly. This process gave

rise to a layer of flocculent material between two clear solutions. If the dilution was not too great, the flocculent material slowly dissolved when the container was shaken. But on great dilution the precipitate could not be put into solution again. Ordway¹⁰ showed that the precipitate salted out of sodium silicate solutions became more siliceous on dilution and concluded therefrom that the silicate was decomposed by water.

When any of the usual methods¹¹ for the determination of the degree of hydrolysis is applied to sodium silicate solutions, it must be remembered that such solutions are colloidal and, therefore, two-phase systems. Ultramicroscopic examination proves the presence of the tiny particles which are present in the continuous phase of aqueous liquor. These particles have selectively adsorbed certain ions from the continuous phase. Since the particles move toward the positive pole when subjected to a potential gradient, it is assumed that the hydroxyl ions are adsorbed. This negatively charged particle attracts the positive sodium ions less strongly. The net result is that at the interface between the two phases there is a higher concentration of alkali than elsewhere in the system. Since the sodium ion is bound to the particle, it seems doubtful whether it can be called "free alkali." The arrangement is shown diagrammatically herewith. Possible ions other



ARRANGEMENT OF THE POSITIVE IONS AROUND THE NEGATIVE COLLOID PARTICLES

than sodium and hydroxyl are not shown. It may readily be seen that this structure will lead to inconsistent results when different methods are used to determine the degree of hydrolysis.

The structure is especially important when indicators are used, as different indicators will not be affected in the same way by the colloidal particles. Suida¹² has shown that hydrated silica and silicates adsorb basic dyestuffs but not acidic ones. Hence, when an acid dyestuff is used as an indicator, the alkali will be determined in the continuous phase; with a basic one, the higher concentration at the interface will be found.

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†Industrial Fellow of the Mellon Institute of Industrial Research.

¹See Vail, *J. Ind. Eng. Chem.*, vol. 11, p. 1029 (1919).

²Kohlrausch, *Z. phys. Chem.*, vol. 12, p. 773 (1893). Loomis, *Ann. Phys. Chem.*, (2) vol. 60, p. 523 (1897). Kahlenberg and Lincoln, *J. Phys. Chem.*, vol. 2, p. 77 (1898).

³T. E. Thorpe's "Dictionary of Applied Chemistry," vol. 5, p. 20 (1913).

⁴*J. Am. Chem. Soc.*, vol. 35, p. 857 (1913).

⁵*Ibid.*, vol. 30, p. 1916 (1908).

⁶*Ibid.*, vol. 34, p. 1117 (1912).

⁷"The Theory and Use of Indicators" (1917), pp. 210 et seq.

⁸"The Soil Solution" (1911), pp. 65-6.

⁹See Lewis, "A System of Physical Chemistry" (1918), vol. 1, pp. 243-5.

¹⁰*Am. J. Sci.*, (2), vol. 35, p. 185 (1863).

¹¹Lewis, *op. cit.*, pp. 247-8.

¹²*Monatsh.*, vol. 25, p. 1107 (1904).

Bogue¹³ has recently pointed out that the conclusion of the previous investigators¹⁴ that sodium silicate was completely hydrolyzed in dilute solutions is open to question. Experiments with the hydrogen electrode indicate hydroxyl ion concentrations below those which would occur if there were complete hydrolysis. In one-hundredth molar solution of the commercial grades of sodium silicate, this method indicated that 1.58 to 9.27 per cent of the silicates, depending on their composition, had been hydrolyzed. The crystalline metasilicate, which is never used commercially, was 28.43 per cent hydrolyzed. The accompanying table gives the concentration of sodium hydroxide in various solutions calculated from these figures.

CONCENTRATION OF SODIUM HYDROXIDE IN SODIUM SILICATE SOLUTIONS AT 30 DEG. C.						
	— Na ₂ SiO ₃ —		— Na ₂ O.1½ SiO ₂ —		— Na ₂ O.2 SiO ₂ —	
	Silicate	NaOH	Silicate	NaOH	Silicate	NaOH
0.33 molar.....	3.70	0.1205	4.605	0.0364	5.51	0.0239
0.10 molar.....	1.22	0.0647	1.52	0.0212	1.82	0.0082
0.05 molar.....	0.61	0.0369	0.76	0.0122	0.91	0.0041
0.01 molar.....	0.122	0.0115	0.152	0.0038	0.182	0.0013
	— Na ₂ O.2½ SiO ₂ —		— Na ₂ O.3 SiO ₂ —			
	Silicate	NaOH	Silicate	NaOH		
0.33 molar.....	6.42	0.0056	7.34	0.0042		
0.10 molar.....	2.12	0.0034	2.42	0.0029		
0.05 molar.....	1.06	0.0024	1.21	0.0019		
0.01 molar.....	0.212	0.0011	0.242	0.0008		
	— Na ₂ O.3½ SiO ₂ —		— Na ₂ O.4 SiO ₂ —			
	Silicate	NaOH	Silicate	NaOH		
0.33 molar.....	8.245	0.0029	9.15	0.0024		
0.10 molar.....	2.72	0.0020	3.02	0.0015		
0.05 molar.....	1.36	0.0015	1.51	0.0014		
0.01 molar.....	0.272	0.0007	0.302	0.0007		

Silicate = grams of silicate of the given formula per 100 c.c. of solution.
NaOH = grams of NaOH per 100 c.c. of solution.
It will be noted that these figures are approximate percentages.

Here again the two-phase system has its effect. The hydrogen electrode probably measures the concentration of hydroxyl ions in the continuous phase. The rest of these ions are tied to the disperse phase in such a way that they cannot be considered as part of the "free alkali." As very little was known about colloids when the earlier experiments were performed, the possible effect of such structures was not considered. As Bogue has pointed out, the particles may help to carry the current¹⁵ and thus explain part of the discrepancy.

Other factors probably influence the degree of hydrolysis. In general, higher temperatures increase it. The treatment which the sodium silicate solution has received will also have an effect. If, for example, the solution is heated, then cooled, the amount of free alkali will be different than before the application of heat.

From the above discussion it is evident that the determination of free alkali is a different matter which depends on many factors. Although the hydrogen electrode is probably the best method, it is not satisfactory for all purposes, so there is no good general method. Any attempt to determine the free alkali should be carried out under as nearly the same conditions as those under which the sodium silicate is to be used. For example, if the solution is to be used for the manufacture of fiber board, the determination should be made on a sample of the solution at the average concentration and average temperature of the silicate tank on the combining machine.

To be successful, any method will of necessity take into account the factors discussed above.¹⁶

Note on the Properties of Antimonial Lead

BY LOUIS J. GUREVICH AND JANE S. HROMATKO

IN CONNECTION with the investigation of the physical characteristics of lead-plates of storage batteries, it became advisable to investigate the effects of small amounts of antimony on the physical properties of lead. The following physical properties were studied: 1, temperature of melting; 2, hardness; 3, tensile properties; 4, microstructure.

The melting temperature interval of antimony-lead alloys was investigated with a view to determine the possibility of substitution of the melting point test for the chemical analysis in the determination of the composition. A series of eight alloys the antimony content of which varied from 2.76 per cent to 10 per cent were made up. The melts were made on 20-g. samples in carbon crucibles so as to keep all other impurities out of the alloys. A precision potentiometer was used to obtain the necessary data for plotting the

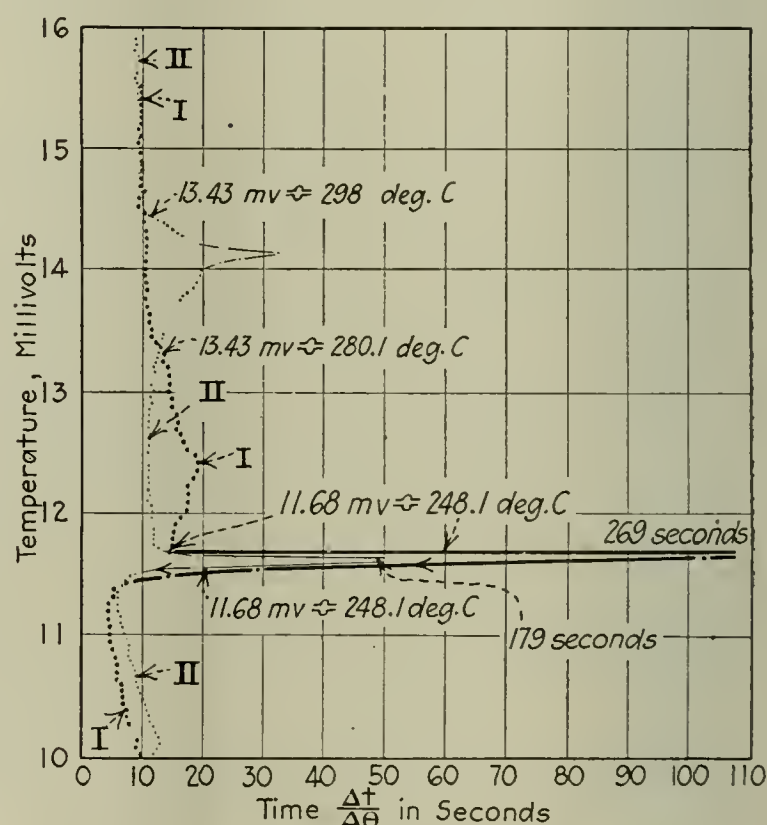


FIG. 1. INVERSE RATE COOLING CURVES.
I—ALLOY B. II—ALLOY F.

inverse rate cooling curves, as described in the authors' previous paper on "Tin Fusible Boiler-Plug Manufacture and Testing," published in the *Transactions A.I.M.E.*, vol. 152, p. 1351.

The cooling curves of the alloys indicate that no definite melting point occurs in these alloys; this can be seen from the results obtained for Table I. There is only retardation in the rate of cooling extending from the temperature of complete liquefaction, or the liquefaction point, of the alloy to the minimum or the temperature of the formation of the eutectic of the alloy. Fig. 2 shows that antimony lowers the melting point of lead to such an extent that the presence of 9.88 per cent of antimony lowers it from 327.4 to 262 deg. C. These data are similar to those obtained by previous investigators.¹ The temperature interval of melting as shown in curves I and II of Fig. 1 in the

¹³J. Am. Chem. Soc., vol. 42, p. 2575 (1920).

¹⁴Kohlrausch, Loomis and Kahlenberg and Lincoln, loc. cit.

¹⁵Based on the work of McBain and others; e.g., see McBain and Salmon, J. Am. Chem. Soc., vol. 42, p. 426 (1920).

¹⁶The development of a suitable analytical procedure of broad application now is receiving research attention at the Mellon Institute of Industrial Research.

¹"Some Notes on the Lead, Tin, Antimony Alloys," by W. Campbell and F. C. Elder, *School of Mines Quarterly*, vol. 32, p. 246. "Lead-Tin-Antimony and Tin-Antimony-Copper Alloys," by W. Campbell, *Proc., A.S.T.M.*, vol. 13, p. 630, 1913.

TABLE I. MELTING TEMPERATURE INTERVAL OF ANTIMONY-LEAD ALLOYS		
Alloy No.	Chemical Composition Per Cent Antimony	Melting Temperature Interval, Deg. C.
A	9.88	262 0-249 0 262 0-249 0 Av. 262 0-249 0
B	8.60	280 1-248.1 273 8-249 0 276 8-250 0 Av. 276 9-249 0
C	7.68	269 7-248 7 273 8-247 2 274 3-249 0 273 8-247 2 Av. 272 9-248 0
D	6.52	279 2-247 2 282.3-250 0 261 0-249 0 Av. 280.8-248.7
E	5.42	287 2-250 0 289 9-249 0 Av. 288.6-249.5
F	4.80	295 2-248 1 298.0-248.1 Av. 296.6-248.1
G	3.94	300.8-250 0 298 9-247 2 Av. 299.8-248.6
H	2.76	310.2-247 2 310.2-248.1 Av. 310.2-247.8
Reference Lead	0	327.4

place of definite critical points, indicates that approximate results only could be obtained in calculating the composition of the alloy from the temperature of incipient fusion of the inverse rate cooling curves, the construction of which takes a considerable length of time, as each must be checked by supplementary inverse rate cooling curves. The curves in Fig. 1 are plotted with the ordinates as temperature indicated by millivolts with a copper-constantan thermocouple and the abscissæ as the number of seconds necessary for the specimen to lower by an amount equivalent to 0.5 millivolt.

HARDNESS

The hardness of the alloys used for the melting-point determination was obtained on a small dead-weight Brinell hardness machine using a 5-mm. ball and a total pressure calculated to be 42.5 kg. Table II shows that there is a gradual increase in the hardness of the alloy as the percentage of antimony present increases.

TENSILE TESTS

For the determination of the tensile properties a series of alloys were prepared containing from 3 to

25 per cent antimony. These alloys were cast in an iron chill mold in form of 7/8-in. round bar, 11 in. long, from which two standard 0.505-in. diameter specimens were prepared. The tests were made on a 20,000-lb. Olsen tensile-testing machine operated at a very low rate of speed, the pulling head moving at the rate of about 0.078 in. per minute. The results of the tests given in Table II and Fig. 3 show that the presence

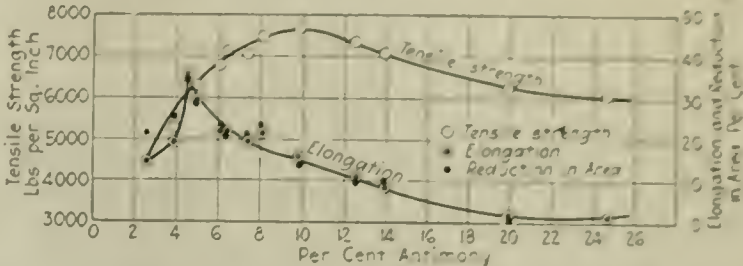


FIG. 3. TENSILE AND ELONGATION TESTS OF ALLOYS CONTAINING FROM 3 TO 25 PER CENT ANTIMONY

of antimony up to 10 per cent increases the tensile strength. Further addition of antimony decreases the tensile strength. The alloy containing 4.5 per cent antimony has the greatest amount of reduction of area, making it also the most ductile.

MICROSTRUCTURE

The second series of alloys, those used for tensile tests, were examined under the microscope after the specimens were properly prepared for the examination.

TABLE II. TENSILE PROPERTIES OF ANTIMONY-LEAD ALLOYS					
Alloy No.	Chemical Composition, Per Cent Sb	Tensile Strength, Lb. Per Sq. In.	Elongation in 2 In., Per Cent	Reduction in Area, Per Cent	Brinell Hardness
Reference Lead	0				3
3	2.6	4,490	15.0	21.6	5.8
H	2.76				5.8
4	3.9	5,270	19.0	25.0	5.8
G	3.94				5.8
5	4.5	6,200	35.5	34.5	6.2
F	4.8				6.2
6	5.0	6,290	28.5	27.3	6.3
E	5.42				6.3
7	6.1	8,750	21.8	23.3	6.5
D	6.4	7,100	21.8	20.8	6.5
8	6.52				6.5
9	7.4	7,050	19.3	21.0	7.0
C	7.68				7.0
10	8.1	7,455	21.5	22.1	7.2
B	8.6				7.2
A	9.88				7.3
11	9.9	7,675	15.5	13.6	
12	12.6	7,350	11.0	10.6	
13	14.0	7,025	8.8	9.3	
14	19.6	6,250	1.8	1.5	
15	24.7	6,065	1.3	0.4	

The results of the examination corroborate the results obtained by previous investigators. The microstructure was found to consist of a ground mass of eutectic with an excess of lead in the alloys numbered 3 to 11 inclusive of Table II. Alloy 12 showed traces of excess antimony, and the remaining alloys showed increased amounts of free antimony.

CONCLUSION

1. Melting point determinations are too indefinite to be used as a basis for calculating the composition of lead-antimony alloys.
2. The addition of antimony increases the hardness of the alloy.
3. The maximum tensile strength of the lead-antimony alloys is reached with an alloy containing 10 per cent antimony.
4. The alloy containing 4.5 per cent antimony gives the greatest reduction of area and is the most ductile.

"Metallurgy of Lead," by H. O. Hofman, p. 26.

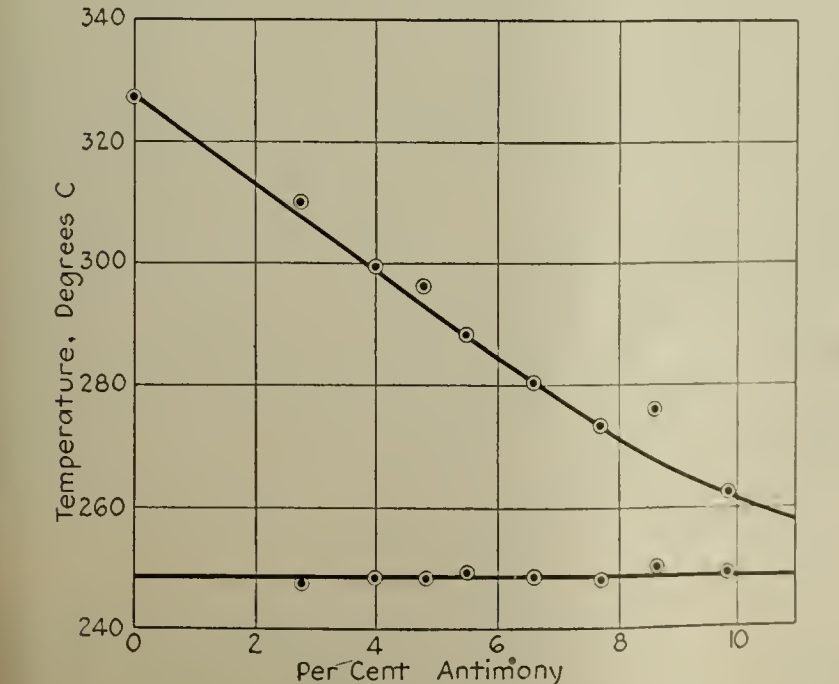


FIG. 2. EFFECT OF SMALL AMOUNTS OF ANTIMONY ON THE FREEZING POINT OF LEAD

More Miles Per Gallon*

A Discussion on Carburetion as Affecting Motor Efficiency, Brake Horsepower and Work—Spark Timing and Brake Load—Relation Between Torque and Engine Speed—Possibilities of More Efficient Utilization of Motor Fuels

By O. C. BERRY

SO MUCH has recently been said about the possibility of fuel shortage that most of us probably have the facts clearly in mind and have formed an opinion as to what we expect to see happen. Our viewpoints will differ, however, so that there will be nearly as many opinions as there are people present, but I feel sure we can all agree that the threatened fuel shortage will not take place this year nor next and that we can expect to experience at least the first effects of a real shortage within the next ten or fifteen years.

The past growth of the automobile industry would have been impossible had it not been for an abundant supply of cheap fuel. So rapid has been this growth that in a single generation we are consuming annually approximately four billion gallons of gasoline in the United States, and our Bureau of Petroleum Technology estimates that our known petroleum reserves are 40 per cent exhausted. We have not yet reached the point where we can expect a sharp increase in prices, however, as production is still able to keep pace with demand, and the price of any commodity tends to follow one of two standards:

When the raw material is plentiful and generally available, the price of the finished product will tend to be the cost of production plus a reasonable profit.

When the raw material is hopelessly inadequate, the price of the finished product will tend to rise until it represents all that the user is willing to pay rather than be utterly deprived of the product.

I feel safe in making the prediction that the production of gasoline in the United States will not be able to keep ahead of the demands of our growing automotive industry for as many as fifteen more years, so that the shift toward the utility value of gasoline as a measure of its price will be taking place in less than that time. We will soon see the time when any man who rides in an uneconomical car is not only paying too much for his ride and forcing up the price of fuel, but is also forcing some neighbor to stay at home for lack of the fuel he has wasted. In France at the present time gasoline is selling at \$1.90 per American gallon. What can we rich Americans expect to pay when our supply runs short?

POSTPONING THE INEVITABLE FUEL SHORTAGE

From present indications it would seem that a fuel shortage is inevitable, but there are many things we can do to postpone it and to lessen its ill effects when we are forced to face it.

We can hunt for new petroleum deposits, and thus increase our available supply of raw material.

We can learn how to cut down the present wastes in mining and storing petroleum.

We can learn how to produce more gasoline per barrel of petroleum used at the refineries.

We can learn how to make substitute fuels on a large scale and at a low price.

We can learn how to get more out of each gallon of fuel we use.

We must depend upon the mining engineer and the "wildcatter" to locate more oil deposits and upon the petroleum technologist and chemist to prevent wasting the oil during mining and storing operations. To the chemist we owe what we know about the methods of making our most effective substitutes for gasoline—benzene and alcohol—and to him we must look for our future help along these lines. The discovery of an economical method of producing shale oil or an efficient method of making alcohol from farm wastes would prove a great help. The latter would be almost a complete solution for our problem. We commend these problems to this great body of scientists.

It is my purpose not only to point out what the chemist can do to make it possible for the world to ride in automobiles, but to stimulate him to action by pointing out what the automotive engineer has done and is doing. You will be interested to know that it is possible to nearly double the miles per gallon of the American automobile. In a recent economy test in France a Voisin limousine weighing 5,300 lb. went 28.3 miles per American gallon. A Citroen car weighing 2,500 lb. went 53 miles per gallon and a 1,200-lb. Peugeot went 76.9 miles.

Contrast these figures with the performance of the average American car and you will see that our room for improvement is indeed great. Probably there is no one feature of our cars that has received less of the careful attention of our engineers in the past than has their capacity for economical running. There are no features incorporated in foreign cars for fuel economy that we do not know about and understand and I do not concede for a moment that the foreign engineer is one whit more resourceful or well-informed than the American. It is therefore up to us to look the situation squarely in the face, and recognizing the importance of fuel economy, to make a careful study of all of the factors influencing miles per gallon and to see to it that every possible improvement is incorporated in the design of our future models. With these facts in mind, I have set about making such a study and am pleased to be able to present some of the information I have got together.

CARBURETION

One of the outstanding reasons for the poor mileage of the average American car is poor carburetion, or more accurately poor carburetor adjustment. In order to make this clear it will be necessary to show

*Paper read at the Automotive Symposium, American Institute of Chemical Engineers, Detroit, Mich., June 23, 1921.

the effect of the richness of the fuel mixture on the power and economy of an engine. In studying this point, use was made of a Willys-Knight engine mounted on an electric dynamometer. The results of these tests are shown by the curves in Fig. 1. In these curves the pounds of gasoline per pound of dry air in the fuel mixture is plotted horizontally and brake horsepower and per cent thermal efficiency vertically. In carrying out these tests the throttle was arranged so that it could be securely fastened, and all of the tests were run at a constant engine speed. The gasoline was weighed to the one-hundredth part of an ounce, the air metered to the tenth part of a cubic foot, and the brake-load, speed, temperatures, etc., were carefully measured. Under these conditions and with the carburetor adjusted to give a rich and powerful mixture, the first test was run. The power, efficiency and mixture ratio were then computed and a point established on both the power and efficiency curves. The gasoline adjustment was then made slightly leaner, the brake-load adjusted to produce the correct speed and a second test was run. This procedure was repeated until the mixture became too lean to allow proper engine performance. More gasoline was then introduced each time until the mixture was entirely too rich. The mixture was

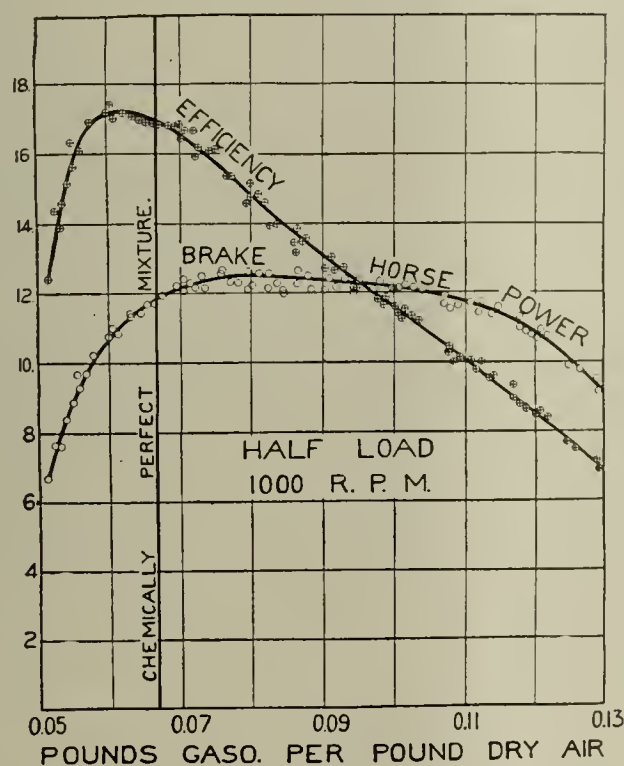


FIG. 1. EFFICIENCY AND BRAKE HORSEPOWER CURVES

thus made alternately richer and leaner until a sufficient number of points had been located on each curve to indicate quite clearly the effect of the richness of the fuel to air mixture on both the power and the efficiency of the engine.

It will be noted that there is a wide range of mixtures through which the richness has but little effect on the power of the engine. The lean and the rich mixture give equally good power and both result in what seems to be perfect engine performance. This accounts for the fact that the comparatively crude carburetors of earlier days gave quite satisfactory performance.

The range of mixtures giving the highest efficiency is very narrow, and corresponds to about the leanest mixture with which the engine will run without missing. As more gasoline is added the efficiency drops off very rapidly, so that the richest mixture producing full power will result in only about half maximum

efficiency. This explains why it is that of two cars of the same make and both performing nicely, one may go nearly twice as many miles per gallon as the other.

WHY OVER-RICH MIXTURES ARE USED

There are several reasons why so nearly all of our carburetors are adjusted so as to give too rich a mixture when the engine is hot.

Gasoline flows much more slowly when cold than when warm, so that an opening large enough to deliver the required charge to a cold engine will inevitably deliver too much when the engine is warmed up.

Cold air is denser than warm air, so that the weight of air delivered through the air opening in a carburetor will be greater when the air is cold than when it is warm, thus causing the mixture to become richer as the temperature of the engine increases.

For these reasons the mixture furnished by a carburetor with a fixed adjustment will become richer as the temperature rises. To make matters worse, not nearly all of the gasoline in a cold mixture is vaporized so that it can be burned. This makes it necessary to supply a considerable excess of fuel in a cold mixture to get the engine to run at all.

The American public has been taught to demand a car that will start easily in any kind of weather and continue to run without requiring any attention or adjusting. They have been supplied with a large variety of non-adjustable, or what has aptly been termed "foolproof" carburetors. These carburetors will deliver a mixture rich enough to start well in cold weather, and due to the great range of the explodable mixtures of gasoline and air, will keep the engine running with full power and seemingly perfectly in summer or in winter. The only fault to be found is that when the engine is hot the mixture is often 50 to 75 per cent richer than necessary and the miles per gallon are correspondingly low. A non-adjustable carburetor cannot be made so that it will make starting easy and also give high efficiency in driving.

DASH ADJUSTMENTS

A carburetor adjusted for maximum economy on a hot engine will be too lean to start when cold. There are two ways in common use for meeting this situation.

A choke may be supplied that can close off the main supply of air to the carburetor, thus enriching the mixture.

A means of adjusting the carburetor may be connected up to the dash or the steering post of the car.

The action of the choke is very severe. It causes raw gasoline to be sucked into the engine in large quantities. Its action becomes increasingly severe as the engine speeds up, so that if the mixture is rich enough to start the engine it will be much too rich after considerable speed has been obtained.

The dash adjustment may be made very satisfactory in its action if correctly used, and quite convenient as well. Its use is easily understood, as the idea is to get it set as lean as possible, and it is very easy to tell when it is too lean, as the engine will lose power and fire back through the carburetor. A proper dash adjustment set right for one speed and load will be correct at all speeds and loads at the same temperature, and will need to be changed only as the

temperature changes. The mixture should be just right for a hot engine with the dash adjustment set at its leanest position.

DISCUSSION OF CURVES

The curves in Fig. 1 show that a richer mixture is required for maximum power than for maximum efficiency. It is therefore obvious that a carburetor adjusted for maximum "miles per gallon" will be too lean to give the full power of the engine. This difficulty can be got around in this way: When driving on a level road at any speed that the law allows the engine is never called upon to deliver nearly its full power. Under these conditions the most important consideration is economy. When a steep hill is to be climbed, acceleration is desired or a neighbor wants to race, full power is the important thing. The constant speed driving is done with the throttle pretty well closed and the power work with the throttle wide open. It is possible to design a carburetor that will furnish the engine with the most economical mixture at all ordinary speeds on a hard, level road, and with the most powerful mixture when the throttle is wide open.

The fuel is almost never entirely vaporized in the intake manifold of the engine. A considerable portion flows along the manifold walls as a liquid, and lags behind the air that passed through the carburetor with it. When the engine is idling this layer of liquid is very thin, but under full load it usually forms quite a large stream. When the engine is put under load quickly, the air rushes ahead, leaving at least a portion of liquid on the manifold walls. If the mixture is lean enough to be efficient under steady running conditions, this temporary impoverishment will often be sufficient to stall the engine. It is therefore necessary to incorporate into the design of the carburetor some special means of temporarily enriching the mixture during acceleration. There are many types of construction in use, some of which are very satisfactory. It is therefore possible to get perfect acceleration even when using a mixture lean enough for maximum efficiency. The more perfect the manifold design the easier this becomes, and with the very best manifolds very little special provision is necessary for acceleration.

THE IDEAL CARBURETOR

In my estimation the highest type of carburetor yet developed for our American gasoline will meet the following requirements:

It will furnish the engine with the most efficient mixture when the car is driven at a constant speed on a hard, level road.

It will furnish the engine with the most powerful mixture when the throttle is wide open.

It will make perfect acceleration possible, even when adjusted for maximum economy.

It will have a dash adjustment that will make starting and warming up an easy matter, even in the coldest weather.

There are carburetors on the market meeting all of these requirements. They make much better "miles per gallon" possible, as well as being more satisfactory to handle than the cruder "foolproof" varieties.

THE TIMING OF THE SPARK

The second factor influencing the economy of the automobile is the timing of the spark. If the spark

passes too early it will lessen the power of the engine and tend to produce what is called a "spark" knock. If it passes too late it will also reduce the power of the engine. The proper timing of the spark in any given engine will vary with two things—the load the engine is carrying and the speed at which it is running. The latter fact is pretty generally understood, and nearly everybody knows that the faster an engine runs the earlier the spark must pass to give best results. The former fact has received comparatively little attention and will therefore be enlarged upon at this time.

In making a study of this point an engine was mounted on an electric dynamometer in such a way that the exact time of the passing of the spark could

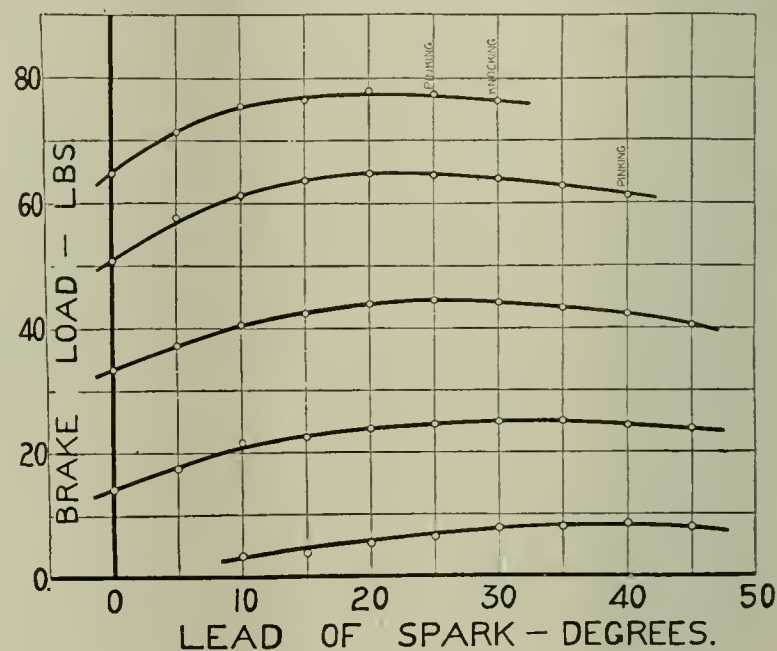


FIG. 2. DEGREES ADVANCE OF SPARK OVER FLYWHEEL AND BRAKE-LOAD

be read, as well as the speed of the engine and the brake-load carried. The engine was run at a series of different spark settings at each of a series of different throttle openings. The results of these tests are shown in Fig. 2. In these curves the lead of the spark in degrees on the flywheel is plotted horizontally, and the brake-load carried is plotted vertically. All of the tests were made at 1,000 r.p.m. Each curve was made at a constant throttle opening, the brake-load being changed along with the spark timing to keep the speed constant.

It will be noted that a lead of 20 degrees is required for maximum power at full throttle, and a lead of 25 degrees will result in a knock. As the throttle is gradually closed the lead required for highest power is gradually increased until with the lightest load carried, a lead of 40 degrees is required. At this throttle opening the engine will carry only 60 per cent as much load with a 20 degree spark lead as it does with a 40. It is so disagreeable to have an engine knocking during acceleration and hill climbing that the spark is almost never advanced beyond the point where knocking occurs at full load. Since the engines in our American cars run at such a low per cent of their power capacity, the spark is timed much later than it should be for greatest economy, resulting in a considerable loss in miles per gallon.

The vacuum in the intake manifold of an engine varies in almost inverse ratio with the brake-load carried. It therefore follows that the lead required by the spark at a light load beyond that required at full load will vary directly with the intake manifold vacuum. This fact has been made use of in produc-

ing an automatic device for changing the time of the spark to correspond to the load carried. This device, when properly installed together with a standard controller compensating for speed, provides a completely automatic means of timing the spark that is very accurate. This device is not on the market at the present time, but I have personally conducted a series of tests showing its merit, and feel confident that it will be perfected and presented to the public in the near future. When properly installed it should add considerably to the economy obtained by the average driver.

THE LOAD ON THE ENGINE

Another opportunity to improve the economy of our automobiles has to do with the large reserve power in the engines. A good American car can climb a steep hill in high gear, and accelerate very rapidly.

This delightful "activity" necessarily means that under ordinary driving conditions on a hard, level road the engine is called upon to exert a very small per cent of its full torque capacity. In order to get accurate information on this point, a car was chosen of a make known to be carefully designed, well built and a good average accelerating ability, about 3.2 ft. per sec. per sec., and tests were made showing the torque capacity of the engine and the power required to propel the car at varying speeds. The results of these tests may be taken as representing the average performance of good American cars.

The method of conducting the tests was to insert between the carburetor and intake manifold a plate having a hole drilled through it that would serve as a throttle opening. A determination was then made of the maximum speed the car could attain on a long stretch of hard, level road with this orifice in place. This test was repeated with a number of orifices of different sizes. With the engine removed from the

at that speed with that orifice, as shown by the dynamometer tests. The results of these tests are shown in Fig. 3. In these curves the engine speed is plotted horizontally and the brake-load is at a radius of 15.1 inches vertically. The upper curve shows the torque capacity of the engine and the lower the torque measured at the flywheel of the engine that is required to propel the car at corresponding speeds. The distance between the upper and lower curves is therefore proportional to the reserve power of the engine and represents its ability to accelerate rapidly or climb a steep hill.

In this particular car an engine speed of 1,000 r.p.m. corresponds to twenty miles per hour. It will be noted that at this speed only about 14.7 per cent of the torque capacity of the engine is used when driving on a good road. Any one familiar with the performance characteristics of an engine knows that this fact alone will account for a large reduction in the thermal efficiency obtainable from the engine under ordinary driving conditions. This is such an important consideration that a special series of tests was carried out to show the exact situation.

EFFICIENCY AT DIFFERENT LOADS

It is well known that the brake thermal efficiency of an engine varies from zero at no load to a maximum which occurs at a little less than full load. Engines differ in their ability to perform under different conditions, according to their design, some doing comparatively better at light loads and others at full load. Tests were therefore carried out on the engine previously used, to determine the effect on its thermal efficiency of changing the load.

The engine was installed on the dynamometer and run at 1,000 r.p.m. and at a series of different throttle openings. At each throttle opening a series of tests was run at different carburetor settings, similar to the tests plotted in Fig. 1, and showing the mixture corresponding to highest efficiency at that throttle, together with the corresponding power and efficiency. The brake-load was expressed in terms of brake mean effective pressure, and a curve was drawn through the points showing the highest efficiency at each load. This curve is shown in Fig. 4, and indicates the maximum efficiency obtainable with this engine at each brake-load, the engine running at 1,000 r.p.m. The efficiencies will vary as the speed is changed, so that this curve should be interpreted as applying only to the one speed.

The carburetor was adjusted lean enough to give maximum economy at all loads until the throttle was wide open. After this point was reached the increases in power had to be obtained by enriching the mixture, until the full power was obtained. These richer mixtures result in reduced economy, thus causing the curve in Fig. 4 to show a decided drop as full power is approached. This curve therefore offers one more illustration of the importance of using lean mixtures when high economy is desired.

Fig. 4 shows how important it is to run the engine under a comparatively large per cent of its full load capacity. Since the miles per gallon of any car under given running conditions will vary directly with the thermal efficiency of the engine, a change in the load factor on the engine can result in greatly increased economy. This fact was checked in part by installing a different rear axle ratio and noting the

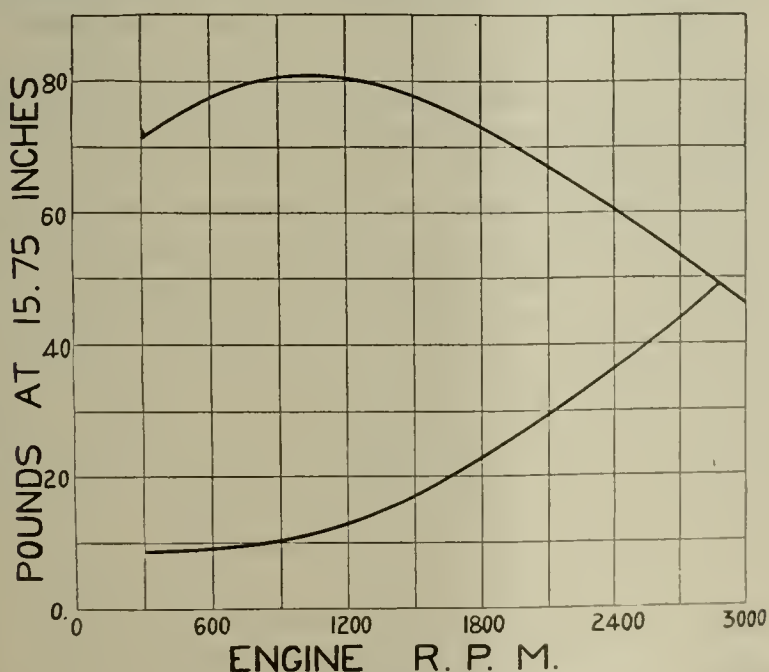


FIG. 3. RELATION BETWEEN TORQUE AND SPEED OF ENGINE

car and connected to an electric dynamometer, tests were run to determine the torque capacity of the engine at varying speeds with each of the orifices in place. Knowing the size of the rear wheels and the gear ratio, the engine speed corresponding to any car speed is accurately known. The torque required to drive the car at any one of these maximum speeds for a given orifice is the torque capacity of the engine

change in the car economy. The standard ratio was $4\frac{1}{2}$ to 1, and resulted in a load factor of 14.7 per cent at a speed of twenty miles per hour. Under these conditions the car could go 28 miles per gallon when loaded so as to weigh 3,100 lb. A gear ratio of $2\frac{1}{2}$ to 1 would result in nearly twice the former load factor, and Fig. 4 shows that this should result in

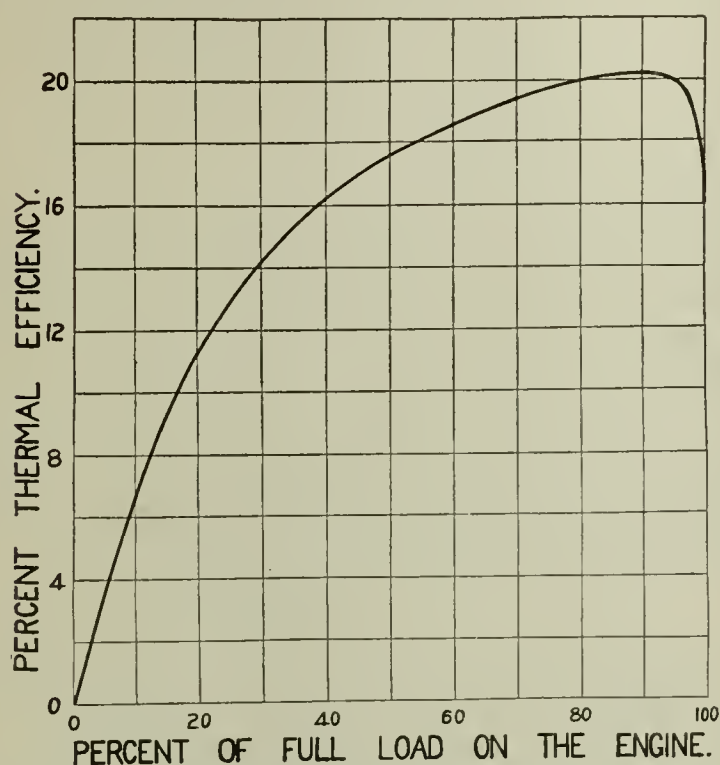


FIG. 4. EFFICIENCY OBTAINABLE AT EACH BRAKE-LOAD

an increase of about 50 per cent, or 42 miles per gallon. Under test the car actually ran 43 miles per gallon. These tests were all made with a carburetor equipped so as to make starting easy in cold weather, through the use of a dash adjustment.

ADVANTAGES AND DISADVANTAGES OF AN ADDITIONAL GEAR SPEED

Efficiency and a great ability to accelerate cannot be obtained at the same gear ratio. The former requires that the engine run at a high per cent of its torque capacity and the latter requires the other extreme. We cannot afford to compromise the delightful activity of our cars. On the other hand I feel confident that the first company to produce a car with the activity we are used to and which is also capable of going more miles per gallon than any other car of its weight in the country will become both rich and famous. We can accomplish this if we have four speeds forward. Third speed could be called the "power" or "speed" gear and the fourth the "economy" gear. Such an arrangement would be a benefit in the following ways:

It would greatly increase the miles per gallon.

It would reduce the engine vibration at the common touring speeds.

It would increase the speed at which one could tour with comfort and satisfaction on good roads.

It would enable one to tour at high speeds with the mental satisfaction that would result from knowing that one is not punishing the engine, while any other car at the same speed would be going entirely too fast for its own good.

It would greatly reduce the wear on the engine, thus prolonging its life and reducing maintenance costs.

The disadvantages are the following:

The four-speed transmission would be expensive when sufficiently well made to be quiet on two gears.

The gears would have to be shifted more often.

The possible advantages are therefore fundamental and far-reaching, and the disadvantages are of a practical nature, and though difficult, still I do not feel that they will be beyond our engineers when they really get interested in mastering them.

Our knowledge of how to increase car economy is not yet complete. There are factors influencing miles per gallon that are not mentioned here. This paper is merely a progress report presented at an early stage. I feel, however, that it has gone far enough to demonstrate the value of the study and warrant a conviction that American engineers can be depended upon to produce cars in the future showing economies that would now seem almost impossible.

In conclusion allow me to repeat that a fuel shortage in the near future is inevitable, but that its ill effects can be greatly lessened by taking the right steps at the present time. By lessening wastes in mining and storing petroleum, by perfecting the processes of making gasoline and especially by developing ways of producing substitute fuels economically and in large quantities, the chemists of the country can help make it possible for future generations to ride in automobiles. In the meantime the engineers will be steadily increasing the economy of our cars and thus adding greatly to the value of each gallon of available fuel.

Legal Notes

BY WELLINGTON GUSTIN

Company Held Not Responsible for Injury to Employee by Explosion in Gas Pipe Line

A question of negligence is decided in favor of the employer by the Supreme Court of Appeals of West Virginia in the case of Miller vs. the United Fuel Gas Co., reversing the trial court. (106 S. E., 421.)

Miller charged negligence on the part of the company in failing to keep its pipe line in a reasonably safe condition and state of repair and in permitting too great a volume of gas to remain in the pipe at high pressure; and in failing to lay a line sufficiently strong to carry with reasonable safety the volume of gas transported through it. Miller was injured by an explosion of gas in the pipe line while working about the pipe, and he brought an action for damage.

In its holdings the Court of Appeals says there was no evidence that the pipe line was improperly constructed or maintained. On the other hand, the company had constructed it only six months before the accident, and in its construction had used none but new material, obtained from La Belle Iron Works of Toledo, Ohio, the manufacturer, whose test showed a resistance sufficient to withstand a pressure of 1,500 lb. for each square inch of surface. The superintendent in charge of the work testified to its proper construction. The explosion did not occur at a coupling, but in the pipe itself, near a point where it was bent to conform to the curve of an embankment over which it ran. There was nothing to show that the pipe was improperly strained in bending or that the work was

done carelessly or negligently, but evidence to the contrary was brought out.

Failure to shut off the gas pending the search for the leak does not alone constitute negligence, because the usual way to locate a leak in one of several pipes forming part of a pipe line system is by means of the escaping gas. Though tested to withstand a pressure of 1,500 lb., the line on the day of the accident did not carry more than 350 lb.

The court said that under these facts, with the absence of any knowledge on the company's part of a fatal defect likely to cause such an accident and the failure on the part of the claimant to show by proof that it was due to some negligent act or omission to act on the part of the defendant, there is nothing to support a finding of liability against the company. The claimant was engaged on a dangerous work and well knew the risk and hazard attending it; therefore, before he can recover for the injury he must show actionable negligence on the part of the company.

When the employer has exercised reasonable care and diligence in providing a reasonably safe place within which his employees may perform the work assigned to them, he has fulfilled his duty to them in that regard. (99 S. E., 75.)

Only Attempt to Sell Goods as Another's Is Unfair Competition

A question of unfair competition in marketing one's product came up in the case of the Upjohn Co. vs. The William S. Merrell Chemical Co., a decree for the defendant being affirmed in the United States Circuit Court of Appeals, 269 Fed., 209.

It appears that plaintiff had marketed its product by extensive advertising and selling throughout the United States in 1908, when defendant's salesmen found the product on the market and sent in to the house samples of plaintiff's article. Defendant thereupon decided to make the same thing in the same form, with the expectation that it would thereby be able to fill with something "equally as good" a part of the demand which the plaintiff company was creating. To this end defendant put up an article which was indistinguishable from plaintiff's, but it did not use the latter's trade name or mark, and put the product up in bottles or packages bearing its own name as manufacturer.

It was not claimed that in the bottles or cartons, or anything except in the product itself, was there fraudulent imitation or unfair competition. Nor was it denied that defendant had, inherently and originally, the same right plaintiff had to select from the common stock this particular size, shape and color for its product.

WHEN IMITATION IS UNFAIR COMPETITION

The court said it was well settled by decisions of the U. S. Supreme Court that a plaintiff is entitled to relief against unfair competition only where defendant attempts to palm off on the purchasing public his goods as the goods of the plaintiff; that where the imitation relates only to matters as to which the defendant has, *prima facie*, a right equal to plaintiff, there must have been a public acquiescence in plaintiff's appropriation of these things for his product—whereby they have become indicia of origin, to make the imitation unfair competition.

That while, when the plaintiff has selected as his means of identification words or marks that are arbi-

trary and hence proper trade marks, his title is at least initiated by the appropriation; yet as to those means of identification which are descriptive or which for any reason are known and open to all there is no basis in principle or authority for the creating of a title of quasi-exclusive right in plaintiff, except the theory that there has been this public sanction of plaintiff's appropriation, by acquiescence which has continued long enough and under circumstances suitable to raise a presumption that the public concedes the right and to make it inequitable and unfair thereafter to dispute it.

The court said there were plenty of other sizes, shapes and colors than plaintiff's which defendant might have adopted; it must have copied plaintiff's complete combination because it expected to get commercial benefit from the copying. But this is not enough, says the court; to be condemned it must have expected to practice a fraud or contribute to the practicing of it.

The situation must be judged as it existed when defendant introduced his copy of the product, and the fact that plaintiff's product, whose appearance and composition were alike open to everybody, had been in the hands of distributors for a few months does not establish a sanction by the consuming public of plaintiff's appropriation of that composition and appearance for its own use and product sufficient to prevent its subsequent appropriation by the defendant.

Many cases were cited supporting the claim of unfair competition, and the court granted that each case depends so absolutely upon its own circumstances that a controlling precedent is not to be expected. Each of the cited cases upon which plaintiff specifically relies depends upon the finding that the consuming public had come to regard the trade dress as indicating that the thing was the article which it was in the habit of buying and wanted to get.

REASONING BY THE COURT

Further the court says: "Perhaps the result which we reach in this case, rested as it is upon the fact that defendant copied the product and began its competition before there was time for plaintiff to get the indicative effect of its trade dress sufficiently established, is most severely tested by saying that this would make the diligent thief immune, while the one who might hesitate and delay must give up his plunder. The answer is that there can be no larceny unless the title or possessory right of the first holder is better than that of the second taker"—and that in this case, until the general public belief among users that any product of this appearance was plaintiff's product connected with its trade name had come into existence, plaintiff's title to this combination of characteristics was no better than defendant's.

To establish unfair competition by copying the appearance of plaintiff's product, it is necessary that the appearance has received such sanction as to identify the article sold under plaintiff's trade mark or name.

As to the injustice in a state of the law which denies protection to a plaintiff who has expended \$30,000 and more in introducing to the public his peculiar form of product, the court points out that in this case the expense indivisibly inured to the advantage of the trade mark; and in any case it says it may be a lesser evil that plaintiff must fail of full protection than that free choice of common form should be denied to competitors. No unfair competition was found.

Definitions of Physical Terms

BUREAU OF STANDARDS Circular 100, on "Nickel," (published in large part serially in *CHEMICAL & METALLURGICAL ENGINEERING*, beginning Jan. 5, 1921) contains the following definitions of physical constants. These have often been determined for various metals and alloys:

Absorption Index.—When monochromatic light traverses a distance equal to its own wave length, λ , in a material, is the ratio of the amplitude of the emergent light J'_λ to that of the entering light J_λ .

$$\frac{J'_\lambda}{J_\lambda} = e^{-2\pi\kappa}$$

when κ is the absorption index.

(A variety of usage prevails regarding the definition of this term. This definition is used in the Smithsonian physical tables.)

Density.—The density of a substance is the mass per unit volume. It is usually expressed in terms of grams per cubic centimeter.

Electrical Conductivity and Resistivity (χ , ρ).—There are two methods of expressing electrical resistivity in common use, each being defined quantitatively in terms of the resistance of a unit specimen. The volume resistivity is ρ in the equation

$$R = \frac{\rho l}{s}$$

in which R = resistance, l = length, and s = cross-section. The volume resistivity thus defined may be expressed in various units, such as microhm-cm. (microhm per centimeter cube), ohms per foot of a uniform wire 1 mil in diameter, etc. The commonly used units, in abbreviated terminology, are: Microhm-cm., microhm-inch, ohm (meter, mm.), ohm (meter, sq.mm.), ohm (mil, foot).

The other kind of resistivity is mass resistivity, and is defined as δ in the equation

$$R = \frac{\delta l^2}{m}$$

in which m = mass of the wire. The usual units of mass resistivity are: ohm (meter, gram), and ohm (mile, pound).

Per Cent Conductivity.—The term "conductivity" means the reciprocal of resistivity, but it is used very little in wire calculations. In connection with copper, however, extensive use is made of the per cent conductivity, which is calculated in practice by dividing the resistivity of the international annealed copper standard at 20 deg. C. by the resistivity of the sample at 20 deg. C.

Temperature Coefficient of Resistance.—The temperature coefficient of electrical resistance is the fractional change of resistance per degree change of temperature. Its value varies with the temperature, and hence the temperature from which the resistance change is measured must always be stated or understood. For a temperature t_1 , the temperature coefficient α_1 is defined, for a metal like copper, by

$$R_t = R_{t_1} [1 + \alpha_1 (t - t_1)],$$

in which R_{t_1} = resistance at the temperature t_1 and R_t = resistance at any other temperature t . The temperature coefficient that is usually used at 20 deg., for example, is

$$\alpha_{20} = \frac{R_t - R_{20}}{R_{20}(t - 20)}$$

Boiling Point.—The boiling point of a liquid is the

temperature at which it boils under atmospheric pressure, or better the temperature at which its vapor pressure is equal to the external pressure.

Brinell Test.—An indentation is made, by pressure, on a polished surface of the material, using a hardened steel ball. There are several ways of expressing the hardness:

The commonest definition of the Brinell hardness is the pressure in kilograms per unit area (square millimeters) of the spherical indentation. (Hardness numeral = H. N.)

$$H. N. = \frac{\text{Pressure}}{\text{area of spherical indentation}} = \frac{P}{t\pi D}$$

$$\text{where } t = \frac{D}{2} - \sqrt{\frac{D^2}{4} - \frac{d^2}{4}}$$

P = pressure used;

t = depth of indentation;

D = diameter of sphere;

d = diameter of indentation.

Electrolytic Solution Potential (E).—At the junction of a metal and any conducting liquid there is developed a solution potential, which is a measure of the free-energy change of the chemical reaction which is possible at the surface of the metal and liquid. In particular if the chemical reaction consists in the solution of the metal, forming ions, the e.m.f. is

$$E = \frac{RT}{nF} \ln \frac{P}{p}$$

where R = the gas constant;

T = absolute temperature;

n = valence of metal;

F = 96,500 coulombs, the Faraday constant;

P = solution pressure of metal;

p = osmotic pressure of metal ion formed in solution.

In any electrolytic cell the sum or difference of two such potentials is measured, one of which may be a standard electrode; for example, the hydrogen or the calomel electrode. The e.m.f. of an electrolytic cell of the following type: Normal hydrogen electrode—solution—metal is often called the single e.m.f. (e_h) for the metal in the solution; that is, arbitrarily assuming the e.m.f. of the normal hydrogen electrode to be zero.

Emissivity (E or E_λ).—The coefficient of emissivity

E for any material represents the ratio $\frac{J'_\lambda}{J_\lambda}$ of the intensity, J'_λ , of radiation of some particular wave length or color, λ , emitted by the material at an absolute temperature T to that J , emitted by a black body radiator at the same temperature.

The coefficient of total emissivity E for any material represents that ratio $\frac{J_1}{J}$ of the intensity of radiation of all wave lengths, J_1 , emitted by the material at an absolute temperature, T , to that, J , emitted by a black body radiator at the same temperature.

This coefficient is always less than 1, and for metals is equal to 1 minus the reflection coefficient for normal incidence (Kirchhoff's law).

For any optical pyrometer using monochromatic light a value of the observed or "black body" temperature of any substance (not inclosed) is reduced to the true temperature by the following formula:

$$\frac{1}{T} - \frac{1}{T_0} = \frac{\lambda \log E_\lambda}{6232}$$

where T = true absolute temperature;

T_o = observed absolute temperature;

λ = wave length in microhm (0.001 mm.);

$E\lambda$ = relative emissivity of substance for wave length.

Erichsen Test.—This test is carried out to determine the ductility of sheets. An indentation is made in the sheet with a die with hemispherical end. The greatest depth of indentation which can be made without incipient cracking of the sheet, measured in inches or millimeters, is known as the Erichsen value for the sheet.

Heat of Fusion.—The heat of fusion of a substance is the quantity of heat absorbed in the transformation of unit mass (1 g.) of the solid substance to the liquid state at the same temperature.

Magnetic Properties.—The usual magnetic characteristics of a substance are given either by the permeability, μ , or the susceptibility, κ . Permeability is the ratio of the magnetic induction (B in gauss per square centimeter) to the magnetizing force (H in gauss per square centimeter). This is indicated by the relation

$$\kappa = \frac{B}{H}$$

Susceptibility is given, in corresponding units, by

$$\kappa = \frac{\mu - 1}{4\pi}$$

For all materials except iron and a few other ferromagnetic metals μ is very nearly unity and κ is only a few millionths. When κ is positive in sign the substance is paramagnetic, when negative diamagnetic. The susceptibility as thus defined is sometimes called volume susceptibility and indicated by κ_v . A quantity called mass susceptibility is also used, and is equal to the volume susceptibility divided by the density of the material; it is represented by κ_m .

Melting Point.—The melting or fusing point of a substance is the temperature at which it fuses (under atmospheric pressure), or more accurately the temperature at which the solid and the liquid metal are in equilibrium with each other.

Peltier Effect (π).—When at the junction of two metals current flows from one to the other, heat is in general absorbed or liberated (see "thermoelectromotive force" below); the coefficient, the amount of heat liberated when a unit quantity of electricity flows across the junction, is known as π (measured either in calories per coulomb or in volts), the Peltier effect.

Refractive Index.—The ratio of the velocity of light in vacuum to that in any material is called the refractive index (n) of that material. (This physical quantity ceases to have a meaning at or near an absorption band in the material.)

Scleroscope Test (Shore).—A hardened hammer falls from a constant height onto a polished surface of the material, and the distance of rebound is measured on a scale 10 in. long, divided into 140 equal parts. The scleroscope hardness is expressed as the distance of rebound on this arbitrary scale, the value 100 representing the hardness on this scale of hardened steel.

Specific Heat.—(σ).—The true specific heat of a substance is $\frac{du}{dt}$ when u is the total internal heat or energy of unit mass of the substance. The mean specific heat is defined as $\frac{q}{t_1 - t_2}$ per unit mass when q is the quantity

of heat absorbed during a temperature change from t_1 to t_2 . It is generally considered as the quantity of heat (calories) required to raise the temperature of unit mass (grams) by unity (degrees centigrade), either at constant volume or at constant pressure. Unless otherwise noted the specific heat of solids refers to that at constant (atmospheric) pressure. The true specific heat (constant pressure) of metals may usually be expressed sufficiently by an equation of the type

$$\sigma = A + Bt + Ct^2 + \dots$$

Tensile Test.—The quantities determined in the tension test are the following:

The *ultimate tensile strength* is the maximum load per unit area of original cross-section borne by the material.

The *yield point* is the load per unit of original cross-section at which a marked increase in the deformation of the specimen occurs without increase of load.

The *elastic limit* is the greatest load per unit of original cross-section which does not produce a permanent set.

The *proportional limit* is the load per unit of original cross-section at which the deformations cease to be directly proportional to the loads.

The *percentage elongation* is the ratio of the increase of length at rupture between arbitrary points on the specimens to this original length.

The *percentage reduction of area* is the ratio of the decrease of cross-section at the "neck" or most reduced section at rupture to the original section.

Thermal Conductivity (λ).—The coefficient of thermal conductivity (λ) expresses the quantity of heat (small calories) which flows in unit time (seconds) across a unit cube (centimeter) of the material whose opposite faces differ in temperature by unity (1 deg. C.). Its *temperature coefficient* is expressed as

$$\alpha_{t_o} = \frac{\lambda_t - \lambda_{t_o}}{\lambda_{t_o} (t - t_o)}$$

Thermal Expansion.—If l_t is any linear dimension of a solid at any temperature $\frac{dl}{ldt}$ is the linear coefficient of thermal expansivity of that solid in the direction of l . It is not in general proportional to the temperature except approximately over small temperature intervals, but may be expressed in the following manner:

$$\frac{dl}{ldt} = a + bt + ct^2 \dots$$

For small temperature intervals a mean coefficient (α) is often determined; that is,

$$\alpha_{t_o} = \frac{l_t - l_{t_o}}{l_{t_o} (t - t_o)}$$

Thermoelectromotive Force (E).—In an electric circuit composed of two dissimilar conductors, the two junctions being at different temperatures, there exists in general an electromotive force, called the thermoelectromotive force, between the two metals, the value of which is a function both of the temperature and the difference of temperature between the two junctions. It is shown thermodynamically that this e.m.f. is related to the Thomson and Peltier effects in the following manner:

$$\pi = \frac{T dE}{J dt} \quad \text{and is expressed in calories per coulomb when}$$

$$\sigma_1 - \sigma_2 = - \frac{T d^2 E}{J dt^2} \quad J = \frac{418 \text{ dynes} \times 10^6}{\text{calories}}$$

when E is the thermal e.m.f., T the absolute temperature, $\frac{dE}{dt}$ the thermoelectric power (see below), and $\sigma_1 - \sigma_2$ the difference in the Thomson effect of two materials. The form of the function $E = f(T)$ is not known. In general the equation $\frac{dE}{dt} = A + BT$ satisfactorily fits the experimental data over a limited range of temperature of a few hundred degrees.

Thermoelectric Power.—If E is the thermoelectromotive force of any two dissimilar metals, $\frac{dE}{dt} =$ the thermoelectric power; it is at any temperature therefore approximately the thermal e.m.f. of a couple of which the temperatures of the two junctions differ by 1 deg. C.

The Thomson Effect.—When a current flows in a conductor from a point at one temperature to one at another, heat is in general liberated, or absorbed, and an e.m.f. or counter e.m.f. is produced. The coefficient of the Thomson effect is the amount of heat liberated or absorbed when unit quantity of electricity flows from a point at temperature t to one at a temperature $t + dt$, and is equal to σdt calories per coulomb where σ is the so-called Thomson specific heat of electricity. It is called positive for any material when heat is generated in that material as a current flows from a region of higher to one of lower temperature.

The Oxidation of Carbon Tool Steel on Heating in Air

BY HOWARD SCOTT

Instructor in Metallurgy, Harvard University

IT IS SOMETIMES of value, from the viewpoint of both the laboratory and the shop, to know to what extent decarbonization (oxidation of carbon) and scaling (oxidation of iron) are likely to alter the structure and dimensions of carbon tool steel under heat-treatment. There seems, however, to be no systematic data in the meager literature on this subject outside of that presented by Emmons¹, who studied the effect of temperature and oxidizing medium on the depth of decarbonization. It is of perhaps equal importance to determine also the scaling and decarbonizing effect of air for various heating periods and whether the size of specimen has any effect. For this reason the experiments described here were undertaken.

The materials investigated were "Armco" iron in the form of $\frac{1}{2}$ -in. plate and a eutectoid carbon steel in the form of 1-in. round bar which gave the following analysis:

	C	Mn	Si	S	P
Armco iron.....	0.03	0.06	trace	0.021	0.004
Steel	0.86	0.51	0.04	0.040	0.024

Disks about $\frac{1}{2}$ in. thick were cut off the steel bar and ground plane and parallel to 0.001 in. on an alundum grinding wheel. One-inch square specimens were cut from the iron plate and similarly prepared. The specimens were heated in an electric muffle furnace and the duration of the heating was recorded from the time at which they reached the furnace temperature. After treatment they were cooled in lime. The scale was then chipped off the parallel faces, which were slightly re-ground until about half the surface showed metal. One-half the difference between the thickness before and after treatment was taken as the loss due to scaling.

TABLE I. EFFECT OF TEMPERATURE AND TIME ON THE SCALING AND DECARBONIZATION OF CARBON TOOL STEEL

Temperature, Deg. C.	Time, Hr.	Scaling, In.	Decarbonization, In.
780	2	0.001	0.000
780	5	.002	.000
890	$\frac{1}{2}$	0.001	0.000
890	$\frac{1}{2}$	.002	.002
890	1	.002	.004
890	2	.003	.011
890	5	0.006	.020
970	$\frac{1}{2}$	0.001	0.007
970	$\frac{1}{2}$	.002	.016
970	1	.003	.022
970	2	.006	.032
970	5	.008	.049
1,060	$\frac{1}{2}$	0.002	0.016
1,060	$\frac{1}{2}$	.003	.022
1,060	1	.006	.036
1,060	2	.012	.058
1,060	5	.013	.081

TABLE II. RELATIVE OXIDATION OF "ARMCO" IRON AND CARBON TOOL STEEL

Temperature, Deg. C.	Time, Hr.	Iron Scaling (In.)	Steel
780	2	0.002	0.001
780	5	.004	.002
890	2	0.004	0.003
890	5	.008	.006
970	2	0.010	0.007
970	5	.014	.010
1,060	2	0.017	0.012

TABLE III. EFFECT OF THE THICKNESS OF THE SPECIMEN ON THE SCALING AND DECARBONIZATION OF CARBON TOOL STEEL

Thickness, In.	Scaling, In.	Decarbonization, In.
$\frac{1}{2}$	0.008	to center
$\frac{1}{2}$	.008	0.045
$\frac{1}{2}$	.009	.049
1	.009	.045

The steel samples were prepared for microscopic examination by cutting in half perpendicularly to the plane faces and fastening together with bolts pairs which it was desired to compare. These sections were polished and etched with 10 per cent picric acid in methanol. A sharp edge was thus more easily obtained than by electrolytic deposition of copper and the additional advantage was obtained of being able to compare two specimens in the same field.

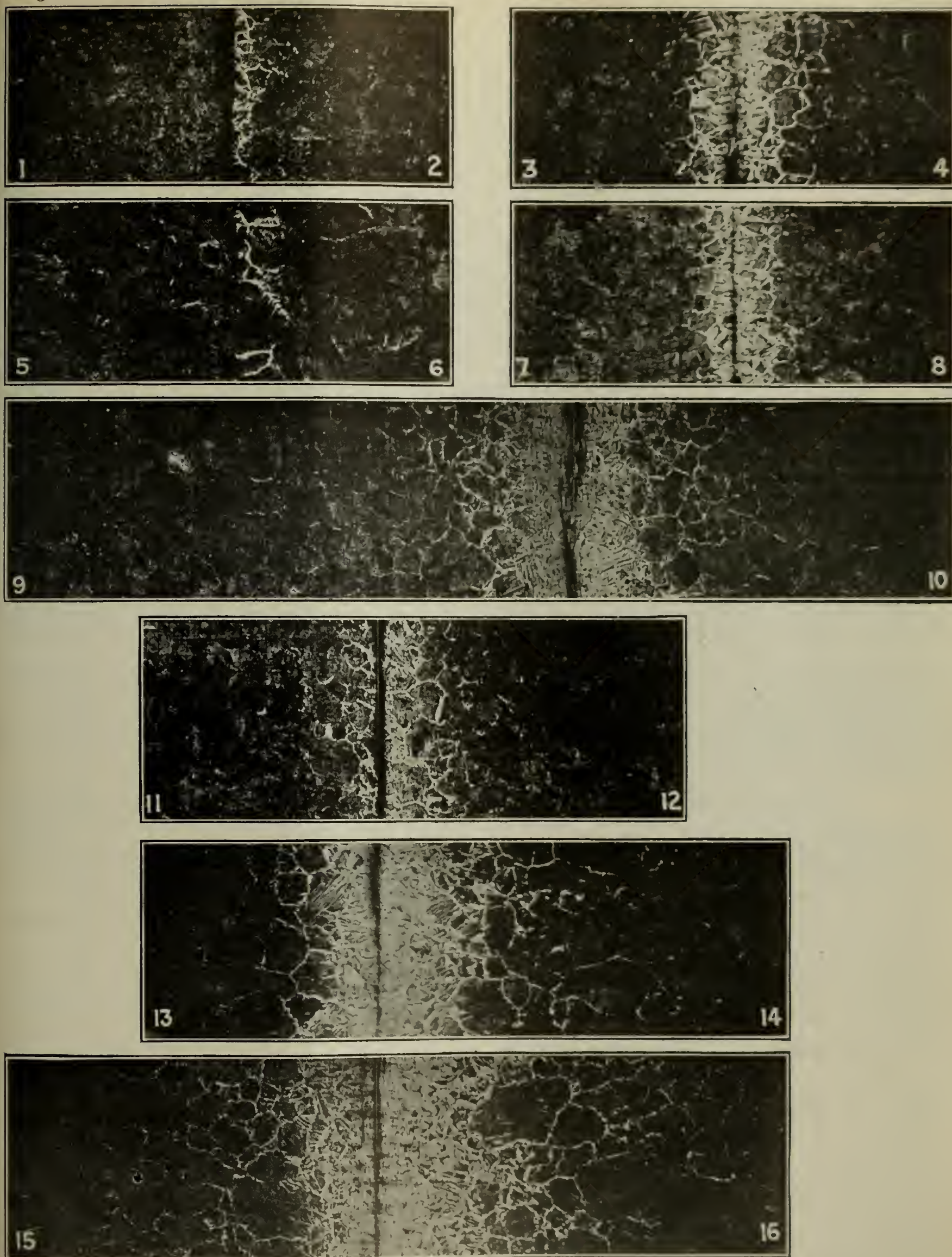
The depth of decarbonization was measured with a graduated eye-piece using a 16-mm. objective. The limit of free ferrite was somewhat irregular, so the values given are estimated averages. They are somewhat higher than those of Emmons, but this is to be expected, for he measured only to the limit of free cementite in a hypereutectoid steel.

The data obtained on the scaling and decarbonization of steel samples for various periods of heating are given in Table I and those for the scaling of iron and steel samples heated simultaneously in Table II. Table III gives the results of heating steel specimens of different thicknesses for five hours at 970 deg. C. Micrographs were also taken of representative specimens and are shown in Figs. 1 to 16.

The results for decarbonization are summarized in Fig. 17, which shows the effect of time and temperature on the depth of decarbonization as measured from the oxidized surface. The total thickness of steel affected by the oxidizing conditions is of course greater and may be obtained by adding the figures for scaling to those for decarbonization as given in the tables.

These data establish several phenomena to which attention might properly be called. First, the scaling of the "Armco" iron is greater than that of the steel under identical conditions. This is a necessary conse-

¹J. V. Emmons, *Trans., A. I. M. E.*, vol. 50, p. 405 (1915).



FIGS. 1 TO 16. DECARBONIZATION OF EUTECTOID STEEL AFTER ANNEALING AT VARIOUS TIMES AND TEMPERATURES

Figs. 1 and 2. $\frac{1}{2}$ hr. at 890 and 970 deg. C. respectively. $\times 40$. Figs. 3 and 4. $\frac{1}{2}$ hr. and $\frac{1}{2}$ hr. at 1,060 deg. C. $\times 40$. Figs. 5 and 6. $\frac{1}{2}$ hr. and 1 hr. at 890 deg. C. $\times 100$. Figs. 7 and 8. $\frac{1}{2}$ hr. and 1 hr. at 970 deg. C. $\times 10$. Figs. 9 and 10. Sample $\frac{1}{2}$ -in. and $\frac{3}{4}$ -in. thick heated 5 hr. at 970 deg. C. $\times 40$. Figs. 11 and 12. 2 hr. at 5 hr. at 890 deg. C. $\times 40$. Figs. 13 and 14. 2 hr. and 5 hr. at 970 deg. C. $\times 40$. Figs. 15 and 16. 2 hr. and 5 hr. at 1,060 deg. C. $\times 40$.

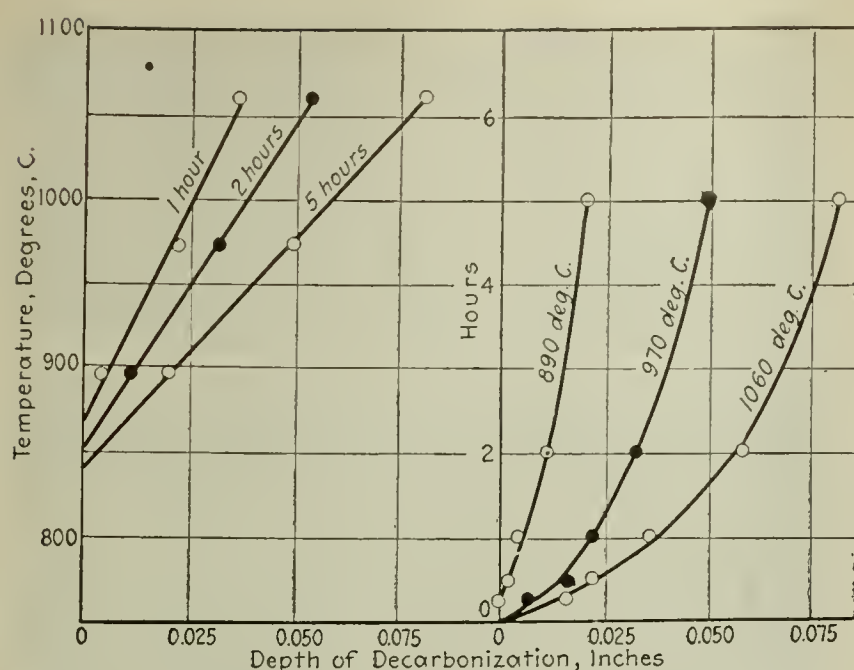


FIG. 17. RELATION BETWEEN DEPTH OF DECARBONIZATION, TIME AND TEMPERATURE

quence of the greater affinity of oxygen for carbon than for iron. Second, the size of the specimen is immaterial under the conditions of the experiment except when it is less than $\frac{1}{8}$ in. thick. Third, the same depth of decarbonization does not imply the same amount of carbon lost; thus one-half hour at 1,060 deg. C. gives the same depth of decarbonization as one hour at 970 deg. C., but the microstructure shows less free ferrite in the latter case.

Possibly the most important inference to be drawn from these results is that below about 850 deg. C. and for a period up to five hours there is no appreciable decarbonization—that is, scaling at least keeps pace with decarbonization.

In conclusion the author wishes to acknowledge the interest in this work shown by Prof. Sauveur, in whose laboratory the experiments were conducted.

Cambridge, Mass.

Outsaving the Wheelbarrow

One of the pressing business questions of the day is the elimination of industrial wastes. It is a factor that has an important bearing on the manufacturer's problem of meeting economic conditions.

Industrial waste may represent material, labor or time. Material wastes are concrete, tangible, and for this reason have received closer study. On the other hand, labor wastes and time wastes, particularly unproductive labor and time represented in the handling of material, have not, generally speaking, received the attention their importance as a definite opportunity for effecting certain economy in manufacturing justifies. That there is that opportunity has been demonstrated time and time again in specific cases. That industry as a whole, and individual manufacturers in particular, may be materially benefited through approved mechanical handling method is certain. Yet, over 90 per cent of the industrial plants in this country are still doing all or a large part of their lifting, transporting and conveying by hand labor, and it is evident that this means the annual expenditure of a tremendous amount of money, which might be used for more productive purposes.

A series of elaborate time-motion studies on the work of electric storage battery trucks vs. wheelbarrows recently made by the Yale & Towne Mfg. Co. at its Stamford, Conn., plant is a case in point.

Accurate records were first made on the cost of handling 600 tons of molding sand from a freight car on the railroad siding to the molding room in the foundry, 200 ft. away. Forty feet of this distance was a 12 per cent grade up a concrete ramp, with a sharp, right-angle turn into the shop at the top. It took eighteen men with wheelbarrows and shovels six days, working nine hours per day, to transfer the 600 tons of sand. The total cost was \$545.72.

A few weeks later another 600 tons of the same sand, delivered by car to the same point, was transferred to the molding room by means of a Yale electric truck equipped with a standard detachable end-dump body of 27 cu.ft. capacity. With one man driving the truck (one member of the former wheelbarrow gang) and an extra man with a shovel to help load the truck, this 600 tons of sand was transferred in four days, nine hours work per day, at a total cost, including interest on capital invested and charges for electric current used by the truck, of \$183.60. Thus on this one job, \$362.12 was saved. Needless to say, the mechanical way is standard practice at the plant.

The following itemized statement is interesting:

MECHANICAL METHOD

Material handled: Molding sand.	
From: Freight car.	
To: Molding room storage.	
Distance: 400 ft. round trip.	
Grade: 12 per cent, 40 ft. long.	
Capacity of Yale dump body truck: 27 cu.ft.	
Men required: To load.....	5
Men required: To unload.....	4
Men required: To operate.....	1
Total men.....	10
Total time consumed to unload shipment of 600 tons.....	4 days
Total cost of labor (9-hr. day).....	\$183.60
Demurrage charges.....	None
Total expense.....	\$183.60

WHEELBARROW METHOD

Material handled: Molding sand.	
From: Freight car.	
To: Molding room storage.	
Distance: 400 ft. round trip.	
Grade: 12 per cent, 40 ft. long.	
Capacity of wheelbarrows: 5 cu.ft.	
Men required: To load.....	3
Men with wheelbarrows.....	15
Total men.....	18
Total time consumed to unload shipment of 600 tons.....	6 days
Total cost of labor (9-hr. day).....	\$495.72
Demurrage charges (over 4 days, \$25 per day).....	50.00
Total expense.....	\$545.72

Many more examples could be cited.

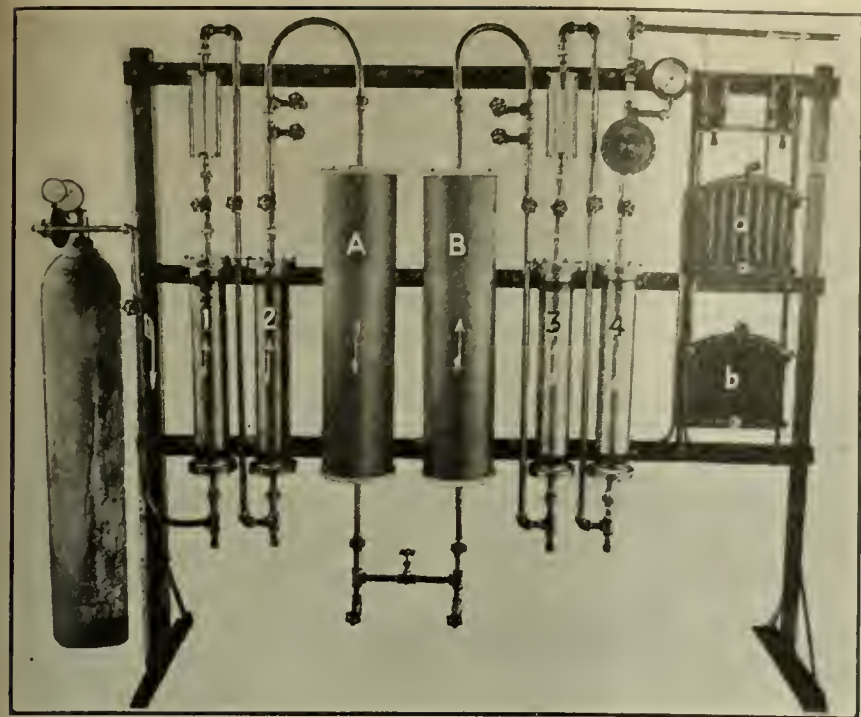
Mechanical handling is one way of accomplishing more work for the same expenditure.

Nitrogen and Argon Gas-Purifying Equipment

The apparatus shown in the accompanying figure is used for purifying the nitrogen or argon used for filling the bulbs of electric lights. In this electric high-pressure nitrogen- and argon-purifying equipment, which is marketed by the Charles Eisler Engineering Co., of Newark, N. J., the gas to be purified under a pressure of 30 to 50 lb. per sq.in. passes through containers 1 and 2, electric furnace A, which holds a steel tubing containing copper, electric furnace B, containing copper oxide, and containers 3 and 4, whence the purified gas, after being reduced to 5 to 6 lb. per sq.in. pressure by means of a diaphragm reducing valve, enters the supply line.

The electric furnaces operate on 110 or 220 volts and take about 9.4 amperes each. They are separately controlled by the respective rheostats *a* and *b*. The temperature for purifying is between 500 and 650 deg. C.

The advantages of operating the apparatus under



ELECTRIC HIGH-PRESSURE NITROGEN- AND ARGON-PURIFYING EQUIPMENT

high pressure may be summarized as follows: The purifying materials react more rapidly, so that complete removal of impurities is possible, even with somewhat lower temperatures in the tubes containing the copper and copper oxide; when gas is drawn at 5-lb. pressure from purifiers operating at 40 lb. the gas is in contact with the reagents practically three times as long as when the purifiers are operated at 5 lb.; when the gas-filled furnaces are allowed to cool to room temperature the final internal gas pressure is above that of the atmosphere, so that it is impossible for air to enter the purifiers through leaks.

In starting the apparatus, from 20 to 25 minutes is required to bring the purifiers to the proper temperature. The capacity of this apparatus is equivalent to 18,000 to 20,000 100-watt lamps per day.

Synopsis of Recent Chemical & Metallurgical Literature

Industrial Combustion of Gaseous Fuel.—The April, 1921, issue of *Chaleur et Industrie* contains the first part of a paper presented by André Grebel before the Central Office of Rational Combustion. Mr. Grebel suggests three new terms which shall express the main factors involved in the study of combustion.

1. Combustive power (*pouvoir comburivore*) which shall express: the number of volumes of dry air at normal tem-

perature and pressure which are necessary for the complete theoretical combustion of one volume of gaseous fuel.

2. Comburimeter. An apparatus for measuring the comburivorous power.

3. Thermic potential, which shall express the number of calories contained in one cu.m. of the theoretical mixture of combustible gas and air at 0 deg. C. and atmospheric pressure.

The thermic potential P_{th} is given in function of the calorific power of the gas P_{co} and of its comburivorous power P_{co} by the equation

$$P_{th} = \frac{P_{co}}{1 + P_{co}}$$

The value of the thermic potential multiplied by 2.5 gives the theoretical temperature of combustion.

He describes in detail the Grebel-Velter comburimeter. In the accompanying table are summarized the main coefficients of various combustible gases.

Concrete in the Construction of Salt Plants.—An interesting example of the extensive use of concrete at salt plants is given on page 271 of the June issue of *Concrete*. The plant described is that of the Pomeroy Chemical Co., at Pomeroy, Ohio, built in 1919 by the Rust Engineering Co.

The salt beds are about 1,300 ft. below the level of the Ohio River at Pomeroy Bend, the brine, which is a 10 per cent solution with a gravity of 7 deg. Bé., being forced up into the storage tank by an air lift. From there it runs over a measuring weir to a pre-heater, where it is heated to 68 deg. C., and then through tanks in which it is concentrated to a 20 per cent solution.

The brine next passes through concrete mud-settlers and draw settlers and then into concrete grainers, where copper steam pipes concentrate the solution to 35 deg. Bé., when the salt crystallizes and can be removed by a mechanical scraper ready to be packed for shipment. The mother liquor is further concentrated in a concrete bittern grainer and pumped to stills where bromine and calcium chloride are separated.

When the plant is in continuous operation the temperature in the mud settlers is practically constant, varying only 4 or 5 deg. C. The draw settlers are subject to wider variations, since the brine level changes with the filling of the grainers. As the grainers are completely emptied when the salt is removed and are not immediately refilled, their temperature may range from atmospheric (which is sometimes zero) to 82 deg. C., or 176 deg. F.

The settler tanks are 158 ft. long, 11 ft. wide and 3 ft. deep; the grainers have the same length and width, but are only 1 ft. 8 in. deep. Due to their length, these tanks were not built monolithic, but were constructed in sections about 13 ft. long, with bell joints, which allow a smooth inner surface.

When it is remembered that in the bittern grainer the concrete is in contact with concentrated brine of 40 deg. Bé., it is evident that good concrete will withstand even concentrated brine solutions, because the plant has been in operation about two years and there are no appreciable signs of deterioration. The wide temperature range, about 200 deg. F., should also be noted.

Other successful installations are also briefly referred to in this article.

COEFFICIENT OF COMBUSTION OF DIFFERENT GASES

	Acetylene, C ₂ H ₂	Benzene, C ₆ H ₆	Ethylene, C ₂ H ₄	Methane, CH ₄	Hydrogen, H ₂	Average Illuminating Gas	Carbon Monoxide, CO	Average Pure Water Gas	Average Cokes-Oven Gas	Average Blast-Furnace Gas
Weight in μ g. per cu.m. at 0 deg. C. and atmospheric pressure...	1.102	3.486	1.252	0.715	0.089	0.52	1.251	0.86	1.26	1.30
Highest calorific power per cu. m. in calories.....	13,881	36,016	14,906	9,547	3,062	5,000	3,055	2,600	1,100	800
Lowest calorific power per cu.m. in calories.....	13,398	34,566	14,000	8,581	2,578	4,600	3,055	2,400	1,060	835
Combustible power, volumes of air.....	11.942	35.827	14.334	9.556	2.389	5.0	2.389	2.3	0.9	0.65
Thermic potential, calories.....	1,035	938	913	813	760	766	901	727	557	506
Average temperature of flame in bunsen burner, deg. C.....	2,400	.....	.....	.....	1,900	1,780	.....	1,775	1,300	.....
Velocity of burning of the theoretical mixture with 2 per cent of oxygen, meters per second.....	6.15	.....	.....	0.60	4.50	1.25	2.00	.....	.....	.....
Igniting point in free air, deg C.....	406-440	.....	542-547	650-750	580-590	580-550	644-658	.....	.....	.....

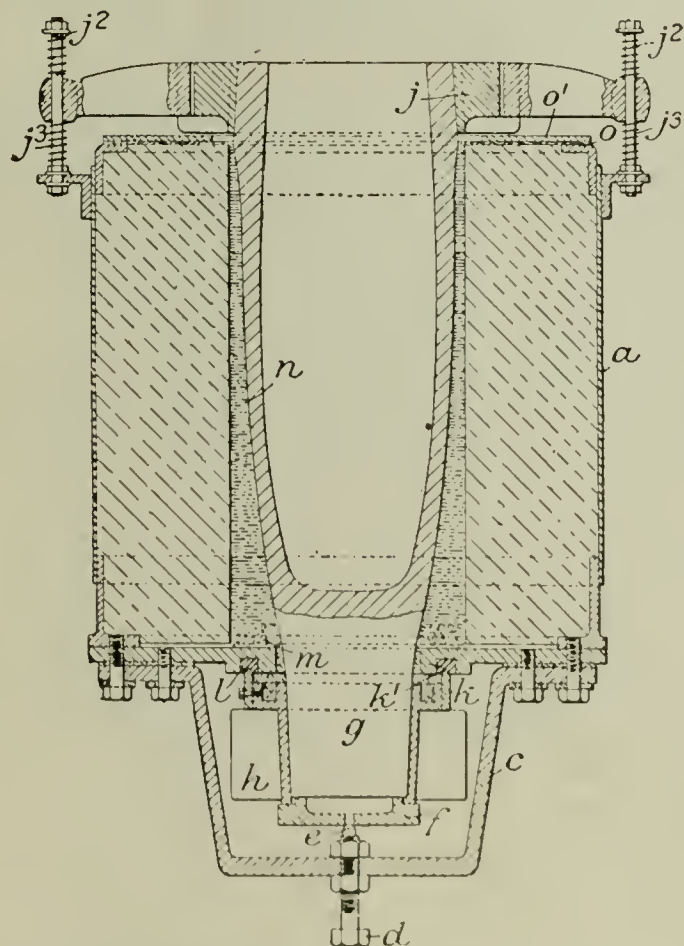
Recent Chemical & Metallurgical Patents

British Patents

For complete specifications of any British patent apply to the Superintendent, British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Process of Extracting Catechin and Catechu-Tannic.—A process for the extraction of catechin and catechu-tannic acid from vegetable substances containing them consists in digesting the disintegrated raw material with hot water in the absence of air and preferably in an autoclave, filtering and concentrating the decoction, then cooling it in absence of air to allow the catechin to separate out, and finally evaporating the filtrate to dryness in absence of air and preferably *in vacuo* to obtain the catechu-tannic acid. The precipitated catechin is purified by washing with cold water and is then dried in the dark either by a current of hot air or by absorption of the contaminating liquid by means of sand contained in bags. As starting material, the wood of *Acacia catechu* or *Acacia sendra* and the leaves and shoots of *Uncaria gambier* are mentioned. (Br. Pat. 161,431; INDIAN WOOD PRODUCTS CO., LTD., Calcutta. June 1, 1921.)

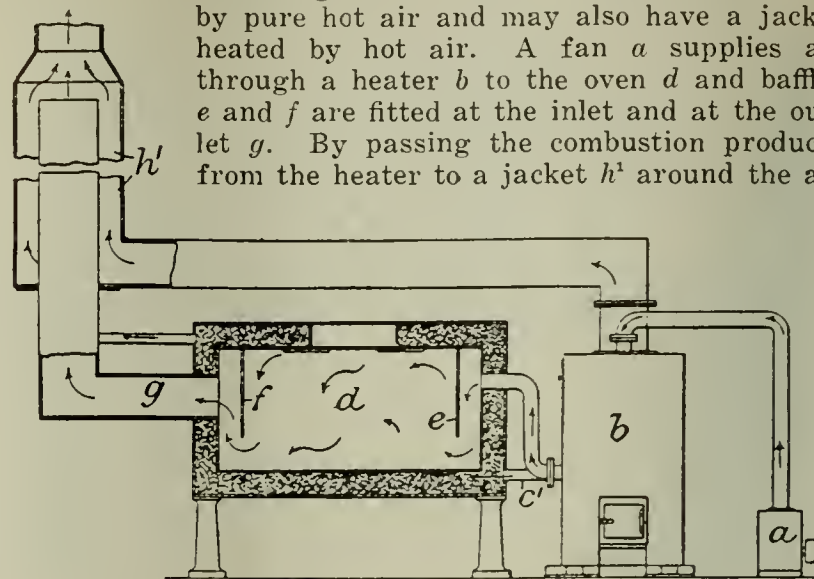
Electric Furnace.—A crucible, tube or the like acting as heating resistance is provided at its upper end with a terminal *j* having one or more arms sliding on guide rods *j*² and partly supported by springs *j*³ to allow expansion. The lower end *g* of the crucible, which is fitted with an air-cooled terminal *h*, may rest on a disk *f* supported through a ball-and-socket or like joint from a bracket *c* secured to the casing *a*. As shown, the disk *f* has a central spherical



recess or hole to receive the rounded or pointed end of an adjusting screw *d* working in the bracket *c*. A ring *k* on the terminal is provided with a sharpened edge *k*¹ bearing on an asbestos or other packing ring *l* in a groove in the casing. In a modification, a tube resistance has a lower water-cooled terminal supported by a ring carried by three adjustable bolts attached to the casing, and a sharp-edged ring in the casing can be screwed down onto an asbestos or other ring on the top of the terminal. In either arrangement, the crucible or tube is surrounded by a filling material within a brick lining of the casing *a*. The filling material may be retained by an asbestos cover plate *o*, held by a flat

metal ring *o*¹. (Br. Pat. 161,603; MORGAN CRUCIBLE CO., LTD., and C. W. SPIERS, Battersea, London. June 1, 1921.)

Vulcanizing Rubber Oven.—An oven particularly applicable for vulcanizing india rubber is heated internally by pure hot air and may also have a jacket heated by hot air. A fan *a* supplies air through a heater *b* to the oven *d* and baffles *e* and *f* are fitted at the inlet and at the outlet *g*. By passing the combustion products from the heater to a jacket *h*¹ around the air



outlet shaft sufficient induced draft is created to dispense with the fan. An independent hot air supply is provided for the jacket by a pipe *c*¹. (Br. Pat. 161,701; F. O. BYNOE, Twickersham, Middlesex. June 8, 1921.)

Continuous Fermentation Process.—A continuous fermentation process for industrial sugar solutions consists in passing the liquid through a series of closed vessels containing filters impregnated with yeast or other ferment, the rate of flow being adjusted so that complete fermentation is effected. The order of the vessels is changed from time to time to prevent destruction of the ferment. The process is applicable to the production of butyl alcohol, glycerine, lactic acid, butyric acid, citric acid, acetone, etc., as well as ethyl alcohol. (Br. Pat. 161,870; A. ROMER, Stuttgart, and DEUTSCH-KOLONIALE GERB. U. FARBSTOFF GES., Karlsruhe. June 8, 1921.)

Lactose.—In manufacturing lactose from whey, the lactalbumen is precipitated by the addition of a substance which produces in the whey a suitable colloid. It is suggested that the precipitation is due to the production of a negatively-electrified colloid in presence of the albumen. Sodium thio-sulphate, yielding colloidal sulphur, is stated to be suitable. The whey may be heated to 70-80 deg. C. before adding the precipitant. (Br. Pat. 161,887; J. TAVROGES, J. W. ROCHE and G. MARTIN, all of Manchester. June 8, 1921.)

Coffee Extracts.—An infusion of roasted coffee is concentrated at or near 0 deg. C. in a high vacuum and the concentrated extract dried either by the circulation of air, or *in vacuo* with the aid of absorbents such as concentrated sulphuric acid or zinc or calcium chloride. The concentration may be effected on the surface of rotary disks or drums dipping into the liquid, heat being supplied by water circulating through the hollow shafts of the disks or drums, and the concentrated liquid removed by scrapers. Small quantities of lactose and dextrine may be added to the dried product. The product may be added to cocoa butter, etc. The extract may be frozen and allowed to evaporate as solid *in vacuo*. (Br. Pat. 161,920; not yet accepted; A. CHALLAS, Neuilly sur Seine, France. June 8, 1921.)

Vegetable Gelatine.—Vegetable gelatine is extracted from seaweed, specially carragheen, by first softening and cleaning the material in hot or cold water, then heating it with water containing a small quantity of an acid, such as acetic acid, a salt or an alkali, in order to break down the vegetable tissue, and after running off the liquor, adding the liquor obtained by subjecting the residue to pressure, and finally filtering the amalgamated liquors and evaporating them to dryness. The seaweed may be bleached before the breaking-down treatment; and a preservative, such as bisulphite or benzoate of soda, may be added before evaporation. The evaporation of the liquid may take place on trays, on heated rollers, or by spraying into a current of hot air. The product is of use as a food. (Br. Pat. 161,612; M. M. MALCOLM and C. S. TOWNSEND, both of London. June 1, 1921.)

Current Events

in the Chemical and Metallurgical Industries

European Interest in Chemical Exposition

That European chemical industries are intensely interested in the forthcoming Chemical Exposition in New York was ascertained by Worth Colwell, who has just returned from Europe. Mr. Colwell is one of the exposition's publicity representatives and with a member of his staff visited England, France and Switzerland. In London, after presenting the various phases of the exposition to Dr. J. P. Longstaff and Sir William Pope of the Society of Chemical Industry, assurances were given that the British chemical experts will be well represented at the American exposition when it opens the week of Sept. 12 in the Eighth Coast Artillery Armory, New York.

In France leading chemists stated that they intend to make the transatlantic trip for the event, and in Switzerland a number of experts are especially interested in the development of chemical machinery in the United States. The future of the dye industry is a topic much discussed abroad and also the fuel problem. The French are particularly interested in the latter, largely because gasoline is costly there and the matter of obtaining substitutes for gasoline or "essence" is of vital importance.

Pennsylvania Industrial Relations Conference

An industrial relations conference, authorized by Gov. William C. Sproul of Pennsylvania, is being arranged by Dr. Clifford B. Connelley, Commissioner of the Department of Labor and Industry, Commonwealth of Pennsylvania, to be held at Harrisburg, Pa., Oct. 24 to 27.

This conference will include the features of the welfare and efficiency conferences and safety congresses of other years. The main topics to be discussed will include industrial waste, industrial co-operation, industrial publicity, industrial education, women and children in industry and the medical supervision of industry.

Prohibition Act Amendment Reported to Senate

The amendments to the national prohibition act which were passed by the House of Representatives June 27 were altered in some minor particulars by the Senate Committee on the Judiciary and were reported to the Senate on July 6. The presumed intent of the bill, as reported to the Senate, is satisfactory to the manufacturers of industrial alcohol, but it is believed that certain modifications will be necessary to make clear what is thought to be the purpose of the committee. As reported to the Senate, the paragraph of particular interest to the manufacturers of industrial alcohol reads as follows:

"If distilled spirits, upon which the internal revenue tax has not been paid, are lost by theft, accidental fire or other casualty while in possession of a common carrier subject to the transportation act of 1920 or the shipping act of 1920, or are lost by theft from a distillery or other bonded warehouse, and it shall be made to appear to the commissioner that such losses did not occur as the result of negligence, connivance, collusion or fraud on the part of the owner or person legally accountable for such distilled spirits, no tax shall be assessed or collected upon the distilled spirits so lost, nor shall any tax penalty be imposed or collected by reason of such loss, but the exemption from the tax and penalty shall only be allowed to the extent that the claimant is not indemnified against or recompensed for such loss. This provision shall apply to any claim for taxes or tax penalties not collected that may have accrued since the passage of the national prohibition act, or that may accrue hereafter."

The Senate committee in the first sentence added the words, "upon which the internal revenue tax has not been

paid." The common carrier was expanded so as to include a carrier by water. The committee in the last sentence added the words, "not collected." It is around this addition that some difference of opinion exists as to the meaning. After the word "warehouse" the bill as passed by the House contains this phrase: "and the person guilty of the theft has been convicted of the offense." That phrase was stricken out by the Senate committee.

Chemical Tonnage on Railroads

Chemicals and explosives furnished railroads of the country 17,336,161 tons of freight during the calendar year of 1920, according to the Interstate Commerce Commission's figures. Fertilizers furnished 13,976,256 tons of freight during the same period. Together these commodities furnished 1.39 per cent of the total tonnage carried by the railroads during the year. During the first quarter of 1921 chemicals and explosives furnished 1,337,246 tons of freight, while fertilizers furnished 2,142,552 tons.

Clay Products Work Begins

With the funds contributed by the associations of brick manufacturers to add to the money appropriated by Congress, the Bureau of Mines now has available approximately \$25,000 for work on heavy clay products. In addition, the Bureau of Standards has an appropriation of several thousand dollars which will be used on those phases of the work which fall within its field.

The first step being taken by the Bureau of Mines is to conduct an investigation as to the practice at a limited number of carefully chosen brick plants which are believed to be typical of many plants of the same character. A part of the work will be done at the University of Illinois. An effort will be made there to determine the maximum rate of vitrification and the maximum rate of water smoking.

Protest Against Duty on Jute

Members of Congress are receiving numerous protests against the duty on jute levied in the tariff bill. Jute fabric takes a duty of 1c. per lb. in the bill recommended by the committee. When the jute fabric is bleached, stenciled, colored or rendered non-flammable, an additional duty of 13 per cent ad valorem is levied. Bags or sacks made from plain woven fabrics of single jute yarns or from twilled or other fabrics composed wholly of jute are dutiable at 1c. per lb. plus 17 per cent ad valorem. Many of the protests are from fertilizer manufacturers who use jute bags for the distribution of their product.

"For the first time in history," says Representative Frear, of Wisconsin, one of the Republican members of the committee, "farmers will now pay for dutiable jute for the bags in which to ship grain. A non-competitive article thus enjoys the distinction of carrying a duty for revenue purposes only in a bill formulated to give protection to American interests, including the farmer."

Data Wanted on Glue and Gelatine

A monograph on "Glue and Gelatine" is being prepared by Jerome Alexander, one of the scientific and technologic monographs being issued under the auspices of the American Chemical Society and the Interallied Congress of Pure and Applied Chemistry. In order to round out his information on the subject, he would be glad to receive memoranda from men engaged in producing glue, gelatine, isinglass, or their substitutes, covering physical properties, chemical behavior, methods of manufacture, testing, and uses or specifications. Dr. Alexander's address for the summer is R.F.D. 4, Ridgefield Conn.

Lead Poisoning in the Pottery Trades

That workers engaged in certain branches of the pottery trade are seriously and constantly exposed to lead poisoning, chiefly from the lead contained in the glaze, and that this danger can be reduced, provided certain facilities and methods are altered by the pottery owners and certain precautions taken by the workers, sums up the findings of a report to the United States Public Health Service made by Consulting Hygienist Bernard J. Newman, Dr. William J. McConnell, Dr. O. M. Spencer and Statistician F. M. Phillips. This report is now in press.

The investigation, which was begun early in 1919, had been requested by the Brotherhood of Operative Potters because they desired to disprove the contentions that their trade was extremely hazardous and that the workmen in certain occupations were likely to develop lead poisoning. These contentions were maintained by life insurance companies as grounds for discrimination in the granting of life insurance policies to certain groups of pottery workers. The investigators received cordial support from both the workers and the pottery managers.

Ninety-two potteries, situated in New Jersey, Ohio, Pennsylvania and West Virginia, employing 21,000 persons, or 53 per cent of the total pottery workers in the United States, were investigated. Only the workers exposed to lead were examined, and of the total examined, 1,504 were males and 398 females.

LEAD RECEIVED THROUGH THE STOMACH

The portal of entrance through which the larger part of the lead is received by the body was found to be the stomach, as the lead was inhaled as dust, retained in the nasal and pharyngeal cavities and later swallowed with mucus, saliva and food. The chewing of tobacco, eating food contaminated with lead dust, and carelessness in personal habits such as wiping the lips, mustache, etc., with glaze-covered fingers, are contributory means toward the entrance of the lead into the human body.

A lesser, but still important portal of entry, is by the lungs, which absorb lead from fumes as well as dust. Absorption of lead through the skin is possible, but was found to be almost negligible in this case.

Risk of lead poisoning differs greatly in the many occupations of the pottery trade. The highest percentage of poisoning among men was found to be among the dippers and the next highest among the mixers and the odd-men. The highest percentage of poisoning among the women is among the dippers' helpers and the ware gatherers. These, among both men and women, are specified occupations, brought into direct contact with the glaze.

The percentage of lead poisoning for these, as well as for other workers, drops as the percentage of lead used in the glaze decreases and lead poisoning of course may be expected to disappear when leadless glaze is used. The adoption and use of leadless glazes is not impossible, for they are used now satisfactorily by European potteries. Certain objections, however, which have prevented their use in America, can at present be overcome only by radical changes in the manufacturing and firing methods. However, great improvements toward the decrease of lead poisoning can be brought about by the adoption of fritted lead glazes, as it would only be necessary to employ two or three men to prepare and frit the glaze against the present methods now employed, whereby large numbers come in contact with the lead glaze, either in its preparation or its use. Methods and formulas for making proper frits are given in the report.

The number of cases of poisoning found in the various occupations of the pottery trade does not alone establish their relative hazard, for this must be considered in the light of numerous modifying factors. The investigation, for instance, showed that the number of cases of lead poisoning increases with age of the workers, with their relative years of exposure and with the length of the work day. It showed also that poisoning is more prevalent among the men than among the women; but this was shown to be due to the fact that the men had been exposed for about three times as many years as the women. It

showed also that poisoning was more prevalent among workers who eat in the workroom or drink from vessels used in the workroom but not properly covered; and in plants where the toilet facilities, ventilation and lighting are bad, and in those where the dust counts and percentage of lead in the dust are high. It is easy to see that any or all of these respective factors are likely to be influenced by the susceptibility of the individual, or play a more or less important part in the production of lead poisoning as the personal habits and tendencies of the individual vary.

The relative weight to be given to these and other minor factors is very difficult to fix definitely, and the authors urge that no one should jump at the conclusion that to remedy any particular condition, other than remove the lead from the glaze, would immediately reduce poisoning.

RECOMMENDATIONS TO PLANT MANAGERS

It is recommended that plant managers should supply: Bubbling fountains with palatable drinking water; adequate dressing rooms with two-compartment lockers for each worker; decent and adequate toilet facilities; and adequate natural and artificial illumination and ventilation. They should discourage eating in the workroom and eating anywhere without previous washing of the hands and face; should encourage the use of overalls; should absolutely forbid dry sweeping and all sweeping of any type during work hours; and should prevent, so far as possible, the spilling of glaze and the consequent dust and dirt.

American Valuation Association

The American Valuation Association was formed by a gathering of representative American manufacturers at the Chemists' Club, in New York City, June 16. Walter Camp, president of the New Haven Clock Co., was chosen president of the association at that time. Other officers are: D. W. Jayne, of The Barrett Co., vice-president; Stanley Williamson, of the Linde Air Products Co., secretary, and F. D. Dodge, of the Toy Manufacturers of the U. S. A., treasurer.

The executive committee includes William Burgess, of the U. S. Potters' Association; Walter Camp; George Chatillon, of John Chatillon & Sons; F. D. Dodge; Clement J. Driscoll, of the Liberty Lace & Netting Works; D. W. Jayne; H. J. Strugnell, of the Remington Arms Co., Stanley Williamson, and J. F. Zoller of the General Electric Co. Mr. Zoller is also chairman of the membership committee, and Mr. Driscoll is chairman of the publicity committee.

It is the purpose of the new association, as announced by the executive committee, to take up every phase of the valuation of imported merchandise and to submit to manufacturers a statement regarding the advantages to be derived by American industry through adopting the American rather than the foreign valuation plan.

Summer Pulp and Paper Course at University of Maine

In order to make full use of its facilities for training technical men for the pulp and paper industry, the University of Maine has instituted a pulp and paper summer school which opened on June 27 with a good-sized class. The courses in pulp and paper chemistry and technology will continue until Aug. 5. They include: Laboratory and small-scale experiments on soda pulp and sulphite pulp, pulp bleaching, paper testing and analysis; general lectures on raw materials of present or probable future use, modern pulp and paper making, costs, use of libraries, visits to mills.

C.W.S. Moves Offices

The headquarters of the Chemical Warfare Service in Washington has been moved from 1800 Virginia Ave. to the seventh wing of the Munitions Building. General Fries' office is No. 1062. Under the new arrangement the entire service is housed compactly in much better offices than those occupied by the service in one of the temporary buildings.

Plans for Fall Meetings of Chemical Societies

Departing from its usual custom, the society of Chemical Industry will hold its annual meeting on this side of the Atlantic. The members will join with the Canadian branch of their organization in sessions in Montreal late in August. Their official hotel quarters will be the Windsor Hotel, while the scientific and business sessions will center at McGill University, where there will be a special convocation. The Canadian and British chemists will then inspect numerous plants and on Thursday, Sept. 1, will visit Grand Mère and Shawinigan Falls industries under the auspices of the Shawinigan Falls section of the society. The delegates will then proceed to Ottawa and Toronto, where they will be entertained by the local sections. On Monday, Sept. 5, they will reach Niagara Falls, where they will view the vast establishments which modern chemistry has created.

On the afternoon of Labor Day the members will cross the border into this country. They will be met by a committee of the American section of their society and conducted through the industrial plants on this side of the Falls. Dinner will be served at Buffalo, after which the visitors and their hosts will leave on a special train east. On their arrival next morning (Sept. 6) at Syracuse they will have luncheon with the Solvay Process Co. and make a tour of the large factory of this corporation. The chemists will then go to Albany and from there take the night boat down the Hudson River to New York City.

The visitors will be welcomed next day by members of the American Section of the Society of Chemical Industry, who will be their hosts at a luncheon. Elaborate arrangements for the reception of the chemists of all three nationalities will be carried out, as now being planned by the various societies, through the co-ordinating committee, of which Dr. B. C. Hesse is chairman and Dr. Allen Rogers is secretary. The festivities, meetings and entertainments which will follow are designed to bring into closer bonds all chemists of Anglo-Saxon stock.

The fall meeting of the American Chemical Society is to be held in New York City Sept. 6 to 10, inclusive. The first contact between the visiting members of the two great organizations which represent chemistry in three lands will be at a lawn party to be given on the afternoon of Sept. 7 to foreign guests and to scientific societies at Columbia University. Other societies asked to participate in the welcoming of the visitors from abroad are: The American Electrochemical Society, the American Institute of Chemical Engineers, the American Section of the Société de Chimie Industrielle and the Manufacturing Chemists Association of the United States. All the foreign guests have also been invited to the smoker and entertainment of the American Chemical Society, which will be held on the evening of Wednesday, Sept. 7.

Scientific sessions of the American Chemical Society are to be held at Columbia University, its official headquarters. To all these meetings the British and Canadian guests have been bidden. They will also be present at the banquet of the American Chemical Society on the evening of Sept. 9 at its hotel headquarters, the Waldorf-Astoria.

An interlude devoted to social activity on Sept. 10, with plenty of golf and tea, and on the 11th to a boat excursion will fill in the time before the next event.

The National Exposition of Chemical Industries, which is to be held during the week of Sept. 12, will constitute a most appropriate sequel to the international gathering of chemists. Here under one roof the visiting chemists will find every type of apparatus used in American chemical plants as well as a wide variety of the products of the chemical industries—all conveniently arranged for study and inspection.

Civil Service Examination

Vacancies for assistant metallurgical chemists at the Naval Ordnance Plant, South Charleston, W. Va., at \$5.44 per day, will be filled from an open competitive examination to be held Aug. 17.

Applicants should apply at once for form 1312 to the Civil Service Commission, Washington, D. C.

Book Reviews

RUBBER MANUFACTURE. By *H. E. Simmons*, professor of chemistry, University of Akron, Ohio. New York: D. Van Nostrand Co. 150 pp., illustrated. Price \$4.50.

This book deals in a rather general way with the problems of the rubber industry, and apparently has for its object the enlightenment of young compounders who have to deal with the difficulties of so-called "service work." This class of compounders is not as a rule very well grounded in "theory" but is usually well up on the "practice" of keeping the factory going. These compounders will agree to find a substitute for everything used in the factories with the single exception of sulphur. The conception of the type of man this book is intended for is of prime importance.

The writer feels that as a whole the work has been reasonably well done. Here and there are chapters which are exceptionally good, as for example the one on physical testing. From the service man's point of view it is excellent. But all too frequently glaring errors occur, and other evidences of lack of thorough digestion of the matter in question. In addition there are several mistakes which should have been caught by the proofreader. Also terms are used which have not been previously described or otherwise defined. In view of the fact that many of the readers will be young rubber chemists, this is very regrettable. With this in mind the writer will attempt in reviewing the various chapters to correct a few of the errors which appear most glaring.

Chapter I—The History of Caoutchouc, in which the historical features are well covered.

Chapter II—Rubber in the Amazon Basin, in which the South American rubbers are described in sufficient detail for the average compounder. The explanation of the excellence of fine para rubber being due to carbon from the smoke of the *uricuri* palm nut is, to say the least, rather novel.

Chapters III and IV.—These describe the rubbers of Africa and Central America respectively. In speaking of the harvesting of guayule the author mentions that the rubber is extracted from the ground shrub by means of naphtha, which is then partly distilled, after which alkali is added. This, he says, holds the resins in solution and the rubber separates out. This is also rather novel.

Chapter V.—Rubber plantation practice is described. It is rather good, though not quite exact as to modern methods. It is customary on the best plantations to dilute the latex to constant rubber content and then to add a definite amount of dilute acetic acid.

Chapter VI.—A discussion of colloids and colloidal principles is contained in this chapter. The subject matter is aptly chosen and the presentation is particularly good.

Chapter VII.—This chapter is an attempt to apply the principles of colloidal chemistry to problems met in coagulation and other phases of the industry. It must be observed that the writer continually confuses lampblack with gas or carbon black. It is the latter and not lampblack which imparts such desirable properties to rubber.

Chapter VIII.—This contains a very much condensed review of the work of Eaton, Grantham and others on different means of coagulation and variability. Unfortunately, the subject is somewhat too broad for so much "boiling down." However, the chapter is particularly good and were it not marred by the use of technical terms without explanation and the discussion of subjects such as "Byrne cure" without description it would be excellent.

Chapter IX.—This chapter on the theory of the constitution of rubber is good and sufficient for the purpose intended.

Chapter X.—This discusses synthetic rubber. The author makes the very apt comment that we might as well attempt to produce synthetic apples. Rubber is a vegetable product and as such can be grown in sufficient quantity to meet the demand.

Chapter XI.—Methods for testing crude rubber are described. It might be observed that most rubber companies have become very careless in this respect. Rubber is bought at the various auctions almost solely on appearance and the reputation of the estate producing it. The wide use of organic accelerators has eliminated the difficulties due to "variability"—i. e., the variation in time of cure when mixed with sulphur alone.

Chapter XII.—The manufacture and use of inorganic fillers are discussed. The subject matter included has not been well chosen or well arranged, and in a few instances is erroneous. For example, the toughening effect of zinc oxide and gas black are not mentioned. One would imagine that the chief use of zinc oxide is as a white pigment, while as a matter of fact about 90 per cent of that consumed contains a little lead and therefore gives the stock a slight yellow cast. Lithopone is a better white pigment than zinc oxide. Red lead passed out of use about five years ago. Many specifications exclude it, and because of its strong oxidizing tendencies most compounders would not use it under any conditions. Under lime the author fails to differentiate between hypothesis and fact in discussing the ability of lime to take up moisture and prevent blowing in stocks. Under barytes, the brown color of "off color" material is due to iron.

Aluminum oxide made through the sodium aluminate route is not "coming into use in some factories," due to the alkali which it contains and which is almost if not completely impossible to extract.

Under the caption of fillers the author has neglected glue, which is now widely employed.

In discussing the production of zinc oxide it will be noted that the author did not avail himself of the services of the New Jersey Zinc Co. Research Laboratories, otherwise he would not have overlooked the decided advantages of this material and his description of the process of manufacture would have been more to the point.

Under antimony, the reviewer ventures to suggest that crimson antimony is usually oxysulphide and not trisulphide. Also "stibnite" is the mineral employed, not "sribnite."

It might also be observed that the manufacturer's explanation of the merits of an antimony tube are highly interesting but not very instructive.

Many of our most satisfactory pigments are lakes.

Lampblack is not a toughener and is not extensively used in tire stocks, but gas black is.

Graphite due to its coarse particles has no stiffening effect.

Chapter XIII.—The manufacture and use of organic accelerators are discussed. Of the common accelerators he mentions: aldehyde ammonia, paranitrosodimethylaniline, paraphenylenediamine, hexamethylenetetramine, thiocarbanilide, aniline. He fails to mention: triphenyl guanidine, diphenyl guanidine, formaldehyde aniline, the CS₂ reaction products with dimethylamine and piperidine. Nothing is said regarding the proper proportions of any accelerator. He makes the highly interesting observation that aldehyde ammonia is produced by passing dry ammonia gas into a solution of formalin. This would give hexamethylenetetramine. He should have said "acetaldehyde."

Chapter XIV.—The manufacture and use of rubber substitutes are rather well described. Mineral rubber (MR) deserves more treatment than it received.

Chapter XV.—This chapter contains a description of the theories of vulcanization. Except for poor proofreading it is well done. For example the following reaction is given without explanation of its terms:



The term NS₂ is rather misleading; certainly there is no combination of nitrogen and sulphur like that. The author might have mentioned *n* mols of C₁₀H₁₀ plus *N* mols of S₂, which would certainly have made the passage more clear.

It should be noted that the addition of sulphur to rubber increases with the time of heating, which is contrary to our usual experience with chemical reactions.

Chapter XVI.—This describes "Reclaiming" and is very

good, except for the fact that the Mark's process, which is most generally employed, is not sufficiently emphasized.

Chapter XVII.—The preparation of crude rubber for compounding and manufacturing is recounted.

Chapter XVIII.—The principles of compounding are discussed. From the service man's viewpoint the work is excellent.

Chapter XIX.—Several of the author's methods for analyzing manufactured rubber are described. Chloroform is used rather extensively in place of the carbon bisulphide specified. The Watters and Tuttle method for total sulphur, which is now in almost general use, is not mentioned.

Chapter XX.—This chapter, on Physical Testing, is very good. An illustration of a plastometer is included without mention or description in the text.

Chapter XXI.—The work which Prof. Simmons is undertaking in Akron in the way of establishing a reputable course in rubber chemistry is described. His effort is good and he deserves the support of all American rubber companies and the Rubber Association.

ANDREW H. KING.

Personal

C. L. BACHELDER, who has been assistant in the pulp and paper section of the Forest Products Laboratory, has resigned, and is now with the Consolidated Water Power & Paper Co., Appleton, Wis., under Dr. Otto Kress.

H. H. BARKER, formerly chief chemist and plant manager of the Ore Products Corporation, Denver, Col., is now chief chemist of Corning & Co., Albany, N. Y.

ALFRED T. CHILD, for the past two years associate professor of chemistry at Rose Polytechnic Institute, Terre Haute, Ind., will spend the summer at Stamford, Conn. He plans to visit industrial plants.

VANCE P. EDWARDES, who has been with the Forest Products Laboratory for the past three years, is now with the Interlake Pulp & Paper Co., Appleton, Wis., in the sulphite department.

REIMAN G. ERWIN, formerly with the Roessler & Hasslacher Chemical Co., St. Albans, W. Va., is now chemical engineer with the Celluloid Co., Newark, N. J.

CHARLES H. MACDOWELL, president of the Armour Fertilizer Works, was re-elected president of the National Fertilizer Association at the recent annual convention held at White Sulphur Springs, W. Va. This is Mr. MacDowell's fourth term as president of the association, he having been previously elected to that office in 1903 and 1904 and again in 1920.

JOHN J. MULLIGAN, who was formerly plant metallurgist for the U. S. S. Lead Refinery, Inc., East Chicago, Ind., is now assistant superintendent for the same company.

DR. HENRY P. TALBOT has been appointed acting dean of Massachusetts Institute of Technology to succeed Dr. A. E. Burton, who recently resigned. Dr. Talbot is chairman of the faculty, and will also retain the directorship of the department of chemistry.

ARTHUR L. WALKER, professor of metallurgy at the Columbia School of Mines, has gone to Europe for the vacation months.

The Society for the Promotion of Engineering Education has elected the following officers for the ensuing year: President, Charles F. Scott, Yale University; vice-presidents, H. J. Hughes, Harvard University, and E. J. McCaustland, University of Missouri; secretary, F. L. Bishop, University of Pittsburgh; treasurer, W. O. Wiley, New York City. The following are members of the Council: P. H. Daggett, University of North Carolina; J. H. Dunlap, University of Iowa; M. L. Enger, University of Illinois; J. C. L. Fish, Leland Stanford University; F. E. Gieseke, University of Texas; Morris Knowles, Pittsburgh, Pa., and O. M. Leland, University of Minnesota.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, July 11, 1921.

Trading of a desultory character has featured the chemical market during the past week and there has been little in the way of price changes uncovered. A fair amount of miscellaneous inquiries was received, but these did not result in any large lot transactions and most of the business placed has been in small lots representing the actual wants of the consuming trade. The holiday exerted its usual quieting influence and the close of the week found business dormant in most local directions.

The first draft of the new tariff bill is now under discussion and the trade can draw its own conclusions from what Mr. Fordney thinks about the import duty as a protection to the American chemical industry. Importations of German chemicals are increasing and may be expected to increase until the new tariff bill becomes a law, the time being purely problematical. Meanwhile some relatively low prices are being named on chemicals which forecast dullness for American goods.

Among chemicals which have shown some activity are soda ash, caustic soda, bichromate, prussiate and nitrite of soda. The first two have shown considerable steadiness. Bleaching powder has sold more freely and the outlook has improved for business in this chemical through the recent settlement of the labor strike at paper mills in this country and Canada. Bleach showed a better tone at the close with some sellers a little higher in their views. Among the smaller items citric acid has ruled about steady. Imported tartaric acid has not declined any further regardless of a lowering in the price of domestic producers. Formaldehyde showed some irregularity in second hands. Camphor has been in fair request at steady prices all around. In general, it can be stated that quite a few can see no prospects of material improvement in trade conditions during July and August, but early in September it is expected that the beginning of a general recovery will become pronounced. For more than six months manufacturers and others have been engaged in working off high-cost inventories. This has been largely at the expense of earnings. It has added to the feeling of depression that has prevailed and probably in many instances has made the situation appear to be much worse than it is in reality. Consumers are uncertain as to future prices and having been taught a severe lesson because of overexpansion in the inflation period, are now exceedingly careful and will not take the chance of laying in supplies at what might be considered high prices later on. The country has gone from one extreme to another and that there will be a rebound is an inevitable conclusion.

GENERAL CHEMICALS

Spot *caustic soda* is being held steady at \$4.10 per 100 lb. for standard brands, and moderate trading was reported at this price. It is stated that miscellaneous inquiries are reaching the market in fair volume and that business in the aggregate is quite satisfactory. Resale offerings are not heavy and some sellers showed a disposition to advance their views. Producers are maintaining the contract price of 3½c. per lb., basis 60 per cent, f.o.b. works.

Producers report a quiet trading in *fluoride of soda* and state that small sales are going through on the basis of 12c. per lb. Buyers seem to be fairly well supplied with this material and are content to operate in small quantities. Prices on spot *nitrite of soda* are heard all the way from 7¼@8c. per lb., depending entirely upon the seller. Scattered transactions were reported at 7½c. per lb. As stated previously, stocks of this chemical appear to be well held in most directions and there continues to be a

feeling that the market would respond to any buying movement. Spot *bichromate of potash* is generally quoted at 11¾@12c. per lb., but odd lot sales have been made below this price and in one direction it was stated that 11c. could be done. Activity has continued along narrow lines and the desire to secure new business in the face of a quiet demand has kept the market somewhat irregular.

Dealers in *caustic potash* quote the 88-92 per cent at 5@5½c. per lb., and in some quarters it was intimated that the inside price might be shaded on a firm offer. Rumors were heard that a few small lots have changed hands down to 4¾c. per lb., but this figure did not represent the actual market, according to sellers. Standard *bichromate of soda* was quoted at 8¼@8½c. per lb. Scattered transactions were noted at 8½c. but the market appeared quiet in most directions, with offerings relatively small among second hands. Imported *prussiate of soda* was quoted at 12½@12¾c. per lb., according to seller. Odd lots might have been purchased at slight concessions, but the market in general looked somewhat steadier than it did at the close of the previous week. Resale *soda ash* in single bags sold at \$2.10 per 100 lb. and upward, according to quantity. Barrels were in fair request, with small lot sales noted up to \$2.60 per 100 lb., while 2½c. per lb. was named in some quarters for carlots. No change in prices was heard at the works, and sellers named \$1.60 per 100 lb. for single bags basis 48 per cent. Prices are a shade easier on formaldehyde with prominent sellers offering as low as 13¼c. per lb. for immediate shipment. Odd lot sales have been made by dealers down to 13c. and the extreme range is 13@14c. per lb., depending upon seller, brand and quantity. Trading in *oxalic acid* is taking at 17½@18c. per lb. on spot. Some sellers are asking above 18c. for domestic material and this variety is governed entirely by the views of the individual seller at present. The minimum price quoted is for imported stock.

COAL-TAR PRODUCTS

Trading in the coal-tar products market during the past week has shown no particular change from that of previous reports, which were of a somewhat improved tone with inquiries coming from a broader field and concerning a larger variety of products. The amounts involved in transactions were confined to small quantities for use at the moment and nothing in the nature of contract business was developed. There was not much activity in the crude market outside of *benzene*. The demand for both the pure and the 90 per cent is steady and prices are firm. Supplies of *naphthalene* are plentiful and with the lack of demand prices depend upon the seller, with some quoting as low as 7c. per lb. and others steady in their views at 8½c. per lb. for flakes. The tone in the market for *phenol* is improving and some sellers report a more active tendency among buyers. There is very little business being done below 10c. per lb., while the range was up to 15c. per lb., depending on quantity. Intermediates were steady in tone and small lots continued to move in a routine manner. A fair demand was reported for *phthalic anhydride* and prices were steady at 45@50c. per lb. *Aniline oil* was dull and prices remained practically unchanged. *Beta naphthol* was somewhat lower at 35@38c. per lb., with trading reported quiet. Consumers of *aniline oil* are interested only in supplies sufficient for the moment and so far this week no large sales were reported. Prices, however, remained steady at 20@26c. per lb., depending upon quantity and seller.

There was very little activity noticeable in any quarter of the market on *dimethylaniline*. Prices varied somewhat depending on seller with a range from 40@50c. per lb. The tendency of the demand for *beta naphthol* has seemed to fall off and while factors in some quarters are fairly steady in their quotations, sellers in some quarters will shade on a firm order so that 35c. per lb. has been possible. Factors state there is very little change taking place in the situation on *alpha-naphthylamine* and very little interest is shown on the part of consumers. Prices are held on the recently quoted basis of 35@40c. per lb. The market on *paranitraniline* shows few signs of any

broadening and only a moderate routine business is passing, while prices depend on seller, with 85c. per lb. heard in some quarters. A firm order for round lots might bring shading. Factors continue to report a fairly steady consuming demand for moderate quantities of *para phenylenediamine*. The market is in a fair condition on supplies, with prices ranging from \$1.75@ \$2 per lb., depending on quantity.

MISCELLANEOUS MATERIALS

Interest in the market for miscellaneous materials centered in the publication of details on the Fordney tariff bill. The bill as presented to the House of Representatives provides for higher duties on *barytes* and *zinc oxide*. The measure provides for a duty of \$4 per ton on crude *barytes* and \$7.50 per ton on the manufactured. The market held at \$36@ \$42 per ton on prime material and \$26@ \$28 per ton on off colored. Prices on *blanc fixe* ruled steady, but closed unchanged at 4½c. per lb. in carlots and 4½c. per lb. for less than carlots. There was a fair inquiry noted for this material. Interest in *zinc oxide* centered around the announcement made by leading producers of a general reduction in prices. The decline amounts to 1½c. per lb. on the lead-free and French process *zincs*. Lead-free closed at 7½c. per lb. carlots, with the 5 per cent at 7½c. and the 10@35 per cent at 7c. per lb. French process, red seal, closed at 8½c., carlot basis, with the green seal at 9½c. per lb. and the white seal at 11c. The XX variety was quoted at 7½c. per lb.

VEGETABLE OILS

Spot prices for *chinawood oil*, so far as importers were concerned, held around 15c. per lb., but resale material was available here and there at concessions. Futures were neglected, but held nominally at 10½@10¾c. per lb., hardwood barrels included, c.i.f. N. Y. The feature of the market on *coconut oil* was the sale of several large parcels of copra at comparatively steady prices. One lot of 900 tons of Java copra sold at \$4.95 per 100 lb., July shipment. Another lot sold at 5c. per lb. c.i.f. N. Y. The domestic oil trade was not very active with prices more or less nominal. There were sellers of domestic Ceylon type oil at 8½c. per lb., sellers' tanks, N. Y. On the coast 8½c. was bid for snowflake oil, immediate shipment, but no sales were recorded. Outside lots of Manila oil for immediate shipment were offered at 8½c. lb. bulk basis, c.i.f. N. Y. with intimations that that figure might be shaded on a firm bid. Cochin style oil held at 11@11½c. per lb. on spot. Owing to the strength in cottonseed oil and other competing oils sellers in the West were not free in offering crude *corn oil* and in some directions 6c. per lb. was regarded as an inside figure, tank car basis, f.o.b. Chicago. There was a good inquiry for domestic crude *peanut oil*, and sales were noted in the past few days at prices ranging from 6¼@6½c. per lb., tank cars, f.o.b. mills, southeast. The sale at the outside figure was noted during the week. The market was firm reflecting the uplift in crude cottonseed, which actually sold at 6½c. per lb. f.o.b. Texas.

The St. Louis Market

ST. LOUIS, Mo., July 8, 1921.

Business in the general list of drugs and fine chemicals continues to increase, with large and frequent inquiries and in most cases, resulting in business. The demand for heavy chemicals has been considerably lighter in the past two weeks, as the market for the most part remains unchanged. The prediction of two weeks ago has apparently been justified—i.e., that the second-hand stocks are about depleted and that the buyer can again safely take the manufacturer's schedule as indicative of the real market price. The market in the past on many chemicals was weakened owing to the severe foreign competition, but since the introduction of the proposed tariff bill made public during the last week, the market is again assuming a firm position and many commodities are stiffening.

ALKALIS

Caustic soda demand has been very poor, with manufacturer's schedule prevailing. The demand for *soda ash* is very light, with the price in round lots holding at \$2.95@

\$3.25 per 100 lb., basis 58 per cent light. *Bicarbonate of soda* and *sal soda* have a demand much under routine, with prices remaining the same.

INDUSTRIAL CHEMICALS

Carbon bisulphide is one of the very active items at the present moment, with many inquiries resulting in business. The demand for *hyposulphite of soda* continues to be steady and is moving through regular channels. Sulphur remains at \$2 per 100 lb. for the commercial, with demand a trifle light within the previous two weeks. A few sales have been reported below cost in an effort to move heavy stocks of this item.

DRUGS AND PHARMACEUTICALS

Acetanilide continues to be quiet. *Acetphenetidine* is not moving as rapidly as might be expected, inquiries being small and few. The *bromide* situation has undergone no material change. Foreign importations continue to be noted and supplies are liberal. *Caffeine* is in fair demand with no change in price. *Carbon tetrachloride* has been in a fair demand, with a price at 12c. per lb. in 100-gal. drums. The status of *chloral hydrate* has had no change, with a normal demand from regular sources. *Cream of tartar* continued to maintain its present schedule with a limited demand. There is a decided improvement in the demand for *glycerophosphates* and a very substantial amount of business is passing. *Hydrogen peroxide* continues to move very briskly. Some of the *hypophosphite salts* are showing an increase. *Iodides* have shown a fair increase and manufacturers hope this condition will continue with the present price reduction brought about by the keen competition of second hands. *Mercurials* have shown no improvement since last report. *Phenolphthalein* continues to move in a routine way with a slight improvement in inquiries. *Rochelle salt* and *seidlitz mixture* are lacking interest since the recent reduction in price. The second-hand lots of *saccharine* are still a disturbing factor to the market and until these goods are disposed of factors do not look for any improvement. A routine business of *salicylates* is being enjoyed. *Sodium benzoate* remains easy and the demand is rather light. Competition in this commodity does not seem to be as sharp as it was recently. The hot weather which has been experienced lately has had a good effect on *zinc stearate*, which is now moving in large volume and jobbers should carry liberal stocks. *Glycerine* again declined to 15½c. per lb. spot, with contracts offered at 16c. Most of the six months' contracts were signed at the latter figure.

ACIDS

The position of heavy acids has not made any material change. However, a fair improvement has been noted with no change in price. Factors are still disappointed in the *citric acid* situation. The demand is a trifle better, but soft drink manufacturers are still averse to anticipating and purchasing larger quantities. The movement into consuming channels is also below normal. The activity in *pyrogallie acid*, both *resublimed* and *crystals*, remains since last report and some very nice business is being transacted. Some very large inquiries have been received for *succinic acid*, and in most cases business has resulted. Since the reduction in price recently announced by manufacturers, there has been nothing of importance developed in the *tar-taric acid* situation.

VEGETABLE OILS

Linseed oil has declined slowly the past two weeks and now holds at 75c. per gal. in cooperage, with little contracting. *Castor oil* still holds at 10½c., with only a fair demand. *Turpentine* has likewise been affected by the slowup of the paint industry and is offered at 57c. per gal. in 5-bbl. lots.

PAINT MATERIALS

The paint industry is experiencing the dulllest season in years, and as a consequence the demand for *barytes* and *lithopone* has been exceedingly light. Though prices remain the same, shading is to be expected when there is any amount of business in sight.

The Iron and Steel Market

PITTSBURGH, July 8, 1921.

Last week it was common talk in the steel trade that formal price reductions would be announced this week, probably on Tuesday. On Monday night the Bethlehem Steel Co. gave to the Associated Press a statement that it was reducing its regular prices by certain amounts. Other independents promptly "recognized" the new prices and on Wednesday night the United States Steel Corporation made an announcement that it had reduced its prices correspondingly.

At the middle of April a uniform market was developed, by the independents making some advances from their former cut prices while the Steel Corporation reduced its prices. Since then there had been a plain decline of \$5 a net ton in wire products and in sheets. In other products the April prices were nominally though in most cases not actually the market.

The prices thus announced are: Billets, \$33; slabs, \$34; sheet bars and small billets, \$35; bars, 1.90c.; shapes and plates, 2c.; blue annealed sheets, 2.65c.; black sheets, 3.50c.; galvanized sheets, 4.50c. Tin plate is \$5.75 per base box. It had been \$6.25 by the April schedule, while there had been shading to \$5.75 or less on stock plate but little shading on plates ordered for production.

The new prices are the market on sheets, and probably the market on bars. On plates prices of 1.90c. and less had already been named quite freely and it is quite improbable that the market will advance to a 2c. level.

New prices for pipe, hoops and some other commodities are still to be announced. The April price on hoops had been 2.75c., but 2.50c. has frequently been done in the past two or three weeks.

The season cotton tie price has been announced, \$1.35 per bundle, weighing 45 lb. This compares with \$2 in 1920, \$1.70 in 1919, \$2.10 in 1918 and 1917 and an average of 79½c. in the ten years 1904 to 1913 inclusive.

TRADE AWAITING "FINAL" REDUCTION

For months past the trade has been looking forward to the time, indefinitely in the future, when the steel market would experience a sort of "final" decline—i. e., a decline that would occur when buyers became ready to take hold in something like a free way and there would be an incentive to the mills to make prices that would induce the placing of business. The declines to date have not been of that character, since they have not perceptibly increased the volume of business, and they have occurred simply through mills competing with one another for the limited quantity of business that was going to be placed anyhow. There is no sign yet of the time when a buying movement can be started. Consumers are still engaged in liquidating stocks of steel and of their products made from steel, and they do not seem to be making very rapid progress.

The condition, of course, is that the production and shipments of steel by the mills is well below the rate of actual consumption, or wearing out, or putting into employment, of steel. The movement in steel is far below a relation to the volume of business activity generally, even though general business is relatively quiet. It is rather startling to observe that debits to individual accounts at banks as reported by the Federal Reserve Board and which the board says "are indicators of the volume of the nation's business" were only 19 per cent less in the five weeks ended May 25 than in the same period of 1920, whereas the production of steel is barely 25 per cent of the rate of a year ago.

PRODUCTION OF STEEL AND PIG IRON

Production of steel ingots is now at about 10,000,000 gross tons a year, or at a shade under 20 per cent of capacity, the Steel Corporation operating at above that rate and the independents at below it, some independent mills being entirely closed. Pig-iron production is at the rate of about 11,000,000 tons.

Pig iron prices continue to soften, prices being off 50c. in the week, with bessemer at \$22, basic at \$20 and foundry at \$21, valley furnaces. Connellsville coke is a shade stronger, being rather firm at \$3.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots	Less Carlots
Acetic anhydride.....lb.	10.12 - 10.12	10.13 - 10.15
Acetone.....lb.	2.50 - 2.75	3.00 - 3.25
Acid, acetic, 28 per cent.....100 lbs.	4.00 - 4.25	4.50 - 5.50
Acetic, 56 per cent.....100 lbs.		
Acetic, glacial, 99½ per cent, carboys, 100 lbs.	9.75 - 10.00	10.25 - 10.50
Boric, crystals.....lb.	.13 - .14	.14 - .15
Boric, powder.....lb.	.15 - .15	.16 - .16
Citric.....lb.		.44 - .45
Hydrochloric.....100 lb.	1.50 - 1.65	1.75 - 2.00
Hydrofluoric, 52 per cent.....lb.	.12 - .12	.12 - .13
Lactic, 44 per cent tech.....lb.	.10 - .11	.11 - .12
Lactic, 22 per cent tech.....lb.	.04 - .05	.06 - .07
Molybdic, C. P.....lb.	4.00 - 4.50	4.50 - 5.00
Muriatic, 20 deg. (see hydrochloric).....lb.		.07 - .07
Nitric, 40 deg.....lb.	.06 - .06	.07 - .07
Nitric, 42 deg.....lb.	.07 - .07	.07 - .07
Oxalic, crystals.....lb.	.17 - .18	.18 - .19
Phosphoric, 50 per cent solution.....lb.	.13 - .14	.14 - .15
Picric.....lb.	.20 - .25	.27 - .35
Pyrogallol, resublimed.....lb.		1.90 - 2.15
Sulphuric, 60 deg., tank cars.....ton		11.75 - 14.00
Sulphuric, 60 deg., drums.....ton		13.00 - 15.00
Sulphuric, 66 deg., tank cars.....ton	18.00 - 20.00	
Sulphuric, 66 deg., drums.....ton	21.00 - 22.00	22.50 - 23.00
Sulphuric, 66 deg., carboys.....ton		
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	21.00 - 22.00	
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	23.00 - 23.50	24.00 - 24.50
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	31.00 - 32.00	33.00 - 34.00
Tannic, U. S. P.....lb.	.45 - .48	.90 - 1.00
Tannic (tech.).....lb.		.50 - .55
Tartaric, crystals.....lb.		.29 - .30
Tungstic, per lb. of WO.....lb.		1.30 - 1.40
Alcohol, Ethyl.....gal.		4.65 - 5.00
Alcohol, Methyl (see methanol).....gal.		
Alcohol, denatur ed, 188 proof.....gal.		.31 - .36
Alcohol, denatur ed, 190 proof.....gal.		.38 - .42
Alum, ammonia lump.....lb.	.03 - .03	.04 - .04
Alum, potash lump.....lb.	.03 - .04	.04 - .04
Alum, chrome lump.....lb.	.10 - .11	.11 - .12
Aluminium sulphate, commercial.....lb.	.01 - .02	.02 - .02
Aluminium sulphate, iron free.....lb.	.02 - .02	.03 - .03
Aqua ammonia, 26 deg., drums (750 lb.).....lb.	.07 - .07	.07 - .08
Ammonia, anhydrous, cyl. (100-150 lb.).....lb.	.30 - .32	.33 - .35
Ammonium carbonate, powder.....lb.	.08 - .08	.09 - .10
Ammonium chloride, granular (white sal ammoniac).....lb.	.06 - .06	.07 - .07
Ammonium chloride, granular (gray sal ammoniac).....lb.	.07 - .08	.08 - .08
Ammonium nitrate.....lb.	.07 - .07	.07 - .08
Ammonium sulphate.....100 lb.	2.60 - 2.75	2.80 - 3.00
Amylacetate.....gal.		4.00 - 4.25
Amylacetate tech.....gal.		2.50 - 3.00
Arsenic oxide, (white arsenic) powdered lb.	.06 - .07	.07 - .08
Arsenic sulphide, powdered (red arsenic) lb.	.11 - .11	.12 - .13
Barium chloride.....ton	59.00 - 59.50	60.00 - 62.00
Barium dioxide (peroxide).....lb.	.20 - .21	.22 - .23
Barium nitrate.....lb.	.07 - .07	.08 - .08
Barium sulphate (precip.) (blanc fixe).....lb.	.04 - .05	.05 - .06
Bleaching powder (see calc. hypochlorite).....lb.		
Blue vitriol (see copper sulphate).....lb.		
Borax (see sodium borate).....lb.		
Bristone (see sulphur, roll).....lb.		
Bromine.....lb.	.41 - .42	.43 - .45
Calcium acetate.....100 lbs.	2.00 - 2.05	
Calcium carbide.....lb.	.04 - .04	.05 - .05
Calcium chloride, fused, lump.....ton	23.50 - 24.00	24.50 - 25.50
Calcium chloride, granulated.....lb.	.01 - .02	.02 - .02
Calcium hypochlorite (bleach powder) 100 lb.	2.15 - 2.25	2.35 - 2.50
Calcium peroxide.....lb.		1.40 - 1.50
Calcium phosphate, tribasic.....lb.		.15 - .16
Camphor.....lb.		.75 - .78
Carbon bisulphide.....lb.	.06 - .07	.07 - .08
Carbon tetrachloride, drums.....lb.	.10 - .10	.11 - .12
Carbonyl chloride (phosgene).....lb.		.60 - .75
Caustic potash (see potassium hydroxide).....lb.		
Caustic soda (see sodium hydroxide).....lb.		
Chlorine, gas, liquid-cylinders (100 lb.).....lb.	.08 - .09	.09 - .10
Chloroform.....lb.		.40 - .43
Cobalt oxide.....lb.		3.00 - 3.10
Copperas (see iron sulphate).....lb.		
Copper carbonate, green precipitate.....lb.	.19 - .19	.20 - .21
Copper cyanide.....lb.		.50 - .62
Copper sulphate, crystals.....lb.	.05 - .06	.06 - .06
Cream of tartar (see potassium bitartrate).....lb.		
Epsom salt (see magnesium sulphate).....lb.		
Ethyl Acetate Com. 85%.....gal.		.85 - 1.00
Ethyl Acetate pure (acetic ether 98% to 100%).....lb.		.50 - .52
Formaldehyde, 40 per cent.....lb.	.13 - .13	.13 - .14
Fusel oil, ref.....gal.		3.00 - 3.25
Fusel oil, crude.....gal.		1.75 - 2.00
Glauber's salt (see sodium sulphate).....lb.		.16 - .16
Glycerine, C. P. drums extra.....lb.		3.65 - 3.75
Iodine, resublimed.....lb.		.10 - .20
Iron oxide, red.....lb.		
Iron sulphate (copperas).....ton	19.00 - 20.00	21.00 - 22.00
Lead acetate.....lb.		.11 - .13
Lead arsenate, paste.....lb.	.09 - .09	.10 - .11
Lead nitrate.....lb.		.15 - .20
Litharge.....lb.	.33 - .08	.08 - .09
Lithium carbonate.....lb.		1.30 - 1.40
Magnesium carbonate, technical.....lb.	.09 - .09	.10 - .11
Magnesium sulphate, U. S. P.....100 lb.	2.40 - 2.75	
Magnesium sulphate, technical.....100 lb.		1.20 - 1.75
Methanol, 95%.....gal.		.77 - .80
Methanol, 97%.....gal.		.80 - .85
Nickel salt, double.....lb.		.14 - .14
Nickel salt, single.....lb.		.15 - .15
Phosgene (see carbonyl chloride).....lb.		
Phosphorus, red.....lb.	.45 - .46	.47 - .50
Phosphorus, yellow.....lb.		.35 - .37
Potassium bichromate.....lb.	.11 - .12	.12 - .12

		Carlots	Less Carlots
Potassium bitartrate (cream of tartar).....	lb.	\$. . . \$. . .	\$0.30 — \$0.31
Potassium bromide, granular.....	lb.		.16 — .25
Potassium carbonate, U. S. P.....	lb.	.35 — .40	.45 — .50
Potassium carbonate, 80-85%.....	lb.	.05 — .05½	.06 — .07
Potassium chlorate, crystals.....	lb.	.07½ — .07½	.08 — .12
Potassium cyanide.....	lb.		.26 — .28
Potassium hydroxide (caustic potash).....	lb.	.05 — .05½	.05½ — .06
Potassium muriate, 80% K.C.L.....	ton	45 00 — 50.00	
Potassium iodide.....	lb.	.09½ — .09½	2.75 — 3.00
Potassium nitrate.....	lb.	.29 — .30	.10 — .12½
Potassium permanganate.....	lb.	.35 — .37	.31 — .32
Potassium prussiate, red.....	lb.	.24 — .24½	.38 — .40
Potassium prussiate, yellow.....	lb.		.25 — .25½
Potassium sulphate (powdered).....	per unit		1 50 — 1.75
Rochelle salts (see sodium potas tartrate)			
Salammoniac (see ammonium chloride)			
Sal soda (see sodium carbonate)			
Salt cake.....	ton		26.00 — 28.00
Silver cyanide.....	oz.		1.35 — 1.38
Silver nitrate.....	oz.		.40 — .41
Soda ash, light.....	100 lb.	2.10 — 2.15	2.20 — 2.50
Soda ash, dense.....	100 lb.	2.40 — 2.45	2.50 — 2.75
Sodium acetate.....	lb.	.04½ — .04½	.04½ — .05½
Sodium bicarbonate.....	100 lb.	2.25 — 2.40	2.50 — 2.75
Sodium bichromate.....	lb.	.08½ — .08½	.08 — .09½
Sodium bisulphate (nitre cake).....	ton	5 00 — 5.25	5.50 — 6.50
Sodium bisulphite powdered, U.S.P.....	lb.	.05 — .05½	.05½ — .06
Sodium borate (borax).....	lb.	.06 — .06½	.06½ — .07
Sodium carbonate (sal soda).....	100 lb.	1.50 — 2.00	2.10 — 2.40
Sodium chlorate.....	lb.	.07½ — .07½	.08 — .08½
Sodium cyanide.....	lb.	.19 — .21	.22 — .30
Sodium fluoride.....	lb.	.11 — .12	.12 — .13½
Sodium hydroxide (caustic soda).....	100 lb.	4.10 — 4.20	4.25 — 4.65
Sodium hyposulphite.....	lb.		.03½ — .03½
Sodium nitrate.....	100 lb.	2.90 —	3.00 —
Sodium nitrite.....	lb.	.07½ — .07½	.07½ — .08
Sodium peroxide, powdered.....	lb.	.25 — .26	.27 — .30
Sodium phosphate, dibasic.....	lb.	.04½ — .04½	.05 — .05½
Sodium potassium tartrate (Rochelle salts)	lb.		.26 — .27
Sodium prussiate, yellow.....	lb.	.12½ — .12½	.13 — .13½
Sodium silicate, solution (40 deg.).....	lb.	1.00 — 1.15	1.25 — 1.40
Sodium silicate, solution (60 deg.).....	lb.	.02½ — .03	.03½ — .03½
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	100 lbs.	1.50 — 1.75	2.00 — 2.25
Sodium sulphide, fused, 60-62 per cent (conc.) lb.	lb.	.05½ — .05½	.06 — .06½
Sodium sulphite, crystals.....	lb.	.03½ — .04	.04½ — .04½
Strontium nitrate, powdered.....	lb.	.15 — .15½	.16 — .17
Sulphur chloride, red.....	lb.	.07 — .07½	.07½ — .08
Sulphur, crude.....	ton	20.00 — 22.00	
Sulphur dioxide, liquid, cylinders extra.....	lb.	.08 — .08½	.09 — .10
Sulphur (sublimed), flour.....	100 lb.		2.25 — 3.10
Sulphur, roll (brimstone).....	100 lb.		2.00 — 2.75
Tin bichloride, 50 per cent.....	lb.	.18 — .19	
Tin oxide.....	lb.		.40 — .42
Zinc carbonate, precipitate.....	lb.	.15½ — .16	.16½ — .17
Zinc chloride, gran.....	lb.	.11 — .11½	.11½ — .12
Zinc cyanide.....	lb.	.45 — .49	.50 — .60
Zinc dust.....	lb.	.11½ — .11½	.11½ — .12½
Zinc oxide, XX.....	lb.	.07 — .07½	.08 — .09
Zinc sulphate.....	100 lb.	3.00 — 3.25	3.30 — 3.50

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude.....	lb.	\$1.10 — \$1.15
Alpha-naphthol, refined.....	lb.	1.25 — 1.30
Alpha-naphthylamine.....	lb.	.35 — .40
Aniline oil, drums extra.....	lb.	.20 — .27
Aniline salts.....	lb.	.26 — .29
Anthracene, 80% in drums (100 lb.).....	lb.	.75 — 1.00
Benzaldehyde U.S.P.....	lb.	1.50 —
Benzidine, base.....	lb.	.85 — 1.00
Benzidine sulphate.....	lb.	.75 — .85
Benzoic acid, U.S.P.....	lb.	.60 — .65
Benzoate of soda, U.S.P.....	lb.	.55 — .60
Benzene, pure, water-white, in drums (100 gal.).....	gal.	.27 — .32
Benzene, 90%, in drums (100 gal.).....	gal.	.25 — .28
Benzyl chloride, 95-97%, refined.....	lb.	.28 — .30
Benzyl chloride, tech.....	lb.	.20 — .25
Beta-naphthol benzoate.....	lb.	3.50 — 4.00
Beta-naphthol, sublimed.....	lb.	.70 — .75
Beta-naphthol, tech.....	lb.	.35 — .38
Beta-naphthylamine, sublimed.....	lb.	1.75 — 1.80
Cresol, U. S. P., in drums (100 lb.).....	lb.	.16 — .18
Ortho-cresol, in drums (100 lb.).....	lb.	.25 — .27
Cresylic acid, 97-99%, straw color, in drums.....	gal.	.70 — .80
Cresylic acid, 55-97%, dark, in drums.....	gal.	.65 — .70
Cresylic acid, 50%, first quality, drums.....	gal.	.45 — .50
Dichlorobenzene.....	lb.	.06 — .09
Diethylaniline.....	lb.	1.20 — 1.25
Dimethylaniline.....	lb.	.40 — .50
Dinitrobenzene.....	lb.	.26 — .28
Dinitrochlorobenzene.....	lb.	.20 — .30
Dinitronaphthalene.....	lb.	.30 — .40
Dinitrophenol.....	lb.	.35 — .40
Dinitrotoluene.....	lb.	.27 — .30
Dip oil, 25%, car lots, in drums.....	gal.	.40 — .45
Diphenylamine.....	lb.	.60 — .65
H-acid.....	lb.	1.20 — 1.30
Meta-phenylenediamine.....	lb.	1.15 — 1.20
Monochlorobenzene.....	lb.	.12 — .14
Monoehtylaniline.....	lb.	1.75 — 1.85
Naphthalene crushed, in bbls.....	lb.	.07 — .08½
Naphthalene, flake.....	lb.	.07 — .08
Naphthalene, balls.....	lb.	.08½ — .09
Naphthionic acid, crude.....	lb.	.70 — .75
Nitrobenzene.....	lb.	.12 — .15
Nitro-naphthalene.....	lb.	.30 — .35
Nitro-toluene.....	lb.	.16 — .18
Ortho-amidophenol.....	lb.	3.10 — 3.20
Ortho-dichlor-benzene.....	lb.	.15 — .20
Ortho-nitro-phenol.....	lb.	.80 — .85
Ortho-nitro-toluene.....	lb.	.15 — .20
Ortho-toluidine.....	lb.	.20 — .25
Para-amidophenol, base.....	lb.	1.50 — 1.60
Para-amidophenol, HCl.....	lb.	1.75 — 1.80

Para-dichlorobenzene.....	lb.	.15 — .20
Paranitroaniline.....	lb.	.85 — 1.00
Para-nitrotoluene.....	lb.	.85 — .95
Para-phenylenediamine.....	lb.	1.75 — 2.00
Para-toluidine.....	lb.	1.25 — 1.40
Phthalic anhydride.....	lb.	.50 — .60
Phenol, U. S. P., drums.....	lb.	.11 — .13
Pyridine.....	gal.	2.00 — 3.50
Resorcinol, technical.....	lb.	1.75 — 1.85
Resorcinol, pure.....	lb.	2.25 — 2.30
Salicylic acid, tech., in bbls.....	lb.	.19 — .22
Salicylic acid, U. S. P.....	lb.	.20 — .25
Salol.....	lb.	.80 — .85
Solvent naphtha, water-white, in drums, 100 gal.....	gal.	.25 — .28
Solvent naphtha, crude, heavy, in drums, 100 gal.....	gal.	.14 — .16
Sulphanilic acid, crude.....	lb.	.30 — .35
Tolidine.....	lb.	1.25 — 1.35
Toluidine, mixed.....	lb.	.40 — .45
Toluene, in tank cars.....	gal.	.25 — .28
Toluene, in drums.....	gal.	.28 — .31
Xylidines, drums, 100 gal.....	lb.	.40 — .45
Xylene, pure, in drums.....	gal.	.40 — .45
Xylene, pure, in tank cars.....	gal.	.45 —
Xylene, commercial, in drums, 100 gal.....	gal.	.33 — .35
Xylene, commercial, in tank cars.....	gal.	.30 —

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark.....	lb.	\$0.24 — \$0.25
Beeswax, refined, light.....	lb.	.27 — .28
Beeswax, white pure.....	lb.	.42 — .45
Carnauba, Ilora.....	lb.	.58 — .60
Carnauba, No. 2, North Country.....	lb.	.25 — .26
Carnauba, No. 3, North Country.....	lb.	.15½ — .16
Japan.....	lb.	.17 — .17½
Montan, crude.....	lb.	.06½ — .06½
Paraffine waxes, crude match wax (white) 105-110 m.p.....	lb.	.03 — .03½
Paraffine waxes, crude, scale 124-126 m.p.....	lb.	.02½ — .02½
Paraffine waxes, refined, 118-120 m.p.....	lb.	.03½ — .03½
Paraffine waxes, refined, 125 m.p.....	lb.	.03½ — .04
Paraffine waxes, refined, 128-130 m.p.....	lb.	.04½ — .04½
Paraffine waxes, refined, 133-135 m.p.....	lb.	.05 — .05½
Paraffine waxes, refined, 135-137 m.p.....	lb.	.05½ — .06
Stearic acid, single pressed.....	lb.	.09 —
Stearic acid, double pressed.....	lb.	.09½ —
Stearic acid, triple pressed.....	lb.	.10 — .10½

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl.....	280 lb.	\$4.95 —
Rosin E-I.....	280 lb.	5.00 — 5.20
Rosin K-N.....	280 lb.	5.55 — 6.50
Rosin W. G.-W. W.....	280 lb.	7.25 —
Wood rosin, bbl.....	280 lb.	6.25 —
Spirits of turpentine.....	gal.	.57½ —
Wood turpentine, steam dist.....	gal.	.55 —
Wood turpentine, dest. dist.....	gal.	.53 —
Pine tar pitch, bbl.....	200 lb.	 7.00
Tar, kiln burned, bbl. (500 lb.).....	bbl.	 11.50
Retort tar, bbl.....	500 lb.	 11.50
Rosin oil, first run.....	gal.	.33 —
Rosin oil, second run.....	gal.	.35 —
Rosin oil, third run.....	gal.	.39 —
Pine oil, steam dist., sp.gr. 0.930-0.940.....	gal.	1.80 —
Pine oil, pure, dest. dist.....	gal.	1.50 —
Pine tar oil, ref., sp.gr. 1.025-1.035.....	gal.	.46 —
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.....	gal.	.35 —
Pine tar oil, double ref., sp.gr. 0.965-0.990.....	gal.	.75 —
Pine tar, ref., thin, sp.gr. 1.080-1.960.....	gal.	.35 —
Turpentine, crude, sp. gr. 0.900-0.970.....	gal.	1.20 —
Hardwood oil, f.o.b. Mich., sp.gr. 0.960-0.990.....	gal.	.35 —
Pinewood creosote, ref.....	gal.	.52 —

Solvents

73-76 deg., steel bbls. (85 lb.).....	gal.	\$0.41 —
70-72 deg., steel bbls. (85 lb.).....	gal.	.39 —
68-70 deg., steel bbls. (85 lb.).....	gal.	.38 —
V. M. and P. naphtha, steel bbls. (85 lb.).....	gal.	.30 —

Crude Rubber

Para-Upriver fine.....	lb.	\$0.16 — .17
Upriver coarse.....	lb.	.09 — .09½
Upriver caucho ball.....	lb.	.11½ — .12
Plantation—first latex crepe.....	lb.	.14½ —
Ribbed smoked sheets.....	lb.	.12 — .12½
Brown crepe, thin, clean.....	lb.	.15 —
Amber crepe No. 1.....	lb.	.17 —

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls.....	lb.	\$0.08½ — \$0.09
Castor oil, AA, in bbls.....	lb.	.10 — .10½
China wood oil, in bbls. (f.o.b. Pac. coast).....	lb.	.14½ — .15
Cocoonut oil, Ceylon grade, in bbls.....	lb.	.10½ — .10½
Cocoonut oil, Cochinchina grade, in bbls.....	lb.	.11 — .11½
Corn oil, crude, in bbls.....	lb.	.07½ — .07½
Cottonseed oil, crude (f. o. b. mill).....	lb.	.06 — .06½
Cottonseed oil, summer yellow.....	lb.	.07½ — .08½
Cottonseed oil, winter yellow.....	lb.	.08 —
Linseed oil, raw, car lots (domestic).....	gal.	.72 — .73
Linseed oil, raw, tank cars (domestic).....	gal.	.66 — .67
Linseed oil, in 5-bbl lots (domestic).....	gal.	.75 — .77

Olive oil, Denatured.....	gal.	\$1 25	—	\$1 40
Palm, Lagos.....	lb.	06	—	07
Palm, Niger.....	lb.	05½	—	05½
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	06½	—	06½
Peanut oil, refined, in bbls.....	lb.	10	—	10½
Rapeseed oil, refined in bbls.....	gal.	83	—	90
Rapeseed oil, blown, in bbls.....	gal.	91	—	95
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	07½	—	—
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	05½	—	—

FISII

Light pressed menhaden.....	gal.	\$0.42	—	—
Yellow bleached menhaden.....	gal.	.44	—	—
White bleached menhaden.....	gal.	.45	—	—
Blown menhaden.....	gal.	.50	—	—

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$24.00	—	30.00
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	22.00	—	26.00
Barytes, crude, 88% @ 94% ba., Kings Creek.....	net ton	10.00	—	12.00
Barytes, floated, f.o.b. St. Louis.....	net ton	26.50	—	28.00
Barytes, crude, first grade, Missouri.....	net ton	7.00	—	—
Blanc fixe, dry.....	lb.	04½	—	04½
Blanc fixe, pulp.....	net ton	45.00	—	55.00
Casein.....	lb.	08	—	10
Chalk, domestic, extra light.....	lb.	04½	—	05
Chalk, domestic, light.....	lb.	04	—	04½
Chalk, domestic, heavy.....	lb.	03½	—	04
Chalk, English, extra light.....	lb.	04½	—	05
Chalk, English, light.....	lb.	04½	—	05
Chalk, English, dense.....	lb.	04	—	04½
China clay (kaolin) crude, f.o.b. mines, Georgia.....	net ton	8.00	—	10.00
China clay (kaolin) washed, f.o.b. Georgia.....	net ton	12.00	—	15.00
China clay (kaolin) powdered, f.o.b. Georgia.....	net ton	18.00	—	22.00
China clay (kaolin) crude f.o.b. Virginia points.....	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points.....	net ton	15.00	—	25.00
China clay (kaolin), imported, lump.....	net ton	12.00	—	20.00
China clay (kaolin), imported, powdered.....	net ton	20.00	—	25.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	gross ton	8.00	—	14.00
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27.00	—	30.00
Fullers earth f.o.b. Mines.....	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Ia.....	net ton	15.00	—	18.00
Fullers earth, powdered, f.o.b. Fla.....	net ton	18.00	—	—
Fullers earth, imported, powdered.....	net ton	24.00	—	27.00
Graphite, Ceylon lump, first quality.....	lb.	07½	—	08
Graphite, Ceylon chip.....	lb.	06	—	06½
Graphite, high grade amorphous crude.....	lb.	02½	—	03
Pumice stone, imported, lump.....	lb.	04	—	50
Pumice stone, domestic lump.....	lb.	05	—	05½
Pumice stone, ground.....	lb.	06	—	07
Quartz (acid tower) first to head, f.o.b. Baltimore.....	net ton	—	—	10.00
Quartz (acid tower) 1½ @ 2 in., f.o.b. Baltimore.....	net ton	—	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	—	—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange fine.....	lb.	.68	—	—
Shellac, orange superfine.....	lb.	.70	—	.71
Shellac, A. C. garnet.....	lb.	.53	—	.54
Shellac, T. N.....	lb.	.65	—	.67
Soapstone.....	ton	12.00	—	15.00
Sodium chloride.....	long ton	12.50	—	13.00
Talc, paper-making grades, f.o.b. Vermont.....	ton	11.00	—	20.00
Talc, roofing grades, f.o.b. Vermont.....	ton	8.50	—	13.00
Talc, rubber grades, f.o.b. Vermont.....	ton	11.00	—	18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	10.00	—	14.00
Talc, imported.....	ton	30.00	—	40.00
Talc, California talcum powder grade.....	ton	18.00	—	40.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	per ton	\$37.50—40.00		
Carborundum refractory brick, 9-in.	1,000	1250.00		
Chrome brick, f.o.b. Eastern shipping points.....	net ton	60		
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in car lots, f.o.b. Eastern shipping points.....	net ton	30-32		
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	36-40		
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	30-35		
Magnesite brick, 9-in. straight.....	net ton	70		
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	77		
Magnesite brick, soaps and splits.....	net ton	98		
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	42-45		
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	46-50		
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	35-38		

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00 — \$225.00		
Ferrochrome per lb. of Cr. contained, 6-8% carbon, carlots.....	lb.	.14	—	—
Ferrochrome, per lb. of Cr. contained, 4-6% carbon, carlots.....	lb.	.15	—	—
Ferromanganese, 76-80% Mn, domestic.....	gross ton	70.00	—	75.00
Ferromanganese, 76-80% Mn, English.....	gross ton	70.00	—	75.00
Spiegelisen, 18-22% Mn.....	gross ton	27.00	—	28.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.50	—	—
Ferrosilicon, 10-15%.....	gross ton	40.00	—	42.00
Ferrosilicon, 50%.....	gross ton	68.00	—	70.00
Ferrosilicon, 75%.....	gross ton	140.00	—	145.00
Ferrotungsten, 70-80%, per lb. of contained W.....	lb.	.45	—	.50
Ferrouanium, 35-50% of U, per lb. of U content.....	lb.	6.00	—	—
Ferrovandium, 30-40% per lb. of contained V.....	lb.	5.00	—	6.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content.....	gross ton	\$2.00 — \$10.00		
Chrome ore, Calif concentrates, 50% min. Cr ₂ O ₃	unit	35	—	40
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard.....	unit	35	—	40
Coke, foundry, f.o.b. ovens.....	net ton	4.00	—	4.50
Coke, furnace, f.o.b. ovens.....	net ton	2.75	—	3.00
Coke, petroleum, refinery, Atlantic seaboard.....	net ton	14.00	—	15.00
Fluorspar, lump, f.o.b. mines, New Mexico.....	net ton	12.50	—	—
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	18.00	—	20.00
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01½	—	.01½
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	25	—	—
Manganese ore, chemical (MnO ₂).....	gross ton	55.00	—	60.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.55	—	.60
Monazite, per unit of ThO ₂ , c.i.f. Atlantic seaport.....	unit	30.00	—	—
Pyrites, Spanish, fines, c.i.f. Atlantic seaport.....	unit	.14	—	.14
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.14	—	.14
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.12	—	.13
Rutile, 95% TiO ₂ per lb. ore.....	lb.	.15	—	—
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	2.75	—	3.00
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	3.00	—	3.25
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	1.50	—	2.50
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.25	—	2.50
Vanadium pentoxide, 99%.....	lb.	12.00	—	14.00
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1.00	—	—
Zircon, washed, iron free.....	lb.	.03	—	—

Non-Ferrous Metals

New York Markets

Copper, electrolytic.....		12.75		
Aluminum, 98 to 99 per cent.....		28.00 @ 28.5		
Antimony, wholesale lots, Chinese and Japanese.....		41		
Nickel, ordinary (ingot).....		41.00		
Nickel, electrolytic.....		44.00		
Monel metal, spot and blocks.....		35.00		
Monel metal, ingots.....		38.00		
Monel metal, sheet bars.....		40.00		
Tin, 5-ton lots, Straits.....		29.00		
Lead, New York, spot.....		4.40		
Lead, E. St. Louis, spot.....		4.12-4.25		
Zinc, spot, New York.....		4.55		
Zinc, spot, E. St. Louis.....		4.20-4.25		

OTHER METALS

Silver (commercial).....	oz.	\$0.59		
Cadmium.....	lb.	1.00-1.25		
Bismuth (500 lb. lots).....	lb.	1.50 @ 1.55		
Cobalt.....	lb.	4.00		
Magnesium (f.o.b. Philadelphia).....	lb.	1.25		
Platinum.....	oz.	75.00		
Iridium.....	oz.	160.00 @ 180.00		
Palladium.....	oz.	65.00-70.00		
Mercury.....	75 lb.	46.00-47.00		

FINISHED METAL PRODUCTS

		Warehouse Price		
		Cents per Lb.		
Copper sheets, hot rolled.....		21.25-21.50		
Copper bottoms.....		28.75-29.00		
Copper rods.....		20.00		
High brass wire.....		17.25		
High brass rods.....		14.25		
Low brass wire.....		16.75		
Low brass rods.....		18.75		
Brazed brass tubing.....		27.50		
Brazed bronze tubing.....		32.25		
Seamless copper tubing.....		22.00		
Seamless high brass tubing.....		20.00		

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York	Cleveland	Chicago
	Current		
Copper, heavy and crucible.....	9.25 @ 9.50	9.25	9.50
Copper, heavy and wire.....	8.25 @ 8.50	8.50	8.50
Copper, light and bottoms.....	7.25 @ 7.75	7.50	7.25
Lead, heavy.....	3.25 @ 3.50	3.25	3.25
Lead, tea.....	2.25 @ 2.35	2.25	2.25
Brass, heavy.....	4.25 @ 4.50	4.50	5.00
Brass, light.....	3.25 @ 3.50	3.25	3.50
No. 1 yellow brass turnings.....	4.25 @ 4.50	4.25	4.50
Zinc.....	2.00 @ 2.50	2.00	2.25

Structural Material

The following base prices per 100 lb. steel or structural shapes 3 in. by ½ in. and larger, and plates ½ in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes.....	\$2.38	\$3.00	\$3.00
8 ft steel bars.....	2.28	2.80	2.80
Soft steel bar shapes.....	2.28	2.90	2.90
Soft steel bands.....	2.50	3.20	3.20
Plates, ½ to 1 in. thick.....	2.38	3.00	3.00

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

GADSDEN—The Etowah Health Chemical Co. has acquired a local building and will establish a new plant for the manufacture of sweeping compounds and kindred products.

Arkansas

EL DORADO—The El Dorado Refining Co., recently incorporated, has preliminary plans under way for the erection of a new oil refinery. The initial works will comprise two units, each with daily output of about 1,000 bbl. It is proposed to increase this production to about 5,000 bbl. per day at a later date.

SPRINGDALE—The Welch Grape Juice Co., home office, Westfield, N. Y., plans the erection of a large plant here, for the manufacture of grape juice from the product of the vineyards in the Ozark regions of Arkansas. W. A. Ragland, McCall Bldg., Memphis, Tenn., will have direction of this work.

California

SAN FRANCISCO—The W. K. Minerals Co., San Francisco, has acquired the property and business of the Magnesia Products Co., with mineral lands near Patterson, Stanislaus Co. The new owner is said to be planning for extensive operations at the property for the manufacture of magnesia products.

Delaware

WILMINGTON—The blending house at the plant of the United States Flashless Powder Co., Carrerott, near Wilmington, was damaged by fire, caused by an explosion, June 30. An official estimate of the loss has not been made.

WILMINGTON—The Darco Corporation, du Pont Bldg., a subsidiary of the Atlas Powder Co., is said to be selecting a site in Louisiana, in the vicinity of Houma, for the erection of its proposed new carbon-refining works, estimated to cost about \$1,000,000 with machinery. The carbon will be produced from lignite beds in this section. W. J. Webster, head of the Atlas company, is president of the Darco Corporation; H. B. Walmsley is vice-president and secretary.

Illinois

BLUE ISLAND—The American Wire Fabrics Co., 136th St. and Western Ave., is taking bids for the erection of a new 1-story galvanizing plant at its works, 47 x 145 ft. A warehouse building will also be constructed and both structures are estimated to cost about \$100,000. Headquarters of the company are at 208 South La Salle St., Chicago.

CHICAGO—LaSalle Extension University is planning the erection of a \$500,000 building at the southeast corner of Michigan Ave. and 41st St. Architect's plans call for a 6-story reinforced-concrete structure with white terra cotta exterior.

Indiana

COLUMBUS—The Indiana Oil Refining Co. will commence the immediate erection of the superstructures for the different buildings at its new refining plant, located on a site about three miles from the city. Foundation work has been completed. The new refinery is estimated to cost about \$500,000 with machinery. O. L. Bartlett is president.

Iowa

DES MOINES—The Keith Furnace Co., West 11th St., manufacturer of furnaces, etc., is taking bids for the erection of a new 1- and 2-story plant at East 26th St. and Bran Ave., estimated to cost about \$250,000 with equipment. Boyd & Moore, 314 Security Bldg., Des Moines, are architects.

Kentucky

ASHLAND—The Mayo Oil Service Co., 11th and Front Sts., recently incorporated, is planning for the erection of a new oil refinery on a local site. John C. C. Mayo is president and treasurer.

Louisiana

SHREVEPORT—The Henderson Cotton Oil Co. is reported to be planning for the rebuilding of the portion of its plant, destroyed by fire, June 22, with loss estimated at about \$300,000, including equipment.

Maryland

BALTIMORE—The Gwynns Falls Paper Co., 517 Calvert Bldg., has completed plans for its proposed new plant at Gwynns Falls and will begin construction during the present month. The plant will be devoted to the manufacture of high-grade paper board products and will be equipped for a maximum daily output of about 85 tons of material. It will give employment to about 150 operatives and is estimated to cost in excess of \$500,000. Joseph H. Wallace & Co., 5 Beekman St., New York, are engineers. Joseph G. Mayo, formerly connected with the Spanish River Pulp & Paper Mills, Canada, will be manager at the plant. George W. Davis is head.

BALTIMORE—The Holdtite Rubber Co., 919 Baltimore St., has foundations under way for the erection of its proposed new plant at Warner and Ostend Sts., for the manufacture of rubber specialties. It will be 1-story, 50 x 125 ft., and estimated to cost about \$25,000.

Michigan

DETROIT—The Solvay Process Co., Syracuse, N. Y., has arranged for the curtailment of operations at its local plant for an indefinite period.

Missouri

ST. LOUIS—The Wrought Iron Range Co., 5661 Natural Bridge Ave., has filed plans for the erection of its proposed new 2-story plant addition, 146 x 220 ft., estimated to cost about \$75,000. The Murch Bros. Construction Co., Railway Exchange Bldg., is contractor.

KANSAS CITY—The new chemical laboratory now being erected at 729 Holmes St. by A. W. Estabrook is nearing completion and will be equipped and placed in operation at an early date. The structure is 2-story and basement, 40 x 60 ft.

New Jersey

LAKEHURST—The War Department is arranging for the abandonment of the property occupied here by the chemical warfare plant, and plans are being perfected for the removal of this work to the Edgewood Arsenal, Maryland. The local site is about 18,000 acres and will be placed on the market.

JERSEY CITY—Colgate & Co., 105 Hudson St., are said to have plans under way for the remodeling and improving of the state reformatory buildings at Jeffersonville, Ind., recently acquired for the establishment of a new branch plant for the manufacture of soaps, powders and kindred specialties. With new structures, the work is estimated to cost about \$500,000.

MILLVILLE—The Whitall Tatum Co. has blown out two of its local glass manufacturing plants for the summer season. The glass works at South Millville will be continued in service for several weeks.

New York

SYRACUSE—The Onondaga Pottery Co., 1858 West Fayette St., manufacturer of earthenware products, is completing plans for the erection of a new plant on Court St., estimated to cost about \$500,000 with machinery. No date has as yet been set for asking bids, or time decided for erection of the structure. Guy L. Noble, Union Bldg., is engineer.

MELLENVILLE—The Columbia Valley Paper Co., 44 Howard St., Albany, N. Y.,

has completed plans for the erection of a new paper mill at Mellenville. Construction will be commenced at an early date. F. B. Oldham is president.

ALBANY—The Hires-Turner Glass Co., 30th and Walnut Sts., Philadelphia, Pa., has awarded a contract to the Panzieri-Hogan Co., 90 State St., Albany, for the erection of its proposed new local plant on Tivoli St., comprising main glass manufacturing building and boiler plant, estimated to cost about \$100,000.

North Carolina

MIDVALE—The Canton Brick & Fireproofing Co., Canton, N. C., is planning for the construction of a new plant at Midvale for the manufacture of brick and other burned clay products.

Ohio

STEUBENVILLE—The Wheeling Steel Corporation, Wheeling, W. Va., has preliminary plans under way for extensions and improvements at its La Belle Iron Works, Steubenville, to cost in excess of \$2,000,000. It is said that the company proposes to develop this plant as its leading producing unit.

SANDUSKY—The Hord Color Products Co. has completed the erection of its new plant, to replace the works destroyed by fire last fall, and operations have been started.

Oklahoma

ENID—The Garfield Refining Co. has acquired the properties of the Oil State Petroleum Co., the Healdton Oil Co. and the Penn-Oklahoma Oil Co., with total holdings estimated at \$4,000,000 in valuation. The new owner plans for extensive development and operation.

Ontario

HAILEYBURY—Fire, June 27, destroyed a portion of the plant of the Haileybury Brick & Tile Co., with loss estimated at about \$22,000.

Texas

ORANGE—The Reclamation Oil Co., recently incorporated with a capital of \$2,000,000, has plans under way for the erection of a new oil-refining plant on local site. E. J. Pike is president.

CORPUS CHRISTI—The Isthmus Co. is planning for the erection of a new distillation plant in connection with a local gas works, estimated to cost close to \$150,000.

SAN ANTONIO—The Taft Packing Co. is planning for extensions in its local cottonseed oil plant, to increase the daily production to about two carloads of material per day. Plans are under way for the construction of a new fertilizer manufacturing plant at Taft, Tex. Herbert S. Greene, San Antonio, is architect. V. H. Fetick is manager.

FORT WORTH—The White Eagle Refining Co., Augusta, Kan., is planning for extensions and improvements in its local oil refinery.

MARSHALL—The Industrial Gas Co. has awarded a contract to the Hope Engineering & Supply Co., Mt. Vernon, O., for the construction of a new local gasoline plant. With subsidiary works, the new plant is estimated to cost about \$350,000. W. H. Sedberry is engineer.

BROWNWOOD—The Blue Ribbon Refineries, Box 295, is planning for the installation of new filters, driers and other equipment at its oil works. P. J. Baney is president and manager.

Virginia

ROANOKE—The Viscose Co. of America, Marcus Hook, Pa., manufacturer of artificial silk under a chemical process, has plans under way for the erection of an addition to its plant at Roanoke to double the present capacity. The extension, with machinery, will cost close to \$1,000,000. The Ballinger Co., 105 South 12th St., Philadelphia, Pa., is architect.

PORTSMOUTH—The Texas Co., Texas Bldg., Houston, Tex., operating oil refineries, has acquired property, 100 x 600 ft., at Portsmouth, for the erection of a new plant. Preliminary plans are said to be under way.

West Virginia

WHITE SULPHUR SPRINGS—The Cosmopolite Mfg. Co., recently incorporated with a capital of \$25,000, will operate a local plant for the manufacture of spark plugs. G. P. Brown is president and W. M. Sullivan, vice-president.

Wisconsin

MILWAUKEE — The American Metal Products Co., 671 Kinnickinnic Ave., has awarded a contract to the Worden-Allen Co., Washington Rd., for the erection of a new 1-story foundry addition on Bernham Rd. A machine shop will also be constructed.

Capital Increases, etc.

THE PYRAMID BRICK Co., 1007 Scofield Bldg., Cleveland, O., has filed notice of increase in capital from \$300,000 to \$400,000.

THE BLANCHARD OXYGEN Co., Esopus, N. Y., has filed notice of dissolution under state laws.

A petition in bankruptcy has been filed against the **YARDLEY CHEMICAL CORP.**, 50 Union Sq., New York City, by a number of creditors.

THE HANNA FURNACE Co., Leader Bldg., Cleveland, O., producer of pig iron, has arranged for a bond issue of \$4,000,000 for general financing, operations, etc. The company is affiliated with M. A. Hanna & Co., Inc., H. M. Hanna, Jr., is president.

THE WILLIAM E. DEE CLAY MFG. Co., 30 North La Salle St., Chicago, Ill., has filed notice of increase in capital from \$100,000 to \$600,000.

THE DIBBLE COLOR Co., Detroit, Mich., manufacturer of colors, etc., has filed notice of increase in capital from \$50,000 to \$100,000.

THE OCTAGON DROP FORGE Co., 2428 Lowe Avenue, Chicago, Ill., has filed notice of increase in capital from \$30,000 to \$105,000.

THE PORT HURON SALT Co., Port Huron, Mich., has filed notice of decrease in capitalization from \$235,000 to \$10,000.

THE AMERICAN MARINE PAINT Co., 8 Bridge St., New York City, has filed notice of increase in capital from \$100,000 to \$250,000.

THE FIVE POINT CHEMICAL Co., Richmond, Va., recently incorporated, has filed notice of increase in capital from \$25,000 to \$150,000. John B. Brooks is president.

New Companies

THE BIXIE CORP., New York City, has been incorporated with a capital of \$55,000 to manufacture soaps, oils and kindred products. The incorporators are H. N. Henry, R. S. Childs and L. McManus. The company is represented by McKercher & Link, 17 Battery Pl.

THE RUBBER PROINATE CORP., Richmond, Va., has been incorporated with a capital of \$15,000 to manufacture rubber products. A. M. Rubenstein is president, and C. V. Blackburn secretary.

THE MERCHANTS LEATHER GOODS Co., Inc., Providence, R. I., has been incorporated with a capital of \$50,000, to manufacture leather products. The incorporators are Julius Abrams, Charles M. Robinson and Harry Lapen, 65 Moore St.

THE GEORGE F. CROAK FOUNDRY Co., Boston, Mass., has been incorporated with a capital of \$25,000, to manufacture iron, steel and other metal castings. The incorporators are George F. Croak, Athol, Mass., who has been elected president and treasurer; Winthrop Q. Nottage and Gerald M. Croak.

THE SIGNAL PETROLEUM CORP., Long Beach, Cal., has been incorporated with a capital of \$300,000, to manufacture petroleum products. The incorporators are J. C. Rogers, E. S. Dobbin and W. B. Murphy. The company is represented by Desmond & Larzelere, Long Beach.

THE CENTURY MANUFACTURING Co., Buffalo, N. Y., has been incorporated with a capital of \$100,000, to manufacture chemicals and paints. The incorporators are R. A. Maltby, W. N. Carlsile and F. F. Everingham. The company is represented by F. W. Thomas, Ellicott Sq., Buffalo.

THE FRANK MASON CHEMICAL Co., 737 West Madison St., Chicago, Ill., has been incorporated with a capital of \$20,000, to manufacture chemical products. The incorporators are Frank Mason, George E. Krueger and Elmer T. Good.

THE MILLS BROS. Co., Gloversville, N. Y., has been incorporated with a capital of \$200,000, to manufacture leather products. The incorporators are W. E. Mills, D. McEwen and R. E. Toye. The company is represented by F. L. Carroll, Johnstown, N. Y.

THE STATE LINE OIL Co., 28 East Jackson Blvd., Chicago, Ill., has been incorporated with a capital of \$82,500, to manufacture refined oil products. The incorporators are Paul Herbert, E. J. Alexander and B. M. Schlichting.

THE J. F. MOSSER CORP., Boston, Mass., has been incorporated with a capital of \$100,000, to manufacture and deal in tanning extracts and kindred products. J. F. Mosser, 176 Federal St., is president and treasurer; Joseph N. Welch and G. L. Willson are directors.

THE FEDERAL CHEMICAL CORP., Hyattsville, Md., has been incorporated with a capital of \$100,000, to manufacture chemicals and byproducts. The incorporators are William A. Mills, J. L. Humphrey and E. G. Bucklin, Hyattsville.

THE HAMLIN OIL Co., Buffalo, N. Y., has been incorporated with a capital of \$50,000, to manufacture oil products. The incorporators are C. P. Lake and A. Wlberg. The company is represented by W. H. Warhus, Ellicott Sq., Buffalo.

THE COAL GROVE BRICK & TILE Co., Huntington, W. Va., has been incorporated with a capital of \$100,000, to manufacture brick, tile and other burned clay products. The incorporators are T. E. Jeffries, Huntington; and J. W. Lowry, Ironton, O.

THE LANTAGNE LABORATORY, INC., Lowell, Mass., has been incorporated with a capital of \$40,000, to manufacture chemicals, drugs, etc. Joseph T. Lantagne is president; and William A. O'Malley, Draught, Mass., treasurer.

THE MARINE PETROLEUM Co., Chicago, Ill., has been incorporated with a capital of \$1,000,000, to manufacture oil products. The incorporators are L. E. Gowan and A. E. Manheimer, 10 South LaSalle St.

THE CLARK RUBBER SYNDICATE, Rochester, N. Y., has been incorporated with a capital of \$50,000 to manufacture rubber products. The incorporators are F. P. Dunham, I. D. Allen and S. A. Millington. The company is represented by G. V. Holton, attorney, Rochester.

THE S-O-BELL SOAP Co., Kittery, Me., has been incorporated with a capital of \$250,000, to manufacture soap and kindred products. Horace Mitchell is president and D. E. Phillips treasurer, both of Kittery.

THE MONROE OIL & REFINING CORP., Fort Worth, Tex., has been incorporated with a capital of \$1,000,000 to manufacture refined oil products. The incorporators are H. H. Harolson and V. S. Monroe, Fort Worth; and C. W. Perry, Polytechnic, Tex.

THE TENNESSEE METAL TIE Co., Camden, Tenn., has been incorporated with a capital of \$100,000 to manufacture metal ties and other metallic products. The incorporators are Ira L. Presson, J. F. Lindsey and J. M. Holladay, Camden.

THE WOFFORD OIL Co., Birmingham, Ala., has been incorporated with a capital of \$10,000,000 under Delaware laws to manufacture oils and greases. The incorporators are George T. Wofford, J. Gregory Johnston and C. B. Deming, Birmingham.

THE CO-OPERATIVE PAPER BOX Co., Inc., 3502 Cottage Ave., Baltimore, Md., has been incorporated with a capital of \$50,000 to manufacture paper boxes and containers. The incorporators are Benjamin F. Garrett, Edward W. Williams and Alfred W. Watson.

THE GUY LEE LEATHER Co., Philadelphia, Pa., has been incorporated with a capital of \$15,000 to manufacture leather products. Guy Lee, Woodbury, N. J., is treasurer.

THE PHOSPHATE PRODUCTS Co., Mount Pleasant, Tenn., has been incorporated with a capital of \$250,000 to manufacture phosphates, fertilizers, etc. The incorporators are N. B. Stewart and E. E. Fisher, Mount Pleasant.

THE WYOMING DYESTUFF & CHEMICAL Co., Scranton, Pa., has been organized to manufacture sulphur colors, chemicals, etc. A. H. Ney is president and J. F. Higgins secretary-treasurer, both of Scranton.

W. C. DAMBACH, INC., Buffalo, N. Y., has been incorporated with a capital of \$40,000 to manufacture chemicals and chemical byproducts. The incorporators are W. G. Dambach, F. D. Perrin and J. J. Stein. The company is represented by Stein & Barber, Brisbane Bldg., Buffalo.

THE AURORE OIL Co., Syracuse, N. Y., has been incorporated with a capital of \$50,000 to manufacture oil products. The incorporators are A. L. and J. A. McAdam, and J. Bundy. The company is represented by Weils, Neily & Nichols, attorneys, Syracuse.

THE PHE-DER-MOL Co., Inc., Reading, Pa., has been incorporated with a capital of \$100,000 to manufacture special compounds, chemicals, etc. The incorporators are E. E. Clement, A. P. Utt, Reading; and S. B. Wentzel, Pottstown, Pa.

T. VAN AMRINGE & SON, INC., New York City, has been incorporated with a capital of \$60,000 to manufacture petroleum products. The incorporators are I. Kemp, W. R. Halsey and A. Y. Van Amringe. The company is represented by B. C. Meighan, 120 B'way.

THE BREWSTER DRUG Co., New York City, has been incorporated with a capital of \$25,000 to manufacture chemicals, chemical byproducts, drugs, etc. The incorporators are L. Walcott, C. Forbes and J. Rooney. The company is represented by C. A. Winter, 597 Fifth Ave.

THE MONTVILLE PAPER Co., Palmertown Road, Montville, Conn., recently incorporated with a capital of \$50,000 to manufacture paper products, has been organized with E. H. Backes, Wallingford, Conn., as president; C. E. Dunn, Wallingford, secretary, and R. C. Burchard, Montville, treasurer.

THE PERCY OIL Co., Clarksburg, W. Va., has been incorporated with a capital of \$500,000 to manufacture oil products. The incorporators are D. J. Carter and J. W. Woodell.

THE HOME RIDGE OIL Co., 1104 Harris Trust Bldg., Chicago, Ill., has been incorporated with a capital of \$10,000 to manufacture oils, greases, etc. The incorporators are R. O. Farrell, E. F. Brubaker and J. A. Langlands.

THE LUMINO MFG. Co., New York City, has been incorporated with a nominal capital of \$5,000 to manufacture soaps, polishes, etc. The incorporators are A. Podel, W. H. England and M. Katz. The company is represented by E. M. Garbe, 13 Park Row.

THE CORNWALL CHEMICAL CORP., New York City, has been incorporated with a capital of \$50,000 to manufacture chemicals and chemical byproducts. The incorporators are N. Criss, I. Mark and R. Brown. The company is represented by L. B. Bouldin, 110 West 40th St.

Industrial Notes

THE LYONS FAIR will hold its autumn meeting Oct. 1 to 15, 1921, in Lyons, France. This Fair is for the promotion of international trade, and American manufacturers are extended a hearty welcome to exhibit their products. The Fair exhibits all articles manufactured, from clothing to freight locomotives, and include in our field products for general engineering, industrial buildings, india rubber goods, agricultural products, agricultural machinery, etc. Information can be obtained by addressing Emile Garden, 150 Nassau St., New York City.

PAUL H. HSU, a graduate of the Massachusetts Institute of Technology and at one time employed as research chemist with the Larkin Co., Buffalo, N. Y., and also with the chemical division of the Procter & Gamble Co., Cincinnati, O., is on his way to China, where he expects to be engaged in consulting work and marketing of chemical machinery and materials. He requests that manufacturers send him catalogs, blueprints, etc. He can be reached care of Government Institute of Technology, 18 Sic-cawei Road, Shanghai, China.

THE AMERICAN CHEMICAL & SUGAR MACHINERY Co., Philadelphia, announces the Fred W. Kolb, its Pacific Coast representative, has associated with him M. Gillespie and that the business will now be handled by the firm of Kolb & Gillespie, 576 Moradnock Bldg., San Francisco.

ARNOLD, HOFFMAN & Co., 61 B'way, New York City, announce that they are now sole selling agents for the Belle Alkali Co. of Belle, W. Va., manufacturer of pure liquid chlorine, in 100-lb. and 150-lb. cylinders and 2,000-lb. tanks, and electrolytic caustic soda 76 per cent, solid and flake, in large and small drums.

THE WESTINGHOUSE ELECTRIC & MFG. Co. has opened an interplant wireless communication service between the East Pittsburgh plant and the Cleveland foundry. Besides the Cleveland and East Pittsburgh factories, the Springfield, Mass., works and the Newark, N. J., works are being equipped with stations for the transacting of company business.

THE COMBUSTION ENGINEERING CORP., New York City, announces that the sales organization in Philadelphia has been increased and a new service department inaugurated, which has necessitated getting new office space. Its new location is on the tenth floor of the Finance Bldg. The territory is under the management of W. C. Stripe.

THE ASBESTOS STEEL PLATE & SHEATHING Co. has leased warehouse space in the North Pier Terminal Warehouse, Chicago, with suitable offices at 319 North Wells St., to handle business in that territory.

THE ELECTRIC FURNACE CONSTRUCTION Co., Philadelphia, Pa., announces that the Compania Electro Metallurgica Brasileira and the Batcheller-McConnell Co., New York City, have recently acquired from Frank

Hodson, president of the company, and his Swedish associates the exclusive rights and licenses for Brazil for the Gronwall type "Electrometall" electric shaft smelting furnace. Two large furnaces, each of 3,000-kw. capacity, are at present being installed by the Brazilian company.

THE ARMSTRONG CORK CO., Pittsburgh, Pa., announces the following branch office changes: The Armstrong Cork & Insulation Co., Cincinnati, O., moved from 1608 First National Bank Bldg. to 1015 B'way. P. E. Thomas is manager. The Armstrong Cork & Insulation Co., Boston, Mass., moved from 84 North St. to 14 Columbia St. F. W. Robinson is manager, succeeding A. L. Dorr, who recently resigned. The Kansas City, Mo., office address is 529 Lee Bldg., this being only a change in name of the building.

THE FRANKLIN INSTITUTE OF THE STATE OF PENNSYLVANIA, acting through its committee on science and the arts, investigating the jet entraining apparatus of the Surface Combustion Co., New York City, has awarded to the inventor, W. Barton Eddison, the Edward Longstreth Medal of Merit.

H. E. LABOUR, who was formerly connected with the Chemical Equipment Co., has organized a new corporation under the name of the LaBour Co., with headquarters at Michigan City, Ind. This concern will be engaged in the manufacturing and sales business. One of the first units put on the market will be a new type of centrifugal pump invented by Mr. LaBour.

H. G. CARRELL has been appointed sales manager of Wing & Evans, New York City, the sales agents for the Solvay Process Co.

THE METAL & THERMIT CORP., New York City, has recently transferred William Aldrich from the Southern territory to the Western territory. He will travel extensively through California, Oregon, Washington, Idaho, Nevada, Utah and Arizona and will make his headquarters at the new South San Francisco office. William H. Moore, who until recently was assigned to the Chicago territory, now has charge of the Southern territory. This company also announces that in order to handle more satisfactorily its detinning business in the West it has constructed and will shortly place in operation in South San Francisco, Cal., a large new plant for the production of detinned billets, in addition to the detinning plants already operated at Chrome, N. J., and East Chicago, Ind. This new plant has been equipped with a large welding shop containing equipment and facilities for undertaking repairing by the Therman process.

THE TERMINAL ENGINEERING CO., New York City, has added to its staff J. F. McGonigal, formerly of the Foamite Co., and J. H. Potter, a graduate of New York University. M. E. Lyle, for many years with the Columbia Graphophone Co., has been elected a vice-president and is directly responsible for new business, and M. E. Peck has been elected secretary and assistant treasurer.

THE MAGNETIC CO. moved on June 20 into its new plant at 275 23rd Ave., Milwaukee, Wis. The new plant trebles the floor space in the former plant, providing up-to-date facilities for the continued production of its line of magnetic separators.

THE LINK-BELT CO., Chicago, has acquired all of the capital stock of the H. W. Caldwell & Son Co., and Frank C. Caldwell has been elected a director of the Link-Belt Co. The Link-Belt Co. has thus added two new lines, helicoid conveyors and power transmission machinery, to its present line of manufacture. The H. W. Caldwell & Son Co.'s plant will continue to operate under separate corporate existence and under its present name.

THE BROWN INSTRUMENT CO., Philadelphia, Pa., has opened a branch office in Cleveland in the Reliance Bank Bldg., to take care of that district.

PAWLING & HARNISCHFEGGER CO., Milwaukee, Wis., announces that the San Francisco office has been moved from the Monadnock Bldg. to 32 Beale St. At this new address the company maintains a complete service station warehouse and display room for cranes and hoists, machine tools and excavating machinery. R. M. Taylor is district manager.

SAVELL & FROST, of Niagara Falls, N. Y., announce that anhydrous aluminum chloride of high purity is now being produced in commercial quantities at their plant by a process which will make this chemical available for a number of uses requiring a better and cheaper material than has been obtainable heretofore.

THE DOMINION OXYGEN CO., LTD., is breaking ground for a new quarter million oxygen plant at Montreal, which will double the company's present capacity. The build-

ing will be 100 ft. x 100 ft. and will be substantially a duplicate of the company's Toronto plant, which until now has supplied oxygen to Canadian industrial users through five district distributing stations. The Montreal plant will be the second of five producing plants projected at the time the company was organized last year.

Manufacturers' Catalogs

THE DRAPER MFG. CO., Cleveland, O., has issued a very attractive catalog, No. 7, entitled "Steel Barrels for All Purposes." The first section illustrates and describes the various types of steel barrels and gives their capacity, dimensions, cubic space, weight and average number to car load. The Interstate Commerce Commission tests to which these barrels were subjected are explained. Pages 103 to 160 contain useful tables not ordinarily found in a catalog of this type. This feature makes the booklet of unique value.

THE PAWLING & HARNISCHFEGGER CO., Milwaukee, Wis., has issued two new leaflets, on shovel attachment for P. & H. types 205 and 206 excavator-cranes.

THE STEERE ENGINEERING CO., Detroit, Mich., has issued a pamphlet on "The Intensive Scrubber for Recovery of Ammonia from Coal Gas."

THE GRISCOM-RUSSELL CO., New York City, has issued Bulletin 1140, on Stratton team Separator, and a pamphlet on G-R expansion joint.

THE CHICAGO PNEUMATIC TOOL CO., New York City, has issued Bulletin 648, which describes little giant geared air hoists, motors and winches. This bulletin shows application views of this hoist in various industries and for innumerable operations, such as handling steel plates in storage yards, serving sheet steel to cutting machine at large boiler shops, etc. Copies will be sent to those interested, upon request.

THE CAROLINA, CLINCHFIELD & OHIO RY., Johnson City, Tenn., has issued a booklet on "The Mineral Resources of the Clinchfield Territory."

CARRIER AIR CONDITIONS CO. OF AMERICA, Buffalo, N. Y., has issued Catalog 480, on "Carrier Air Washers and Humidifiers," which is well illustrated.

THE PACIFIC TANK & PIPE CO., San Francisco, Cal., have issued Catalog 14 on "Pacific Wood Stave Pipe." This attractive 128-page catalog is the first pipe catalog this company has issued for a number of years and is the result of study of wood pipe for the past thirty years. Illustrations and description of some installations are given of Pacific wood-stave pipe and the various kinds of joints, fittings, valves, etc., that are used of both types—viz., "Continuous-stave" and "machine-banded." Tables have been inserted based on formulas resulting from an extensive series of investigations made by the U. S. Government. These are conceded to be the latest word on the subject of flow water through this kind of pipe. In the final section is a description of several Pacific products closely allied to the manufacture of wood-stave pipe.

THE PETROLEUM RECTIFYING CO. OF CALIFORNIA has issued a catalog on the Electrical Process for the Dehydration of Crude Oil Emulsions.

THE SULLIVAN MACHINERY CO., Chicago, Ill., has just issued Bulletin 78-A, which describes and illustrates dry vacuum pumps, single cylinder, steam and belt driven. These pumps are equipped with improved wafer type plate valves for both intake and discharge openings. The Sullivan Turbine Hoist is another new product, which is described in Bulletin 76. These hoists are used in mining of coal and metal and in many phases of industrial work.

THE WHEELER CONDENSER & ENGINEERING CO., Carteret, N. J., announces the publication of the 1921 edition of its "Steam Tables for Condenser Work." This is the sixth edition. The tables are in book form, pocket size. The properties of saturated steam are tabulated from 29.8 in. vacuum to atmospheric pressure in increments of tenths of an inch referred to a 30-in. barometer. The values were especially calculated for this book by Prof. Marks. As it is customary in vacuum work to read vacuum in inches of mercury, this is superior to the old method of giving absolute pressures in lb. per sq. in. Above atmospheric pressure the increments are in pounds gage. The book explains how measurements are made by means of the mercury column and barometer, and gives

constants and tables for making corrections. Corrections for the thermal expansion of mercury, for the relative expansion of mercury and brass scale, and other corrections are included.

THE PFAUDLER CO., Rochester, N. Y., has issued a new booklet on "Glass-Lined Steel Equipment," such as mixing tanks, stills, pots, crystallizing pans, etc. The company's research laboratory is featured as being the power behind the sales organization.

New Publications

BOOKS

SWEET'S ENGINEERING CATALOG, Seventh Annual Edition. Compiled, edited and published by Sweet's Catalog Service, Inc., New York. Cloth, 1251 pages; illustrated and indexed.

Sweet's Engineering is a catalog filing system which contains the separate catalogs of about seven hundred manufacturers. The field it covers is that of engineering and power plant equipment, or, to quote more definitely from the preface, it lists "Materials, equipment and supplies relating to the practical construction, equipment and maintenance of all projects of an industrial or engineering nature." In other words, the products it describes range from drawing boards to dynamos and from lighting receptacles to locomotive cranes.

The seventh edition of Sweet's Engineering, which has just appeared, marks an improvement in many ways over those which preceded it. The products index, for example, has been revised and simplified, so that it is now much easier to locate any desired information. This information, in turn, has been arranged in a more logical fashion. Even the appearance of the book has been improved by a better balance of cut and by the use of a better quality of paper. The new edition is smaller, lighter and easier to handle, although the number of pages in the volume and the number of firms represented show a marked increase.

TEXT BOOKS ON THE MANUFACTURE OF PULP AND PAPER. Five volumes. Price, \$5 per volume. Published by the Joint Committee on Vocational Education of the Pulp and Paper Industry, Thomas J. Keenan, secretary of T.A.P.P.I., 542 Fifth Ave., New York City.

Volumes I and II of this set deal with arithmetical calculations, elementary mathematics, drawings, etc. Volumes III, IV and V, to be issued shortly, will deal with pulp woods and their preparation, manufacture of pulp, analytical methods and all aspects of paper manufacture. In the selection of classroom problems bearing on the principles and practice of pulp and paper manufacture these books represent a high standard in text book publishing.

Coming Meetings and Events

AMERICAN CERAMIC SOCIETY's summer meeting will be held at Canton, Alliance, Sebring and East Liverpool, Ohio, July 25 to 27. Headquarters will be at the Hotel Courtland, Canton, Ohio.

AMERICAN CHEMICAL SOCIETY, THE SOCIETY OF CHEMICAL INDUSTRY and the American Section of the latter society will hold a joint meeting in New York, Sept. 6 to 10.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in Lake Placid, N. Y., Sept. 29 and 30, and Oct. 1.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its fall meeting at Wilkes-Barre, Pa., Sept. 12 to 17.

AMERICAN MINING CONGRESS AND NATIONAL EXPOSITION OF MINES AND MINING EQUIPMENT will hold its twenty-fourth annual convention in the Coliseum, Chicago, Oct. 17 to 22.

AMERICAN SOCIETY FOR STEEL TREATING will hold its third annual convention and exhibition Sept. 19 to 24 at Indianapolis.

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SEVENTH) will be held during the week of Sept. 12 in the Eighth Coast Artillery Armory, New York City.

NEW JERSEY CHEMICAL SOCIETY has discontinued meetings for the summer and will resume them in October.

SOCIETY OF CHEMICAL INDUSTRY (BRITISH) at the invitation of the Montreal section will hold its annual meeting in Montreal and other Canadian cities during the week of Aug. 29, 1921. Details will be printed in this magazine from time to time.

CHEMICAL & METALLURGICAL ENGINEERING

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A consolidation of
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ALAN G. WIKOFF
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CHARLES N. HULBERT
Assistant Editors
CHESTER H. JONES
Industrial Editor
J. S. NEGRU
Managing Editor

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New York, July 20, 1921

Number 2

Culture in Technical Education

AT THE twenty-ninth annual meeting of the Society for the Promotion of Engineering Education held at Yale University a few weeks ago, Prof. WILLIAM H. BURR, formerly professor of civil engineering in Columbia University, criticized the society for what he regarded as neglect to bring engineering education to such a plane that engineering as a profession would be elevated to a parity with law and medicine. The burden of his criticism was that the present four-year course in engineering, as given at most institutions, is quite inadequate to enable the graduate to command professional respect or discharge his highest duties as an engineer and a citizen. Characterizing the four-year course as a "college scientific course" and admitting that it had served a good purpose, he contended nevertheless that the time has arrived when a greater proportion of liberal arts must be mixed with science and engineering in order to reach a higher goal for engineers. He advocated a six-year course following high school preparation, devoting three years to liberal arts and three to engineering.

The subject has been before engineers and engineering teachers long enough so that more should have been accomplished than is evident. We are reminded of MARK TWAIN'S comment on the weather, when he said that everybody was always talking about it but nobody ever did anything about it. The situation in engineering education is not exactly parallel, because something has been done. The six-year course is established at Columbia University and other institutions have their combination undergraduate and graduate plans. For the most part, however, the four-year course prevails.

Prof. BURR has our support and approval. When the subject was still in the abstract we were convinced on general principles, supported by observation, that engineering and technical graduates were losing necessary breadth and culture through too close confinement to technical studies. It was apparent even then that a change would not be effected save by heroic action on the part of college faculties, because the necessity for study of the liberal arts could not be appreciated by young students. They were restive under instruction in subjects which had no apparent "practical" bearing. They itched to get into the field. But broad vision and sound counsel have prevailed in some quarters and the student is being better educated in spite of his personal predilection.

Considering the engineer as a citizen, we think that he can rise to even higher places of authority and responsibility than are now held by the lawyer and physician and that the community can learn to look up to him with greater confidence and assurance than they now show toward our public servants. But this will not be possible unless the engineer is given a broader

foundation than can possibly be built on technical studies. The lack may not be apparent in the first few years out of college, when competition for professional recognition and preferment is keen, but at forty the liberally educated engineer will surpass and excel his narrowly trained colleague, not only in general affairs of life but perhaps in engineering as well. The problem before the Society for the Promotion of Engineering Education, as we see it, is to discover those fundamentals in engineering education that will produce men who in their mature years will command not only professional respect from their colleagues but also recognition and approval from society in general. The details of the course of instruction can then be left to individual educators.

Ford Proposes to Buy Government Nitrate Plant

UNUSUAL interest attaches to the offer of HENRY FORD to purchase Nitrate Plant No. 2 at Muscle Shoals and to lease the Wilson dam. The disposition of these war-time projects has been a matter of great concern to the War Department on account of the vast sums already invested and the additional millions required to complete the dam and power plant. Our readers will recall that one solution proposed by Secretary Baker was the creation of the United States Fixed-Nitrogen Corporation to acquire and operate the nitrate plant, the dam and power plant to be completed at Government expense. Congress refused to create the proposed corporation, and declined to appropriate further money for the completion of the dam, work on which was stopped last Spring. With the change of administration Secretary Weeks finally announced that the nitrate plants would be retained under Army control in the most economical standby condition, but that he would not recommend an appropriation, estimated at about thirty million dollars, for the completion of the dam unless he could find private business interests that would assure him of the commercial utility of the project and agree to take it over and operate it when completed. Under such conditions he expressed himself as willing to recommend the necessary appropriation by Congress.

It is too early to determine whether Mr. Ford's proposal in detail will be satisfactory to the Secretary, though on its face it appears to conform to the announced requirements and will call for sincere consideration.

A number of interesting speculations may be indulged in. Has Mr. Ford definitely allied himself with the agricultural interests that have been urging Government operation of the nitrate plants for the production of fertilizer? Will his definite offer lend encouragement to the Congressional bloc that has

shown non-partisan strength in agricultural matters? How will Congress look upon Mr. Ford's offer in the light of its previous defeat of proposed legislation looking to the formation of a corporation to operate the nitrate plant and appropriation for continuance of work on the dam? It looks as though Congress and Secretary Weeks would be embarrassed if they now refuse to entertain this bona fide offer from a private source.

Seen Through

Friendly Eyes

IT IS not so many years since it was a fixed habit of a few critical travelers from Europe to come to this country for a few days, and after seeing New York City and Niagara Falls return home to write their impressions. Probably there was an equal number of Americans who were guilty of the same performance in regard to Europe. Having made a few isolated observations, they promptly drew general conclusions which illustrated mainly their lack of intelligence. Conditions are much improved today, however, because people on both sides of the Atlantic have taken pains to see more of the countries they visit. Intelligent Europeans no longer think they are in the West when they reach Pittsburgh—in this respect surpassing some of our natives. Nor do Americans think that they have seen England or France through a business trip to London or Paris.

It is always refreshing to read the impressions of an intelligent and alert visitor who is familiar enough with conditions at home to enable him to make his comparisons and draw his conclusions rationally. If it so happens that he is of our trade or profession, the more interested are we in his observations on things in general, because we may assume that he sees them through eyes trained much like our own. Accordingly we looked forward with pleasure—and were not disappointed—to the impressions of ERNEST J. P. BENN, of the *Chemical Age*, London, who made a recent business tour of the United States. In a delightful address before the New York Business Publishers Association Mr. BENN gave an intimate view of industrial conditions in England, and after he returned home he published in the *Chemical Age* a very frank and illuminating statement of his impressions regarding ourselves. The fairness of his judgment in the latter case only serves to lend confidence in his appraisal of conditions at home.

Observe the frankness with which he endeavors to convey his opinion that the trouble with England is that it is "absolutely steeped up to the neck in socialism," of innumerable brands, all having their roots in the broad conception that there is something wrong with private enterprise, private property, wealth and profit, and claiming that we must produce for use and not for profit. As a remedy for this distressful condition he sees the need of a crusade in England on behalf of a true understanding of that system of thrift, work and economy called capitalism, which offers opportunity for individual initiative. Contrasted with this condition in England, the American socialist, in Mr. BENN's eyes, is of a pale, anæmic variety, quite incapable of qualifying for membership in the English Socialist party.

But if Mr. BENN failed to find socialism rampant in this country it did not affect his observation of that outstanding difference between industry in England and America—quantity production by mechanical means.

He sees us devoted also to personal efficiency, which is largely responsible for the fact that we accomplish more per unit of time than do our English friends. He reaches the conclusion that even prohibition is accepted in principle as "a weapon in international industrial competition." In his mind it is "the greatest force to be reckoned with in the world today." Efficiency in industry and in personal matters is seen by Mr. BENN as a fetish of the American people.

There is encouragement for American industry in these views on the part of one who has studied industrial conditions in England and observed them critically in the United States. When we are inclined to think that we have trouble with labor and production, we can find solace in Mr. BENN's conclusion that "America is not heaven, but it is, as I see it, as near to an economic heaven as we mortals shall ever approach."

Readjustment

Or Economy?

A FEW months ago all the talk about business affairs generally was that we had entered a period of readjustment. The thought was that the period would be a short one, in which we should simply revise our price lists and things and then business would go ahead much as formerly. The most common remark was that buyers had gone on strike, the idea of a strike of course being that the striker has certain terms and will go to work whenever he gets those terms. The common thought seemed to be that the buyers would win the strike and that would be the end of it. It was all very simple. If a manufacturer could not sell profitably at the prices bid, all he had to do was to reduce his costs. If workmen wanted wages that were too high all that was necessary was for them to be idle a few weeks, or possibly months in the case of the most recalcitrant, and then they would be back at their old jobs, simply working for less money. The bright remark was made that this industrial depression was different from those of the past in that the people knew this time precisely what they were waiting for.

We all know better now. It is much more than a readjustment. It is vastly more than a revision of price lists and wage scales, much more even than a change in men's minds whereby they will kindly become willing to work harder for society, whether in making profits or earning salaries or wages. We have to build up afresh. We must not only become willing to work, we must find a job, or devise means whereby we can render better service.

It is only a few months ago that the main thought was about prices. They would have to come down, and the idea was that as soon as they had come down they would start advancing again. That is not the natural course of affairs. During the war and for a time afterward an "endless chain" was much spoken of, whereby one advance brought on another, and so around a circle. There was an ascending spiral. Can there not be a descending spiral? Dr. RALPH G. HURLIN, statistician of the Russell Sage Foundation, has answered this question, by carrying an index number of commodity prices in the United States back to 1810. This shows that after the war of 1812 there were generally descending prices for about thirty years, then advances culminating in the Civil War, after which there were declining prices for about thirty years, advances then culminating, as we all know, in

1920. One may say that things are different now, but a sapient observer in 1865 might have pooh-poohed the statistics of what followed the war of 1812—that was ancient history! Of course a war does not cause advancing prices for thirty years before it occurs. Quite likely the general or normal trend is upward, but a war sends prices so much above normal that it takes many years for complete return to normal. Dr. HURLIN'S figures, by the way, shows the three war peaks to be of practically the same height, and there is no great difference in the two troughs.

It is not a quick readjustment, something to be got through with, but simply years and years ahead of us of hard work, economy and striving for greater and greater efficiency. It is not a case of waiting until the thing is done. The matter of prices is a statistical detail. From about 1896 to 1920 the trend in prices and wages was generally upward. Those who succeeded by reason of that fact will have to adopt a new philosophy. Those who succeeded because they were economical and efficient will not have to change. There will be no success in waiting for prices to come down or in waiting for them to go up. Success will come in reducing costs, and then reducing them more.

Concerning the Threefold State

OUR READERS may recall that in our issue of May 25 we gave the index number of various commodities showing average prices for April of this year as compared with those of 1913 at 100. We recorded farm products as 115, foods 141, clothing 186, building materials 203, housefurnishing goods 274, etc., and it seemed rather hard for the farmer getting 115 for his product to pay 274 to furnish his house.

The fact is and always has been—as a general rule, of course, and subject to modification—that everyone gets as much as he can for his work or his wares. The trouble is that some trades are able to jockey for position while others are not. In our present situation there are occupations which do not call for intelligence above that of a child of twelve or fourteen years, requiring hardly any preparation and involving no personal responsibility, which are better paid than work calling for long years of professional training. Coincident with this we have a great deal of unemployment and not a little suffering from actual want.

Collective bargaining has great merit, and we doubt if employers of labor as a whole are good enough to get along without it. But collective bargaining, as we call it, is a misnomer. It is rather group bargaining, and the separate groups often play havoc with the general welfare. It has also a degrading tendency on skilled labor, for it destroys initiative and sometimes discourages specially good work. By including unskilled labor in certain occupations it has made a hod-carrier a \$10 man, while the draughtsman in the architect's office who is a graduate architect gets \$30 or \$40 a week. We do not begrudge the hod-carrier his \$10 a day, or whatever he gets; we object only to the high price that his less lucky brother must pay for rent in consequence of increased building costs. What we lack is co-ordination in the rewards of labor that would provide for the welfare of all.

All sorts of remedies have been proposed for the former evil which obtained when employers fixed wages and the present one when leaders of separate groups of laborers fix them for those they represent, but the

right way does not seem to have come into function. Now comes a new proposal by Dr. RUDOLPH STEINER, a Hungarian, whose book "The Threefold State" has had a great sale in Continental Europe and in England, but as yet has not got into general circulation here. Dr. STEINER holds that most of society's ills are due to excessive centralization. He describes the contradictory forces at work and proposes to separate the fields of human endeavor into a trinity of departments, viz.: into the Economic, the Political, and the Spiritual State.

The Economic State is concerned with materials, with the most economical production, and the distribution of commodities. It is business; it employs labor, but does not fix wages. Labor is not a commodity, and to confuse the function of men with that of materials leads to trouble every time. We have not his book, but are informed that business may be conducted under such an economic state in a manner similar to that which now obtains except that employers shall have no voice in fixing rates of wages or hours of work. If the cost of labor is too high business will not undertake the venture.

The Political State fixes and adjusts the rates of wages for all crafts and all labor, and the hours of work. This is done by the people's representatives as a whole, and therefore all dispute between employers and employees as to wages and working hours shall come to an end. Then politics will not fix the pay for a few favored ones very high and let the others starve. If carrying a hod is worth \$10 a day and plasterers should get \$15 to \$20 for what they call "bankers' hours" (which are the hours of banks' customers rather than the hours of the bankers themselves), then these rates will rule. If, however, such wages make rents too high, the chances are that politics will bring them down, for there are too many printers, clerks, street railway employees, policemen and miscellaneous people for hod-carriers and plasterers to rule politics. Whatever politics says in regard to labor, goes.

The so-called Spiritual State includes education, the guarding of individual liberty, and is to hold the individual genius free from outside control.

That is the rough outline from a brief review of the proposal that is being widely read and considered in Europe. An industrial company called the Futurum Co., Ltd., with \$1,000,000 capital has been organized to carry on manufacture under Dr. STEINER'S plan at Dornach, near Basel, in Switzerland. The proposal has to do with governments rather than with corporations, as we understand it, but the projectors of the Futurum Co. are so certain of the merits of the plan that they believe their methods will become general and accepted by all.

We hope the book will soon become available, for it behooves us to keep posted on the ideas that are spreading. Had more intelligent persons who are familiar with the actual problems of administration made themselves thoroughly familiar with the socialist theories we might have been delivered from much of our present trouble. Many readers have been misled because they lacked the vision that comes from experience, and there has been lacking the quality of criticism that speaks from experience. We are free to confess that the Threefold State looks rather raw at first glance, but for all that it certainly deserves careful and sympathetic study. The present chaotic method of fixing wages by means of strikes and bludgeons is not sound.

Readers' Views and Comments

Heterogeneity in *Canis Variegatus*

To the Editor of *Chemical & Metallurgical Engineering*

SIR:—Having noted in a recent issue of your English contemporary the *Ironmonger* brief mention of an important research by my friend, Dr. B. Feeter, F.R.S., M.I.V., F.O.O.L., etc., etc., I take the liberty of forwarding you this somewhat more extended account of his remarkable findings, hoping for its hospitable reception in your columns. Dr. Feeter, as is well known, was the Kitchener Research Scholar for 1901, and Fitts medalist in 1903. His latest investigation into scientific technology is "On the Variations in the Distribution of Currants in Spotted Dog."

Spotted Dog, as it is perhaps unnecessary to point out, is the English urchin's pet name for a goody which to know is to appreciate. However, the question of the rendering in correct scientific language of the term "Spotted Dog" has been a matter of anxious consideration to the editor of the *Ironmonger*. It was finally concluded that the choice lay between *Canis variegatus* and *Canis maculatus*. The objection to *variegatus* was that, though the adjective might pass if the object under examination had been a pink or a peony, a variegated dog, and still more a variegated pudding, were monstrosities, even in Latin. On the other hand, *Canis maculatus* suggested not only a spotted dog, but a blotched or pimply dog, and even, if taken in its ethical sense, an immoral dog. What clinched the matter was the discovery that in the text about the leopard and his spots, spots is given as *varietates*. But anyway, says the editor rudely, one spotted dog-Latin word is as good as another. So his article was entitled "An Investigation of *Canis Variegatus*."

Dr. B. Feeter points out, in the first place, that it has long been recognized that marked irregularities occur in the distribution of currants in spotted dog. For example, Van p'Uff showed in 1907 in the *Archiv für Küchenwissenschaft*, Band CXIX, Heft 497, that in fifty commercial specimens examined by him there was marked segregation toward the center, and when this was excessive was very detrimental to its cohesion and general rigidity. Dr. P. L. Um proved, in *Wirtschaftliche Mitteilungen von Podingswesen*, for Jan. 15, 1908, by taking consecutive sections that currants were entirely absent from the extreme ends. Mr. P. R. Ice, in comment on this work, showed that little objection would be encountered from the purchaser if the currants were deep seated, that is subcutaneous, and not contributing to any surface defect. Mr. Chowder, in the National Quizzical Society's Memoirs for 1909, reviewed all the work of experimenters and propounded the theory that is now associated with his name. Mr. Chowder's hypothesis, as is well known, is based almost wholly on the assumption that the distribution of currants is effected solely by heat-treatment, and he rejects the hitherto accepted theory that it is caused by a lack of homogeneity in the plastic mass.

In order to test the soundness of this theory the author, with the advice and assistance of Prof. Costard, entered upon the research which is here recorded.

It had been suggested that a simple method of procedure would be to watch a number of spotted dogs

during the processes of manufacture, but this plan was rejected as both unscientific and unlikely to require the thousands of observations that are demanded by a modern research. It was felt that the correct course to pursue was as follows:

1. To obtain as large a number of spotted dogs as possible, and here it is proper to record special indebtedness to the co-operating concerns, who in the interest of science, and for the upbuilding of their product to technical excellence, have so generously supplied the specimens.

2. To make a complete analysis of each specimen.

3. To take consecutive sections (a) in a horizontal plane, (b) in a vertical plane, (c) in a plane inclined to the vertical, (d) in a plane inclined to the horizontal, (e) in tangential planes at intervals of five degrees round the circumference, and (f) in a left-handed spiral extended from the apex at one end to the apex at the other.

4. To test the specimens thus secured by tensile, bending, impact and torsion, both in the state as received, after having been fully annealed, and after a quenching. It was recognized by Dr. Feeter that these were not strictly required for the research, which, it may be remembered, was merely to study the *distribution* of currants in *Canis variegatus*. However, we are more clearly coming to perceive that the normal failures are not giving us the trouble to explain as are the abnormal, and the latter are doubtless due in the last instance to submicroscopic segregation. Consequently, any investigation into segregation has a special application in this direction. Furthermore, it was thought that the results of such a series of tests as in item 4 would furnish a volume of data which would enable a comparison with the results being obtained by the International Joint Co-operative Investigation of the Effect of Sulphophosphates on Meal.

5. To determine the hardness by the Brinell method and by the scleroscope.

6. To examine all specimens by reflected, transmitted, plane polarized light, and to determine, if possible, the number of currants per meter cube by counting the fragments of seeds as seen in an oil immersion microscope.

To carry out this program in its entirety no less than 12,500,764 separate observations had to be made, but the results have fully justified the work involved.

The original manuscript starts out by giving a description of the apparatus employed (which occupies seventy-five pages of his paper and is accompanied by forty-nine drawings and photographs). Then follows a tabulation of the results in 963 tables. It is much easier to appreciate the findings by examining the graphs which are attached to the original manuscript, 742 in all.*

CONCLUSIONS

1. It has been finally proved that dimorphic allotropic forms of dough (α dough and β dough) may exist side by side in a single specimen of the size used in these tests. The exact nature of β dough is unknown; Prof.

*Unfortunately it will be impossible to reproduce even a few of these remarkable diagrams on account of a lack of space.—[Ed.]

Costard holds that it is a true allotrope, although pseudomorph after another modification. B. Feeter, however, contends that it is a transitional form, between alpha and a hypothetical gamma state, which latter are thought to be the stable varieties. Beta is therefore probably a solid solution, or perhaps an allocolloid. Further research is necessary to clear this important point.

2. That undoubted segregation of currants does occur, being greatest toward the center of length and the middle third of the height.[†]

3. That segregation is irrespective of the nature of the dough, but

4. Is due in some manner that it was impossible wholly to determine to the heat treatment.

5. The determination of the $Ar_{1,2,3}$ points by means of the Le Chantecler pyrometer is rendered extremely difficult by reason of the freezing of the eutectic before the currants have gone into solid solution.

6. Several marked examples of twinning were observed, and the appearance of slip-bands supports Dr. Rosenfield's theory of viscous flow in the intercrystalline amorphous cement.

It should be noted that owing to a misunderstanding on the part of the laboratory boy, who is now suffering from fatty degeneration, the specimens set apart for observations on season-cracking were destroyed. Many instances of fire-cracking have been reported by the manufacturers, and it has been suggested that the Kitchener research fund make a further grant to determine this very practical commercial aspect of the question.

MARTIN SEYT.

Industrial Alcohol and Prohibition

To the Editor of Chemical & Metallurgical Engineering

SIR:—The article on "Industrial Alcohol and Prohibition" in the June 22 number of your journal is most illuminating. Dr. Whitaker struck the keynote when he said that the public, to say nothing of the prohibition enforcement agents, need education on the subject of the industrial importance of alcohol.

Words and letters are great teachers, but the greatest of all is experience. Suppose the alcohol producers of the United States refuse to produce or sell alcohol for any purposes whatsoever until the ridiculous enforcement and interpretation of the laws is done away with, and the legitimate use of pure and denatured alcohol is aided and encouraged as expressly provided for by the Volstead act.

Let the overzealous narrow-minded prohibition enthusiast go to the drug store and find that his favorite antiseptic, hair tonic, mouth wash or the simple household remedies such as tincture of iodine or spirits of camphor are either selling at a fancy price or not available at all—and his wife go shopping only to find that perfumes, flavoring extracts, celluloid articles, certain shades of cloth are not in stock. Let them both understand when they ask the reason for this state of affairs that alcohol is necessary for the manufacture of these articles, but that its sale and manufacture have been made so intolerable they have been temporarily abandoned.

Let the public learn by experience, if we cannot convince them any other way, the importance of industrial and medical alcohol. I dare say it would be only

a few weeks before the prohibitionists themselves would rush to make amends or pass legislation requiring the manufacture and sale of alcohol for legitimate purposes, which would accomplish the desired results.

In other words, let the public learn by experience, the quickest and best teacher, and the narrow-minded prohibitionist have his heart's delight—remove alcohol temporarily from the market.

Even if research, college and control laboratories have to close for a few months, the sacrifice will be worth the victory. Science must save her master tool, alcohol. For chemistry to go without alcohol is like trying to run an automobile on three wheels.

Malden, Mass.

EDWARD O. HOLMES, JR.

Recovery of Volatile Solvents by Bregeat Process

To the Editor of Chemical & Metallurgical Engineering

SIR:—I have read with interest the article by Messrs. Roulleux and Dort on "Recovery of Volatile Solvents by the Bregeat Process," and must compliment these gentlemen on the interesting data given therein, which will, I am sure, prove of considerable interest and service to many users of solvent recovery systems.

The industrial application of the Bregeat process is, of course, more or less similar to the application of other systems of solvent recovery in its principal points, and I do not wish in any way to decry the methods put forward or the results obtained.

There are only one or two statements in the entire article which I feel, in justice to several other processes available, should be corrected. While I am not personally familiar with the development of the Bregeat process in France prior to 1917, I am quite certain that processes for solvent recovery based on accurate scientific principles were in operation in Great Britain and this country before that time. I am personally familiar with the construction and installation of one plant in Great Britain for the recovery of ether-alcohol mixture from cordite manufacture, with which the Bregeat company had nothing to do whatever. I am also familiar with another installation in Great Britain, in 1915, which made use of a crude cresylic oil for the absorption of ether, alcohol and acetone mixture and, of course, in Great Britain crude creosote oil has been in use for many years for the absorption of benzene from coke-oven gases.

I wish to correct one or two statements in the summary, in which it is stated: "Until the Bregeat process had been developed the solvent recovery was not an industry itself. The Bregeat process is responsible for bringing solvent recovery out of the class of an incidental and casual art into that of an independent and well-established business."

It seems to me that these two statements require considerable modification in justice to both British and American firms which have been building and installing solvent recovery equipment of the highest type for several years. In Great Britain, I mention my own firm of Blair, Campbell & McLean, Ltd., of Glasgow, Scotland, which was probably the first in the field, and in this country Messrs. Badger of Boston, Lummus of Boston and finally, the American offshoot of Blair, Campbell & McLean, Ltd.—namely, the American Chemical & Sugar Machinery Co., which in co-operation with the Lewis Recovery Corporation of Boston has developed the explosion-proof solvent recovery system.

Philadelphia, Pa.

JAMES C. LAWRENCE.

[†]See Tables 904 to 950 and diagrams 300 to 360 of the original.—[Ed.]

Solvent Extraction in the Vegetable Oil Industry

Principle Involved in the Solvent Extraction of Oil From Vegetable Oleaginous Materials—Commercial Development of the Industry—Stationary and Rotary Types of Extractors—Principal Solvents—Economic Considerations—Uses of Products Obtained*

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FOR a great many centuries man has obtained vegetable oil from fruit and seed by applying pressure. One of the earliest applications was that simulating the simple mortar and pestle, whereby the operator broke the oil cells by pounding a small lot of the oil-bearing material in a heavy container and collected what oil flowed freely. An early application of power was the grinding mill operated by a bullock. Then were developed powerful edge-runner grinders in which the oleaginous material placed in a rotating pan was ground by vertical grindstones running on their rims. The direct application of static pressure to given lots of oleaginous material was the old wedge press, wherein the charge was bagged or wrapped in some sort of heavy cloth, placed in a frame and subjected to a pressure of many atmospheres by driving heavy wedges between the cake and a head block. Following this, the hydraulic press was developed, whereby the wrapped cakes of oleaginous material were subjected to powerful hydraulic pressure. A more recent development is the hydraulic cage press, whereby two or three times more pressure is applied and a steel basket is substituted for the cloth wrapping of the cake. In the best of these the cake still carries about 4.5 per cent of oil, and more usually about 5.5 to 6 per cent. Many mills cannot produce even as well as this.

In view of the ready solubility of vegetable oil in several volatile solvents and the universal laboratory application of this to the exacting requirements of quantitative analytical procedure, it is to be expected that effort would be made to apply it to industrial operations. This was successfully done about seventy-five years ago.

The principle involved embraces grinding the oleaginous material to such a degree that the oil cells are broken as much as practicable, and then treating the mass with an excess of some volatile solvent such as gasoline or benzene, drawing off the oil solution from the extracted residue (or pomace, as it is called), and distilling the solvent from the oil. The solvent is returned to storage and used for subsequent extraction. The process sounds simple, and so it is theoretically, but as an industrial operation it is somewhat involved and requires a high degree of technical attention to be a successful commercial enterprise.

COMMERCIAL DEVELOPMENT

The advantages and simplicity of the solvent extraction of oils early led to its application to the olive-crushing industry. The residues left after expressing as much oil as possible are treated usually with carbon bisulphide; hence the trade name, sulphur oil. This oil is of low grade, caused not only by the solvent used—

namely, carbon bisulphide—but also due to the residues having been previously pressed, macerated with water, heated and again pressed, often several times previously to extraction with solvent. Such technical mistreatment probably accounts in a large measure for much unfavorable criticism of extracted oil.

Before the war a large industry grew up in Germany based on the extraction of oil-seed cake which contained a particularly high percentage of oil. The inefficient crushing performance of tropical native and even more or less modern mills was the basis for this thriving industry and high-oil cake was shipped all the way from the Philippines to Hamburg. German firms were growing rich on what others wasted. Usually gasoline or one of the chlorinated hydrocarbons was the solvent. Both the oil and the meal were successfully marketed, although at a discount because of the quality produced.

For years the solvent extraction of oils has been practiced in England on a large scale. This has been quite successful, as is manifest from the favorable criticism appearing in the literature.¹ Extracted oil of high grade is now made for edible purposes, particularly for use in the margarine industry, but opinion differs as to the uniformly satisfactory character of the finished oil. This extracted oil is refined and deodorized following practices similar to those applied to hydraulically produced oil. A recently equipped mill has a capacity of 1,200 tons of raw material per week. Some mills produce their entire tonnage of oil by solvent extraction, without applying a preliminary hydraulic pressing to the oil-bearing material.

It is common knowledge that in Manchuria a soybean solvent extraction plant was installed several years ago and is apparently being operated satisfactorily. Several more such plants are now being introduced into Japan.

In the United States the use of solvent extraction has not been an unqualified success. Four concerns applied it to extracting linseed oil from flaxseed, using gasoline and the stationary percolator type of extraction machinery. One plant after another was discontinued until at the present time none of these plants is extracting by solvent. Much trouble was experienced in marketing the meal due to the difficulty of removing therefrom the residual traces of solvent. This unsatisfactory performance has become so widely known that today it is presented as irrefutable evidence of the futility of the method, notwithstanding the fact that modern practice has greatly improved the procedure by using improved equipment and better solvent. Only in the manufacture of castor oil and recovery of low-

*Prepared in connection with work done in the Office of Drug, Poisonous and Oil Plant Investigations, Bureau of Plant Industry.

¹*Oil and Color Trades Jour.*, Dec. 13, 1919, p. 2281; *Margarine and Allied Trades Jour.*, vol. 1, p. 382 (January, 1920).

grade industrial greases and fats does solvent extraction play a necessary and generally recognized part.

At the present time several extraction plants in this country are operating apparently satisfactorily on various vegetable oil-bearing materials. They are extracting coconut oil cake and parings, cottonseed, cottonseed cake, corn germs cake, castor beans, palm kernels, pine-tree wastes and other miscellaneous oleaginous materials. One plant here is said to be making a solvent extracted oil of edible grade for cooking purposes after refining and deodorizing it. Then, in addition to these,

This finds its greatest application in treating garbage and slaughter-house wastes. Several such plants are in active operation in the United States.⁷ Since, however, this is a special line, it is not discussed here.

TYPES OF EQUIPMENT

The machinery used in the solvent extraction of vegetable oil and other fat-bearing material consists of two general classes—namely, stationary and rotary. In the former the extraction unit is essentially a stationary tank, usually with its longer axis vertical, and

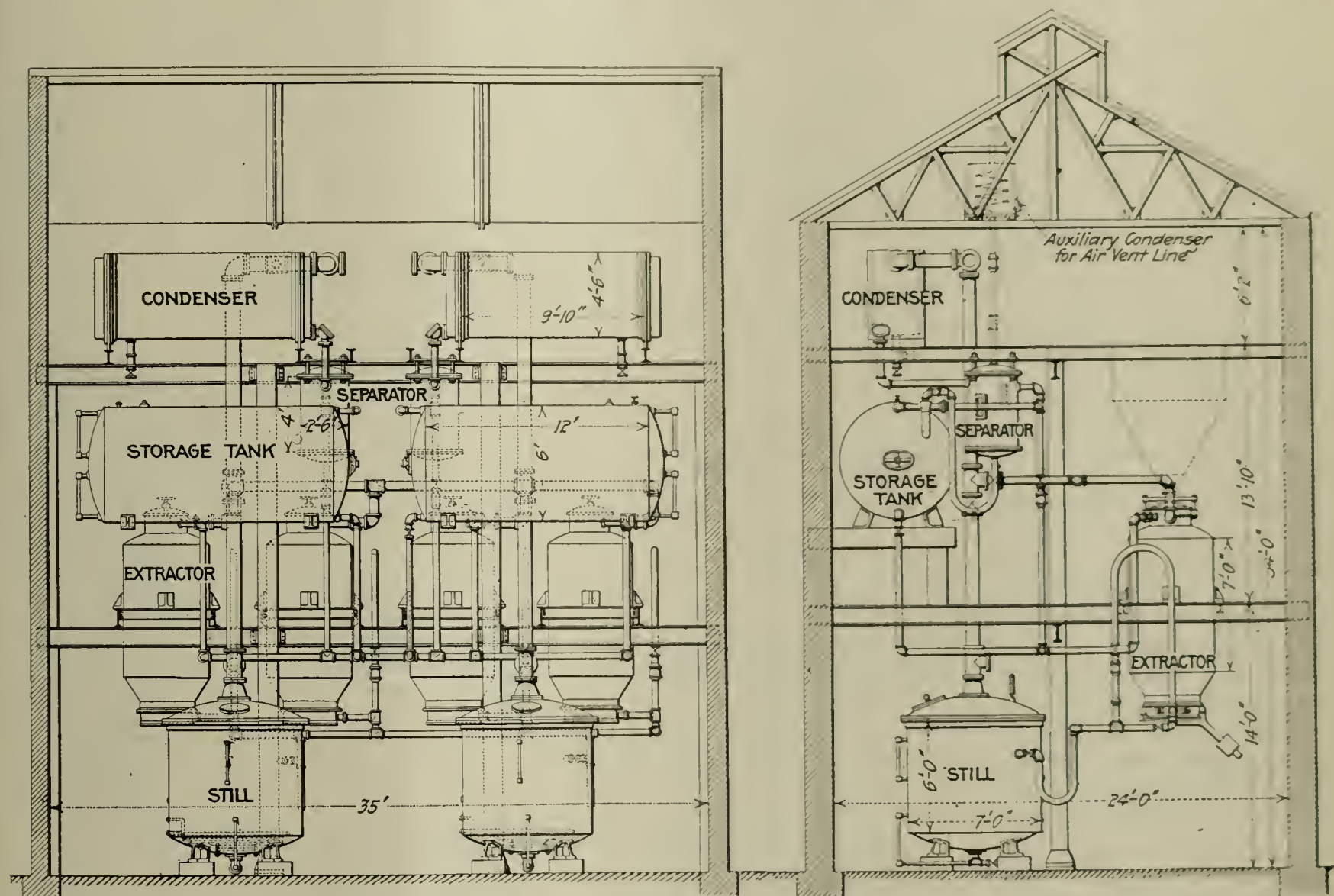


FIG. 1. SECTION OF EXTRACTION PLANT OF GERMAN TYPE

several plants are engaged in extracting the residual fat from bones and other animal wastes.

Thus this industry is fairly well developed. It has a foothold in the leading countries engaged in producing oil and is not only holding its own but is growing. Although originally developed for treating materials producing inedible oils and fertilizer, it has been so improved that now it is being increasingly applied to the production of oil and meal of edible grades. Among the materials treated by this process have been:

Palm kernels	Olive residues
Coconuts (fresh)	Rice bran
Copra	Fish residues
Rapeseed	Fullers earth
Soya beans	Pine chips and stumps
Linseed	Shay nuts
Castor beans	Mowrah nuts
Corn germs	Meat scraps
Cottonseed	Bones
Wheat germs	Garbage

Another phase of solvent extraction has been developed departing in some respects from the procedure as above described—namely, treating a wet oleaginous mass with solvent whereby the oil or fat is removed.

equipped with an agitator of some sort. The rotary extractor, on the other hand, is usually a tank shaped like a boiler and mounted to rotate on its horizontal axis, thus avoiding the necessity of an agitator.

STATIONARY EXTRACTORS

In Figs. 1, 2 and 3 are illustrated different types of stationary extractors. In Fig. 1 the system is more like the German development, in which continuous extraction with fresh solvent received special attention, according to the well-known Soxhlet principle. The solvent-oil solution in the still is kept boiling; the pure solvent vapor rises through the vapor pipe and is conducted into the extractor from above, slowly percolates through it and flows back into the recovery tank with oil in solution. Thus the oleaginous material to be extracted is becoming weaker and weaker in oil; the solution in the receiving tank is becoming stronger and stronger in oil. It is stated that this type is not suitable to the installation of large units, batches of one ton presenting the optimum working conditions. Such

⁷U. S. Pat. 1,267,611, May 28, 1918; *Chem. Ind.*, vol. 37, No. 17, p. 519-A, Sept. 16, 1918.

small charges may seem uneconomical, but on the other hand it is urged that a small batch can be more easily controlled, with consequent improvement in performance and quality of product.

In Fig. 2 the units are larger and represent the British type of equipment. The extractor unit may be 8 ft. in diameter and 12 ft. high. An iron plate perforated with $\frac{1}{2}$ -in. holes is placed over steam coils to form a false bottom. Over this is laid a plate with smaller holes, and again over this is placed a screen covered with a coarse textile. Such an arrangement keeps the charge of extractive material from falling into and clogging up the draw-off pipe. A stirring arm may be provided in the form of a curved sweep which rotates on the central vertical axis. Since the sill of the discharging door is almost flush with the floor of the extractor, the rotation of the stirring arm can be used to force out the extracted residue when the extraction and steaming off are concluded. The charging door on the top of the extractor allows loading from an overhead hopper or conveyor.

Fig. 3 shows a type in which during the first cycle the hot solvent is saturated as nearly as possible by repeated percolation of the oleaginous material, but without being evaporated and recondensed. In the second cycle the solvent is boiled off from the extracted oil in the lower compartment of the extraction cell, condensed and run back to the extraction cell, where it accumulates and periodically siphons back to the still below. This is in strict accordance with the Soxhlet principle and results in repeatedly washing the nearly spent material with clean solvent. The periodical siphoning is controlled by a float in the lower compartment containing the solvent. In the third cycle the extract accumulated in the still is concentrated by evaporating off the excess of solvent. The condensed solvent is conducted to the storage tank for repeated use. In the fourth cycle both spent meal and oil extract are freed from solvent by steam.

Plants recovering grease from garbage operate on the extraction principle. Several processes are being used for this purpose, but since this is a field in itself, no detailed consideration is given it here. The problem presents itself as one dealing with a low grease content (3 to 5 per cent) and a large amount of water (about 85 to 90 per cent).

ROTARY EXTRACTORS

A more recent type of extractor has been developed along somewhat different lines. This so-called rotary extractor consists essentially of a horizontal, boiler-shaped tank designed to rotate and provided with charging and discharging manholes. A false head or false

bottom allows the solvent with its content of oil to drain away from the oleaginous charge when the percolator is at rest and to be freely pumped out.

Figs. 4 to 6 illustrate several types of rotary extractors. The plant illustrated in Fig. 4 will handle about twenty-five tons per twenty-four hours. The extractors in Figs. 5 and 6 have free chambers placed above or below, or both, corresponding to a false top and false bottom; if one becomes clogged during the drainage of the solution, the extractor is rotated 180 deg. to use the fresh surface. It is evident that the rotating of the extractor serves to break up any tendency to lumping, channeling, etc. When the solvent has taken up a large amount of oil, the rotation is discontinued to allow ready removal of the oil-solvent solution. In the type wherein a free chamber extends the length of the unit (Figs. 5 and 6), the extractor is stopped in the position where the false bottom is below; in that provided with a false head any

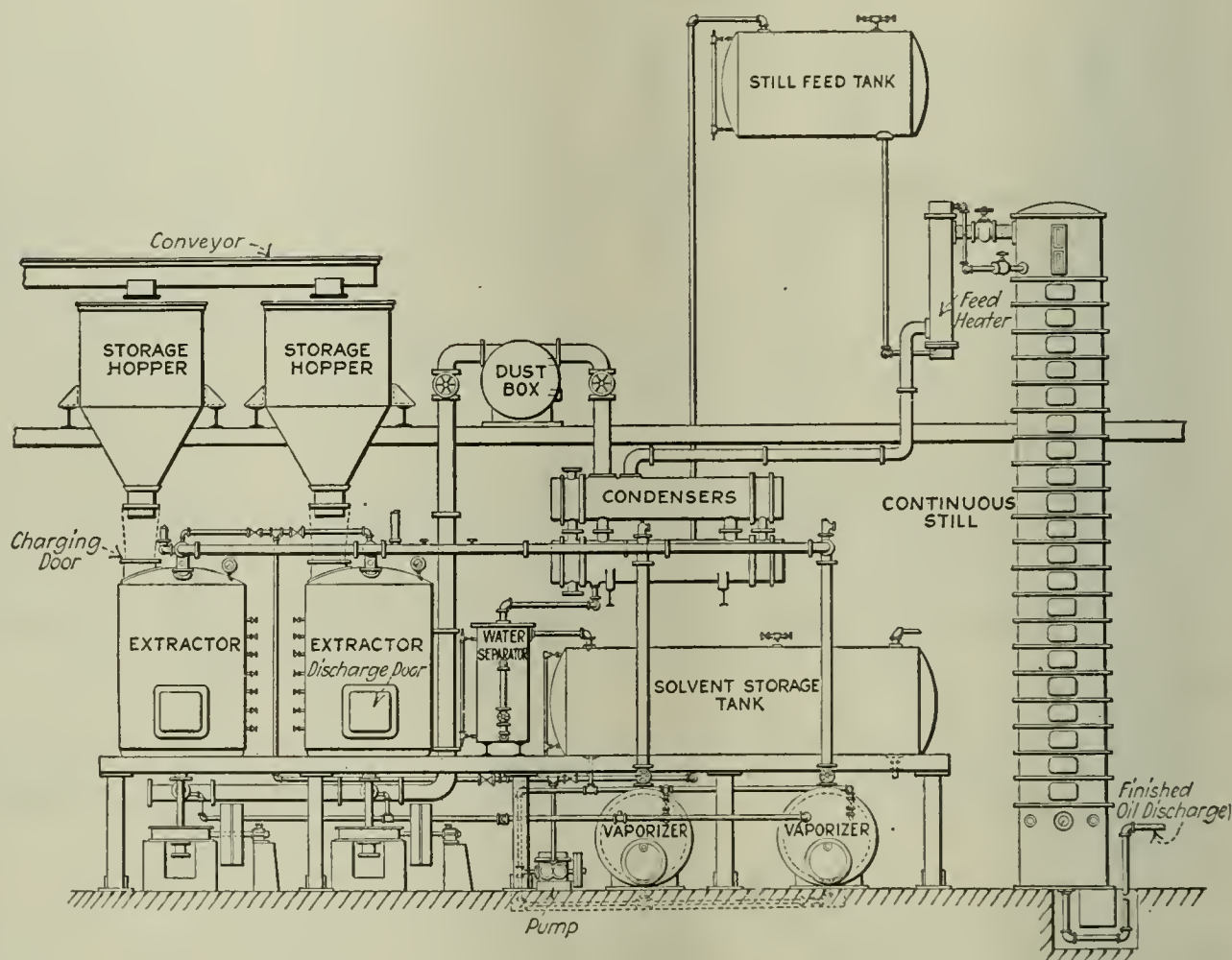


FIG. 2. SECTION OF STATIONARY PLANT OF BRITISH TYPE

position, when at rest, is satisfactory. The solvent-oil solution then slowly drains into the free space within the compartment, whence it is pumped out. A fresh lot of solvent (or preferably one used as a wash in a previous batch) is then pumped into the extractor, and the whole operation is repeated several times until the extraction reaches the point of economic equilibrium—i.e., until there remains so little oil in the charge that its removal is not profitable. In well-operated plants less than 1 per cent of oil is lost in the extracted residue.

Likewise in the process of solvent removal from the extracted oil-free residue (pomace), rotation serves to keep the mass from packing and from allowing the steam to blow through open channels and other free paths of travel.

When the process is complete, the manhole covers are removed and the machine is rotated. At every rotation a large part of the extracted and dried residue

is discharged onto a belt or hopper under the extractor and conveyed to the pomace storage house. The machine is emptied in a few minutes and is then ready for a new charge.

SOLVENTS

One of the most vital factors contributing to the success or failure of the solvent extraction process is that of the kind of solvent used. The issue is not joined so much to the relation between its chemical constitution and the quality of the oil extracted therewith as it is to what might be called the physical or certainly secondary chemical effects. Since these are more or less specific to the several solvents discussed, they will be considered under the respective solvents.

As stated above, carbon bisulphide was the first to be used on a large scale and is even now employed for treating olive residues of low oil content. Such so-called sulphur oil immediately raises in the mind of the trader and user a corroboration of the current discount borne by extracted oil. The technological abuse given the olive pomace before extraction, the more or less faulty equipment and the unsatisfactory solvent are

is a mixture of products with ascending boiling points, varying often from 80 deg. C. (176 deg. F.) to 170 deg. C. (338 deg. F.). When distillation of the solvent from the oil is attempted, the lighter fractions go over first in preponderating amounts. As these are more and more removed, the residual solvent becomes richer and richer in the higher boiling constituents. The result is that the last traces of solvent, which at best would be more or less difficult to remove (as is commonly experienced in removing even ether in laboratory

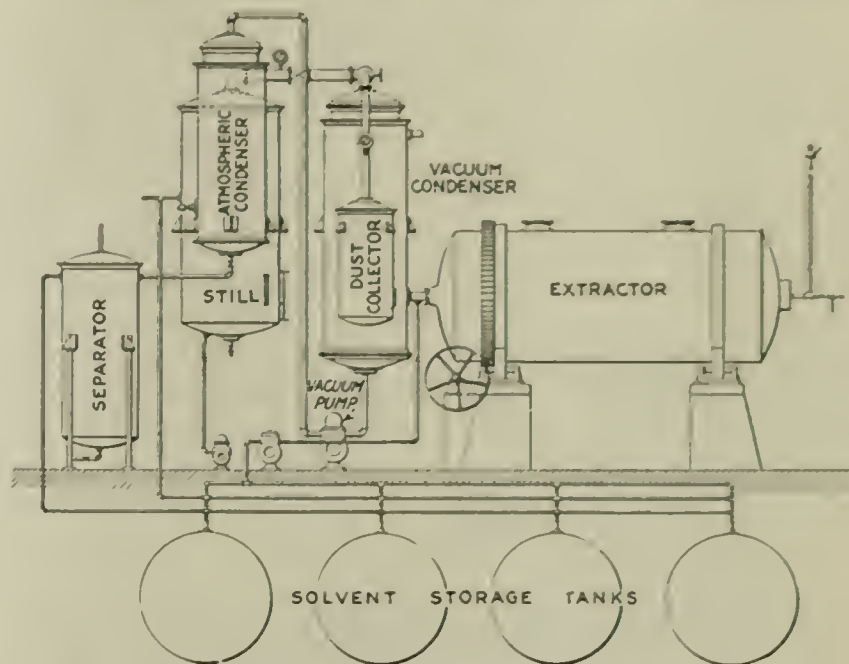


FIG. 1. SECTION OF ROTARY EXTRACTION PLANT

analyses), are rendered increasingly so on account of the residual fractions of unusually high boiling point. It has been pointed out that the losses of solvent accompanying such extraction are greater in the low-boiling fractions with the result that the whole body of solvent gradually becomes richer in high-boiling constituents, thus raising the average boiling temperature. This is corrected by adding some special low-boiling fractions from time to time. The factors favoring the use of this substance are cheapness and availability.

One of the war-time benefits to industry is the greatly increased production of benzene. It is now sold at prices comparable to gasoline and is produced in such quantity that its availability seems to be assured. It comes on the market in several grades designated by the color and the percentage which distills over at 100 deg. C. The residue consists of mixtures of higher boiling constituents. Consequently, use of such a solvent introduces the difficulties experienced in using gasoline—namely, temperature range of distillation and difficulty of removing last traces of the higher boiling fractions. It seems from theoretical considerations, laboratory tests and factory operations that 100 per cent water-white benzene gives the best general results in so far as the common commercial solvents are concerned. At the present time its use in this country in the extraction of the higher grade vegetable oils is probably greater than that of any other solvent.

NON-FLAMMABLE SOLVENTS

All of these solvents, however, possess great flammability. Carbon bisulphide is declared to be spontaneously combustible under certain conditions. To this must be added a toxic effect on the workmen. The flammability of gasoline and benzene is well known. Accordingly efforts have been made to introduce a

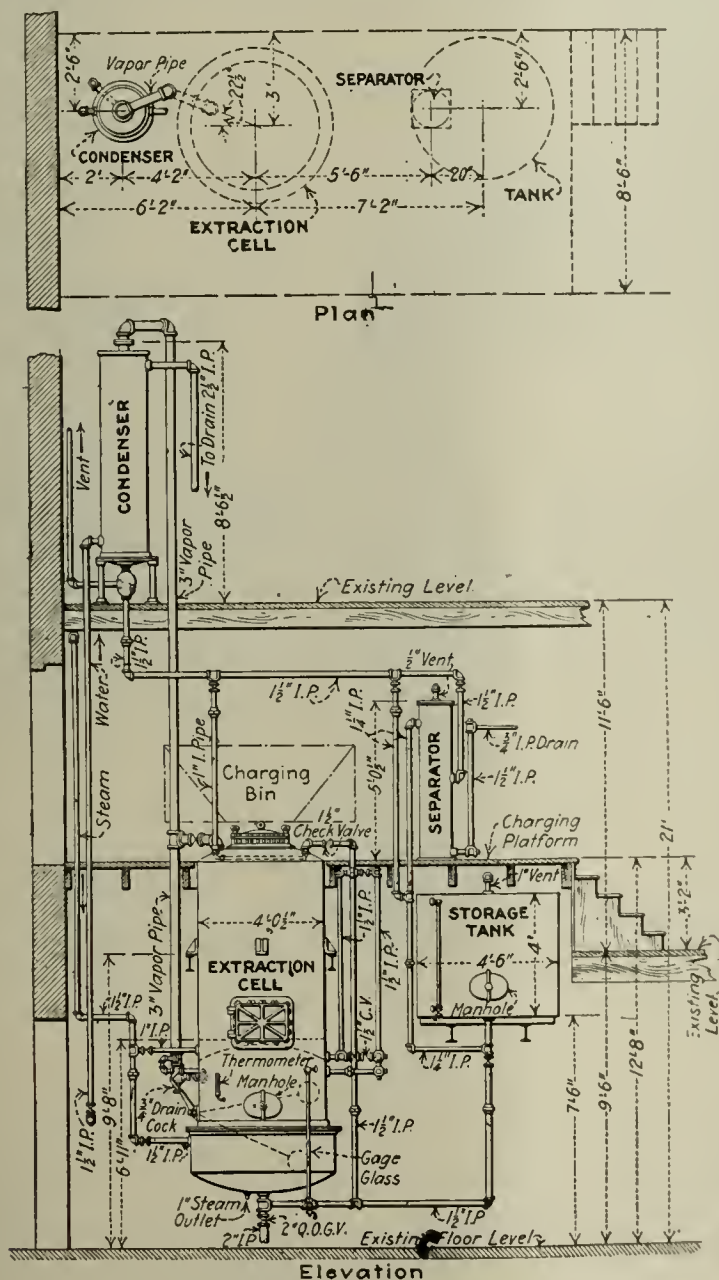


FIG. 3. SECTION OF STATIONARY EXTRACTION PLANT

overlooked. Experience shows that substances containing sulphur more or less loosely combined are exceedingly difficult to remove from products treated with them.

Another widely used solvent in the same category but not quite so difficult to handle is solvent naphtha or gasoline. As is well known, this product is not a single chemical compound with constant properties, but

solvent free from fire risk. The so-called chlorine-substituted hydrocarbons have been found to answer this purpose. Essentially, they are single chemical products consisting of one or more atoms of chlorine substituted for as many of hydrogen in certain organic compounds. Specifically, the more common ones are bichlorethylene, trichlorethylene, tetrachlorethane, pentachlorethane and carbon tetrachloride. All of these are non-flammable and can be made practically constant in boiling point. The last one is a product of widespread general industrial use. Demand has placed some of the others also on the market to a limited extent. It is claimed that these solvents produce a higher grade of crude oil than do ethyl ether, carbon bisulphide, gasoline and benzene, and that such crudes refine to an edible grade more readily than those produced by benzene and gasoline. This is attributed to their selective solvent action in dissolving out the oil and leaving the other accompanying products unaffected.³ However, recent work by Sievers and McIntyre⁴ shows quite plainly that from the standpoint of the quality of finished extracted oil in laboratory tests made in glass flasks there are no facts to indicate the advantage of trichlorethylene and carbon tetrachloride over benzene

tion, protection can be secured by lining the equipment with lead.⁶ Probably better practice is to adopt the method patented by Barstow,⁷ whereby the solvent is passed over a layer of unslaked lime to remove in each cycle the hydrochloric acid formed during steaming. Just how much solvent decomposition takes place is brought out in the following experimental results.⁸ The

TABLE I. PRINCIPAL SOLVENTS WITH THEIR RESPECTIVE PROPERTIES

	Carbon Bisulphide	Extraction Naphtha	Carbon Tetrachloride	Trichlorethylene, $C_2H_3Cl_3$	Ethylenebichloride, $C_2H_4Cl_2$	Benzene
Density...	1.27	0.75	1.632	1.460	1.281	0.884
Boiling point	46°	108°-112°C average	76°C.	87.5°C.	64.9°C.	80.4°C.
Action on metal...	nil	nil	rapid on iron	slight	.....	.....
Specific heat	0.1596 (86-190°)	.50	.131	.....	0.319 (60°C.)	0.436
Latent heat of vaporization...	100.5 (100°) 90.0 (0°)	130	46.4 (76.2°) 82.6 (0°)	.....	85.4 (0°)	100.0 (0°)

figures represent the amount of hydrochloric acid liberated and found either free or combined in solution at the end of forty-eight hours' boiling of a mixture con-

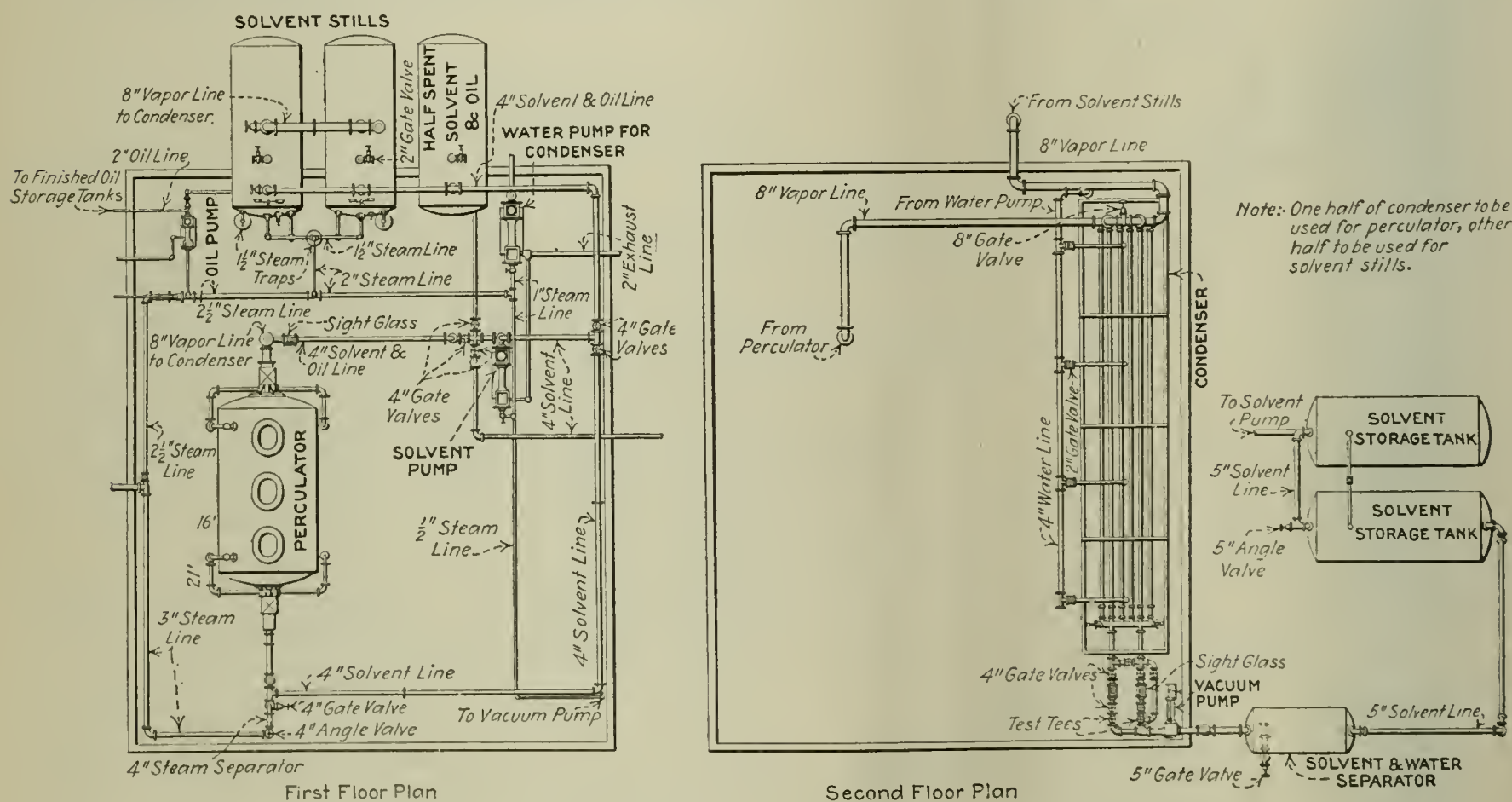


FIG. 5. PLAN OF ROTARY EXTRACTION PLANT

cr gasoline, in so far as quality of finished oil is concerned.

Although these properties of non-flammability make the solvents appear ideal, it is also stated that they decompose during the cycle of extracting and steaming with the liberation of free hydrochloric acid. This attacks the equipment and necessitates the use of lead lining throughout. In reply to this it is stated that carbon tetrachloride is the greatest offender and that if trichlorethylene is kept free from the bichloro-derivatives it is perfectly safe from dissociation.⁹ Even if solvents are used which undergo this slow decomposi-

taining 250 g. of solvent and 100 g. of water in an iron vessel having 2 sq.dm. of exposed surface.

Bichlorethylene, grams.....	0.01
Trichlorethylene, grams.....	0.007
Perchlorethylene, grams.....	0.036

It seems that the chlorinated substances do attack the containing equipment, necessitating a relatively expensive lining with lead. Table I gives a list of the principal solvents with their respective properties.⁹

The speed of evaporation of various solvents is frequently of special interest. Table II¹⁰ shows the com-

⁶Oil and Color Trades Jour., vol. 36, p. 2109.

⁷Les Matieres Grasses, No. 102, Oct. 15, 1916, p. 4612.

⁸Oil and Color Trades Jour., vol. 36, p. 2109.

⁹This table was prepared from data in standard compendia.

¹⁰Booklet of The Barrett Co., issued September 1, 1919.

³Oil and Color Trades Jour., vol. 42, p. 549 (1912).

⁴Cotton Oil Press, February, 1921.

⁵Oil and Color Trades Jour., Jan. 20, 1920, p. 331.

TABLE II. SPEED OF EVAPORATION OF PRINCIPAL SOLVENTS

	Minutes
Ether.....	2
Carbon bisulphide.....	5
Gasoline, 70-72° Bé.....	10
Carbon tetrachloride.....	11 5
Pure benzene.....	12 5
Straw color benzene.....	26
Motor benzene.....	27
Straw color toluene.....	35
Pure toluene.....	38
Pure xylene.....	120
Motor gasoline 58-60° Bé.....	155

parative speed of evaporation of the most commonly used solvents. In each case 5 c.c. of each material was allowed to evaporate under similar conditions from an alberene stone dish approximately 4 in. in diameter. The materials tested, other than coal-tar products, were purchased in the open market and therefore represent commercial grades.

The financial advantage of using a solvent with a fairly constant boiling point over one which has a wide

which is non-flammable, will distill off at the lowest practicable temperature, require the least coal, produce the best grade of oil, be cheap, stable and commercially available. No one solvent fulfills all of these requirements. At the present time, practice seems to favor benzene.

ECONOMIC CONSIDERATIONS

It is at once apparent that if the process is at all practicable it points to great economic advantage. The most evident advantage of solvent extraction over pressure is in the matter of yield of oil. When an ordinary hydraulic box press produces cake with 6 per cent oil, it is considered good performance. The average in the cottonseed oil industry for the 1919 season was about 6.4 per cent, as is evident from the analytical reports constantly presented in the cottonseed oil press. The introduction of the cake or curb press is stated to improve on this to some extent, since they are said to

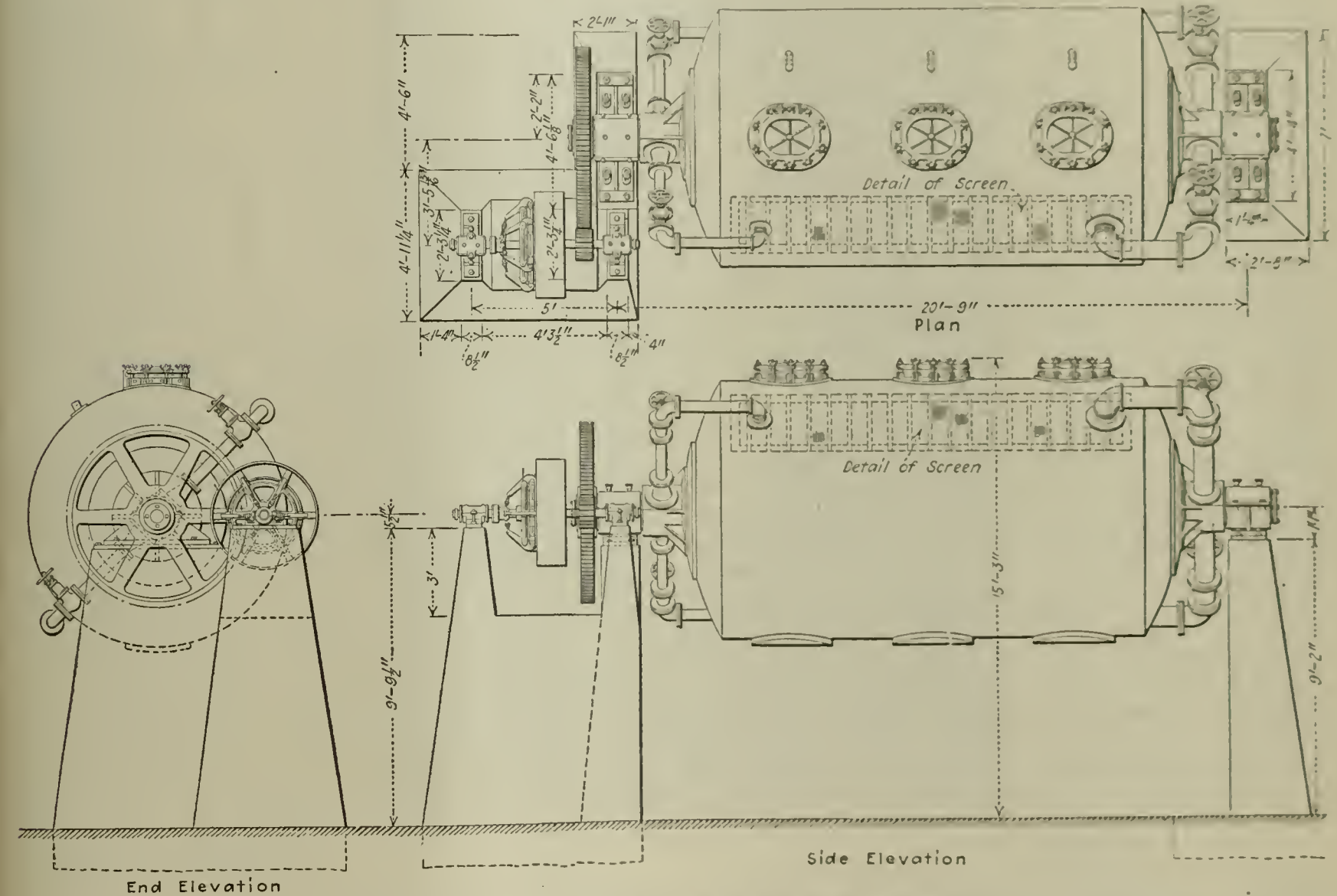


FIG. 6. PLAN AND ELEVATION OF ROTARY EXTRACTOR

temperature range of distillation is brought out by the statement of an operator who has used both gasoline and benzene that about 3,000 lb. of steam per ton of garbage treated would be required to distill off 72 deg. Bé. gasoline, leaving about 2 1/2 gal. in the residue (hence lost), while benzene would require about 2,200 to 2,300 lb. of steam, leaving only about 1 gal. unrecovered. It is to be noted that this estimate is checked by the fact that in the proportions of the heats of vaporization of gasoline and benzene—namely, 130 and 100—there would be required 2,308 lb. of steam for the benzene distillation, assuming that 3,000 lb. of steam were required for the gasoline.

It will be recognized that the best solvent is one

have produced cake as low in oil as 4 per cent. However, this is admittedly uncommon practice. About 6.4 per cent oil in cake can be accepted as representing average practice in the oil industry where hydraulic pressure is used.

To produce a meal by solvent extraction containing 2 per cent oil presents no difficulty whatever. Manufacturers of this type of machinery guarantee meal to contain no more than 1 1/2 per cent oil. It is to be expected that 1 per cent oil-bearing meal is perfectly feasible. From such a non-fibrous, mushy product as castor beans, a pomace can be produced which will average as low as 0.6 per cent of oil.

Table III gives the oil yields by the pressure method

TABLE III. OIL YIELDS BY PRESSURE AND EXTRACTION METHODS

Oilseed	Percentage of Total Oil					
	Oil Content Per Cent	Pressure Per Cent	Yield of Oil Per Cent	Extraction Per Cent	Contents Per Cent	Difference Per Cent
Peanut.....	46-50	42	47	86	98	12
Cottonseed.....	23-25	17	23	67	97	30
Copra.....	64-66	61	64	94	99	5
Hedge mustard seed.....	24-26	17	24	68	96	28
Hempseed.....	30-35	25	32	76	97	21
Kapok.....	24-26	17	24	68	96	28
Flaxseed, European.....	34-36	28	34	75	97	22
Flaxseed, East Indian.....	39-42	33	41	81	98	17
Corn germs (dry process).....	17-22	12	19	60	94	34
Corn germs (wet process).....	40-50	40	44	89	98	9
Poppy seed.....	48-50	42	48	84	98	14
Mowrah.....	50-52	46	50	89	98	9
Palm kernels.....	48-52	44	49	88	98	10
Rapeseed.....	39-42	33	41	82	98	16
Castor beans.....	45-55	45	51	90	98	8
Sheanuts.....	46-48	41	46	87	98	11
Soya beans.....	17-19	10	17	55	93	38
Sunflower seed.....	29-34	23	30.5	74	97	23

The last column gives some idea of the oil economy in solvent extraction. Note: It is to be noted that the yield of oil cannot be found by subtracting the oil content of cake from that of the seeds, because oil in cake is figured on the basis of cake and not on the original seed.

versus extraction, with the corresponding loss of oil. These figures are recalculated from Merz' table;¹¹ the extraction figures are based on leaving 1½ per cent oil in cake. Fractions less than 0.5 are discarded; those greater than 0.5 are as units.

Another item of particular importance at this time is that of cost of operation. A force of one foreman and two laborers can operate a 50- to 100-ton percolator plant. In fact it is estimated that an overall charge of \$11 per ton of raw material will cover all costs of producing crude oil by solvent extraction in a 50-ton plant, while about \$7.50 per ton of raw material will cover those in a 100-ton plant. In addition to the monetary saving, there is the added advantage of reducing labor to a minimum.

Against these advantages are fire risk, lower grade crude oil and trade prejudice. The first seems prohibitive, but when one considers the great number of pharmaceutical houses, paint and varnish works, explosive plants and last but not least every automobile, regarding which there is no hysteria, the objection pales considerably. A lower grade of crude oil is undoubtedly obtained in some cases (though not necessarily in view of certain recently published work of J. H. Shrader, *Cotton Oil Press*, April, 1921, p. 42). Trade prejudice is indeed to be considered, but is not insurmountable, particularly if the plant procedure is such as to produce a high-grade refined oil. After all, trade prejudice is built on experience; it can be destroyed accordingly.

USES OF PRODUCTS

It is often and persistently stated that products (oil and meal) obtained by solvent extraction are not comparable with those yielded by expression. Such statements are only partly correct. There is no doubt that solvent extraction has produced oil and meal of low grade, evidenced by high color and traces of solvent. But it is also true that extracted products have been produced free from such objection. The operator of the extraction plant of a large linseed oil company stated that in the years of his service he never received a single complaint of solvent in his meal. It is moreover true that extracted oils may be darker in color than expressed oils, but these can often be refined to comparable grades indistinguishable from expressed standards.

Heretofore the chief rôle of the solvent extraction

plant in the vegetable oil industry has been to work up off-grade residues, damaged seed, leather scraps and other materials of little or no other value than their fat content. Not much attention seems to have been devoted to giving the products any other outlet than what they can readily find in competition with other admitted low-grade commodities. The oils go to industrial uses (paint, soap, etc.); the meal mostly goes to fertilizer. In Europe, however, these extraction products are used for human food. In this country the meal is beginning to find a market as stock feed. If history repeats itself (we seem almost always to follow European practice) we shall follow Europe in finding ways to prepare even the oil for food.

Classification of Lead Production

Sub-committee I of the Society for Testing Materials' committee on non-ferrous metals and alloys reports as follows on the available supply of pig lead:

For the ten years ended Dec. 31, 1920, the production of pig lead in the United States from foreign and domestic ores averaged 559,000 tons per annum. This production can be divided into the following classes:

DOMESTIC		Tons
Desilverized (corroding and common desilverized).....		273,000
Southeast Missouri (chemical lead).....		176,000
Southwest Missouri (soft Missouri lead).....		33,000
Antimonial lead (not covered by these specifications).....		16,000
Total.....		498,000
FOREIGN		
Desilverized.....		58,000
Antimonial.....		3,000
Total.....		61,000
Grand total.....		559,000

Corroding Lead.—The greatest use for pig lead in the United States is for the manufacture of paint pigments. As the production of low-bismuth corroding lead is insufficient to fill this demand and as there are consumers who prefer low-bismuth corroding lead for purposes other than the manufacture of paint pigments, corrodors to obtain the benefit of a broad market should take quotations on both grades of corroding lead.

Chemical Lead.—Of the southeast Missouri lead ore from which chemical lead is produced about one-third is refined by the Parkes process and thereby made into a high-grade low-bismuth corroding lead 99.99 per cent pure. More than 100,000 tons of chemical lead is used annually by the manufacturers of acid-resisting sheet lead, storage batteries, lead-encased cable, lead pipe traps and bends, etc., and in the Central Freight Association territory, where the freight rates are favorable to users of common lead.

Soft Missouri Lead.—The production of this grade is comparatively small, and its use is largely confined to the St. Louis and Chicago districts.

Desilverized Lead.—As all grades of lead are desilverized with the exception of chemical and soft Missouri lead, this class would cover all other grades of lead not pure enough to be sold under corroding specifications.

Chemical specifications for pig lead in the tentative standards now specify for both low-bismuth and high-bismuth corroding lead, as follows:

Element	Low-Bismuth Corroding Lead Per Cent Not Over	High-Bismuth Corroding Lead Per Cent Not Over
Bismuth.....	0.0050	0.0500
Silver.....	0.0015	0.0010
Copper.....	0.0015	0.0010
Copper and silver together.....	0.0025	0.0015
Arsenic.....	0.0015	0.0015
Antimony and tin together.....	0.0095	0.0060
Zinc.....	0.0015	0.0015
Iron.....	0.0020	0.0020
Lead (by difference).....	99.9780	99.9375

¹¹Merz. *Chem. Trade Jour.*, vol. 53, p. 97.

Frederick Fraley Sharpless, Secretary, A.I.M.E.

IF THERE is anything in name and antecedents the directors of the Institute did well in selecting Frederick Fraley Sharpless to succeed Bradley Stoughton as secretary of the American Institute of Mining and Metallurgical Engineers.

Born in West Chester, Pa., of good old Quaker stock, his early days were spent on the farm on the Brandywine, in the center of Revolutionary battlefields. The companionship of his father, an able mineralogist, the gathering of a collection of his own of no mean proportions from the inexhaustible riches of Chester County and the enthusiasm of an Ann Arbor graduate serving as an instructor of sciences in the normal school of his native town filled young Sharpless with a desire to study chemistry.

Columbia and Tech. were beyond his means, but the generosity of Michigan rendered possible the study of chemistry at Ann Arbor. Studying under such men as Prescott, Cheever, Pettee, and Alexander Winchell, and a summer with Theodore Robinson and F. A. Emmerton at Joliet, it was no wonder that the students of chemistry absorbed some of the enthusiasm of these men, and the belief that chemistry would eventually be regarded as an indispensable asset to metallurgy, geology, mining—in fact many and diverse branches of industry.

Upon graduation (1888) Mr. Sharpless went with the late Dr. M. E. Wadsworth to Houghton as instructor and later became professor of metallurgy, ore dressing and assaying.

The students of those days—our associates of today—have not forgotten his lessons in stoichiometry and furnace reactions, which modern chemists tell us were all wrong in spite of the way the equations balanced and the metal ran out of the tap hole.

Mr. Sharpless became a member of the Institute in the year 1889, and was one of the members visiting Europe as the guests of European mining engineers that year. Referring to the records of the Plattsburg meeting of the Institute in 1892, as recorded in the *Transactions*, it will be noted that Mr. Sharpless was married in June of that year, and that a reception for him and his bride was one of the features of the meeting. Dr. Raymond, making the presentation speech, gave him some sound advice, which possibly is responsible for his good standing with the members of the Auxiliary. The lines the doctor spoke in handing some silver spoons to the bride were:

Take then these trifles, may they teach a golden truth
in silver speech;
That as the years of wedlock run, the days of spooning
are not done.

Leaving Houghton in 1892, he opened a chemical laboratory in Minneapolis in association with H. V. Winchell. Winchell gathered the samples, Sharpless made the analyses and assays, but it was not long before questions in regard to mine and mill operating began to come thick and fast. Since the business had developed in an unanticipated direction it was evident that a part of his education had been neglected. He therefore proceeded to remove the deficiency and become acquainted with operating details in the mine and smelter. The laboratory was closed and Sharpless went to work as a miner and mill hand on the Mother Lode, where Richard A. Parker and W. L. Honnold were

conducting extensive exploration work. Two or three years' strenuous work from Coulterville to Angels Camp gave him the experience that he had previously lacked. From this College of Hard Knocks he graduated to accept the management of the California Copper Co. A furnace at Madera was operated until it had smelted all the ore in its own mine, and all that it could beg, borrow, buy or steal from its neighbors.

From 1900 to 1912 Sharpless was a wanderer, traveling, reporting, exploring and operating for English principals, chiefly as American representative of the Consolidated Mines Selection Co. of London and its affiliated organizations. This work took him to British Columbia, the Yukon, Alaska, to many parts of Mexico, into Salvador, Honduras, and South America, where his mining experience was interesting and profitable and

where his political experience rivaled that of Richard Harding Davis. Two years in Colombia familiarized him with mining possibilities of that country, and was followed by the investment of considerable English capital in substantial mining ventures. Only one who has lived the life can know much of the continued interest in new scenes, the examination of operating and abandoned mines, near mines and prospects.

A season was spent in Asia Minor, where the mercury resources were investigated, two properties were bought, equipped with Scott furnaces and placed on a producing basis. One of them was a pronounced success, and during the World War the Turks found it quite serviceable. Another season was spent in the bush on the West Coast of Africa, in mining examination and in fighting malaria, yellow fever and various other microbes which make life interesting if not enjoyable in that country. Sandwiched into these in-



Photo by Pach

FREDERICK FRALEY SHARPLESS

vestigations was a trip to Dawson. It occurred in the spring preceding the visit of Beatty and Perry, and Sharpless spent a month looking over the field with the idea that many of the frozen placers could be worked by modern dredges—thus having the same thing in mind which they later took up. While Sharpless was of the opinion that such a venture would eventually prove profitable, he advised against tying up for a long time the immense amount of money involved, pending the acquisition of reasonably accurate data on the returns which would be secured.

For the past eight years Mr. Sharpless has had an office in New York where he has been employed in consulting work, visiting many of the mining districts through the United States, Mexico and Canada for American clients. For three years he was secretary of the Mining and Metallurgical Society of America, and at all times he has given freely of his time to that class of the engineer's work which brings no emoluments except the satisfaction of knowing that one has done a work that was worth the doing.

Note on Alloying Tellurium With Some White Metals

BY J. H. RANSOM AND C. O. THIEME

IN A mimeographed article recently received from the Solder and Bearing Metal Manufacturers Association the secretary, as a result of his observations at the National Chemical Exposition, called attention to the appearance of tellurium and suggested its use as a hardener of lead, and, perhaps, of other metals. Since the writers had already undertaken a study of its action on lead and other white metals, it seems of interest to record these results in a preliminary note in order that others interested in investigating the subject may have before them such facts as have been obtained.

The tellurium used in this investigation was obtained from Superintendent A. E. Hall, of the American Smelting & Refining Co., Omaha, Neb., to whom we express thanks.

The first experiment with tellurium was carried out in an attempt to use it instead of sulphur in removing copper as an impurity from 50:50 (tin:lead) solder. The solder was made to contain 0.45 per cent copper; 163 grams of the solder was melted and to it was added 0.9 g. of tellurium, 0.733 g. being the amount necessary to combine with the copper present to form cuprous telluride. As soon as the tellurium touched the solder it burst into a glow and then seemed to form hard lumps which only slowly, and in part, disappeared. After stirring the molten mass for some time, during which a dross collected on the surface, the metal was poured to form a number of buttons. The dross was then heated to a higher temperature, when it burned to a yellow powder insoluble in both dilute and concentrated nitric acid and in a concentrated solution of sodium hydroxide. This would indicate that the insoluble residue is not tellurium oxide. On heating some of the yellow powder on charcoal before the blowpipe, the color was somewhat changed, but no lead was formed. Its action with concentrated nitric acid was to form a white powder, perhaps metastannic acid. It was not further investigated. Analysis of a button revealed the presence of 0.27 per cent copper, showing that the tellurium had removed nearly one-half of the copper.

In a second experiment 142 g. of the solder containing 0.27 per cent of copper was again melted and 1.5 g. of

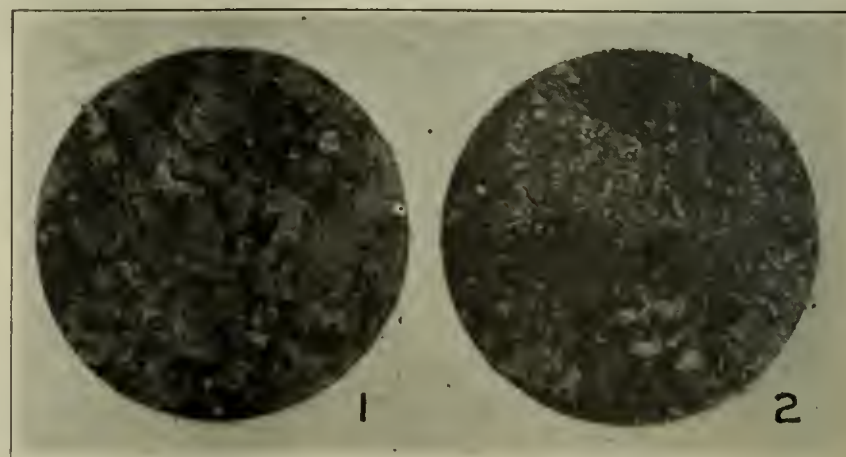
tellurium added to the just molten mass. No change in the tellurium was noted, but on heating to a slightly higher temperature the same glowing occurred as before with the formation of large pieces floating on the surface. The pieces partly disappeared after some time. Some of them were removed, powdered, and then returned to the bath. In the powdered form they were nearly white. During heating the molten bath was constantly stirred with a piece of dry, soft wood, and when most of the pieces had disappeared, the metal was poured into molds. The dross weighed 8.5 g. In this case, however, the copper was not removed, but was present in larger amounts than at first, probably due to the fact that the analysis (0.27 per cent Cu) was not representative of the original melt.

TELLURIUM AND LEAD

In order the better to interpret the results stated above a study of the action of tellurium on lead and on tin, separately, was undertaken. First, 129 g. of pure lead was just melted and upon the surface was sprinkled 1.3 g. of powdered tellurium. The tellurium glowed with the formation of large lumps mixed with a powder which floated as a dross. After heating to a higher temperature and stirring with a piece of dry wood, the metal was poured into a mold. It weighed 115 g. and the dross weighed 14.5 g. The lumps were then separated from the finer powder, which latter was a mixture of metallic particles with a yellow, non-metallic powder. The former were hard but somewhat malleable, and they, as well as the metallic powder, contained both lead and tellurium. Tellurium could not be found in the yellow powder and its nature has not been established. The lead was found to contain 0.2 per cent tellurium and had a Brinell hardness of 5.1. The lumps of dross tested 7.5 Brinell, and possessed a more metallic ring than does lead.

TELLURIUM AND TIN

Some pure tin bars were melted and poured, making four chill-cast cylinders. Two of these were used for comparison and the others, weighing 650 g., were heated just to melting. After removing them from the heat, 7 g. of tellurium was added in powdered form and stirred into the semi-fluid tin. The mass was again heated while being stirred. Some solid pieces collected on the surface and there was some solidification around the edges of the bath, though the temperature was far above the melting point of tin. Most of the floating lumps finally disappeared, leaving a dross upon the surface. No glowing was observed. Finally the metal was heated very hot and poured, making two bars. The dross, which included much metal, weighed 22 g. Tests made with



PHOTOMICROGRAPHS OF TIN AND TIN-TELLURIUM
Fig. 1. Matrix: crystallized tin. $\times 100$. Fig. 2. Bright pin-like areas of tin telluride in a matrix of crystallized tin. $\times 100$. Both etched with 10 per cent nitric acid.

the bars in an Olsen testing machine showed that the elongation as compared with that of the bars of pure tin had decreased from an average of 65 per cent to 54 per cent, while the tensile strength per sq. in. had increased from 3,800 to 4,265 lb. The bars were remelted and poured to form buttons for hardness tests and to get samples for analysis. The tests showed that the metal containing tellurium was slightly harder than the pure tin. Two closely agreeing analyses gave an average of 1.12 per cent of tellurium. This element was also found in the dross.

In order to study the structure of the metal containing tellurium, photomicrographs were made from one of the buttons, and for comparison a similar photomicrograph of pure tin. The etching reagent was a dilute nitric acid. As will be seen from an inspection of Figs. 1 and 2, the tellurium causes the formation of a large number of small particles which appear as white dots in the picture. These are probably tin telluride in a matrix of crystallized tin.

TELLURIUM WITH ZINC AND WITH ALUMINUM

Experiments similar to those carried out above were made with tellurium and zinc and with tellurium and aluminum. In neither case were more than traces of tellurium found in the treated metal, most of it apparently remaining with the dross. However, in spite of its absence in the finished products, the tensile strength, in the case of zinc, was increased from 4,955 lb. to 5,510 lb. per sq.in. and in the case of aluminum from 13,840 lb. to 14,810 lb. In the case of zinc the elongation was nil both with and without the tellurium, while with aluminum the use of this element increased the elongation from 18.5 per cent to 28.5 per cent. The hardness was not changed appreciably in either case.

An experiment was carried out in order to determine if any hardening effect would result from the addition of tellurium to an alloy of lead containing 0.5 per cent of magnesium. No increase in hardness resulted, neither was the appearance changed. It is a question whether the tellurium formed a solution or other intimate mixture with the alloy, since one part of the product gave a good test for tellurium with concentrated sulphuric acid, while a repetition of the test with another portion gave negative results. It is probable that magnesium telluride was formed and that it very largely escaped from the molten alloy.

TELLURIUM WITH ZINC-BASE DIE-CASTING METAL

One per cent of tellurium was added to zinc-base die-casting metal and the molten mass thoroughly stirred. Tests made with the chill-cast bars did not show any change in properties due to the presence of the tellurium, except that the metal appeared to be more nearly free from blowholes. In one test the metal showed the presence of tellurium; but in a subsequent test on the same bar no evidence of its presence could be found.

SUMMARY

Only two of the common white metals appear to dissolve tellurium, and these two only in small amounts. Where solution is effected the hardness and tensile strength are increased to an appreciable extent. In all cases investigated it is probable that tellurides of the metals are formed and that these are little soluble in the molten mass.

Michigan Smelting & Refining Co.,
Detroit; Mich.

Note on Schwartz Furnace Atmosphere When Melting Complex Bronzes

BY R. J. ANDERSON AND J. H. CAPPS

In the course of an investigation of the gas atmospheres in aluminum alloy melting furnaces, reported in *CHEMICAL & METALLURGICAL ENGINEERING*, vol. 25, No. 2, p. 54, July 13, 1921, an opportunity was presented to analyze the gases within a Schwartz furnace melting leaded zinc bronze and lead bronze.

A summary of the results of the analyses is given in Table I. Three samples each were taken from the three different heats, and wide variations in the percentages of carbon dioxide, carbon monoxide, nitrogen and oxygen were found. The variations were undoubtedly due to variations in the operating conditions. The last three samples, however, are fairly uniform. Comparing them with the analyses presented in Table VI of the article cited above, it is seen that combustion is more complete; CO₂ being higher, and CO, H₂, CH₄, and oxygen lower in the bronze-melting furnace.

This may be due to the fact that the melting temperature in the case of bronze is considerably higher than should normally be used for light aluminum alloys,

TABLE I. ANALYSES OF GASES IN CONTACT WITH METAL IN A TILTING, OIL-FIRED, OPEN-FLAME EGG-SHAPED FURNACE (SCHWARTZ TYPE), MELTING COMPLEX BRONZES

Composition, Constituents per Cent, by Volume						
Time Sample Drawn,	Carbon Dioxide, CO ₂	Carbon Monoxide, CO	Hydrogen, H ₂	Methane *, CH ₄	Nitrogen, N ₂ , by Difference	Oxygen, O ₂
Melting lead-zinc bronze †						
3:10	14.5	0.0	0.0	0.0	84.3	1.2
3:15	13.6	0.0	0.0	0.0	83.4	3.0
3:35	4.4	2.4	0.2	0.2	78.9	13.9
11:50	18.6	16.4	1.8	0.0	63.2	0.0
11:57	17.1	24.9	2.6	0.0	55.4	0.0
12:05	19.9	2.2	3.0	0.0	74.5	0.4
Melting lead bronze ‡						
11:10	12.0	0.0	0.0	0.0	87.0	1.0
11:16	12.7	0.0	0.0	0.0	86.2	1.1
11:24	16.4	0.0	0.0	0.0	83.4	0.2

* Unsaturated hydrocarbons tested for and not found.

† 87.5 per cent copper, 10.0 per cent tin, 1.5 per cent zinc, and 1.0 per cent lead.

‡ 89.0 per cent copper, 10.0 per cent tin, and 1.0 per cent lead.

and the method of conducting the firing in the same furnace used for melting these different alloys should be altered for the alloy. Practically, however, the open-flame tilting furnace, when melting light aluminum alloys, is generally run as fast as possible so as to secure a rapid rate of melting.

A temperature of the second lead-zinc bronze noted in Table I was about 1,190 deg. C., while the furnace atmosphere at about 12 m. was 1,210 deg. C.

Conditions in Belgian Zinc Industry

Belgian zinc production in 1920 was 82,960 tons, in comparison with 19,860 in 1919 and 204,220 in 1913.

Only two Belgian plants manufacture lithopone. They are the Société Anonyme des Produits Chimiques de Wilsele, near Louvain, and the Société Anonyme Stella, at Haren, north of Brussels. Their joint annual production is 16,000 tons.

The production of other zinc products is still considerably below the pre-war figures. While 9,118 tons of zinc oxide was prepared in 1913, the figures for 1920 show only 1,500 tons produced.

Air Pollution and Wastefulness

BY FREDERIC DANNERTH

A RECENT decision of the U. S. Supreme Court relating to the gas carbon black industry of Wyoming involves a number of points which affect the chemical industry in general and industrial wastefulness in particular.

It appears that the State of Wyoming (Chapter 125, Laws of 1919) passed an act which prohibits as wasteful the burning and consumption of natural gas for its products without fully and actually applying and utilizing its heat for other manufacturing or domestic purposes. It forbids owners or lessees of gas wells to sell or dispose of such gas for the manufacture of carbon or other resultant products, in the making of which its heat is not so utilized for other domestic purposes. The act limits the prohibition to cases where gas wells or sources of supply are within ten miles of any incorporated town or industrial plant. Infractions of the law will be dealt with as misdemeanors.

The case was originally heard in the District Court of the United States for the District of Wyoming, and the appeal from this decision was argued Oct. 13, 1920, and decided Dec. 13, 1920, Justice McKenna delivering the opinion of the court. The Midland Carbon Co., together with the Occidental Oil & Gas Co., both Delaware corporations, asked that the Attorney General of the State of Wyoming be restrained from enforcing or attempting to enforce the act.

CASE OF THE COMPLAINANTS

The complainants state that they had built a plant in Big Horn County at an expenditure of \$375,000, that they produce 13,000 lb. of gas carbon black per day, and that this is sufficient for making 117,000 lb. of printing ink. They also make out of that gas 1,600 gal. of gasoline per day. The Occidental Oil Co. in the course of its existence has secured mineral leases covering 1,200 acres of proved gas territory within ten miles of the town of Cowley. The company claimed that its rights under the Constitution of the United States were violated by the state law, that the proposed restrictions abolish, ruin and destroy the complainant's business while leaving it open to others to engage in the making of gas carbon black.

The present consumption of gas from the sand is 15,000,000 cu.ft. per day; the decrease in pressure for the last year has been 150 lb.; the present pressure is about 200 lb. In view of these facts, at the present rate of decrease in pressure the field will be exhausted in sixteen months and there will be no pressure to force the gas out of the sand. The present consumption of gas is about 5,500,000,000 cu.ft. per year.

POSSESSION OF THE LAND NOT NECESSARILY POSSESSION OF THE GAS

The court emphasized the fact that "possession of the land is not necessarily possession of the gas," and "the property of the owner of lands in oil and gas is not absolute until it is actually in his grasp and brought to the surface." Oil and gas, like other minerals, are situated beneath the surface of the earth, but for this one point of similarity in many other respects they greatly differ. They have no fixed *situs* under a particular portion of the earth's surface within the area where they obtain. They have the power, as it were, of self-transmission. Therefore in a previous case it

was adjudged that their use by one owner of the surface affected the use of other owners and an excessive use by one diminished the use of others. A similarity of other minerals was rejected, and the analogy between oil and gas and animals *feræ naturæ* was declared. It was hence decided that the power of the state can be manifested for the purpose of protecting all the collective owners, by securing a just distribution, to arise from the enjoyment by them, of their privilege to reduce to possession and to reach the like end by preventing waste.

VERY LOW EFFICIENCY

The process used by the Midland Carbon Co. is merely an incomplete combustion of gases in an insufficient amount of air, the flames from the different jets practically touching cast-iron channel plates. These are suspended over the flames and are moved backward and forward at a very slow rate of speed. The carbon is scraped off the plates into hoppers and carried to the packing houses by conveyors. It has been claimed by expert industrial chemists that the efficiency of the carbon black industry is very low. That the largest yield known to the producers themselves is 1.75 lb. per 1,000 cu.ft. of gas. That it has been chemically determined that 1,000 cu.ft. of natural gas contains approximately from 33 to 45 lb. of actual carbon.

WELFARE OF COMMUNITY PARAMOUNT

The Midland company stated that the money value of the carbon black was far greater than that of the natural gas. In securing testimony for its case it endeavored to show that its customers would be inconvenienced and it would meet with disaster if the supply of gas carbon black should cease. This entirely selfish point of view was given little consideration by the court, for it is generally conceded that the money which any corporation hopes to make out of its enterprise is not more important than the welfare of the community which makes the enterprise possible. The wells of the Midland company are drilled into the same sand in which the wells of the Lovell Gas & Electric Co. are drilled. This latter company furnishes gas and electricity to the town of Lovell. The sand is a "free-flowing sand"—that is, one in which the gas has free access from one part of the field to the other, consequently the gas pressure would be approximately the same at all the wells drilled into it. It was stated that the present consumption of the gas would materially interfere with the supply of gas to the town of Lovell.

STATE MAY DETERMINE IF CONSERVATION IS NECESSARY

The court held in its decision that it is for the state to determine if any conservation is necessary, and if so it also has the right to determine how far it wishes to go in exerting its power. The statute was intended only to prevent the selection of one product whose production tended to exhaust the supply of gas in a very little while.

The decree of the lower court granting an interlocutory injunction was reversed. At this time similar action is contemplated in the State of Louisiana, and it would seem that the passage of a similar law in that state was in order if only to compel attention to the systematic wastefulness of certain American chemical industries. An industrial process carried on with an efficiency of less than 5 per cent is surely worthy of some attention at the hands of law makers.

Notes on the Metallurgy of Calcium*

Survey of the Development of the Metallurgy of Calcium — Properties and Uses of the Metal and Its Alloys—Detailed Description of the Successful Methods for Preparing the Pure Metal

By P. H. BRACE

Research Laboratory, Westinghouse Electric & Manufacturing Co.

SIR Humphry Davy¹ appears to have been the first to isolate traces of calcium by the electrolysis of moist lime; though while Davy's work was in progress he received a letter from Berzelius and Pontin which described the results of their experiments on the electrolysis of the alkaline earths with mercury cathodes. Davy repeated these experiments and secured amalgams of calcium and the other alkaline earths, confirming the conclusions of Berzelius and Pontin. In 1854 Bunsen² prepared small quantities of calcium by electrolyzing an aqueous solution of the chloride with a mercury cathode and subsequently distilling off the mercury. Matthiesen³ in 1856 prepared small quantities of impure calcium by the electrolysis of a fused mixture of strontium chloride and calcium chloride.

Comparatively little interest was shown in the subject until Moissan,⁴ in 1898, published his results, which showed that nearly pure calcium could be prepared by the reduction of calcium iodide by means of sodium. In the same paper Moissan mentions the electrolytic preparation of calcium from the fused iodide. Moissan⁵ investigated his product with characteristic thoroughness, for a little later in the same year he published an extensive list of the properties of the calcium prepared by the sodium reduction method. In 1898 Bela von Lengyel⁶ gave an account of the properties of calcium prepared in a cell with a porous diaphragm. He reported a purity of 99.2 per cent, and described his product as having a color similar to that of a silver-rich gold alloy. Evidently his metal was contaminated, for the color of pure calcium is silvery-white. Borchers and Stockem⁷ described a calcium cell in which the metal was deposited in the form of a sponge on a water-cooled cathode projecting upward from the bottom of the cell submerged in the electrolyte of fused calcium chloride. A similar cell was used in 1903 by Goodwin,⁸ but he operated at a higher current density and temperature, and so caused the calcium to collect in the molten state and rise to the top of the bath, whence it was removed by means of a ladle. This was a distinct advance over the method of Borchers and Stockem.

Shortly after this, in 1904, Rathenau⁹ made the next noteworthy advance when he used a cathode which just touched the surface of the molten electrolyte, and operated it at such a current density that the surface of the calcium in contact with the electrolyte was kept molten. The cathode was gradually elevated as the metal accumulated, and an irregular rod was thus built

up. This method was commercially successful. Goodwin,¹⁰ in 1904, published the results of a rather extensive series of experiments with an apparatus of the Rathenau type, and gave a rather complete account of the physical properties of the calcium he had prepared. In 1905 Wohler¹¹ reported on his experiments in which an electrolyte containing 100 parts of CaCl_2 and 17 parts of CaF_2 was used. He believed that the low melting point of the above mixture was an advantage, but the experience of others has since indicated that there are disadvantages which more than outweigh the convenience of the low melting point. This will be referred to again in connection with some of the writer's findings.

Arndt¹² described the preparation of calcium aluminum alloys by the electrolysis of calcium chloride with an aluminum cathode. Alloys containing between approximately 20 and 80 per cent of calcium are described, but no particularly useful properties are mentioned.

In 1909 Frary and Badger¹³ published a comprehensive bibliography of calcium metallurgy, followed by a description of the results of their work with the Rathenau form of cell, and in the following year Frary, Bicknell and Tronson¹⁴ discussed the efficiency of the apparatus just mentioned, and concluded that practically 100 per cent current efficiency could be obtained by proper manipulation. They were of the opinion that pure calcium chloride made a more satisfactory electrolyte than the calcium fluoride-calcium chloride mixture of Wohler. At the same time Johnson¹⁵ published an account of a series of experiments with the submerged cathode cell of Borchers and Stockem, and the Rathenau cell; and described the development and operation of a rather novel apparatus in which the metal was deposited on a perpendicular, vertically moving iron ribbon cathode which closed the narrow end of a V-shaped inclosure containing the electrolyte. The wall of the inclosure opposite the ribbon was of graphite, and formed the anode. The cathode current density was kept considerably lower than in the case of the Rathenau cell, and it appears that the calcium was deposited in the solid state, producing a thick plate on the iron ribbon in much the same way as metals are ordinarily deposited from aqueous solutions. The author concluded his paper with an account of the determination of the decomposition voltage of molten calcium chloride, and stated that the value lay between 2.6 and 2.8 volts. In 1909 Cowper-Coles¹⁶ patented a process for the electrolytic preparation of calcium and similar metals, the principal feature of which was the use of a cathode in

*Paper presented at the March 9, 1921, meeting of the Institute of Metals, Westminster, England.

¹*Philosophical Transactions*, 1808, pp. 343, 354.

²*Ann. Phys.*, 1854, vol. 92, p. 251.

³*J. Chem. Soc.*, 1856, vol. 8, pp. 27-30.

⁴*Compt. rend.*, 1898, vol. 126, pp. 1753-1758.

⁵*Ibid.*, 1898, vol. 127, pp. 584-590.

⁶*Chem. Zentr.* 1898.

⁷*Z. Elektrochem.*, 1902, vol. 8, pp. 757-758.

⁸*J. Chem. Soc.*, 1903, vol. 25, pp. 873-876.

⁹*Z. Elektrochem.*, 1904, vol. 10, p. 508.

¹⁰*Proc. Am. Phil. Soc.*, 1904, vol. 43, pp. 381-392.

¹¹*Z. Elektrochem.*, 1905, vol. 11, pp. 612-618.

¹²*Ber.*, 1905, vol. 38, pp. 904-906.

¹³*Trans. Am. Electrochem. Soc.*, 1909, vol. 16, pp. 185-195.

¹⁴*Ibid.*, 1910, vol. 18, pp. 117-123.

¹⁵*Ibid.*, 1910, vol. 18, pp. 125-164.

¹⁶British Pat. 24,396 (1909).

the form of a disk whose edge just touched the surface of the electrolyte and which was rotated as the deposit collected.

In 1911 a refining process¹⁷ was described, which had in view the elimination of the included chloride and other mechanically held impurities from calcium produced by the Rathenau and similar methods. In this process the calcium was melted under calcium chloride and collected under an inverted conical iron bell submerged in the molten chloride. The idea was that the calcium would separate completely from the chloride and other impurities by virtue of the differences in their densities.

Moldenhausser and Anderson,¹⁸ in 1913, described experiments with mixed fused electrolytes in which calcium alloys with zinc and some other metals were produced. They also stated that potassium chloride might be added to calcium chloride in amounts up to nearly 25 per cent before the potassium content of the calcium produced became too great to permit the successful working of the Rathenau method. In 1920 the writer¹⁹ published a short account of some experiments on the electrolytic production of calcium, and described a type of cell which he believed to be much easier to operate than the conventional form in which the graphite container for the electrolyte formed the anode. This apparatus will be more completely explained below.

This brief review of the literature will show that almost an even hundred years elapsed after the discovery of metallic calcium before serious attempts were made to prepare the metal in large enough quantities to permit accurate determinations and useful applications of its many interesting properties. Between 1898 and 1910 calcium received considerable attention from the standpoint of both preparation and properties. As a result enough demand sprang up to warrant the commercial production of the metal at Bitterfeld, in Germany. During the last ten years interest seems to have lagged somewhat; indeed, J. W. Richards,²⁰ in 1916, mentioned calcium as one of the well-known and available metals which had not received the extensive application which might be expected from a consideration of its many interesting and unusual properties. Richards pointed out the advisability of closer study of the properties and possibilities of the less commonly used metals, calcium among them. At the present time calcium seems to find such small application that supplies are not regularly carried by dealers, and, furthermore, the prices asked are out of proportion to the difficulties of preparation. It is hoped that this paper may stimulate discussion which will bring out all the present applications of calcium, suggest new ones, and put producers and prospective users on such footing that the interaction of supply and demand will operate to create a good market and a satisfactory supply at prices more reasonable than those which are now obtained.

PROPERTIES OF CALCIUM

The accompanying table gives a short list of the more fundamental properties of calcium. The numbers in the right-hand column refer to the references below.

The following condensed list of reactions may be of interest. The numbers in parentheses following the reacting element refer to the references at the foot of the page.

FUNDAMENTAL PROPERTIES OF CALCIUM		
Property	Value	Authority
Atomic weight.....	40.07	21
Specific gravity.....	1.548	22
	3.43	23
Electrical resistivity, microhms per centimeter cube.....	5.32	24
	4.6	25
	6.77	26
	0.00457	23
Temperature coefficient of electrical resistivity, per degree C.....	0.0034	25
Thermo-electric power against lead.....	8.9 to 150° C.	25
Microvolts per deg. C.....	14.0 to 400° C.	25
Specific heat.....	0°-20° C., 0.1453	27
Melting point, degrees C.....	810°	28
Tensile strength, kg. per sq. cm.....	612	23
Brinell hardness, 500 kg. load.....	42.5	Writer
Shore hardness.....	19-20	Writer
Heat of oxidation, calories per g. of metal.....	3,288	29
Heat of chlorination, calories per g. of metal.....	4,248	29

Carbon (30).— CaC_2 formed exothermically by direct interaction of carbon and calcium metal. Pure calcium carbide is a white solid.

Oxygen (30).—No reaction in dry oxygen at ordinary temperatures. Above 300 deg. C. reaction proceeds rapidly, forming CaO . Takes fire in air if heated above a dull red heat, and burns to oxide and nitride with vivid incandescence.

Nitrogen (30).—No reaction at ordinary temperatures. Slow combination above 300 deg. C. Heated in pure nitrogen at approximately 900 deg. C. the nitride Ca_3N_2 is formed. This nitride is a reddish-brown solid which reacts with water to form ammonia.

Chlorine (30), Bromine (31), Iodine (31).—No reaction at ordinary temperatures if these halogens are pure and dry. Above 400 deg. C. reaction goes on, becoming violent as the temperature is raised.

Fluorine (32).—Reacts violently at ordinary temperatures.

Hydrogen (30).—At temperatures near 700 deg. C. the hydride CaH_2 is formed. This hydride reacts with water and liberates the combined hydrogen, and the calcium remaining then attacks the water and liberates its usual quota of hydrogen. Calcium hydride has been used as a portable source of hydrogen for filling balloons.

Water (30).—Pure water is decomposed slowly by calcium. Hydrogen is liberated and calcium hydroxide is formed. The reaction is greatly hastened by small amounts of impurity in the water.

Carbon Dioxide (33).—At a red heat carbon dioxide is decomposed and the carbon liberated. The oxygen goes to the calcium, forming calcium oxide.

Oxides and Halides (34, 35).—The oxygen and halogen compounds of a number of metals are readily reduced by heating them with metallic calcium. Chromium and manganese are thus readily prepared from their oxides.

ALLOYS OF CALCIUM

The list of calcium alloys that have been prepared and investigated is quite large. The outstanding general properties seem to be brittleness and the tendency to the

¹⁷French Pat. 438,772 (March 22, 1911).

¹⁸Z. Elektrochem., 1913, vol. 19, pp. 411-117.

¹⁹Trans. Am. Electrochem. Soc., 1920, pp. 69-82.

²⁰MET. & CHEM. ENG., 1916, vol. 15, pp. 193-197.

²¹International Atomic Weights, 1920.

²²Moissan and Chavanne, *Compt. rend.*, 1905, vol. 140, pp. 122-127.

²³Goodwin, *Proc. Am. Phil. Soc.*, 1904, vol. 43, pp. 381-392.

²⁴Northrup, *MET. & CHEM. ENG.*, 1916, vol. 15, p. 193.

²⁵Swisher, *Phys. Rev.*, 1917, vol. 10, pp. 610-618.

²⁶P. H. Brace, *Trans. Am. Electrochem. Soc.*, 1920, pp. 69-82.

²⁷Arciero Bernini, *Physik. Z.*, 1907, vol. 8, p. 150.

²⁸Moissan and Chavanne, *Compt. rend.*, 1905, vol. 140, pp. 122-127.

²⁹Richards, "Metallurgical Calculations," Part I., p. 18.

³⁰Moissan, *Compt. rend.*, 1898, vol. 126, pp. 1753-1758.

³¹Thorpe, "Dictionary of Applied Chemistry," vol. 1, p. 606.

³²*Ibid.*, p. 599.

³³O. P. Watts, *J. Am. Chem. Soc.*, 1906, vol. 28, pp. 1152-1155.

³⁴Perkin and Pratt, *Trans. Faraday Soc.*, vol. 3, pp. 179-186.

³⁵Perkin, *ibid.*, vol. 3, pp. 115-117.

formation of intermetallic compounds. Very few of the calcium alloys appear to have any usefulness as structural materials. Aluminum-rich alloys may find application because of their slight advantage in weight over pure aluminum. Lead alloys containing calcium and other alkaline earth metals are finding application as bearing metals for service, such as the usual white metals are put to. The following condensed abstracts will indicate the nature of the work which has been done in the field of calcium alloys.

N. Barr³⁶ has published the results of an extensive investigation of the properties of a number of calcium alloys by the method of thermal analysis. Calcium was alloyed with thallium, lead, copper and silver, and in every case definite evidence of the occurrence of intermetallic compounds was secured.

Moldenhauer and Anderson³⁷ investigated the direct production of calcium alloys from fused, mixed electrolytes. Zinc, aluminum and potassium alloys were made.

Cooper³⁸ has patented alloys of calcium with aluminum, in which the calcium content may be as high as 8 per cent. The claims feature lightness, ductility and ease of machining.

Kroll³⁹ has patented the use of calcium and its light alloys as a filling for hollow steel structural members. He has claimed that, as compared with nickel-chromium steel, structures made according to his patent have the same strength with but 41.56 per cent of their weight.

Hirsh and Aston⁴⁰ experimented with the production of iron alloys, and state that up to 6 per cent of calcium may be alloyed with iron by reducing Fe_2O_3 in gas-tight iron cylinders. They state that calcium destroys the welding property of iron.

Watts and Breckenridge⁴¹ used the brittle alloys of calcium with aluminum, silicon and manganese as reducing agents in the course of experiments on the preparation of some of the more difficultly reducible metals. The brittleness of the alloys was found a great convenience, as it enabled them to be pulverized and brought into an intimate mixture with the substances to be reduced.

Stoekem⁴² stated that calcium dissolved in cast iron with the evolution of considerable heat, and that if considerable amounts of calcium were added a scum of calcium carbide collected on the surface of the molten metal; also that calcium alloys with copper in all proportions, and that some of these alloys are useful as deoxidizers and scavengers in non-ferrous alloys.

Watts⁴³ found that calcium acted as a powerful desulphurizer of molten, low-carbon iron, but that the effect on the phosphorus content was relatively small.

Hackspill⁴⁴ prepared lead alloys by the reduction of lead chloride with an excess of calcium. The alloys were harder and less brittle than lead and tarnished in the air. They were slowly attacked by cold water, and more rapidly by hot water. A crystalline alloy, Pb_3Ca_2 , was isolated by distillation *in vacuo*.

USES OF METALLIC CALCIUM

A summary of the more important uses of metallic calcium is here given:

1. As a reducing agent in the preparation of metals and alloys from their oxygen and halogen compounds.
2. As a reagent in the purification of the inert gases.
3. As a scavenger in non-ferrous metals and alloys.
4. As a scavenger, decarburizer and desulphurizer of ferrous alloys.
5. As a dehydrating agent, as in the treatment of oils and alcohols, for example.
6. As a means of fixing atmospheric nitrogen.
7. As a source of pure calcium carbide by direct reaction with pure carbon.
8. As a stiffening filling for hollow metal structural members.
9. As a constituent of a light aluminum alloy having useful properties.
10. As a hardening component in certain lead-base anti-friction alloys.

PREPARATION OF CALCIUM

There are three general methods for the preparation of calcium, as follows:

1. By the reduction of calcium compounds by metals of the alkali group.
2. By the electrolysis of concentrated aqueous solutions with a mercury cathode.
3. The electrolysis of fused halogen compounds of calcium.

Of these three methods the last is by far the simplest and most direct.

Moissan⁴⁵ is the one who has written most authoritatively on the first method. No advance has been recorded in this direction since the publication of his researches. He discovered that calcium was soluble in molten sodium, but not in solid sodium, and that when calcium iodide and a considerable excess of sodium were heated together in a gas-tight steel container to a temperature of approximately 750 deg. C., the calcium iodide was reduced and the resulting calcium dissolved in the excess sodium, from which it crystallized on cooling in brilliant, silvery, hexagonal crystals. The sodium which was necessarily associated with the calcium crystals was removed by the action of absolute alcohol, which reagent has little effect on calcium. Moissan asserts that he obtained a purity of 99.2 per cent, and from his description of the properties of his product it is certain that it was quite pure.

Calcium may be prepared from aqueous solutions by electrolysis with a mercury cathode. Concentrated calcium chloride solution is the usual electrolyte. The cathode current density is kept fairly high. As the calcium is released it amalgamates with the mercury, and is finally recovered by distilling off the mercury *in vacuo*. Some mercury remains in the calcium even after distillation at temperatures above the vaporization point of the calcium. This method of preparation is obviously indirect and cumbersome.

The electrolysis of pure molten calcium chloride is the most direct and convenient method of securing pure calcium. When properly prepared the impurities will total less than 0.5 per cent, and will consist of included particles of chloride and traces of calcium carbide. Small quantities of calcium may be readily prepared by melting a few grams of dry calcium chloride in a porcelain crucible and electrolyzing with a current of a few amperes, using a graphite anode and a stout iron wire as cathode. Small globules will

⁴⁵Compt. rend., 1898, vol. 126, pp. 1753-1758.

³⁶Z. anorg. Chem., vol. 70, pp. 352-394.

³⁷Z. Elektrochem., 1913, vol. 19, pp. 444-447.

³⁸United States Pat. 1,224,362.

³⁹Swiss Pat. 75,891 (Jan. 2, 1918).

⁴⁰Electrochemical and Metallurgical Industry, (now CHEM. & MET. ENG.) 1907, vol. 6, pp. 236-237.

⁴¹Ibid., 1907, vol. 6, pp. 237-238.

⁴²Metalurgie, 1906, vol. 3, pp. 147-149.

⁴³J. Am. Chem. Soc., 1906, vol. 28, pp. 1152-1155.

⁴⁴Comp. rend., 1906, vol. 143, pp. 227-229.

collect about the cathode, and may be recovered by shutting off the current and allowing the melt to solidify. The writer has succeeded in building up little rods weighing a gram or so by gradually raising the iron wire as the calcium collected.

SUBMERGED CATHODE TYPE OF CELL

The earlier attempts at large-scale production resulted in the development by Borchers and Stockem of what may be designated as the "submerged cathode" type of cell. Fig. 1 is a diagrammatic representation of such a cell. A graphite shell, *A*, is closed at the bottom by a water-cooled plate, *E*, to which is fastened the upright, water-cooled cathode, *D*, concentric with *A*. The shell and cooling plate are separated by an insulating ring, *H*, of asbestos or mica. Electrical con-

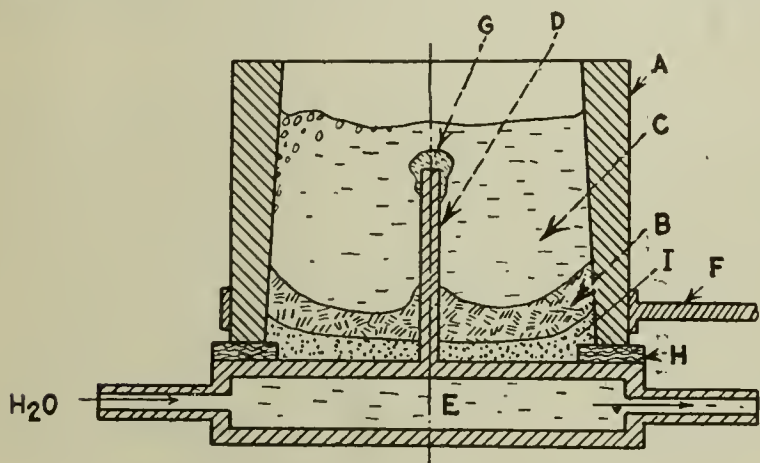


FIG. 1. SUBMERGED CATHODE CELL

A is a graphite shell containing fused calcium chloride, *C*, and forming the anode. The cathode, *D*, is fastened to water-cooled bottom plate, *E*. Calcium collects as at *G*, and rises to surface of electrolyte.

nections are made to the cooler plate and to the graphite shell, as at *F*. The floor of the cell is covered with a layer of powdered calcium oxide or calcium fluoride, *I*.

Operation of the cell is started by filling it with molten calcium chloride and electrolyzing. The calcium collects as at *G*, on the central cathode, and the chlorine is evolved at the inner surface of the graphite shell. The cooler plate maintains a layer of solid calcium chloride, *B*, on the bottom of the cell. The originators of this cell operated it under such conditions of current density and temperature that a sponge of calcium was formed about the cathode. This sponge was compacted by pressing and the chloride removed. The calcium content of the resulting mass was from 50 to 90 per cent. Goodwin worked with this cell in his earlier experiments, and found that much more satisfactory results were obtained by running the cell hot enough to melt the calcium. The globules of metal thus formed rose to the surface of the molten electrolyte, whence they were removed in a ladle and cooled under oil. The writer's experience with this method has been that it will work, but that the product is almost invariably porous and brittle and unsuitable for working into sheet and wire.

THE RATHENAU PROCESS

It appears that the most successful scheme for collecting the calcium as it deposited was developed by Rathenau. He found that a rod of calcium could be built up by using a cooled cathode which just touched the surface of the electrolyte, and operating at such a current density as to keep the surface of the calcium in contact with the electrolyte in a state of fusion while the cathode was gradually moved upward as the deposit accumulated. As successive portions of the electrolyte

were withdrawn from the bath they solidified and formed a foundation for subsequent accumulation. Thus a rod of irregular cross-sectional area was built up. In the usual form of this cell the container for the molten electrolyte was of graphite and acted as anode also.

The writer has worked with a cell of this type, and has found it to be much superior to the submerged cathode arrangement. His experience, however, has been that it was very difficult to get a rod with a cross-section approaching uniformity, and that considerable skill and experience were necessary before one could maintain the cell in operation for any extended period. It appeared that the temperature conditions within the cell were of vital importance, and that they were quite sensitive to changes in the size and position of the areas which were acting as anode. It was conceded that the operator would have much better control of the process if the anode areas were made more definite, and if means could be provided for controlling their size and position. Accordingly, some tentative experiments were then made which showed that the foregoing conclusions were correct, and taught the importance of having the mechanical details worked out with some care and with a view to convenience and certainty of operation.

The arrangement is shown diagrammatically by Fig. 2. The graphite container, *A*, for the fused electrolyte, *B*, was provided with a water-cooled bottom, *C*, which maintained a shell of solid electrolyte, *D*, during operation. A jacket, *F*, of fine graphite and lamp-black protected *A* from oxidation and prevented excessive heat losses. Two water-cooled graphite plates, *G*, *G'*, formed the anodes. These were provided with both vertical and horizontal movement. The cathode, *H*, was water-cooled and provided with gear for raising it steadily at a controllable rate. The continuous current

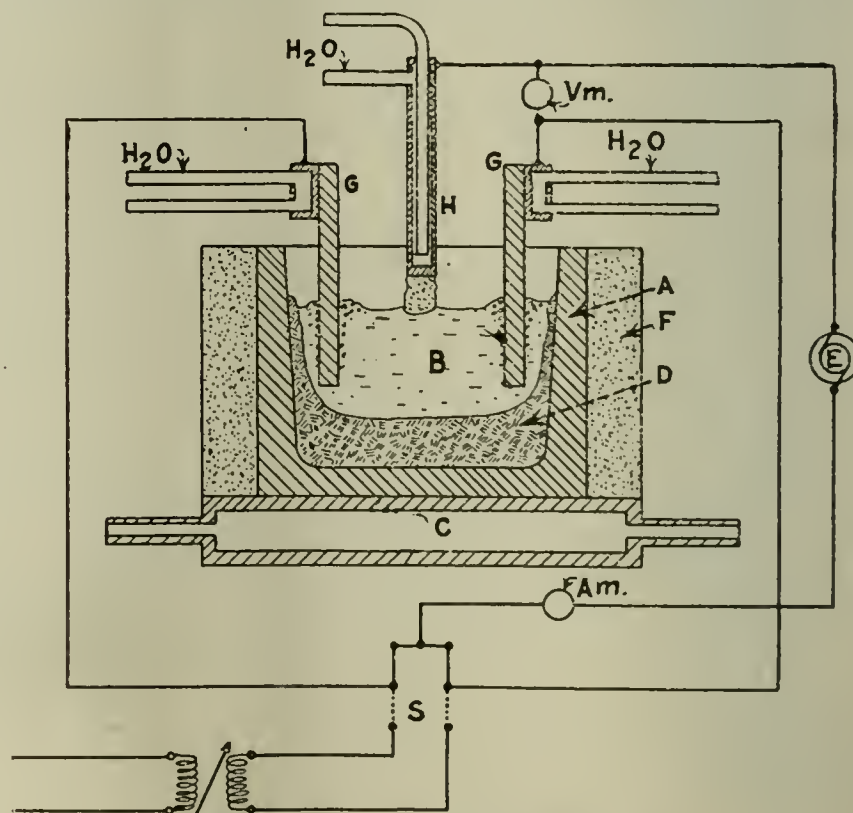


FIG. 2. IMPROVED RATHENAU CELL

A is a graphite shell, cooled by the water jacket *C*. *B* represents the fused calcium chloride. *G*, *G'* are adjustable water-cooled graphite anodes. *H* is the cathode. Current for electrolysis is supplied from a continuous current generator, *E*, connected as shown.

generator, *E*, could be connected to the cathode and anodes by placing the switch, *S*, in the position shown by the solid lines. It could be disconnected and the anodes made the terminals of an alternating-current circuit by placing *S* in the position shown by the dotted

lines. An ammeter, *Am*, and voltmeter, *Vm*, were connected as shown.

Operation of the cell was started by drawing an alternating-current arc between the tips of the anodes, and melting down enough chloride in the bottom of the cell to form a pool into which the anodes were dipped. After this the molten electrolyte carried the current and was heated thereby. Fresh portions of chloride were added and melted till the bath was brought to the desired volume. Switch *S* was then thrown into the direct current position, and electrolysis started by bringing the cathode into contact with the surface of the electrolyte.

The temperature of the cell while operating was very readily controlled by varying the separation and immersion of the anodes. It has been found most feasible to operate at constant current and to control the conditions of deposition by means of the anodes and the rate of cathode movement. In practice this cell has been found to operate very smoothly, the duration of runs being limited only by the range of motion of the cathode. The diameter of the sticks was uniform to within a very few millimeters, and the quality of the metal such that it could be rolled into rods and thin sheets without any difficulty.

The principal dimensions of a 500-amp. cell are given in the following table:

Container, Acheson graphite.
Out-side diameter, 12 in. (30.4 cm.).
Inside diameter—Top, 11 in. (27.9 cm.).
Bottom, 10½ in. (26.6 cm.).
Depth, 9 in. (22.8 cm.).
Anodes, total workable area, 80 sq.in. (516 sq.cm.).
Average running area, 60 sq.in. (387 sq.cm.).
Working charge of electrolyte, 25 to 35 lb. (11.3 to 15.7 kg.).
Cell voltage, 25 to 30 volts.
Current, 400 to 500 amp.

The best results were usually obtained by running the cell with sufficient energy input to keep nearly the entire charge of electrolyte molten, only a small portion on the sides and bottom of the graphite container remaining solid.

If the cell were allowed to run cool so that thick layers of solid electrolyte formed, difficulty would be experienced when the temperature was subsequently raised, apparently owing to the release of graphite or other impurity which had concentrated in the electrolyte that had solidified during the period of sub-normal temperature. A black scum would form on the surface of the bath, which would react with the calcium being deposited and greatly disturb the delicate temperature balance at the cathode.

When the cell was running smoothly, the layer of molten metal on the lower end of the cathode was approximately ½ in. (0.3 cm.) thick. If the molten zone rose too far, a large globule would break off and float around on the surface of the bath until oxidized or cooled against the side walls. This was a very undesirable happening, as the bath was contaminated by the oxide formed and any metal free in the cell was likely to attack the anodes, disintegrating them and sending finely divided calcium carbide into the electrolyte to contaminate the calcium produced.

It has been found that from 4 to 5 units of chloride are used per unit of calcium produced, while the theoretical ratio is but 2.76 units of chloride to one of metal. The low recovery was due partly to the loss caused by the skimming of the bath which became necessary at times; to the chloride layer which formed on the calcium as it was drawn from the bath; but principally to the atomizing effect of the vigorous evolution of chlo-

rine. A fine spray of electrolyte was formed and carried up the flue by the draft sweeping out the chlorine.

ELECTROLYTES

Of the various electrolytes which have been suggested, the writer has tried calcium chloride-calcium fluoride, calcium chloride-potassium chloride, and pure calcium chloride, and is of the opinion that pure calcium chloride properly dehydrated is the most satisfactory. Both purity and complete dehydration of the electrolyte are essential if trouble is to be avoided in operation.

Satisfactory dehydration was secured by boiling the aqueous solution down with excess of hydrochloric acid and a few per cent of ammonium chloride. The white porous cake formed was broken up, mixed with additional ammonium chloride, and heated out of contact with moist air at 500 to 600 deg. C. for several hours.

Incomplete dehydration was made evident by the evolution of hydrogen at the cathode when electrolysis commenced. Oxygen was apparently freed at the anodes, greatly hastening their disintegration and causing the bath to become contaminated with finely divided graphite. The hydrogen liberated at the cathode interfered greatly with deposition, the graphite was carried to the cathode where it reacted with the calcium, and the net result was a disagreeable mess and little calcium.

If the chloride used for electrolyte contained even small amounts of the salts of sodium, magnesium or aluminum, more or less trouble was encountered, because of the fact that these metals were precipitated along with the calcium, and at some stages of the process so lowered the melting point of the deposit as to make it almost impossible to maintain operation of the cell. When using electrolyte of sufficient purity, a cell could be operated for extended periods with no difficulty and with no need for any change of the electrolyte or additions to it other than the fresh material needed to replace that used up.

The powerful reducing action of calcium was well illustrated by the fact that globules of calcium which became detached from the cathode and remained in contact with the molten electrolyte for some time picked up magnesium, aluminum and sodium from the molten electrolyte. Buttons containing several per cent of these metals have been taken from cells which have been in operation on electrolytes containing but small fractional percentages of salts of the metals first mentioned. Some of these buttons were so highly alloyed as to be quite brittle, to react but slowly with water, and to have a melting point below a red heat.

In closing it may be said that the electrolytic preparation of calcium is a simple matter if pure, dry calcium chloride is used. By "dry" is meant perfectly dry; the "anhydrous," "c.p." material supplied for drying tubes and similar applications may contain as much as 0.1 per cent of moisture, and other troublesome impurities.

CONCLUSIONS

1. Goodwin and Rathenau made important advances in the technique of the electrolytic preparation, and the "contact cathode" process of the latter has met with commercial success.

2. Certain modifications permitting the control of anode conditions have been introduced by the writer, and it is believed that marked advantages result.

3. Pure calcium chloride, completely dehydrated and free from calcium hydroxide, is a most satisfactory electrolyte.

Multiple Effect Evaporation

Discussion of the Multiplex Film Evaporator as Regards Features of Construction and Operation—Development of Evaporator Design Since 1885—Comparison of the Multiplex With Other Types

BY BURTON DUNGLINSON

WHERE evaporation is carried out on an extensive scale, economy of heat is a fundamental factor in the efficiency of the apparatus. In a vacuum-evaporating problem it is obvious that there will be no economy of steam for evaporation if a single-effect vacuum evaporator is used, as the lowering in boiling point of the liquid due to vacuum does not conserve sufficient energy to compensate for the energy used in driving the vacuum pump plus the radiation losses. The only reason single-effect vacuum evaporation is resorted to is the fact that low-pressure exhaust steam can be used to advantage and where delicate liquids are being handled the lowering of boiling point prevents decomposition which would occur at higher temperatures.

Multiple-effect vacuum evaporation was introduced with a view of conserving as much heat as possible by utilizing the latent heat of condensation of the steam evolved from the various vessels. Thus, in a quadruple-effect evaporator exhaust steam can be used for heating the liquid in the first effect. The process of evaporation centers on the temperature difference between the heating medium and liquid to be heated. This is obtained in the first effect by a slight vacuum created by the pump above the liquid and the higher temperature of the exhaust steam used as a heating medium. If the evaporated steam being evolved from the liquid in the first effect is to be utilized as a heating medium in the second effect, it is clear that there must be a sufficient temperature difference between the liquid coming from the first effect and the steam being evaporated from same. The temperature difference is obtained by creating a larger vacuum over the liquid in the second effect, and a similar procedure is followed for the third and fourth effects. The actual vacuums usually desired are: First effect, 2 in. mercury; second effect, 6 in. mercury; third effect, 14 in. mercury; fourth effect, 28 in. mercury.

SYSTEMS EMPLOYED

This system of multiple evaporation (as well as any other system) allows the available heat of evaporated water, as steam, to be utilized to advantage. Theoretically, if radiation losses and other factors did not interfere with the laws, one drop of water during process of evaporation should produce just the same amount of heat as was originally transmitted to heat it up to boiling point and complete evaporation. The energy contained in this steam, if transmitted to another drop of water while being cooled to its original temperature, would be sufficient to evaporate another drop of water under the same conditions and so on *ad infinitum*. Unfortunately this theoretical condition cannot be approached in actual practice, as radiation losses are unavoidable and the condensed steam usually

passes away as hot water and retains a fair number of heat units.

The nearest approach to theoretical conditions would be the use of the largest numbers of multiple effects possible with due consideration to mechanical operation and costs of installation. Sextuple-effect evaporators are known but are very rarely used. Their use is confined mainly to processes in connection with soap and paper manufacture, and this applies also to quintuple effects. It is questionable whether the increased efficiency due to the greater heat units developed in 1 lb. of steam compensates for the extra cost of installation and operation in these styles of evaporators.

Quadruple-effect evaporators are quite common in industry, being used mainly in connection with sugar plantations and refineries, where very large quantities of liquids are handled. Triple-effect evaporation is generally used for most operations where liquids have to be concentrated from a density approaching water to 30 deg. Bé. (sp.gr. 1.26) or thereabouts. This type of apparatus is generally accepted as being the "happy medium," where initial cost, floor space, operating costs and economy counterbalance one another.

GENERAL DEVELOPMENT OF APPARATUS

The development of evaporator design has been very gradual and up to recently has been marked by no decided revolution. From the inception of the jacketed pan to the vertical and horizontal tube evaporator no epoch-making devices were introduced. In fact, it is quite a common practice today to evaporate milk and some food products in a steam-jacketed pan, with addition of coils, to permit perfect cleaning after each run. Naturally the efficiency of such equipment is very low, when compared to the tubular evaporator, which maintains a more rapid circulation.

The standard tubular evaporators are built to operate on two principles: One in which the liquid to be heated circulates through the tubes, and the other in which the liquid to be heated is circulated around the tubes. From a standpoint of easy cleaning and general efficiency the evaporator which permits the liquid to circulate through the tubes is the more acceptable.

When a liquid is heated, convection currents are set up, which ultimately produce circulation. This circulation would be impeded by the formation of steam and dissolved air bubbles if means were not introduced for a fairly violent agitation to free these "insulators" from the tube walls. This is accomplished by introducing one or more wide-bore circulating tubes, through which the liquid passes downward. It is a most natural phenomenon, as the heat transmitted through a narrow-bore tube is much greater per unit cross-sectional area than that through a wide-bore tube, hence creating a temperature difference between the liquid in the nar-

row- and wide-bore tubes. Thus the direction of flow is maintained in a positive way by ascending the small-bore heating tubes and descending the wide-bore circulating tubes. Most standard evaporators have the heating elements of tubes about 2 in. in diameter.

Arguing as above, tubes of narrower bore would be expected to transmit more heat per sq.ft. and maintain a much more rapid circulation, and this has proved to be the case in actual practice. A wide-bore tube evaporator, the usual standard type of plant, with 2-in. tubes, must have a greater diameter than a machine of same heating surface using tubes of smaller diameter. It is also plain that with the former type of evaporator, owing to the absence of any separating device for the steam and liquid adjacent to the top tube plate, a greater free space must be allowed for complete separation of liquid drops from the steam, which would otherwise be carried over to the condenser and wasted. To make doubly sure of this important point, a vapor baffle piece is usually embodied in the head of the evaporator.

ELEMENTS OF DESIGN

The four elements constituting a complete evaporator are: (1) The nest of heating tubes, commonly called a "calandria" and embodying the shell and tube plates. (2) The bottom plate, in which the liquor discharge pipe is fixed. (3) The vapor space or section, usually called the "belt piece," which in a standard evaporator must be of sufficient height and volume to prevent entrainment of foam and drops. (4) The vapor and drop separator or "save-all," which is embodied in the design of the cover plate. This is usually an inner and an outer pipe, which change very quickly the direction of flow of the vapors and result in the trapping of any entrained drops, which pass back to the liquid being evaporated, before the vapors travel to the next vessel or to the condenser. This design embodies all types of vacuum evaporators, and the modification, improvisation and disposition of the contained parts cover the patent types of equipment.

STEAM CONSUMPTION

Steam consumption in most standard types of evaporators varies very little for the different designs and the following evaporating figures will serve as a guide to actual practice. Per pound of steam used, the quantities of water evaporated will be:

In a single effect vacuum evaporator,	0.8 lb.
" " double " " "	1.6 "
" " triple " " "	2.7 "
" " quadruple " " "	3.1 "

The heat losses met with are usually due to: (1) Radiation from the large surfaces of calandria, belt piece and connecting vapor pipes; (2) hot condensed

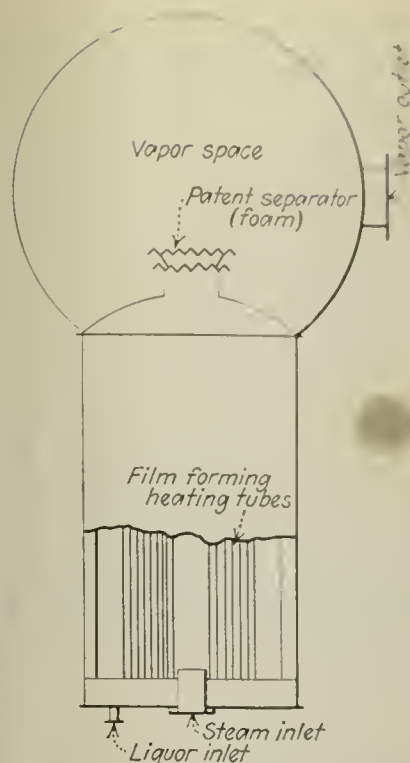


FIG. 1. CROSS-SECTION OF ONE EFFECT MULTIPLEX FILM EVAPORATOR

water passing to vacuum pump, and (3) bad transmission of heat, due to sluggish circulation and consequent incrustation of tubes with deposits from liquid being evaporated.

Efficient condensation is a prime factor in maintaining a high vacuum on the apparatus and it will be readily understood that the more complete the condensation the smaller sized vacuum pump that will be required. For given quantities of liquids treated in a single, double and triple effect, the size of the vacuum pump and condenser will be cut down according to the increase in the number of effects. The liquid under treatment is usually carried from one effect to the other by means of the different vacuums operating in the vessels. A liquor-withdrawing pump is required to discharge the concentrated product from the last effect.

COLOR OF LIQUID

The conditions operating on the last effect in a standard triple-effect evaporator are not conducive to production of a good colored product, free from contaminated decomposition bodies, because to obtain the necessary heat transmission there must be sufficient liquor present at all times to cover the tubes. This means a fair volume of material which must always be present at the finished density, and consequently there will be a prolonged heat-treatment of a large proportion of the liquid. In most cases the time of contact in a standard single- or triple-effect evaporator varies from one to ten hours according to the required density, and as the liquid is in constant though sluggish circulation most of the time, it is subjected to heat-treatment which is detrimental to the finished product, unless particularly high vacuum is maintained together with the use of exhaust steam having a very low pressure.

EXPERIMENTAL WORK

With the desire to eliminate these undesirable factors, experiments were made with a view of increasing the velocity of the liquid in the heating tubes and so determining the time of contact desirable, in the form of a thin film; producing the concentrated product and if possible removing all liquid immediately this concentration is reached. The first practicable plant to produce these results was of the Kestner type, and the design of this plant in the main has not altered materially from its inception. The tubes of this evaporator are about 1 in. in diameter and are not less than 20 ft. long. It will be seen that with such a long tube mechanical difficulties are likely to be encountered, such as sagging of the tube due to its weight and consequent strain of the top tube plate, with the result that leaks will develop.

Owing to the enormous head room required for the plant a triple-effect evaporator must be composed of three single-effect units extended over large floor space with interconnection vapor pipes, and the time of contact with the 20-ft. tube is extremely large, although film evaporation will reduce the deterrent effect of the heating medium to a minimum.

For quite a number of liquids it has not been possible to employ multiple-effect apparatus, because materials which are sensitive to a high temperature could not be evaporated in such equipment without suffering injury, as the operation of a multiple-effect evaporator, say of the triple-effect type, requires evaporation temperatures calculated from the vacuums employed, and

actual readings on a large scale, up to about 176 deg. F., and if a larger number of effects is used, still higher evaporating temperatures are required.

For small or medium quantities of liquid and where the work performed is more or less intermittent, the use of a multiple-effect evaporator is precluded because of the time occupied in starting and stopping the apparatus. The large floor space required and the comparatively high first cost compared with that of a single-effect evaporator and many other disadvantages to be overcome caused experimental work about ten years ago to be directed to mechanical efforts toward a film type of evaporator with a short tube, which, by reason of its construction, would allow three effects to be superimposed, thus utilizing no more floor space than is required for single-effect evaporator and at the same time so calculating the head room that a barometric discharge condenser could be employed if so desired.

Such an evaporator required an immense amount of detail work in design and experiments under actual large-scale conditions before the desired result could be obtained. It was found that although a thin film of liquid was induced through scientific distribution of steam, no foam was experienced until the liquid left the tubes at very high velocity.

MULTIPLEX EVAPORATOR

This mixture of liquid, foam and evaporated steam required some mechanical device to insure complete separation and experiments resulted in a type of foam separator which arrests the high velocity of the liquor and steam and gives a quick change of direction with consequent complete separation. Even with this new type of evaporator, called a "Multiplex," high temperatures in the first effect could not be avoided, but in consequence of the special construction the quantity of liquid contained in each separate effect and under treatment at one time is so small that the liquid remains in the tubes only one to two minutes as a maximum, and is then drawn off immediately after passing through the foam separator into the next effect, which is at a lower temperature, owing to the higher vacuum being maintained.

It will be readily understood that owing to the high velocity and short distances the liquid has to travel through the tubes, not more than 6 ft., the time of contact is exceedingly short. The effect of high temperature is instantaneous with consequent high-grade product and maximum evaporation owing to the formation of film inside the tube.

A very important development in connection with these high velocities obtained in film evaporation is the scouring effect of the liquor passing through the tube, which has been found to prevent formation of scale or other bodies which would result from prolonged heat-treatment. In fact, an experience over six years in the treatment of a very sensitive liquid has shown the heating tubes to be absolutely bright and clean and free from any foreign deposit.

Most liquids will stand the temperatures encountered without suffering practically any injury, and their quality is affected only when the high temperatures act on them for a considerable time. This explains why, notwithstanding the high temperatures met with in the first effect, no deterioration of the quality of the liquid concentrate takes place in the Multiplex type.

The mode of operation is very simple, the apparatus

being set to work by putting the air pump in action and setting the various liquor and foul air valves distributed on a working platform from an angle of 90 deg. The vacuum sucks in the liquid which is to be concentrated through a control valve and pipe coupled to the feed tank, and the concentrated liquid is ejected continuously through a discharge pipe.

The degree of concentration is controlled by the volume of liquid introduced and the achievement of making a direct and immediate concentration from the strength of liquid entering the apparatus to the finished product will be considered unique. Once the valves have been set and the apparatus is operating, it will work continuously without any further attention.

Fig. 1 shows cross-sectional view of one effect of this Multiplex-film evaporator, and Fig. 2 will show triple-effect evaporator with three of these effects superimposed. This evaporator is complete with surface condenser and plunger type of vacuum pump. The apparatus is absolutely complete, with its feed tank, liquor discharge pump and accessories, and it will be noted how extremely small is the amount of floor space taken up. Its operation is described thus:

When the apparatus has been exhausted of air, the liquid to be concentrated enters through a pipe coupled to the feed tank into a double jacket, where it rises to a uniform height in the tubes, which are surrounded with steam entering through the valve. The liquid very soon gets into ebullition and gives off steam and its contained permanent gases. In the lower part of the heating tubes the steam itself forms bubbles, and as these bubbles are surrounded by the liquor while the steam volume is increasing constantly due to the heat contact, the liquid very soon forms a stream of increasing velocity. The bubbles tend to travel toward the center of the tube, and as a result of this the liquid attaches itself to the tube walls and the steam acts as a carrying medium, driving the liquor further up the tube and still in contact with the tube walls.

The middle and upper parts of the tubes are, therefore, no longer filled with liquid and the tube walls are still wet with it traveling at a high velocity. The bubbles of froth formed in

the lower part of the tubes are broken up so that the liquid leaving the end of the tubes in the form of drops meets the foam separator, where change of direction results in the separation of the liquor and steam. The velocity of the steam between the foam separator and tube outlet is so great that the drops do not have sufficient time to fall, but are blown toward the separating device, where the liquid settles to the floor of the vapor space in the evaporator and thereafter rises through a liquor-conducting tube which communicates with the next vessel maintained at a higher vacuum.

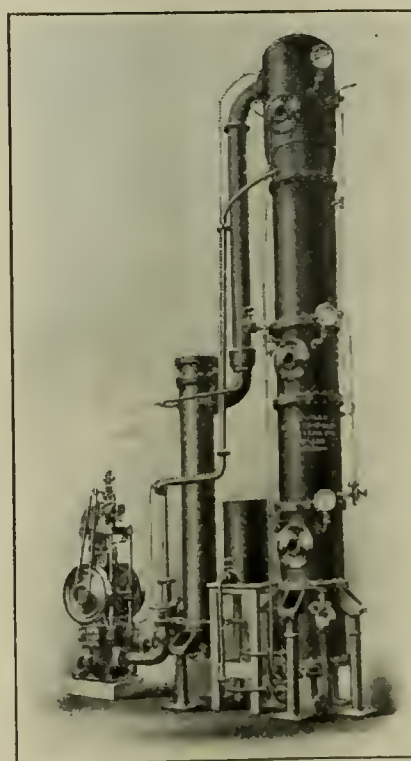


FIG. 2. COMPLETE ARRANGEMENT OF TRIPLE EFFECT MULTIPLEX EVAPORATOR

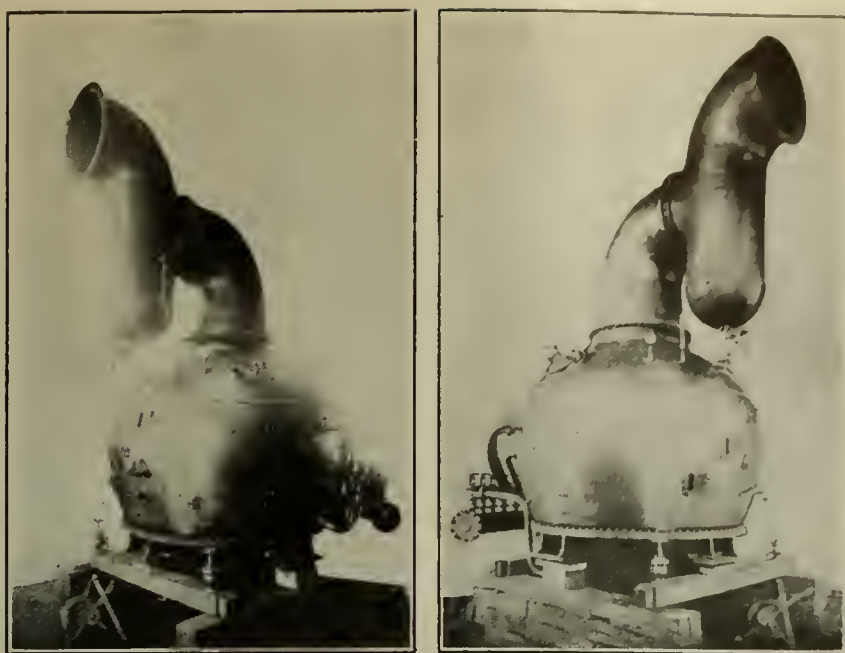


FIG. 3. COIL TYPE VACUUM PAN, 12 FT. DIAMETER.
MODEL OF 1885

The vapor from the first effect rises to the second heating compartment and there serves as a heating medium and the liquor passes into the next effect, where the process of evaporation is repeated in the same way as in the first effect, with the same separation and treatment in the third effect, from which the liquor is drawn off after it has passed through the evaporator only once and has been concentrated to the desired degree. The vapor from the last effect is conducted by means of a vapor pipe to the condenser maintained under vacuum by means of the pump.

MECHANICAL ARRANGEMENT

The simplest way of arranging the effects in this type of film evaporator is to place them one above another, and this can be done for all ordinary problems, but where large quantities of liquid have to be handled it may be advantageous to arrange the effects alongside each other, although the floor space taken up is much smaller than that required for a standard evaporator.

As already pointed out, owing to the mechanical construction, the liquor cannot rush through the tubes in the form of froth, as it very soon adheres to the tube walls in a thin layer and evaporates further without being impeded by formation of froth and pockets resulting from the release of uncondensable gases. These last two factors interfere very much with evaporation in ordinary types of evaporators, and this explains why much greater efficiency can be obtained in the film type of apparatus. The central entrance of steam into the heating space causes and maintains an energetic circulation, so that all the heating tubes are heated with the utmost possible uniformity and no pockets are formed in which deleterious gases can collect.

For liquids which are sensitive to the influence of temperature, such as glue, tanning materials, food products, etc., the apparatus is constructed in such a way that the whole amount of liquid contained in contact with the heating surface in the apparatus is only a few gallons. Every particle of liquid that remains, therefore, is only a few minutes in the apparatus and is then forced up by the liquid following it.

COST DATA

To permit of comparison as to the actual saving in multiple-effect evaporators over single-effect, working

balance sheets have been drawn up. The cost figures stated have only been estimated and the capacity of the apparatus is, in each case, assumed to be ten tons, or 20,000 lb., of water evaporated in ten hours. The cost per ton of steam is taken at \$0.15 and the cost of 32 cu.ft. of water at \$0.005 and the cost of one horsepower-hour at \$0.01.

1. Single-Effect Vacuum Evaporator, Ordinary System		
Steam consumption, 20,000 lb. at 1.05 = 10.5 tons at \$0.15		\$1.57
Water consumption, 10 tons $\times$ 25 = 250 tons at \$0.005		1.25
Power required, 5-hp. 10 hr. = 50 hp.-hr. at 1c		0.50
Cost of evaporating 20,000 lb. of water daily		\$3.32
2. Triple-Effect Multiplex Evaporator:		
Steam consumption, 20,000 lb. at 0.4 = 4 tons at \$0.15		\$0.60
Water consumption, 10 tons $\times$ 10 = 100 tons at \$0.005		0.50
Power required, 2 hp. 10 hr. = 20 hp.-hr. at 1c		0.20
Cost of evaporating 20,000 lb. of water daily		\$1.30
3. Quadruple-Effect Multiplex Evaporator:		
Steam consumption, 20,000 lb. $\times$ 0.3 = 3 tons at \$0.15		\$0.45
Water consumption, 10 tons $\times$ 7.5 = 75 tons at \$0.005		0.37
Power required, 2 hp. 10 hr. = 20 hp.-hr. at \$0.01		0.20
Cost of evaporating 20,000 lb. of water daily		\$1.02

DEVELOPMENT OF EVAPORATOR DESIGN

The original evaporators, utilized on a large scale for the production of concentrated commodities, were coil pans of beautiful design and artistic curvatures; all hand made and polished to give the machine a pleasing appearance. It must be remembered that at this time, from about 1812 to 1885, there were no drawings used in the workshops. The drafting room was unknown and reference to Fig. 3, showing the 12-ft. diameter copper vacuum pan, made in 1885, will show that there is a decided absence of corners and an avoidance of perpendicular sides, in order to maintain a gradual change in velocity of the vapors, thus cutting down frictional resistance. In those days the prevailing opinion was that sharp curves interfered with the operating of the pan and therefore any modification in the design which would tend to influence the results was discarded.

It will be noted that there is an extremely large space for the liquor with a comparatively small vapor space and only coils were used for heating. The general design is made with a view of facilitating manufacture rather than a scientific basis for efficient operating. Evidently no calculations were made as to the yield of vapor, and the change of direction in flow of this vapor,

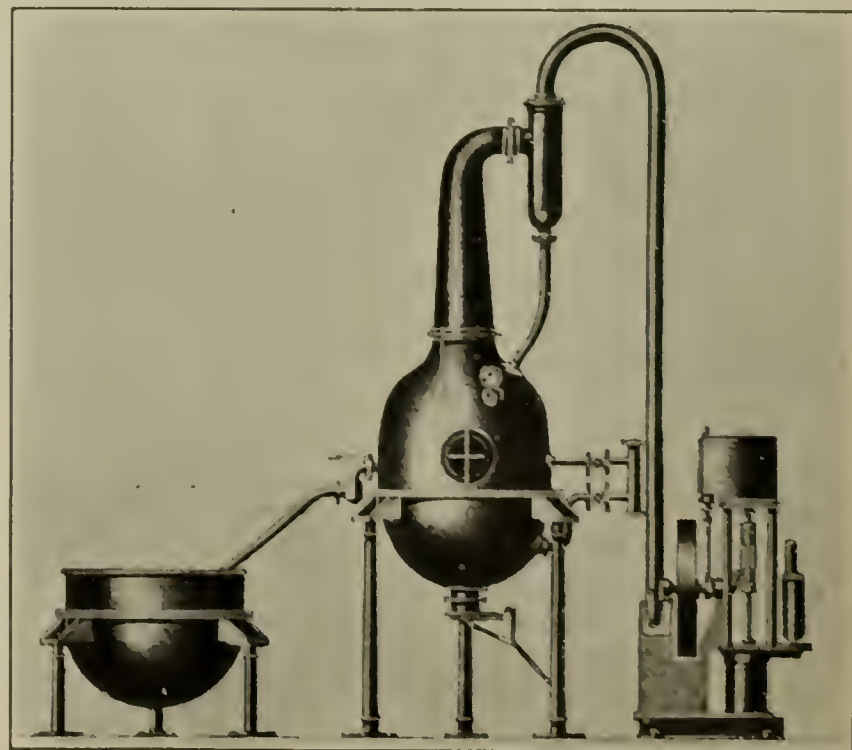


FIG. 4. STEAM-JACKETED VACUUM PAN

for the prevention of entrainment, simply depended on a baffle plate which was included in the external save-all—this being furnished with a return pipe leading to the evaporator.

MILK EVAPORATING PANS

The semi-spherical bottom was evidently included to facilitate complete draining of the concentrated liquid. While the steam-distributing arrangement, comprising header, angle valves and pipes leading to the various coils, is primitive, the solid, rugged, artistic design of this evaporator would insure long life but extremely low efficiency. The present milk pans, as shown in Fig. 4, do not depart much from the above basis of design.

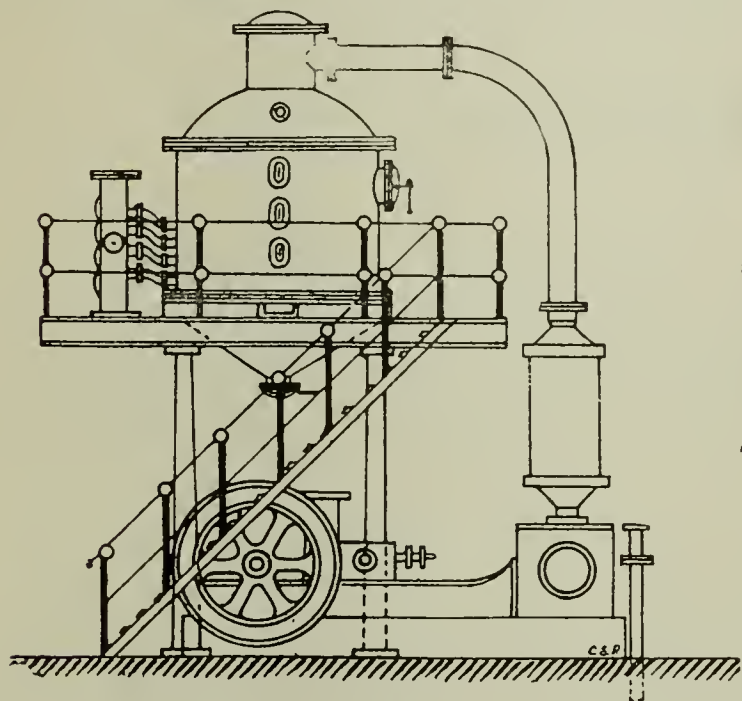


FIG. 5. COIL TYPE VACUUM PAN WITH JET CONDENSER

There is the same contour, with lengthening and widening of the vapor space and an elongation of the dome, with a more scientific application of the save-all for entrainment. The heating arrangements are still of the coil type, supplemented by a steam jacket, the probable reason being to prevent any corners where material would deposit.

One essential feature which influences the design of pans for food products is the rigidly enforced law that there must be no cavities or projections which would not be easily accessible, as the interior of the pan must be cleaned thoroughly

after every run. Otherwise any depositions would eventually become the breeding place for bacteria, which would destroy subsequent charges. These pans are usually of strong and substantial make, consisting of a steam jacket or casing, mounted on columns, fitted with inner copper bottom suitably flanged and joined to the jacket by means of wrought-iron rings, secured by screw bolts and nuts. The head of the evap-

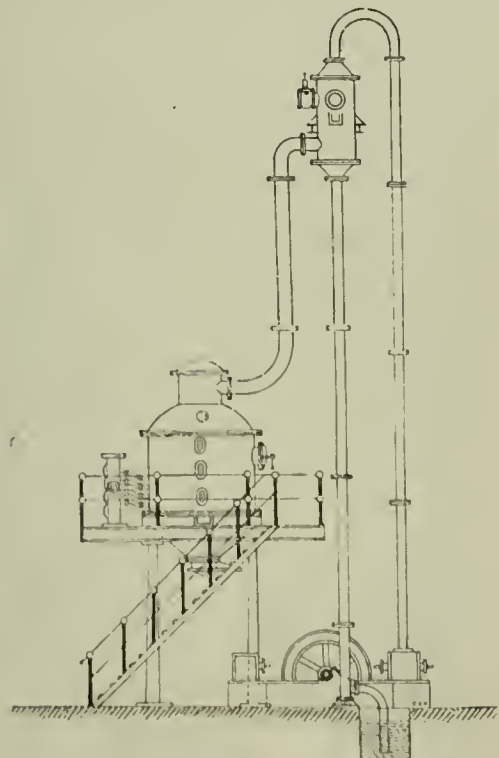


FIG. 6. COIL TYPE VACUUM PAN WITH BAROMETRIC DISCHARGE

orator is usually constructed with a view to avoid losses through the vacuum pump.

COIL EVAPORATORS FOR SUGAR

Coil vacuum evaporators were admirably adapted to the concentration of sugar juices, and as the quantity of this liquid is large special arrangements had to be made for the handling of mammoth quantities. It is common practice to use a coil pan, or combination of a coil and tubular heated pan, for sugar juice. The reason has never been clearly explained or analyzed but appears to be tied up with the production of sugar crystals of a definite size. In evaporating sugar juice it is usual to carry the concentration to a point where an inoculation with crystals will produce crystals throughout the whole mass.

This means that the coil type of pan insures a large body of liquid out of contact with the heating surface (the coils being arranged around the sides and bottom) and thus allows crystallization to proceed uninterrupted. Of course there is also the presence of soluble salts in the juices which deposit on the heating surface, owing to the fact that circulation is sluggish toward the end of evaporation. The coils are easily subjected to inspection and cleaning, thus insuring a popular tendency toward the adaptation of this type of pan for this particular problem.

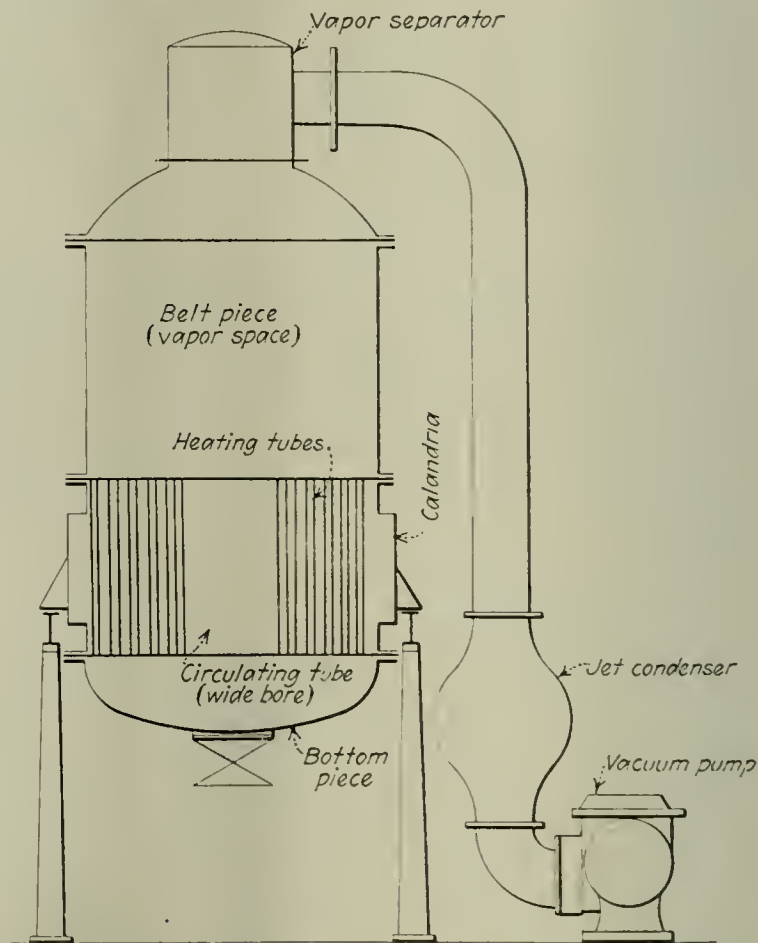


FIG. 7. VERTICAL TUBULAR CIRCULATING EVAPORATOR

These evaporators are usually made in sizes up to 15 ft. in diameter, and as such a large machine requires a proportionate vapor pipe, means had to be found to modify the existing external save-all, which was a separate piece of apparatus coupled to the dome of the pan. This resulted in the development of an internal save-all, comprising an integral part of the evaporator. Fig. 5 shows a general arrangement of such an evaporator with a jet condenser and wet vacuum pump, while Fig. 6 shows the same evaporator with a barometric condenser and dry vacuum pump.

As industry developed there were demands for an evaporator of large heating surface, low floor space,

large vapor space and an arrangement whereby the crystals deposited during evaporation could be removed without interfering with the process. The tubular evaporator was therefore developed in both the horizontal and the vertical type, having much greater heating surfaces per square foot of floor space than the coil type. The large vapor space was made to contend with the heat-treatment of the liquids which are apt to foam under vacuum, and the internal save-all device was also embodied in such a design. It will be noted how the tendency of design is toward an increased height with proportionate diameter. Such an evaporator is used almost universally for problems where crystals are deposited during the process. A cross-sectional view of this type of evaporator is shown, minus the "salt pot," in Fig. 7. The effects are arranged alongside each other, and a comparison with the Multiplex triple-effect evaporator in Fig. 2 will show the important saving in floor space and ease of operation introduced by using this latter machine. The cross-sectional diagram (Fig. 1) shows the method of heating and separation of concentrated liquor from the evaporated steam in the Multiplex evaporator. The accompanying tables show tests of this evaporator handling various solutions.

OPERATING TESTS ON GELATINE LIQUOR WITH MULTIPLEX TRIPLE-EFFECT EVAPORATOR

Construction:	3 superimposed effects, all copper, tinned inside
Weak liquor:	In at 0.2 deg. Be. } 84 per cent evaporation
Strong liquor:	Out at 6 deg. Be. }
Water evaporated:	= 5400 lb. per hour
	= 11 lb. per sq.ft. of heating surface
Steam pressure:	Exhaust steam at 3 lb.
Steam used:	1 lb. per 2.78 lb. of water evaporated
Water in:	80 deg. F. } Surface condenser used
Water out:	110 deg. F. }
Temperature of finished gelatine from last effect = 130 deg. F. at 27 in. mercury vacuum.	

OPERATING TESTS ON MALT SIRUP WITH MULTIPLEX TRIPLE-EFFECT FILM EVAPORATOR

Construction:	3 superimposed effects, cast iron with copper tubes
Weak liquor:	Wort at 4 deg. Be.
Strong liquor:	Out at 28 deg. Be.
Water evaporated:	10,000 lb. per hour
	= 10 lb. per sq.ft. of heating surface
Steam pressure:	Exhaust steam at 5 lb.
Steam used:	1 lb. per 2.8 lb. of water evaporated
Water in:	70 deg. F. } 30 deg. F. rise, using 14,000 gal. per hour.
Water out:	100 deg. F. } with jet condenser and wet vacuum pump
	= 1.4 gal. per lb. of steam evaporated
Temperature of finished malt sirup from last effect at 27 in. vacuum = 126 deg. F.	

EVAPORATION OF ALUM SOLUTION IN MULTIPLEX VACUUM TRIPLE-EFFECT

Weak liquor:	In at 27 deg. Be.
Strong liquor:	Out at 45 deg. Be. at 76 deg. C. (solid on cooling)
Steam pressure:	12½ lb. per sq.in.
Steam used:	1 lb. per 2.78 lb. of water evaporated
Water in:	At 5 deg. C. } 7 deg. C. difference
Water out:	At 12 deg. C. }
Water used:	2½ gal. per lb. of steam evaporated
Note: The solution entered the evaporator at a density which is usually the finishing point for most liquors in a triple effect.	

Microscopic Lenses

A committee of the A.S.T.M. recommends that the term "lens" be used to refer to the combination of simple lenses which makes up the objective, by means of which a real image of the object is produced within the tube of the microscope, or the ocular, or eye piece, which enlarges the real image formed by the objective in the focal plane of the ocular. The lens system includes both objective and ocular.

In addition to the magnification or increase in size of the image with respect to the object produced by a lens, the resolving power or ability to make visible fine detail is of great importance. The magnification produced by an objective may be determined approximately by dividing 250 mm. (the normal reading distance) by the equi-

valent focal distance of the lens. The resolving power depends upon the numerical aperture (N. A.) which in turn depends upon the angle of aperture, α , and the refractive index, n , of the medium between the lens front and the object, e.g., cedar oil in oil immersion lens.

$$N. A. = n \sin \frac{\alpha}{2}$$

On account of the shape of a lens, light focused from near the edge of the lens is not brought through the same point as light passing through the central part of the same lens. This defect is termed spherical aberration. In a somewhat similar manner light of different wave length (color) does not all focus at the same point; this is chromatic aberration.

Achromatic objectives are constructed by a suitable combination of optical glasses of different indices of refraction so that correction for two colors, red and violet, is made, thus reducing chromatic aberration considerably. In apochromatic lenses this correction is carried very much further so that three colors are brought to the same focus.

Canadian Glass Industry in 1918

The mining, metallurgical and chemical branch of the Canadian Bureau of Statistics has just issued an account of the glass industry of the dominion in 1918. It may appear to be a late date to issue statistics for the year 1918, but it should be remembered that the Bureau of Statistics is a comparatively new department, that Canada has been at war, and that about 7 per cent of the whole population was mobilized for the actual fighting line, while a very large number of men were employed in the manufacture of munitions and supplies for the army. This made a big inroad on a total population of less than eight million, consequently many departments have suffered and have not yet gained pre-war efficiency.

During 1918 nine firms were engaged in the manufacture of glassware; of these six confined themselves to the manufacture of lamp and lantern chimneys, drinking glasses, bottles and other pressed and blown glassware; two to vials and chemical glassware, and only one to sheet glass. The total production of glassware was valued at \$6,578,602, of which ware to the value of \$35,367 was exported. On the other hand, Canada imported glassware to the value of \$5,430,873, showing that the country produced only 54.9 per cent of its actual requirements. The total capital invested in the industry was \$7,443,525, employment was given to 2,322 men and women, and \$2,221,563 was paid in wages. The raw material consumed was valued at \$2,056,739 and the fuel at \$598,886. Miscellaneous expenditures chargeable to manufacturing amounted to \$989,747, so that the total expenditures were \$5,882,295.

The following table gives the quantities and values of the raw materials consumed, all of which, with the exception of the soda ash, sodium nitrate and lead oxides, were of Canadian origin:

	Quantity	Value
Silica sand, tons.....	40,344	\$155,854
Soda ash, tons.....	13,468	635,068
Sodium nitrate, tons.....	95	7,905
Limestone, tons.....	4,490	18,076
Lime, tons.....	2,190	18,046
Carbon, tons.....	7	140
Arsenic, white, lb.....	68,314	8,694
Manganese dioxide, lb.....	18,535	1,414
Litharge and red lead, lb.....	169,986	17,764
Other chemicals.....		74,556
Miscellaneous, including crude glass and tubing.....		751,276
Boxes, cases, etc.....		367,946
Total.....		\$2,056,739

Selection of Fuel for Industrial Heating*

THE selection of fuels for industrial heating should be based upon appreciation of the radical difference between the price of fuel on the one hand and the quality and cost of product resulting from the generation, application and utilization of heat on the other.

The result sought from the application of heat is produced not by fuel or heat alone, but by a combination of equipment, fuel and operative. The nature of the heating process, the type and size of furnaces adapted to the manufacturing requirements, the plant conditions, the personnel, and price of available fuels or electrical energy are the controlling factors. Each of these must be considered, any one of which may influence the final choice.

COST PER B.T.U. DOES NOT TELL WHOLE STORY

The practice of selecting fuel on the basis of thermal value and price is both inaccurate and misleading unless at the same time proper consideration is given to other essentials which largely determine the suitability of fuel and equipment regardless of price or thermal value. Otherwise no other form of fuel could compete with bituminous coal burned in the open grate or blacksmith fire.

The form of equipment must be considered with reference to the manner of applying and utilizing the heat and of handling the material to be heat-treated, because these essentials are as directly linked to the quality and cost of finished product as are the price of fuel or method of generating heat, whether it be through combustion or the arc, induction or resistance methods of releasing heat from electrical energy.

Whenever there is a difference in physical or chemical form of fuel, or in mechanical form of equipment, there is a difference in economic value regardless of comparative thermal value.

It is as illogical to compare different forms of heat energy with regard to a certain result as it is to compare electricity with any one form of fuel on the basis of thermal value, unless proper consideration is given to the form of equipment adapted to each.

In industrial heating, as in illumination or transportation, much of the advantage frequently credited to some one form of energy is actually due to the appliance employed in connection with it. A different design of appliance or method of operating may reverse conclusions based on thermal value.

Frequently the "form value" of a suitable combination of equipment and fuel will prevail regardless of price. This is illustrated by the practice of using comparatively expensive gas for intermittent cooking operations in the kitchen in preference to comparatively cheap coal, which under different service requirements is preferable for heating the house. The advantages of incandescent electric lamps for the illumination of the interior of a railway coach may well be accompanied by the use of oil lamps as signals at the end of the train.

A FIELD FOR EACH FUEL

The nature of the heating process, manufacturing requirements and plant conditions may in many in-

stances make city gas at \$1 per thousand cubic feet economically preferable to oil at one cent per gallon or coal at \$1 per ton. In other instances, electricity at a very much higher price, based on energy cost, is given the preference because of the operating advantages made possible by a specific form of electric energy and appliance.

Frequently a fuel such as bituminous coal may be attractive on the basis of price but objectionable in form, or *vice versa*, as in the case of gas or electricity. Gases of the same physical form may vary greatly in chemical composition, which in itself may limit the field of usefulness regardless of price. Suitable furnace design may overcome these objections. Thus the use of bituminous coal is made possible in enameling furnaces by the use of a muffle, which might be unnecessary in electric furnaces in which gases, if any, originating from the resistance material did not affect the product to be heated.

The innumerable factors controlling the selection of fuel and the generation, application and utilization of heat for industrial or domestic purposes denote a field of usefulness, in suitable apparatus, for all varieties of solid, liquid, gaseous and electrical fuel or heat energy. Expansion in the use of any one form automatically follows the development of apparatus for converting that form of energy into useful service. The apparent relative economic value of the different forms on the basis of price at the moment may be changed in the future, as it has been in the past, by the development of better methods of heat application and more efficient apparatus to make possible either a different result or to accomplish the same result at less cost, by decreasing the amount of energy required without any change in the price.

COMPARATIVE FUEL PRICES ON B.T.U. BASIS

The chart gives a means for comparing fuels on the basis of their B.t.u. cost—by direct comparison of the price of one fuel with the price of another; by comparison of the relative costs per million B.t.u., or, on an assumed cost per million B.t.u., reading directly the "permissible" prices for various fuels.

The horizontal lines represent prices for fuels; the vertical lines, costs per million B.t.u. of heat energy; the diagonal lines are the plotted heat unit values of fuels. The chart is read by converting the price of a given fuel (horizontal line), at its intersection with the diagonal line of the heat unit value of the fuel in question, to the vertical intersecting line which, read at the bottom of the chart, indicates the cost per million B.t.u., or *vice versa*.

To illustrate: For a comparison of 12,000 B.t.u. coal at \$5 per ton with fuel oil. Reading from the left scale, the horizontal line from \$5 per ton is followed to its intersection with the diagonal value line for 12,000 B.t.u. coal, then vertically down to the scale at the bottom of the chart, which indicates a cost of approximately 21c. per million B.t.u. The same vertical line is followed to its intersection with the diagonal value line for fuel oil, then horizontally to the scale on the right of the chart, which indicates a price of approximately 3c. per gal., at which such fuel oil would have to be procured to equal on a heat unit cost basis 12,000 B.t.u. coal at \$5 per ton.

Reversing this process, if fuel oil should cost 8c. per gal., this horizontal line carried to its intersection with the fuel oil diagonal, then down to the bottom,

*Excerpts from a pamphlet, copyrighted 1921, by W. S. Rockwell Co.

indicates a cost of approximately 56c. per million B.t.u. This same vertical line carried to its intersection with the 12,000 B.t.u. coal diagonal, then horizontally to the left, indicates a comparative price for coal of \$13.50 per ton. Direct comparisons are thus available between the coal and fuel oil prices; indicating that fuel oil would have to be available at 3c. per gal. to equal in heat unit cost 12,000 B.t.u. coal at \$5 per ton; and that if fuel oil cost 8c. per gal., 12,000 B.t.u. coal would be no higher in B.t.u. cost at \$13.50 per ton.

This method of comparison takes into account the cost per million B.t.u. merely as an intermediate step. If desired, fuel prices may be compared directly. For example, following along the horizontal line of \$5 per ton coal to its intersection with the diagonal 12,000 B.t.u. coal value line, then vertically down to the intersecting diagonal line for fuel oil, then horizontally to the right, reading directly the comparative price of 3c. per gal. for fuel oil.

At an assumed cost per million B.t.u., the "permissible" prices for the various fuels to be considered will be found by following the vertical "cost per million B.t.u." line to its intersection with each of the fuels in question, then to the right or left respectively to read the "cents per gallon" for a liquid fuel, the "dollars per ton" for a solid fuel, or the "cents per thousand cubic feet" for a gaseous fuel.

HEATING VALUE OF GASEOUS FUEL

If mass generation of heat is considered without reference to its nature or use, then the B.t.u. cost of

fuel would be the factor determining the choice. In addition there must be considered the chemical composition of the gas and of the mixture of gas and air supplied for combustion, and also the influence of the design of furnace or other appliance employed for the generation, application and utilization of the heat.

The chemical composition of a gas fixes the volume of air required for combustion, and the mixture so formed, from which the heat is released, has a B.t.u. value per unit of volume much less than that of the original gas itself. The quantity of air required for combustion of the various gases fluctuates greatly, being more for the richer gases and in general less with the decrease in B.t.u. value.

The heat unit value of the usual industrial gases may vary from 100 to 1,500 B.t.u. per cu.ft.; the theoretical quantity of air required for combustion may vary from 1 to 12 cu.ft. per cu.ft. of gas; the B.t.u. value of the combustible mixtures of these same gases, with the theoretical quantity of air required for combustion, may vary from 50 to 115 B.t.u. per cu.ft., or less with an increase in the relative quantity of air supplied. See Table I.

The B.t.u. value of a gas or its combustible mixture does not indicate the temperature obtainable by combustion or determine its field of usefulness.

Natural gas at 900 B.t.u., while apparently three times as rich as water gas at 300 B.t.u. per cu.ft., has a lower flame temperature and rate of flame propagation. Natural gas would not be as suitable as water gas for high-temperature blow-pipe operations such as

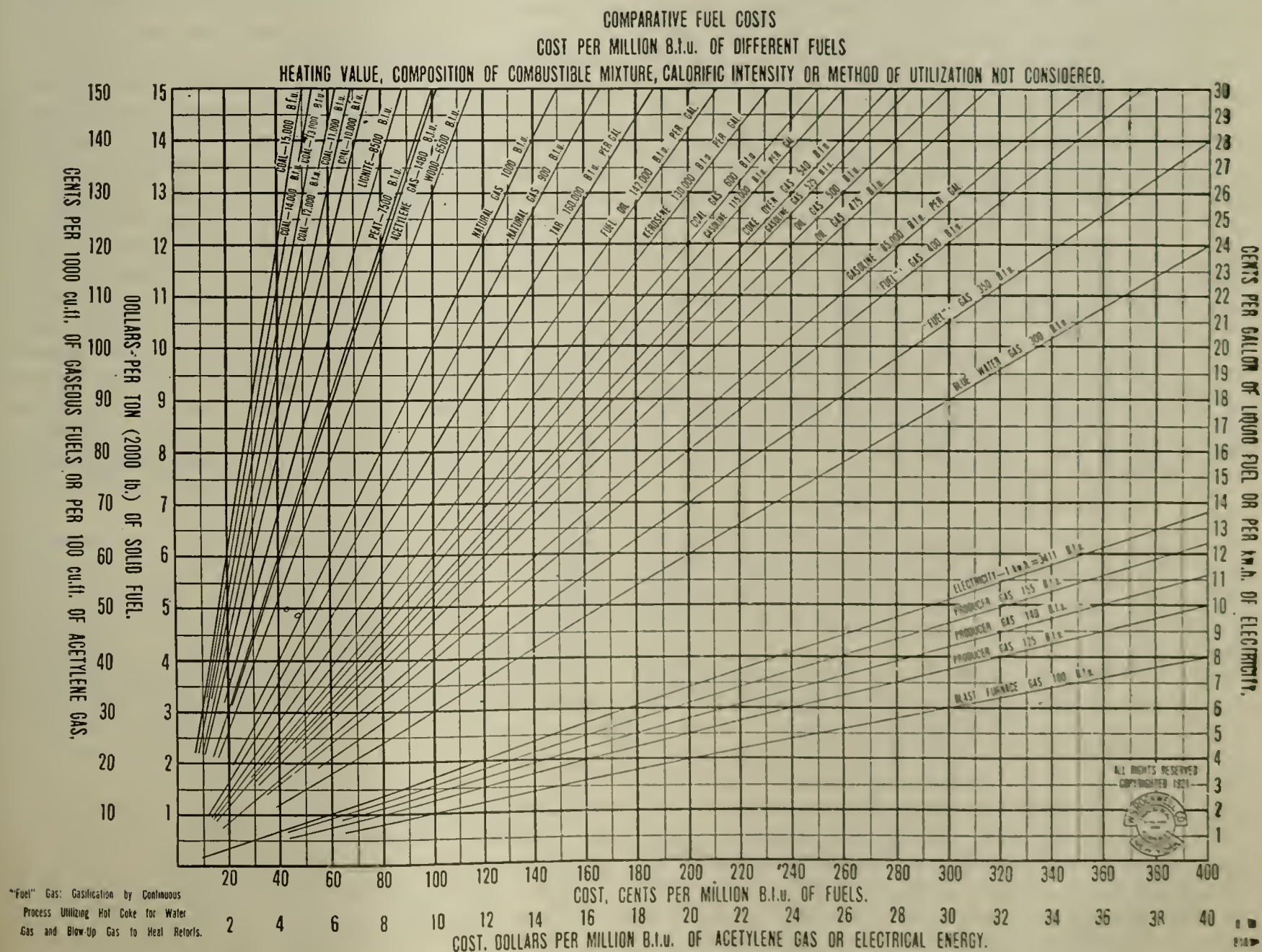


TABLE I. CHARACTERISTICS OF VARIOUS INDUSTRIAL GASES

	Acetylene	Natural Gas	Coal or City Gas	Coke-Oven Gas	Carburetted Water Gas	Oil Producer Gas*	Fuel Gas†	Water Gas	Producer Gas	Blast Furnace Gas
B.t.u. per cu.ft.	1,470	960	600	550	580	450	380	300	130	100
Chemical composition:										
Hydrogen, H ₂	.....	3	41	53	38	1	48	46	12	3
Methane, CH ₄	.....	92	30	35	10	10	12	2	1	1
Acetylene, C ₂ H ₂	96	.....	5	2	13	19	1	.....	.....	.....
Ethylene, C ₂ H ₄	.....	3	.....	.....	3	1	.....	.....	.....	.....
Illuminants	.....	.....	3	.....	.....	.....	.....	.....	.....	.....
Carbon monoxide, CO	.....	.....	16	6	30	4	32	43	25	25
Carbon dioxide, CO ₂	.....	.....	2	2	3	6	3	5	6	13
Oxygen, O ₂	1	.....	1	.....	1	1	1	1	1	1
Nitrogen, N ₂	3	2	2	2	2	58	3	3	55	57
Volumes of air required for complete combustion	12	9.8	5.7	5.3	5.2	4.9	3.4	2.4	1.8	1.3
Maximum temperature obtainable, deg. F.	4,200	3,300	3,500	3,400	3,600	3,300	3,500	3,600	2,800	2,500
Maximum temperature with 100 per cent excess air	2,600	2,100	2,200	2,200	2,300	2,100	2,300	2,400	2,000	1,900
B.t.u. per cu.ft. of above mixture	59	47	48	48	50	47	49	50	41	41

* Oil gas made with air in internally fired retort or generator. † Gasification by continuous process, using hot coke for water gas, and blow-up gas to heat retorts.

welding. On the other hand, natural gas is preferable in internal combustion engines, in which the air and gas are mixed under heavy compression.

Producer gas, in its washed state, while suitable for gas engines, is not as well suited as water gas for high-temperature operations, such as forging or welding, yet with regenerative furnaces it is extensively used for melting steel. The design and operation of the furnace favor a field of usefulness which is not disclosed by an analysis of the gas itself. Both the gas and the air required for its combustion may be preheated to a high temperature in such regenerative furnaces, whereas if natural gas were employed in the same furnaces the preheating would be limited to the air alone, because the natural gas, by reason of its chemical composition, would dissociate in the regenerative chambers at such high temperatures.

The distribution of natural gas is frequently affected in cold weather by the formation of solids in the pipe lines. The distribution of carburetted water gas under similar conditions frequently results in the deposition of oil in the pipe lines resulting from condensaton of certain hydrocarbons peculiar to this gas. Producer gas, while relatively cheap and less susceptible to such conditions in transportation, is not suitable for general distribution by reason of its low heating value and unusually high percentage of incombustibles.

Many examples from everyday practice with various forms of fuel could be given to illustrate the point not generally appreciated, that the difference in composition or "chemical form value" of industrial gases, the influence of the quantity of air supplied for combustion, and the design of the appliance, denote fields of usefulness and limitations which are not revealed by the customary B.t.u. comparison.

IMPORTANCE OF COMPOSITION

The fundamental significance of chemical composition as affecting the quality and cost of product must be considered in the selection of gases and of equipment for the transformation and application of their energy values.

When the material difference in B.t.u. value of the common industrial gases is considered together with the comparatively slight difference in heating value of their combustible mixtures, it is apparent that chemical composition is of greater importance than B.t.u. value in determining their field of usefulness.

The quantity of inerts or incombustibles is relatively small in the majority of industrial gases, with the exception of producer gas. The inert content is important in so far as it relates to the increase in volume of gas or combustible mixture necessary to furnish a given amount of heat energy, and to the

nature and cost of equipment and operations necessary for manufacture and distribution; but it is apparent from comparison of the inert content of the combustible mixtures of the different gases that the heating value of the gases is determined more by the elements forming the combustibles than by the percentage of inerts in the gases or in their combustible mixtures.

Consideration of the comparatively large volume of products of combustion of each gas, which are heated to the maximum temperature of the heating process, will indicate the economies attainable through efficient utilization of the spent gases to perform useful work. The heat in these gases may be utilized to preheat the air or fuel prior to combustion, or, as is generally more desirable, to preheat the material before it is exposed to the final working temperature.

The composition of the products of combustion must be considered in relation to its influence upon the product, because furnace atmosphere plays an important part in some processes which may require either reducing, neutral or oxidizing conditions. Frequently the apparent advantages of a comparatively cheap fuel may be offset by the chemical action of the resultant gases upon the process or apparatus, which would necessitate modifications in the furnace design or process in order to retain the advantage that may be represented by the form or price of such fuel. This is illustrated by the practices of employing crucibles for melting certain metals to decrease the possible effect of oxidation; of packing material in sealed boxes or pots; and by the muffle type of furnace employed for vitreous enameling; in each case permitting the application of heat without contact between the material to be heated and the products of combustion. Special atmospheres may be secured in muffles by passing suitable gases into the muffle, which may or may not be sealed.

Such limitation is not confined to fuels alone, as it is frequently encountered in the arc of resistance methods of releasing heat from electricity due to the gasification of the electrodes or resistance material. In most cases it is desirable to maintain neutral or reducing atmosphere in the heating zone to protect the material from oxidation. While this may be readily accomplished with most fuels in properly designed furnaces by control of the air supplied for combustion, it is comparatively difficult with others. Such a neutral or reducing atmosphere may be readily secured in electric furnaces releasing heat through some form of carbonaceous resistance material, while a different form of resistance material may necessitate the use of a material such as oil to provide the proper atmosphere in the heating zone, even though the heat itself is generated by an electrical process.

Electrically Heated Glass-Annealing Lehrs

BY E. F. COLLINS*

THE accurate degree of temperature control through a cycle of temperatures which is necessary in annealing glass and the difficulty of securing it in the ordinary fuel-fired lehr have led to experiments with a view to developing electrically heated lehrs. One such lehr which has been running several months on a high grade of glass ware and on which reliable overall factory costs have been kept shows a decrease in cost per unit annealed of 20 per cent. This saving is about seventy-five times the total cost of power for heating the lehr.

Generally speaking, the annealing temperature for glass is that constant and uniform temperature at which any stresses which exist in the ware are permitted to relax. The length of the anneal, of "annealing time," depends on the magnitude of the stresses existing before annealing occurs, being a function of each point within the necessary temperature range.

In all glass annealing it is of vital importance that the temperature of the glass mass should be very uniform in the annealing range. Temperature gradients in the mass of homogeneous glass under treatment are solely responsible for setting up strains. These gradients may result either from too rapid cooling, or from a non-uniform and uneven heat distribution. Hence the importance of heat control with respect to time and also proper heat distribution in the lehr through which the ware is passing.

Where glass is treated in the box type oven it is also extremely important that the distribution be good and that the heating equipment lend itself to the exact following of the time-temperature cycle desired, whether it covers a few hours—or a month. Preferably this control should be automatic and correspond to a predetermined cycle. It is for this reason that electrically heated lehrs are successful.

Such automatic control with limits of plus or minus 2.5 deg. C. is available if electrically heated lehrs of proper design are used.

An example of temperature distribution in an electric furnace is given in Fig. 1, with its accompanying table.

*General Electric Co.

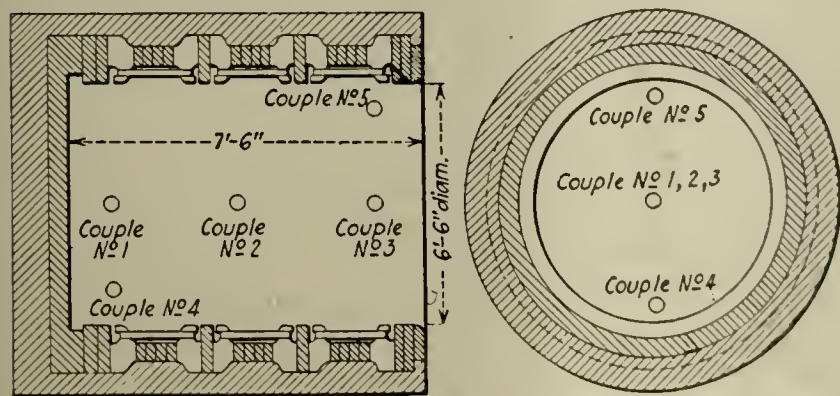


FIG. 1. TEST DATA OF HEAT UNIFORMITY OF ELECTRIC FURNACE

Time	Thermocouples—Temp. °C.					Average Temperature	Per Cent Deviation From Average	Rate of Change, Deg. per Hr.
	1	2	3	4	5			
11.30	25	25	25	25	25	25	0	0
3.30	527	537	532	530	545	534	2.07	1.31
7.30	670	679	671	666	669	669	1.05	0.45
11.30	777	783	776	766	780	776	1.00	1.03
3.30	858	864	857	849	864	860	0.46	1.03
7.30	860	865	862	862	863	862	0.35	0.23
11.30	928	934	930	930	928	930	0.43	0.21
3.30	933	932	927	925	927	929	0.64	0.43
4.30	950	950	952	952	955	952	0.31	0.21

It will be noted on this record of temperature distribution that for a rising temperature of 125 deg. C. per hour over the first four hours only one point varies from the mean temperature by 2.07 per cent. Over the next four hours, with 35 deg. C. change per hour, the maximum variation from mean temperature is 1.5 per cent. The maximum at the rate of 17 deg. C. per hour is 0.43 per cent, while at constant temperatures, at 860 deg. C. the variation is 0.35 per cent, and at 930 deg. C. 0.64 per cent. These figures are for an oven 6 ft. 6 in. in diameter, and 7 ft. 6 in. deep. Such accuracy of control and evenness of heat distribution as these figures show would seem to meet the most exacting requirements of any and all types of glass annealing, including that of large lenses for telescopic work.

Fig. 2 is a graphic representation of the time temperature cycle for annealing fine crown glass for a telescope lens. Such process is best carried on in the

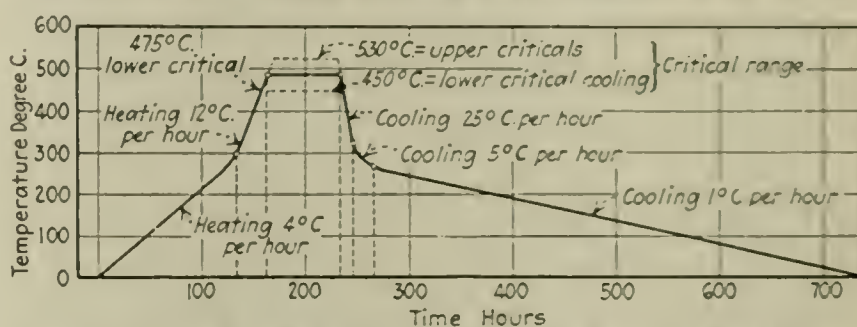


FIG. 2. TIME-TEMPERATURE CYCLE FOR ANNEALING CROWN GLASS LENS FOR TELESCOPE. BOX TYPE ANNEALING OVEN

box type of lehr in which the lens is placed and subjected to a temperature cycle as shown. With electric heat, automatic control is available by means of which this particular cycle or any similar one may be accurately followed and repeated exactly whenever desired. The control instrument is operated by a time-keeping motor supplemented by a simple cam arranged to give different rates of heating or cooling, according to the predetermined characteristic as shown on the curve.

Exact operating costs for electrically heated lehrs are not yet available, but from estimates made for such work it is believed that costs will be greatly in favor of the electrically heated lehr, especially when the improved quality of the product, increased production and elimination of rejects are taken into account.

The factors that assist in turning out better products are, first, there is no opportunity for the ware to absorb the products of combustion, hence no sulphuring takes place, and the product has a bright, polished surface requiring no washing or cleansing. Second, the ware is sterile and absolutely clean, due to the heat, which is important for prescription ware, allowing medicinals to be sealed in as soon as the ware leaves the oven. Lastly, there is the low-temperature gradient, which eliminates breakage, distortion and products developing flaws under the tests given after annealing.

Philippine Sugar Exports

During the period from March 1 to April 15, this year, the Philippines exported 16,189,944 kilos of sugar worth \$2,044,018. Of this quantity 7,941,470 kilos was centrifugal valued at \$1,019,379. The rest was raw sugar amounting to 8,246,674 kilos, worth \$994,599. More than 6,000,000 kilos of the centrifugal sugar exported, worth approximately \$1,000,000, was sent directly from Manila to the United States.

Synopsis of Recent Chemical & Metallurgical Literature

Allotropic Varieties of Oxides.—A study of the conductivities of a certain number of metallic oxides such as CeO_2 , Cr_2O_3 , NiO , CuO , TiO_2 , Mn_2O_3 , MnO , SnO_2 , SnO , Fe_2O_3 , Fe_3O_4 , ZnO and CdO shows that these oxides act like electrolytes and carbon. Their conductivity is a function of temperature, the representative curve being parabolic. Some oxides show peculiarities which can be attributed to allotropic varieties of these oxides.

Miss S. Veil has made a study of the allotropic varieties of such oxides, with special reference to magnetic iron oxide and cadmium oxide, and presented the results of her work at the May 6, 1921, meeting of the French Academy of Sciences. (*Comptes rendus*, vol. 172, pp. 1405-1407.)

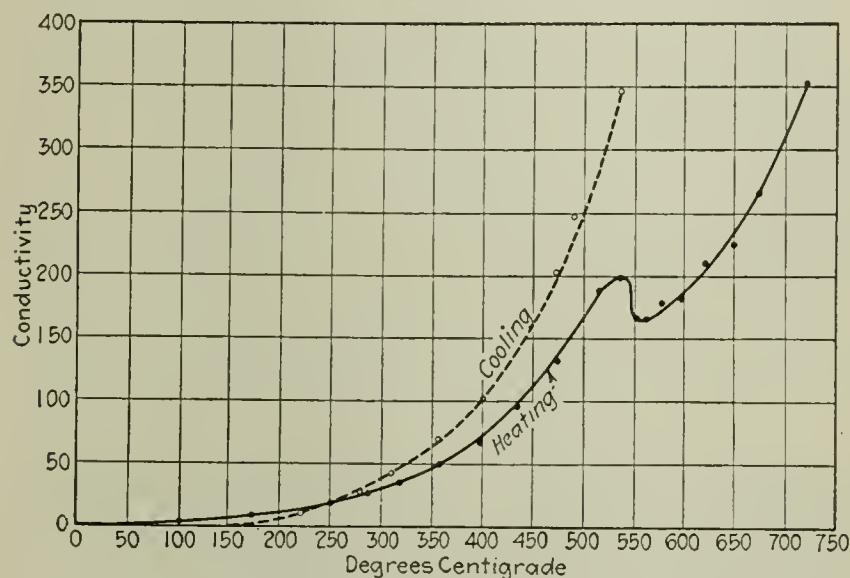


FIG. 1. REGION OF CURIE POINT FOR MAGNETIC IRON OXIDE

In studying magnetic iron oxide Miss Veil found that the conductivity-temperature curve presents a change of direction between 500 and 600 deg. C. (Fig. 1) and that this change corresponds to the Curie point, temperature at which the natural magnetite loses its magnetism. She has worked with temperatures varying up to 1,300 deg. C., but no other change of direction occurs after the Curie point. In cooling, the Curie point is not visible, and this indicates that the system does not pass through an analogous series of states when heated and when cooled. For the same temperature the conductivity is greater during cooling than during heating, as can be seen by the plotted curves.

The Curie point as fixed by Curie is 535 deg. C., whereas

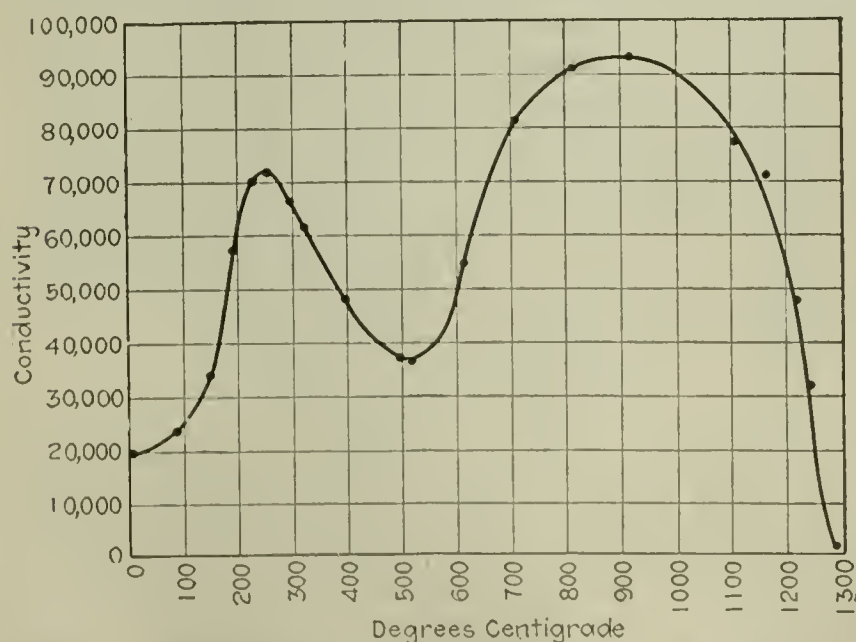


FIG. 2. CHANGE OF CONDUCTIVITY OF CADMIUM OXIDE WITH INCREASE IN TEMPERATURE

Weiss gives it as 580 deg. C. The first was determined by measuring the magnetic susceptibility, the second by the combination of magnetic and specific heat measurements. The Curie point as shown in the curve does not correspond exactly to either of these figures, this being due to hysteresis phenomena and to inherent irregularities in conductivity of oxide briquets.

Cadmium oxide has already an appreciable conductivity at ordinary temperatures (Fig. 2). An increase in temperature increases normally the conductivity, following a parabolic curve, up to about 200 deg. C., when the curve decreases up to about 550 deg. C., then increases again up to the second maximum, at about 850 deg. C., and finally decreases until at 1,300 deg. C. it reaches a conductivity which is only a small fraction of that at normal temperature.

These results can be interpreted by admitting that cadmium oxide presents three allotropic varieties of cadmium oxide—namely, α , β , and γ , whose stable regions are located on both sides of the maxima. Thus the region of the variety α is approximately between the ordinary temperature and 200 deg. C., that of the variety β between 200 and 850 deg. C., and finally that of γ at temperatures above 850 deg. C. The conductivity of the α and β varieties is about of the same order, whereas that of the γ variety is relatively very small.

In cooling rapidly, beginning at 1,300 deg. C., the conductivity remains very small, because the velocity of transformations is too small to take effect during rapid cooling, but if the cooling to normal temperature is slow and is realized only after many weeks, the oxide regains the variety α and shows the corresponding conductivity.

New Developments in the Manufacture of Tungsten and Its Compounds.—Moissan succeeded in melting tungsten in his electric furnace, but in extremely small quantities only and at the expenditure of considerable energy. Hugo Lohmann reports in *Electrochemisches Zeitung*, vol. 26, pp. 29-33, that he has been able to make comparatively large quantities of the crude metal and to obtain therefrom a thoroughly fused carbide in a specially designed furnace. The latter was of the arc type, but was constructed in such a manner that the principal disadvantages of this kind of furnace—viz., the smallness of the source of heat and the space within which it can prevail—are eliminated. It was possible to melt 5 kg., or 12 lb., of amorphous tungsten within fifteen minutes in this furnace. The current consumption is very low. Besides the carbide of tungsten, carbides of titanium, vanadium, zirconium, silicon, boron and uranium were obtained as well.

The hardness of tungstic carbide is 9.8 on Moh's scale. This substance was produced in large quantities and was used with great success to replace the industrial diamond, bort, in all its applications. By melting the carbide it was found that it could be produced in a strong, compact state so that it could be employed in making dies for wire-drawing machines, in fabricating cutting tools of all sorts, boring apparatus, etc. There appear to be important economic as well as technical advantages in favor of the carbide.

The melting of tungsten and the making of castings, forgings, etc., with the metal have rendered it usable for many purposes for which it could not be used hitherto. It was found that high-speed cutting tools made from tungsten gave very remarkable results in their durability and the thickness of the cut. Any tool or machine part that must stand up against extreme wear and exceedingly high temperatures caused by frictional resistance or otherwise has been improved very greatly by being made from the pure fused tungsten metal.

The author has prepared molten uranium at a temperature of 3,500 deg. C. in large quantities. He has used the metal in making the target in X-ray tubes and found that the results corroborated the theory that the higher the molecular weight of the target metal the more effective the X-ray apparatus. He also used the metal in making the contact points for the spark-plugs of gas engines, and instead of platinum for the contact wire in incandescent lights.

Current Events

in the Chemical and Metallurgical Industries

Investigation of the Dye Industry

Opponents of the special dye legislation have recently introduced resolutions in both branches of Congress calling for investigations of the dye industry. Some time ago Senator King of Utah presented a resolution requesting the appointment of a special committee to investigate the existence of a dye monopoly and its employment of lobbyists for the purpose of influencing tariff and other legislation. After this was referred to the Senate Committee on the Judiciary, that committee on July 12 reported a resolution similar in substance and intent, although the investigation was to be carried out by the Committee on the Judiciary or a sub-committee of it.

Congressman Frear, following his recent denunciation of the dye section of the Fordney tariff bill and his attack on the officials of the Chemical Foundation, introduced a resolution in the House requesting the Attorney General to instigate legal proceedings against the Chemical Foundation for its alleged fraudulent purchase, control and license of the patents obtained from the Alien Property Custodian.

Eugene Schneider Receives John Fritz Medal for 1922

With the presentation of the John Fritz Medal to Eugene Schneider, head of the famous Creusot Works, in Paris on Friday, July 8, by a mission of American engineers, came cable advices from London to the national headquarters of the American Society of Mechanical Engineers in this city announcing that more foreign honors had been conferred upon Americans distinguished in the engineering profession.

The cable message, addressed to Secretary Calvin W. Rice, stated that Ambrose Swasey of Cleveland, sponsor of the Engineering Foundation and past president of the American Society of Mechanical Engineers, has been elected to honorary membership in the British Institution of Mechanical Engineers, in the British Institution of Mining and Metallurgy and in the Institution of Mining Engineers.

Charles F. Rand of New York, it was stated, has been elected an honorary member of the Institution of Mining and Metallurgy and of the Institution of Mining Engineers. Mr. Rand, who is chairman of the executive board of the Engineering Foundation, has just been made an honorary member of the British Iron and Steel Institute.

Other elections announced by cable were those of Colonel Arthur S. Dwight of New York and William Kelly of Vulcan, Mich., to honorary membership in the Institution of Mining Engineers. This group of honors is believed to be without precedent in engineering and was described by Mr. Rice, who has been active in promoting closer relations between American and British engineers, as an important step in bringing about world solidarity in the engineering profession. A movement, it was said, has been started in the direction of federating the engineering societies of the British Empire according to the general plan adopted by Herbert Hoover and his associates in organizing the Federated American Engineering Societies, in which are gradually coalescing the national and local engineering organizations of the United States.

The ceremonies in Paris, participated in by a special deputation of thirteen American engineers under the general chairmanship of Mr. Swasey, followed similar ceremonies in London on June 29, when the John Fritz Medal for distinction in applied science was presented to Sir Robert Hadfield, known for his work in the development of manganese steel. The Hadfield award was for 1921 and the Schneider award for 1922. M. Schneider received the gold medal in person for his achievements during the war "in

the industrial and scientific defense of civilization."

The John Fritz Medal Board of Award, in conferring the honor, lauded M. Schneider's "achievement in the metallurgy of iron and steel, in the development of ordnance, especially the 75-mm. gun, and in notable patriotic contribution to the winning of the war."

Mr. Rand, it is said, becomes one of five honorary members of the Iron and Steel Institute, the others being the Prince of Wales, King Albert of Belgium and Dr. Richard Akerman and Baron Gustaf Tamm of Stockholm.

Chemical Exposition Plans

Plans to make the Seventh Annual Exposition of Chemical Industries the greatest in the history of the industry are progressing favorably. Being held during the week of Sept. 12, it will follow immediately the meeting of the American Chemical Society and the Society of Chemical Industry, and the sponsors of the display report more interest than ever, not only in the chemical industry itself but in the wide range of related industries.

Thus far more than 400 exhibitors will have places in the exposition, and before the books are closed Fred W. Payne, who, with Charles F. Roth, is managing the exposition, expects that last year's total of 457 will be exceeded. It is certain that every branch of chemistry will be represented and that the public will be introduced to many new and important phases of chemical development.

The 1921 display will present to the visitor a somewhat different aspect from its six predecessors. The Eighth Coast Artillery Armory can take care of all the exhibits on its one vast floor, comprising 180,000 sq.ft. Thus the appearance of the show will be much more impressive than it was staged on four floors of Grand Central Palace.

Technical sessions will be held in the auditorium, which is a solid brick, fireproof structure at one end of the building. Plans for these meetings include symposia on chemical engineering subjects: one on evaporating and drying, another on crushing, grinding and pulverizing and a third on material handling equipment. The following programs are only preliminary and details will be given in subsequent issues.

Papers on crushing, grinding and pulverizing include: "Ball and Pebble Milling for Pulverizing and Mixing," by H. F. Steinfeldt, of the Abbe Engineering Co.; "Grinding and Pulverizing With Air Separation," by S. B. Kanowitz, of Raymond Bros. Impact Pulverizer Co.

The following speakers are announced for the evaporating and drying symposium: E. G. Rippel, Buffalo Foundry & Machine Co.; A. E. Stacey, Jr., Carrier Engineering Corporation, "The Relation of Atmospheric Conditions to Chemical Processes"; H. S. Landell, Proctor & Schwartz, "Drying and Drying Problems"; Max Donauer, Elyria Enameled Products Co.; Arthur B. Stonex, Hunter Dry Kiln Co., "Drying With Moist Air"; A. S. Lissauer, W. L. Fleisher & Co., "Drying as an Air-Conditioning Problem"; J. D. Stein, Grinnell Co., Drier Division, "Atmospheric Drying by Means of Compartment, Tunnel and Continuous Belt Conveyor Driers With Some Practical Applications"; M. H. Dickerson, Atomized Products Co., "Spray Drying."

Motion pictures will also be shown in the auditorium. Films covering nearly every phase of the chemical industries have been promised. The following are representative: "Saving Wasted Millions Through Material-Handling Equipment," two reels (Courtesy of Economy Engineering Co.); "Conserving Coal and Saving Heat Values by Insulating Steam Pipe and Boilers," one reel (Courtesy Magnesia Association of America); "The Manufacture of Pyrex Glassware," three reels (Courtesy of Corning Glass Co.); "The Story of Sulphur," two reels (Courtesy of Texas Gulf Sulphur Co.)

American Electroplaters' Society Convention

Under the present industrial conditions it was very encouraging to find about 150 foremen electroplaters at the annual convention of the American Electroplaters' Society at Indianapolis, June 29 to July 2. The attendance was somewhat below normal, due in part at least to the failure of employers to pay the expense of their electroplaters, as many have done in former years. In times of industrial depression it is more important than ever to utilize opportunities for research and development, such as are to be gained from educational conventions; and manufacturers may well pay as an investment at least part of the expenses of their employees to such gatherings.

The large number of technical papers presented and the interesting discussions that ensued demonstrated that this organization is rapidly becoming a truly technical society and that through its efforts great progress has been and will be made in the electroplating industry. Several chemists interested in electroplating were present. The number should be increased to mutual advantage, as the chemists can often aid in the explanation of technical points and can at the same time become better acquainted with the platers and their point of view and thereby co-operate more effectively with them.

ELECTRO-ANALYSIS OF PLATING SOLUTIONS

It is significant that a number of the papers presented dealt with research problems and methods. Dr. Hiram S. Lukens, of the University of Pennsylvania, explained in detail various "Electrolytic Methods for the Determination of the Metal Content of Plating Solutions." Electro-analysis is an especially simple and appropriate method for persons engaged in electrodeposition. Emphasis was laid upon the fact that entirely satisfactory results may be obtained by the use of cathodes of copper or nickel, thus eliminating the expense for platinum. The various possible reactions occurring during electrodeposition and the advantage of control by chemical analysis were very clearly explained. The society, and especially the Philadelphia branch, are to be congratulated for securing the assistance and co-operation of Dr. Lukens, and the use for branch meetings of the laboratory at the University of Pennsylvania. Other educational institutions may well follow this example, as has been done by the University of Cincinnati and a few others.

ADDITION AGENTS IN ELECTRODEPOSITION

Dr. F. G. Mathers, of the University of Indiana, gave an interesting address upon the use of "Addition Agents in Electrodeposition, and showed a large number of specimens of lead, tin, antimony and silver deposited in the presence of specific addition agents. Dr. Mathers' paper emphasized the great possibilities in this field and especially the need for further research to explain the causes for the observed effects. Until such further knowledge is obtained, the general application of addition agents in electroplating will be rather limited. This field deserves extended investigation.

STRUCTURE OF BASE METAL AND ELECTRODEPOSIT

George B. Hogaboom, of the Scovill Manufacturing Company (and electroplating adviser to the Bureau of Standards), touched upon an almost entirely new subject when he explained the "Relation Between the Structure of the Base Metal and That of the Electrodeposit." He exhibited numerous photographs which showed clearly that some of the defects and difficulties encountered in electroplating are due not to improper composition of the solution or conditions of operation, but to defective structure of the brass, steel or cast iron upon which the metal was deposited. This subject is of far-reaching importance, as it emphasizes the fact that for successful electroplating the knowledge and services of the metallographist may be as important as those of the chemist and the plater. It is an all too common mistake to assume that electroplating can be used to cover or hide defective material or workmanship!

Several papers were presented upon nickel plating, among which may be mentioned those by R. Suman, of the National

Cash Register Co., and William Blum, of the Bureau of Standards, upon the use of fluorides. The latter paper summarized the work recently presented to the Electrochemical Society and also published in *CHEMICAL & METALLURGICAL ENGINEERING* (vol. 24, pp. 1109-1115, June 22, 1921). From the discussion that followed it appears that nickel solutions containing hydrofluoric or fluorides have been successfully used in several plants during the past year.

W. Blum and T. F. Slattery described the process for the electrolytic reproduction of engraved printing plates, recently installed at the Bureau of Engraving and Printing under the direction of the Bureau of Standards. In this process the printing surface consists of a heavy deposit of nickel (produced in solutions containing fluorides). The body of the plate, which is about 0.25 in. thick, consists of alternate layers of copper (each 0.003 in.) and nickel (each 0.001 in.). The use of such layers, first suggested and patented by George U. Rose, Jr., is advantageous in producing a stronger plate and in decreasing the treeing and thus permitting the use of higher current densities. Details of the process will be published in the near future.

W. Blum and M. R. Thompson, of the Bureau of Standards, presented a paper on the "Acidity of Nickel Plating Solutions," illustrated by experiments and charts. The meaning, measurement and expression of hydrogen ion in concentration were explained in simple terms, and the distinction between the degree of acidity and the amount of acid was emphasized. The use of indicators for the approximate measurement of the p_H of solutions was illustrated. The function of boric acid and of fluorides was shown to be in part that of "buffers"—i.e. regulators of acidity. Specimens of nickel deposited at definite p_H were exhibited.

In a paper by O. W. Storey, of the Burgess Laboratories, the use of methyl red for the factory control of the acidity of nickel solutions was described. This method, used by the author for the past eighteen months, illustrated admirably the practical applications of the principles described in the preceding paper.

COST ACCOUNTING

W. J. Allen, of Grand Rapids, in a paper upon "Cost Keeping in Electroplating" showed that it is entirely possible to determine approximate or average costs both in factory plating and in job plating. This subject is of special interest to engineers and manufacturers, as electroplating is often considered simply as a "necessary evil" and little thought is given to the relation between cost and quality or to the possibilities of real economies in operation.

PLANS FOR RESEARCH

A report was rendered upon the work and plans of the Bureau of Standards in the field of electrodeposition. The effort now being made by the National Research Council to obtain from interested manufacturers funds to augment research in electroplating was explained, and electroplaters were urged to assist in getting such support. All the papers upon the program emphasized the needs and possibilities for investigation in this fertile and important field, and manufacturers will no doubt take advantage of this opportunity for co-operative research.

The social features of the convention were very successful, and in spite of the hot weather all those present felt well repaid. The business sessions and elections were harmonious and showed the true spirit of co-operation. Few if any technical societies can point to as much real progress in less than ten years of existence as the American Electroplaters' Society.

Object to Tea Waste Duty

Objections are reaching Washington to the provision of the Fordney tariff bill which makes impure tea, tea waste, tea siftings or sweepings dutiable at 1c. per lb. The contention is that this important source of caffeine should be admitted free of duty.

While the Fordney bill advances the duty on caffeine itself from \$1 to \$1.50 per lb., it leaves unchanged the provision of the Underwood act which levies 1c. per lb. on the raw material from which caffeine is made.

Bureau of Mines Petroleum Experiment Station Seeks Technical Men

The Petroleum Experiment Station of the United States Bureau of Mines at Bartlesville, Okla., plans to enlarge its program of work and to employ a few additional technical men for conducting the different investigations. Funds for this work are provided by the State of Oklahoma, and for that reason it will not be necessary for applicants for the new positions to take civil service examinations. Persons interested should write H. H. Hill, superintendent Petroleum Experiment Station, Bartlesville, Okla., furnishing a statement of their education, experience and positions held and salary, together with a photograph taken within the past year.

The following is an outline of the positions open and the qualifications for each:

Petroleum Engineer for Work on Water Problems: Applicants for this position should be graduates from a college or university, with a degree in geology, or in mining, mechanical or civil engineering. The applicant should have had at least five years' oil-field experience, of which at least three years should have been on work connected with the development and production of petroleum. The applicant also should have had considerable experience in the solution and correction of water problems in producing oil and gas wells. Salary range \$3,000 to \$3,600 per annum.

Expert Driller: Applicants for this position should have had at least five years' actual drilling experience with cable tools; also experience in shutting off water by the use of mud-laden fluid and cement. Preference will be given to a man who has had supervisory work in connection with mudding, cementing and plugging of wells. Preference will also be given to a man who has had rotary drilling experience. Salary range \$3,000 to \$3,600 per annum.

Natural Gas Engineer: Applicants for this position should be graduates from a university or college with a degree in engineering, preferably mechanical engineering. At least five years' experience in work connected with the transmission of natural gas is required. This experience should include a knowledge of methods of metering natural gas, compressor stations and field equipment. Preference will be given to a man who is familiar with field conditions and who has had experience in the determination of pipe line losses. Salary range \$3,000 to \$3,600 per annum.

Assistant Petroleum Engineer: Applicants should be graduates of a college or university with a degree in geology or engineering. Applicants must have had at least one year's field experience in engineering work as applied to underground problems in oil fields. Salary range \$1,800 to \$2,400 per annum.

Co-operative Factory Investigation on Fish Scaling of Enamels

The committee on research and development of the Enamel Division of the American Ceramic Society is conducting a co-operative factory investigation of fish scaling based on the results of the Bureau of Standards research in this subject. The committee met at Cleveland, Ohio, on June 20, when a comprehensive study of this work on a factory scale was outlined. Steel and iron sheets will be prepared by the mills represented on the committee, and these will be manufactured into enameled ware in the enameling factories co-operating in the work. Some work will also be done by the enamelers in checking results obtained with enamel compositions and in annealing of enameled ware as developed at the bureau.

The preliminary report on the laboratory results as obtained by the bureau will be published in an early number of the *Journal* of the American Ceramic Society. The results of the co-operative work when completed will be combined with the laboratory results and issued later as a technologic paper.

The following members of the Enamel Division are serving on the committee:

R. R. Danielson, chairman, Bureau of Standards, Washington, D. C.; H. C. Arnold, A. D. Little Laboratory, Cambridge, Mass.; J. F. Bardush, Grand Rapids Refrigerator

Co., Grand Rapids, Mich.; J. S. Grainer, Challenge Refrigerator Co., Grand Haven, Mich.; D. M. Buck, American Sheet & Tin Plate Co., Pittsburgh, Pa.; J. A. Aupperle, American Rolling Mill Co., Middletown, Ohio; R. D. Cooke, Columbia Enameling & Stamping Co., Terre Haute, Ind.; J. B. Tyler, Lisk Mfg. Co., Canandaigua, N. Y.; E. P. Poste, ex-officio, Elyria Enameled Products Co., Elyria, Ohio.

Exchange of Wood Waste Through the Forest Products Laboratory

The Wood Waste Exchange of the U. S. Forest Service has been transferred from Washington to the Forest Products Laboratory, Madison, Wis., where its future activities will be centered. The Exchange has in the past contributed much toward more complete utilization of wood, by supplying a medium through which the mills and wood-using factories could locate markets for their side lumber and short lengths, and wood-consuming factories sources of material which would meet their requirements.

Centering the activities of the Exchange at the Forest Products Laboratory will permit an expansion of this service, in that it will be possible to include suggestions as to markets and new uses for byproducts and low-grade material, based on the latest results of technical research carried on by the laboratory. As both the Forest Products Laboratory and the Association of Wood Using Industries have pointed out, there is a large wastage of wood annually because of ignorance on the part of manufacturers of one another's wood requirements.

Quarterly reports on "Opportunities to Sell Waste," similar to those issued in the past, will be sent to all concerns which wish to be listed as having wood byproducts and waste in any form for sale. These reports will contain the names and addresses of manufacturers of various wooden products who could under suitable conditions use raw material from these sources, together with information as to kinds, sizes, form and condition of the stock desired. Suggestions as to the proper methods of caring for the material until it is ready for market will also be included.

A similar report on "Opportunities to Buy Wood Waste" will be sent to wood-using factories and other consumers who ask to be listed for this service. This report will contain information relating to manufacturers who have such material and its character, quality and amount available.

None other than actual producers or consumers of wood stock of this character can become patrons of this Exchange. All communications should be addressed to the Director, Forest Products Laboratory, Madison, Wis.

National Lime Association Urges Protection for Dye Industry

Although the lime industry is not directly interested in the dye industry, a careful analysis of the situation has convinced the members of the National Lime Association that the best interests of the country and those of the chemical and allied industries in particular demand the passage of protective legislation. Accordingly the following resolution was passed unanimously at the recent convention of the association and a copy was sent to each member of Congress.

Whereas a complete, self-sustained coal-tar chemical industry is essential to the industrial development of our country, to its national safety and security, and is important in its very close relation to medical science, and

Whereas it has been shown that unusual protection must be given by the Government to this industry, the development of which began only when the war gave it its opportunity, and that a tariff alone will not protect it adequately against the determined assaults of the German-government-fostered-chemical-cartel which is seeking to regain this, the world's richest market, now the only market without permanent protection; therefore, be it

Resolved, That the National Lime Association hereby urges upon Congress in solemn earnestness the prompt enactment of adequate legislation to protect and maintain in this country this vital chemical industry.

Ford Offers to Lease Wilson Dam and Buy Nitrate Plant

Henry Ford's offer to lease the Wilson Dam and to purchase the nitrate plant at Muscle Shoals promises to be disconcerting to some of the ultra-conservationists in Congress. They opposed Government development of the project both in bringing about the defeat of legislation looking to the formation of the United States Fixed Nitrogen Corporation and in refusing to appropriate for the continuance of the work on the Wilson Dam.

They are embarrassed greatly by Mr. Ford's offer. They fear that private enterprise will obtain the great bulk of the profits likely to come from the development of this resource. In defeating the proposals for Government operation of the Muscle Shoals projects Congress maneuvered itself into a position where it seems that it cannot refuse consistently to entertain a bona fide offer from a private interest. In doing so some of the conservationists fear the loss to the general public of the full advantages of one of their heritages.

Mr. Ford's offer is to lease for 100 years the completed Wilson Dam. On the total cost, Mr. Ford proposes to pay interest at the rate of 6 per cent. It is estimated that about \$28,000,000 will be required to complete the dam. He offers \$5,000,000 for the nitrate plant (No. 2), the steam plant, lands and other equipment.

Colonel Gilchrist Honored

A distinguished service medal has been awarded to Lieutenant Colonel Harry L. Gilchrist of the Chemical Warfare Service. The citation reads as follows:

Lieutenant Colonel Harry L. Gilchrist, Medical Corps, then Colonel, Medical Corps, for exceptionally meritorious and distinguished service as Chief of the De-lousing and Bathing Services of the American Expeditionary Forces. By his superior administration and splendid efficiency he contributed materially to the success achieved by the Army at the ports of Brest, Bordeaux and St. Nazaire, in the return to the United States of the American Expeditionary Forces.

Potash Duty Faces Hard Fight

It is very evident that great difficulty will be experienced in retaining the potash item in the tariff bill. Allegations that this duty will cost the farmers \$6,000,000 or more will be accepted by many members of Congress who represent large agricultural constituencies. Unusual interest is being taken in the matter by the representatives of the farmers, since most farmers have allowed their lands to become under-fertilized and have reached the point where they must make much larger purchases next year. To have anything interfere with possible decline in price brings forth loud complaint.

On the other hand, the representatives of the domestic potash producers point out that the duty in the form prescribed by the committee is not as satisfactory as a straight 50c. duty for which they contended. The duty as provided in the bill may take care of the plants in existence, but it certainly will not encourage any new capital to enter the industry. It also is pointed out that most of the schedules are much higher than they seem, since they are affected by the American valuations. This is not true in the case of any but chemical potash.

New Proving Ground Ready

Field tests of gases now can be carried forward rapidly by the Chemical Warfare Service. This is made possible by the making ready of the new proving ground adjacent to Edgewood Arsenal. This phase of the work of the Service has been interfered with greatly due to the fact that the proper equipment could not be installed at the Lakehurst proving ground when it was known that it was to be abandoned in the near future.

Since there is no uncertainty as to the tenure of the new proving ground, permanent facilities have been installed. These include machine shops, laboratories, field sampling outfits and the general equipment of an efficient proving

ground. In addition there is a light gage railroad which will make for great economy in the conduct of tests. There is the greatest need at the present time to be able to ascertain quickly and with exactness the concentrations of gas under conditions of actual use. General Fries believes that with the improved facilities of the new proving ground great headway will be made in that work. He admits, however, that there is great chance for improvement in the methods of ascertaining gas concentrations in the field. This problem is to be attacked vigorously by the technical men of the Service and it is hoped that valuable suggestions may be contributed by outside chemists.

Growth in French Porcelain Industry

At a recent meeting of the Syndicat des Fabricants de Produits Ceramiques de France, Paris, France, M. Guerineau, honorary president of the association, said that there has been a remarkable growth in the production of refractory materials in that country since the war. The output at the present time approximates 700,000 tons, which is said to be sufficient for all home needs; in 1914 the aggregate production was only 500,000 tons per annum. With regard to floor tile, M. Guerineau says that French producers are now in position to meet the entire home demand, which is quite considerable, including pavement and floor tiles, whether semi-opaque or incrustated. Local manufacturers of enameled tiles for walls, although few in number, are in good position to furnish all requirements of French consumers.

C.W.S. Course Completed

A class of twenty-two was graduated July 9 at the Chemical Warfare Service School. Among those graduated were three students sent to the school by the Navy and three sent by the Marine Corps. Lieutenant Commander J. McC. Miller, one of the Navy men, stood at the head of the class. The graduating class was addressed by General Fries and Major Atkisson.

A number of line officers are expected to be members of the next class. Those graduated July 9 were:

Majors Adelno Gibson, C.W.S.; Charles W. Mason, C.W.S. Captains Maurice Barker, C.A.C.; Arthur A. Dearing, C.W.S.; Egmont F. Koenig, C.W.S.; Edward C. McLaughlin, C.W.S.; Hiram F. Plummer, C.W.S.; James W. Rice, C.W.S.; Adrian St. John, C.W.S.; Edmund G. Sties, C.W.S.; Edward Wolesensky.

First Lieutenants John W. Lowe, John G. Shannonhouse, James F. Smith and Alden H. Waitt.

From the Navy: Lieutenant Commanders Glenn B. Davis, U. S. N.; Norman C. Gillette, U. S. N.; Justin McC. Miller, U. S. N. and Lieutenant Charles Shaffer, M. C. (U. S. N.)

From the Marine Corps: Captain Ernest E. Eiler, First Lieutenant John W. McNamara, Second Lieutenant Leslie G. Wellman.

Carbonization Committee Meets

The carbonization committee of the American Gas Association met on July 6 to make final plans for the annual report in the fall. It is planned that the manufacturers' group on this committee will summarize all new methods of carbonization of interest to the gas industry by brief descriptions of the plant and processes. The operating sub-committee will report upon as many plants as can be investigated carefully, showing typical operating results for new plant developments. The low-temperature carbonization sub-committee will give similar attention to methods, results and general prospects for low-temperature carbonization of coal. Particularly it is hoped to have consideration given to the economic possibilities of such systems and a discussion of the place which they will fill in the general fuels work of the country.

J. H. Taussig of the United Gas Improvement Co., Philadelphia, is general chairman. The sub-committee chairmen are: Manufacturers sub-committee, F. G. Curfman, Improved Equipment Co., New York City; operating sub-committee, W. H. Earle, Rochester Gas & Electric Corporation, Rochester, N. Y., and low-temperature carbonization sub-committee, J. D. Davis, Bureau of Mines, Pittsburgh.

Industrial Gas Mask for Ammonia Approved

The first approval of an industrial gas mask for use in ammonia fumes has been issued by the United States Bureau of Mines to the Mine Safety Appliances Co., of Pittsburgh, Pa. The Burrell ammonia mask successfully passed the exhaustive series of tests given by the bureau's chemists in accordance with Schedule 14, "Procedure for establishing a list of permissible gas masks."

The gas mask used during the war by the United States Army was largely developed under the direction of the Bureau of Mines and the Chemical Warfare Service. Since the war the Bureau of Mines has been engaged in adapting and developing the gas mask for industrial purposes and promoting its safe usage.

The Burrell ammonia mask consists of an Akron type, Tissot facepiece that allows breathing through the nose, fitted with a special ammonia canister containing copper sulphate pumice stone mixture devised by G. St. J. Perrott, Max Yablick and A. C. Fieldner for the Ordnance Department of the United States Army. It has been found to give absolute protection in any percentage of ammonia gas which the wearer of a mask can stand without unbearable skin irritation.

The canisters submitted by the Mine Safety Appliances Co. protected successfully against 3 per cent of ammonia at a breathing rate of 64 liters per minute for a period of five minutes. This represents the maximum concentration that anyone is likely to enter, as it has a very strong action on the skin. In a concentration of 2 per cent ammonia and a breathing rate of 32 liters per minute, corresponding to active work, six canisters gave a service period of thirty to forty-one minutes. The requirement for approval is twenty minutes.

Special tests of the facepieces fitted with special canisters were made in 1 per cent of sulphur dioxide gas in air, since sulphur dioxide gives a more severe test for facepiece leakage than ammonia.

Approval 1,401 issued to cover this mask states that the mask is approved for safety, practicability and efficiency in concentrations of ammonia in air not exceeding 3 per cent for short periods of time, as ten minutes, or for periods of twenty to thirty minutes in air not exceeding 2 per cent ammonia, and for proportionately longer periods of time in lower concentrations. The replaceable canisters were approved for use only with approved facepieces and harness.

Permissible ammonia masks under this approval will hereafter bear a plate with the seal of the Bureau of Mines, approval and caution clause to promote safe usage.

Patent Policy of the War Department

Announcement is made that it is the policy of the War Department to encourage the development of military inventions by officers, enlisted men and civil employees. In consideration of assistance to be given by the department in the issue of patents, it will require of inventors no more than a license to manufacture and use their inventions for governmental purposes, thereby reserving to the patentee complete freedom and ownership of the patent in its commercial applications. In special cases of inventions of great military importance, however, provision is made for exclusive Government ownership and the utmost secrecy.

Personal

CHARLES Y. CLAYTON, professor of metallurgy at the Missouri School of Mines, will be at Dr. Howe's laboratory at Bedford Hills, N. Y., during the summer.

Dr. HARRY A. CURTIS, who has been with the International Coal Products Corporation as chief chemist, is now general manager of one of the subsidiaries of this company known as the Clinchfield Carbocoal Corporation, South Clinchfield, Va. In this capacity he will have charge of

the plant and industrial village owned by the corporation and be responsible for the further development and operation of the carbonization plant.

EDWARD A. DIETERLE, who has been assistant chief chemist of the Koppers Co., Pittsburgh, will be the chief chemist of the Chicago By-Product Coke Co. The latter plant will be in operation about Sept. 1 to supply mixed coke-oven and water-gas to the Peoples Gas, Light & Coke Co., as a portion of its city supply.

MARTIN G. GEIGER, Harrisburg, Pa., has become connected with the Klipstein Chemical Co., Charleston, W. Va., as chemical engineer.

M. R. HULL, designing engineer of the Chile Exploration Co., has returned from a three months' trip to the company's South American properties.

Colonel JOHN W. JOYES has been chosen to head the technical division of the Ordnance Department of the Army. Colonel Joyes was prominently associated with the nitrate work of the War Department during the war. Recently he has been head of the artillery division of ordnance. He succeeds Colonel C. L. H. Ruggles, who has been instructed to take the Army War College course.

JULIUS KLEIN, who was appointed by the President as Director of the Bureau of Foreign and Domestic Commerce, to fill the position made vacant some time ago by the resignation of R. S. MacElwee, has assumed his duties. Dr. Klein first came to the bureau in September, 1917, as chief of the Latin American Division. He remained in that capacity until May, 1919, when he was made commercial attaché of the department at Buenos Aires, Argentina. He resigned from that position in October, 1920.

CHARLES V. MCINTIRE has resigned his position as chief engineer of the International Coal Products Corporation to enter the field of consulting engineering in association with A. Stephen Knowles of New York City. Mr. McIntire will specialize in the preparation and treatment of coal.

W. W. ODELL, fuels engineer of the Bureau of Mines, is now in North Dakota, where he will co-operate with Prof. Babcock of the University of North Dakota on an extended series of tests of lignite carbonization. The experimental work will be done in the small lignite coking plant of the university as a portion of the co-operative work of the Bureau of Mines and the university.

Dr. J. H. SHRADER, formerly of the United States Department of Agriculture, Washington, D. C., has been appointed Director of the Bureau of Chemistry and Food, Health Department, Baltimore, Md., entering upon his duties July 1.

WALLACE F. SUPER has been transferred from the Laurel Hill, L. I., to the Syracuse plant of the Atmospheric Nitrogen Corporation.

Dr. ROSCOE THATCHER, who succeeds Dr. W. H. Jordan as director of the New York State Agricultural Experiment Station, located at Geneva, assumed his duties July 1.

N. JULIEN THOMPSON has left the employ of the State of Connecticut Industrial Waste Commission and will be retained by the Standard Rolling Mills Co. of Springdale, Conn., as engineer, in charge of development work on a byproduct lithopone plant.

The annual meeting and election of officers of the American Institute of Fertilizer Chemists was held at Battery Park Hotel, Asheville, N. C., on June 24, and the following officers were elected for the ensuing year: President, Dr. Frank L. Parker, of Charleston, S. C.; vice-president, A. G. Stillwell, of New York City; treasurer, W. J. Gascovne, Jr., of Baltimore, Md.; secretary, S. W. Wiley, of Baltimore, Md.

Obituary

Dr. WALLACE CALVIN ABBOTT, founder and for more than thirty years president of the Abbott Alkaloidal Co., now known as the Abbott Laboratories, died at his home in Chicago, July 4.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, July 15, 1921.

Chemical inquiries increased in certain products during the week and in these lines the volume of business improved. In other directions trading was slow and the market activity was in specialties. It might be described as steady on the average yet devoid of unusual propelling features and free from any radical developments. While there are some contracts being placed for future business, most of the buying is for immediate consumption. Consumers are still afraid that prices have not touched bottom in the more important items regardless of stability of values in several of the big basic chemicals. Any rise in prevailing quotations would attract keen attention, but it may be some time before there is enough confidence in values to inspire free buying for prompt and forward shipments.

CONSERVATIVE TRADING THE RULE

There are so many conflicting interests at work at present that conservative trading seems to be the only method of operating. The drastic decline of values in the past eight months has prompted caution all around. Resistance to selling pressure is more pronounced at present and there are no more signs of forced liquidation. Fundamentally, the market is in a much better condition than it was at the beginning of the year, but the proposed revision of import duties is not inspiring to large business temporarily and the ebb and flow of small orders is to be expected. The steady influx of imported chemicals at prices below those named for domestic goods is a restraining influence on American outlet, but the producers are convinced that this condition will right itself when once the new tariff law becomes effective.

GENERAL CHEMICALS

One of the large chemicals which evoked keen interest during the past few days was *bleaching powder*. Prominent manufacturers of this chemical state that they have received numerous inquiries and have booked several large orders for shipment from works to paper mills. The settlement of the recent strike in paper plants has permitted mills to resume operations and there was an immediate response in the call for bleach. Another item that attracted considerable attention was the offering of German *caustic soda* at \$3.35 per 100 lb., duty paid. Domestic caustic soda has displayed its recent stability on spot. Dealers quote the market on 88-92 per cent *caustic potash* at 5@5½c. per lb., while rumors are current that some business has gone through below the inside figure. Some of the largest distributors say they cannot sell this material under 5½c. per lb. Moderate trading is reported for soap-making requirements, but the general demand is rather slow at present. The opinion is prevalent that prices in this commodity are quite near rock bottom. Small sales of *permanganate of potash*, U.S.P., were reported at 29@30c. per lb., depending upon quantity. Moderate inquiries have recently reached the market for limited lots and sellers have not experienced much difficulty in obtaining the above prices. This product was selling at \$4 per lb. during the war. Prominent sellers of *acetate of soda* quote the market at 4½c. per lb. inside and the general quotation is 4¼@4½c., depending on quantity. The demand has not shown very much activity during the past few days and the call has been chiefly restricted to small lots for actual requirements. Large factors in *bichromate of soda* quote the market at 8@8½c. per lb. Resale material has changed hands at 8@8½c. per lb., according to seller. In most quarters where resale material is handled it is stated that the market looks as though it was thoroughly liquidated. Dealers report sales of standard brands *caustic soda* at \$4@\$4.10 per 100 lb., while scattered transactions for export have been made at \$4.15@\$4.25 per 100 lb. At the works, resale material was quoted at 3¼@4c. per lb., depending upon seller, the inside figure

being for large lots. The contract price is quoted at 3¼c. per lb. basis 60 per cent, f.o.b. works. It was stated that a 100-ton order of German caustic soda was recently booked at \$3.35 per 100 lb. Sales of *chlorate of soda* are reported by prominent factors on the basis of 7½c. per lb. f.o.b. works for prompt shipment. This price is about as low as can be quoted in any direction. There is not much activity to report on *nitrate of soda* and sellers quote 7¼@7½c. per lb. for spot material. Some interests are above these prices, but odd lots are on the market and buyers seem to be interested only in quotations that are on the spot market for immediate requirements. Spot prices for imported *prussiate of soda* were a shade easier and sellers quoted 12@12½c. per lb. The demand for this chemical has not been pronounced during the past week and some sellers have resorted to price shading in an attempt to stimulate business. Quiet trading continues to feature the market on powdered *white arsenic* and sellers state that only odd lots are moving at the present time. Prices range from 6½@7c. per lb. *Red arsenic* is quoted by producers at figures ranging from 12@13c. per lb., according to quantity.

COMPARATIVE LIST OF CHEMICALS DURING MONTH OF JUNE, 1921

Product	High	Low	Close
Acetate of soda, lb.....	\$0.04½	\$0.04½	\$0.04½
Arsenic, lb.....	.07	.06½	.06½
Bicarbonate of soda, lb.....	.02½	.02½	.02½
Bichromate of soda, lb.....	.08½	.08	.08
Bleaching power, lb.....	.02½	.02½	.02½
Carbonate of potash, 80-85%, lb.....	.06	.05	.05
Caustic potash, 88-92%, lb.....	.05½	.05	.05
Caustic soda, lb.....	.04½	.04	4.10-100 lb.
Citric acid, lb.....	.46	.44	.44
Formaldehyde, lb.....	.14½	.13½	.13½
Muriate of potash, ton.....	50.00	45.00	48.00
Oxalic acid, lb.....	.20	.18	.18
Permanganate of potash, U. S. P., lb.....	.32	.30	.30
Soda ash, 100 lb.....	2.20	2.00	2.10
Sulphide of soda, 60-62%, lb.....	.05½	.05½	.05½
Tartaric acid, lb.....	.30	.28	.29

COAL-TAR PRODUCTS

Producers and sellers in general have little in the way of new developments to report. The consuming demand is irregular, but it is believed that the inquiries in the market show a need of supplies and by going after these business can be done in a small way in domestic quarters. The export business shows little signs of a revival except for benzene. Imports of coal-tar products for the month of May, 1921, amounted to \$401,837, for the corresponding month of 1920, \$634,840. For eleven months ended May, 1921, the total was \$13,732,176, just double that of the corresponding period of 1920, which was \$6,464,047. There were no imports of benzene during the month of May in either 1920 or 1921, but the exports in May, 1921, amounted to 18,102,679 lb., valued at \$788,511, and for May, 1920, 1,483,096 lb., valued at \$97,775. The imports of naphthalene for eleven months ended May, 1920, amounted to 5,358,800 lb., valued at \$139,936, while for the corresponding period of 1921 they amounted to 13,456,830 lb., valued at \$502,490. In comparing the month of May, 1920, with May, 1921, there seems to be about 600,000 lb. less imported this year. Besides the exports of benzene there were other coal-tar distillates valued at \$856,976 in May, 1920, and \$21,228 in May, 1921.

Sellers report a better inquiry, and sales while taking place only in small quantities, are embodying a wider variety of products. Cheap resale lots are fast disappearing from the market. *Benzene* is moving quite steadily and prices are firm at 27@30c. per gal. for the pure and 25@28c. per gal. for the 90 per cent grade. *Naphthalene* is in easy supply, but there is only a little demand noted and prices range from 7@8½c. per lb. In some quarters a fair routine movement is noted in *phenol* with the inside figure heard at 9½c. per lb. Intermediates are gradually picking up and while the demand is confined to small lots, it is nevertheless spreading throughout the list and prices are more steady. *Beta naphthol* continued quiet with the low figure named at 35c. per lb. in some directions. The general quotation ranges from 35@40c. per lb., depending on quantity. *Dimethylaniline* is a shade lower at 38@50c. per lb., depending upon seller. There is little other than a routine movement in *paranitraniline* and prices range from 82@90c.

per lb. Reports from some quarters on *para amidophenol* reflect a steady demand for the base material, and while \$1.50 per lb. is quoted by most sellers, some shading on a firm order is thought quite possible. The hydrochloride is quoted at \$1.60@1.75 per lb., but very little business is being done. The tone of the market in *aniline oil* is steady, although there is still only a small-lot movement of a routine nature. Prices range from 20@26c. per lb. with some producers reporting a limited business around 23c. The demand for *aniline salt* is quiet and only an irregular small quantity of business is reported. Consumers show few signs of coming into the market and prices are a shade lower at 25@28c. per lb.

HIGH AND LOW PRICES IN COAL-TAR PRODUCTS DURING JUNE, 1921

Products	High	Low
Benzene, c.p., gal.....	\$0.27	\$0.27
Cresol, U.S.P., lb.....	.16	.16
Cresylic acid, 97-99%, gal.....	.75	.70
Naphthalene flakes, lb.....	.08	.07
Phenol, lb.....	.11	.10
Solent naphtha, water white gal.....	.25	.25
Toluene, gal.....	.28	.28
Benzoic acid, U.S.P., lb.....	.65	.60
H acid, lb.....	1.30	1.20
Naphthionic acid, crude, lb.....	.75	.70
Salicylic acid, U.S.P., lb.....	.23	.20
Sulphanilic acid, lb.....	.32	.30
Alpha naphthylamine, lb.....	.40	.35
Aniline oil, lb.....	.23	.20
Aniline salt, lb.....	.28	.26
Benzaldehyde, tech., lb.....	.45	.45
Benidine, base, lb.....	1.00	.85
Beta naphthol, tech., lb.....	.40	.38
Diethylaniline, lb.....	1.30	1.20
Dimethylaniline, lb.....	.45	.40
Diphenylamine, lb.....	.60	.60
Monochlorobenzene, lb.....	.14	.12
Nitrobenzene, lb.....	.13	.12
Para nitraniline, lb.....	1.00	.85

VEGETABLE OILS

Trading in *chinawood oil* was inactive and the undertone covering forward business was barely steady. For spot oil nominal quotations ranged from 14@15c. per lb. A quantity now afloat was offered at 11½c. per lb., c.i.f. New York. July shipment from the Orient closed at 10¼@10½c. per lb., c.i.f. New York. On the Coast 12c. was asked for spot oil in hardwood barrels. The demand for *coconut oil* was quiet and prices in some directions were hardly steady. Manila oil was offered at 7½c. per lb., bulk basis, July-August shipment, c.i.f. Coast, while for tank cars there were sellers at 7¾c. per lb., forward shipments, f.o.b. Coast. Prompt shipment oil on the Coast held at 7½@8¼c. per lb., sellers' tanks. Domestic Ceylon type oil closed nominally at 8½@8¾c. per lb., sellers' tanks, f.o.b. New York. Advices from the Middle West reported a slightly firmer tone in the market for *crude corn oil*, in sympathy with the strength in cottonseed oil, but the actual price changes were very slight. The mills in the West were asking from 5½@5¾c. per lb., sellers' tanks, immediate shipment. With the advance in crude cottonseed, the market for *peanut oil* held firm. Oriental crude sold at 6¼c. per lb., Coast, sellers' tanks, prompt shipment. A sale of one carload of imported oil sold at 6½c. per lb., sellers' tanks, f.o.b. Coast. Domestic oil sold at 7c. per lb., basis prime, f.o.b. mills, Southeast, with numerous bids in the market at 6¾c. Several holders of domestic crude raised their views to 7¼c. per lb., buyers' tanks, f.o.b. mill. A sale of *crude soya bean oil* went

HIGH, LOW AND CLOSE IN VEGETABLE OIL MARKET DURING JUNE, 1921

	High	Low	Close
Castor oil No. 1, U.S.P., lb.....	\$0.10½	\$0.10	\$0.10½
Castor oil, tech., lb.....	.09	.08½	.08½
Chinawood oil, coast, bbl.....	.14	.12½	.13½
Chinawood oil, N. Y. bbl., lb.....	.15	.13	.14
Cocoonut oil, Ceylon, bbl., lb.....	.10½	.10	.10½
Cocoonut oil, Cochin, bbl., lb.....	.11½	.11	.11
Corn oil, crude, bbl., lb.....	.07½	.07½	.07½
Corn oil, refined, bbl., lb.....	.09½	.09¼	.09¼
Olive oil, denatured, bbl., lb.....	1.45	1.35	1.35
Palm oil, lagos, bbl., lb.....	.07½	.06½	.06½
Palm oil, Niger, bbl., lb.....	.05½	.05½	.05½
Peanut oil, domestic, f.o.b. mill, lb.....	.06	.05½	.06
Peanut oil, deodorized, lb.....	.10½	.10	.10½
Rapeseed oil, refined, bbl., lb.....	.92	.88	.88
Soya bean oil, N. Y., bbl., lb.....	.07½	.07½	.07½

through late last week at a shade under 6c. per lb., sellers' tanks, duty free, immediate shipment from the Coast. The market closed nominally at 6@6¼c. per lb., Coast basis, tank cars. Importers now believe that there is a possibility for a resumption of trading in futures, owing to the upward tendency of cottonseed and other edible oils.

The Chicago Market

CHICAGO, July 15, 1921.

There were no new developments in the industrial chemical markets during the past two weeks. A fair volume of small orders was reported in most quarters and inquiries were fair, but no large transactions were noted. Dealers and agents seem to have ample supplies on hand and in general prices are firm with a few exceptions.

GENERAL CHEMICALS

Caustic soda is in a very firm position with supplies light. The ground or flake 76 per cent is quoted at \$4.65@4.75 per 100 lb. and the solid at \$4@4.10. *Soda ash* is moving very well and \$2.60 per 100 lb. for barrels was the best offer noted. *Sal ammoniac* is weaker with continued arrivals of foreign material, and supplies of the prime white granular are available at 7¾c. per lb. for large casks. There is a small demand for *barium chloride* and the white crystals are offered at \$75@\$85 per ton, according to the quantity. There was a somewhat better request for *powdered alum* and several sales were noted at 8@8½c. per lb. *Carbon tetrachloride* is firm, with the inquiry good, holders asking 11@11½c. per lb. for the large drums. *Formaldehyde* is rather lifeless and little business was reported at the present level of 14c. per lb. in barrels.

The alcohol market is in a poor condition and little or no business is reported. A wide range of prices can be obtained on completely denatured and stocks in second hands are heavy. Distillers quote 35c. per gal. drum basis on No. 5 c.p. 188 deg. proof. *Methanol* is in a better condition and small orders were filled for the 95 per cent at 85c. per gal. in drums. *Glycerine* is weak, with the inquiry light, and ample supplies are available at 14¾c. per lb. for the large drums. The bichromate situation lacks new features and the prices are firm with only small quantities moving. *Bichromate of soda* is held at 9@9½c. and *potassium bichromate* at 14c. per lb. *Caustic potash* is moving in a fair way at 6¾c. per lb. for the 88-92 per cent. *Nitrite of soda* is firm and unchanged at 9c. per lb. for single casks. *Hyposulphite of soda* is in good demand and holders are asking \$4.05 per 100 lb. for the pea crystals. *Zinc chloride* is steady and spot goods are offered at 11½c. per lb., although a somewhat better offer was noted on material for prompt shipment from the east. *Zinc sulphate* is quiet and supplies are available at 3½c. per lb.

The list of acids is very quiet with few changes in prices reported. *Acetic acid*, 28 per cent, is moving in a fair way at \$2.60 per 100 lb. in barrels. The *glacial acid* is dead and prices range from 8@11c., according to the quantity and holder. *Oxalic acid* is in good demand and supplies are available at 18c. per lb. The heavy acids are unchanged as to price and are not moving so well. *Sulphuric acid* is still quoted at \$19@\$20 per ton in tank cars f.o.b. works.

VEGETABLE OILS

The only item worthy of attention in this market is *linseed oil*. This item is very firm and dealers report a fairly good movement of supplies to the paint trade. The raw oil is offered at 78c. per gal. and the boiled at 80c. in cooperage.

NAVAL STORES

The feature of this branch of the trade was the sharp advance in the price of *turpentine*. Today this material is very firm and a good inquiry is noted. Dealers are quoting 67c. per gal. in drums and report a satisfactory volume of business. *Rosins* are only in a moderate request and the G and H grades are offered at \$4.50 per 280 lb. in carlots. *Rosin oil* is slow and the price is unchanged at 45c. per gal. for material in cooperage.

The Iron and Steel Market

PITTSBURGH, July 15, 1921.

The general condition of affairs in the steel market is not sensibly changed by last week's announcements of steel price reductions. Most of the reductions thus formally announced were simply recognition of prices previously made by the open market, through the price cutting route. Taking the trade as a whole, the idea of recent years, of there being a fixed price for each steel commodity, all other prices being "cut" prices, is yielding rather slowly, although there have been times in the steel trade when the market price of steel was simply what sellers were getting for it, and the position seems to be a perfectly natural position for a commodity market to occupy.

What is perhaps really significant in the market situation is that there is less talk about "the next reduction" or "the final reduction." The trade seems now to be getting away from the idea that the steel market has simply been moving toward a stable level, one that would be maintained or one from which advances would occur. This means, of course, that expectation has been dwindling that there would be in the not distant future, say within a period of months, one of those steel market phenomena known as "a buying movement," in which buyers changed their tactics and bought farther and farther ahead, being encouraged in this by there being slight price advances from time to time. The outlook now is that for an indefinite time the buying of steel will be merely in keeping with requirements as they develop.

STEEL PRODUCTION

Steel production is at not over about 20 per cent of productive capacity, there having been only a slight downward trend in the past week or two. The average rate of production in June was about 27 per cent. July being traditionally a very dull month in the steel industry, it seems improbable that there will be much if any further decline in production, while an increase can easily occur without there being any great change in general conditions.

A factor that will produce an increase in demand upon the steel mills is liquidation of stocks in the hands of buyers of steel, both of stocks of steel and of manufactures of steel. In the case of the agricultural implement factories the stocks of finished implements are much larger than the stocks of steel. With other manufacturing consumers, as a whole, the balance is probably the other way. The liquidation does not seem to be proceeding very rapidly. In the oil industry there remain some stocks of tubular and other goods, while drilling and other work is very light.

In some quarters predictions are made that the railroads will soon become important buyers, favorably affecting steel mill operations. These predictions seem to be based largely on theory, it being a fact that some men, in most intimate contact with the railroads, refuse to make predictions. The fact may not be as generally known as it should be that the railroads owe the steel mills and some customers of the steel mills quite a large sum of money in the aggregate, and remittances rather than orders are desired first.

It is the common view that the demand upon the steel mills, represented by the rate of production, since almost all orders and specifications received are filled within a very few days, is quite below a normal relation to the general industrial and commercial activity of the country. Of that there is no question, but while the fact of the demand being subnormal in this sense may be quite patent there is no light on the question how long it can remain so. In the past the phenomenon was not observed. Steel mill operations before the war never dropped below about 50 per cent of capacity, and that came to be considered the irreducible minimum. Today's 20 per cent operation is equal to only about 30 per cent operation of the total capacity in existence in 1914.

Pig iron has continued to slide off, declines in the week being about 50c. a ton. The valley market is quotable at about \$21 for bessemer, \$20.50 for foundry and \$19.50 for basic. Freight to Pittsburgh is \$1.96, but it should be noted that basic iron for Pittsburgh delivery, from other sources than the valleys, has been available at 50c. or more below the valley equivalent.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots	Less Carlots
Acetic anhydride.....lb.	\$0.12½ - \$0.12½	\$0.40 - \$0.45
Acetone.....lb.	2.50 - 2.75	.13 - .13½
Acid, acetic, 28 per cent.....100 lbs.	4.00 - 4.25	3.00 - 3.25
Acetic, 56 per cent.....100 lbs.		4.50 - 5.50
Acetic, glacial, 99½ per cent, carboys, 100 lbs.	9.75 - 10.00	10.25 - 10.50
Boric, crystals.....lb.	.13½ - .14	.14½ - .15
Boric, powder.....lb.	.15 - .15½	.16 - .16½
Citric.....lb.		.45 - .46
Hydrochloric.....100 lb.	1.50 - 1.65	1.75 - 2.00
Hydrofluoric, 52 per cent.....lb.	.12½ - .12½	.12½ - .13
Lactic, 44 per cent tech.....lb.	.10 - .11	.11½ - .12
Lactic, 22 per cent tech.....lb.	.04½ - .05½	.06 - .07
Molybdic, C. P.....lb.	4.00 - 4.50	4.50 - 5.00
Muriatic, 20 deg. (see hydrochloric).....	.06½ - .06½	.07 - .07½
Nitric, 40 deg.....lb.	.07 - .07½	.07½ - .07½
Nitric, 42 deg.....lb.	.18 - .18½	.18½ - .19
Oxalic, crystals.....lb.	.13½ - .14	.14 - .18
Phosphoric, 50 per cent solution.....lb.	.20 - .25	.27 - .35
Picric.....lb.		1.90 - 2.15
Pyrogallic, resublimed.....lb.		11.75 - 14.00
Sulphuric, 60 deg., tank cars.....ton		13.00 - 15.00
Sulphuric, 60 deg., drums.....ton	18.00 - 20.00	
Sulphuric, 66 deg., tank cars.....ton	21.00 - 22.00	22.50 - 23.00
Sulphuric, 66 deg., drums.....ton		
Sulphuric, 66 deg., carboys.....ton		
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	21.00 - 22.00	
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	23.00 - 23.50	24.00 - 24.50
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	31.00 - 32.00	33.00 - 34.00
Tannic, U. S. P.....lb.	.45 - .48	.50 - 1.00
Tannic (tech.).....lb.		.50 - .55
Tartaric, crystals.....lb.		.29 - .30
Tungstic, per lb. of WO.....lb.		1.30 - 1.40
Alcohol, Ethyl.....gal.		4.80 - 5.00
Alcohol, Methyl (see methanol).....		.31 - .36
Alcohol, denatured, 188 proof.....gal.		.38 - .42
Alcohol, denatured, 190 proof.....gal.		.04 - .04½
Alum, ammonia lump.....lb.	.03½ - .03½	.04 - .04½
Alum, potash lump.....lb.	.03½ - .04	.04½ - .04½
Alum, chrome lump.....lb.	.10 - .11	.11½ - .12½
Aluminium sulphate, commercial.....lb.	.01½ - .02	.02½ - .02½
Aluminium sulphate, iron free.....lb.	.03 - .03½	.03½ - .04
Aqua ammonia, 26 deg., drums (750 lb.).....lb.	.07 - .07½	.07½ - .08
Ammonia, anhydrous, cyl. (100-150 lb.).....lb.	.30 - .32	.33 - .35
Ammonium carbonate, powder.....lb.	.08 - .08½	.09 - .10
Ammonium chloride, granular (white sal ammoniac).....lb.	.06½ - .06½	.07 - .07½
Ammonium chloride, granular (gray sal ammoniac).....lb.	.07½ - .08	.08½ - .08½
Ammonium nitrate.....lb.	.07 - .07½	.07½ - .08½
Ammonium sulphate.....100 lb.	2.70 - 2.75	2.80 - 3.00
Amylacetate.....gal.		4.00 - 4.25
Amylacetate tech.....gal.		2.50 - 3.00
Arsenic oxide, (white arsenic) powdered lb.	.06½ - .07	.07½ - .08
Arsenic, sulphide, powdered (red arsenic) lb.	.11 - .11½	.12 - .13
Barium chloride.....ton	59.00 - 59.50	60.00 - 62.00
Barium dioxide (peroxide).....lb.	.20 - .21	.22 - .23
Barium nitrate.....lb.	.07½ - .07½	.08 - .08½
Barium sulphate (precip.) (blanc fixe).....lb.	.04½ - .05	.05½ - .06
Bleaching powder (see calc. hypochlorite).....		
Blue vitriol (see copper sulphate).....		
Borax (see sodium borate).....		
Brimstone (see sulphur, roll).....		
Bromine.....lb.	.41 - .42	.43 - .45
Calcium acetate.....100 lbs.	2.00 - 2.05	
Calcium carbide.....lb.	.04½ - .04½	.05 - .05½
Calcium chloride, fused, lump.....ton	23.50 - 24.00	24.50 - 25.50
Calcium chloride, granulated.....lb.	.01½ - .02	.02½ - .02½
Calcium hypochlorite (bleach powder) 100 lb.	2.15 - 2.25	2.35 - 2.50
Calcium peroxide.....lb.		1.40 - 1.50
Calcium phosphate, tribasic.....lb.		.15 - .16
Camphor.....lb.		.75 - .78
Carbon bisulphide.....lb.	.06½ - .07	.07½ - .08
Carbon tetrachloride, drums.....lb.	.10½ - .10½	.11 - .12
Carbonyl chloride (phosgene).....lb.		.60 - .75
Caustic potash (see potassium hydroxide).....		
Caustic soda (see sodium hydroxide).....		
Chlorine, gas, liquid-cylinders (100 lb.).....lb.	.08 - .09	.09½ - .10
Chloroform.....lb.		.40 - .43
Cobalt oxide.....lb.		3.00 - 3.10
Copperas (see iron sulphate).....		
Copper carbonate, green precipitate.....lb.	.19 - .19½	.20 - .21
Copper cyanide.....lb.		.50 - .62
Copper sulphate, crystals.....lb.	.05½ - .06	.06½ - .06½
Cream of tartar (see potassium bitartrate).....		
Epsom salt (see magnesium sulphate).....		
Ethyl Acetate Com. 85%.....gal.		.85 - 1.00
Ethyl Acetate pure (acetic ether 98% to 100%).....lb.		.50 - .52
Formaldehyde, 40 per cent.....lb.	.13 - .13½	.13 - .14
Fusel oil, ref.....gal.		3.00 - 3.25
Fusel oil, crude.....gal.		1.75 - 2.00
Glauber's salt (see sodium sulphate).....		
Glycerine, C. P. drums extra.....lb.		.15 - .15½
Iodine, resublimed.....lb.		3.65 - 3.75
Iron oxide, red.....lb.		.10 - .20
Iron sulphate (copperas).....ton	19.00 - 20.00	21.00 - 22.00
Lead acetate.....lb.		.11½ - .13½
Lead arsenate, paste.....lb.	.09 - .09½	.10 - .11
Lead nitrate.....lb.		.15 - .20
Litharge.....lb.	.38½ - .08½	.08½ - .09
Lithium carbonate.....lb.		1.30 - 1.40
Magnesium carbonate, technical.....lb.	.09 - .09½	.10 - .11
Magnesium sulphate, U. S. P.....100 lb.	2.40 - 2.75	
Magnesium sulphate, technical.....100 lb.		1.20 - 1.75
Methanol, 95%.....gal.		.77 - .80
Methanol, 97%.....gal.		.80 - .85
Nickel salt, double.....lb.		.12 - .12½
Nickel salt, single.....lb.		.14 - .14½
Phosgene (see carbonyl chloride).....		
Phosphorus, red.....lb.	.45 - .46	.47 - .50
Phosphorus, yellow.....lb.		.35 - .37
Potassium bichromate.....lb.	.11½ - .11½	.12 - .12½

	Carlots	Less Carlots
Potassium bitartrate (cream of tartar), lb.	\$ \$	\$0.30 - \$0.31
Potassium bromide, granular, lb.		.16 - .25
Potassium carbonate, U. S. P., lb.	.35 - .40	.45 - .50
Potassium carbonate, 80-85%, lb.	.05 - .05½	.06 - .07
Potassium chlorate, crystals, lb.	.07½ - .07¾	.08 - .12
Potassium cyanide, lb.		.26 - .28
Potassium hydroxide (caustic potash), lb.	.05 - .05½	.05½ - .06
Potassium muriate, 80% K.C.L., ton	45.00 - 50.00	
Potassium iodide, lb.		2.75 - 3.00
Potassium nitrate, lb.	.09½ - .09¾	.10 - .12½
Potassium permanganate, lb.	.29 - .30	.31 - .32
Potassium prussiate, red, lb.	.30 - .31	.32 - .33
Potassium prussiate, yellow, lb.	.22 - .22½	.23 - .23½
Potassium sulphate (powdered), per unit		1.50 - 1.75
Rochelle salts (see sodium potas tartrate)		
Salammoniac (see ammonium chloride)		
Sal soda (see sodium carbonate)		
Salt cake, ton		23.00 - 25.00
Silver cyanide, oz.		1.35 - 1.38
Silver nitrate, oz.		.40 - .41
Soda ash, light, 100 lb.	2.00 - 2.10	2.15 - 2.50
Soda ash, dense, 100 lb.	2.35 - 2.40	2.45 - 2.70
Sodium acetate, lb.	.04½ - .04¾	.04½ - .05½
Sodium bicarbonate, 100 lb.	2.25 - 2.40	2.50 - 2.75
Sodium bichromate, lb.	.08 - .08½	.08½ - .09
Sodium bisulphate (nitre cake), ton	5.00 - 5.25	5.50 - 6.50
Sodium bisulphite powdered, U.S.P., lb.	.05 - .05½	.05½ - .06
Sodium borate (borax), lb.	.06 - .06½	.06½ - .07
Sodium carbonate (sal soda), 100 lb.	1.90 - 2.00	2.10 - 2.40
Sodium chlorate, lb.	.07½ - .07¾	.08 - .08½
Sodium cyanide, lb.	.19½ - .21	.22 - .30
Sodium fluoride, lb.	.11½ - .12	.12½ - .13½
Sodium hydroxide (caustic soda), 100 lb.	4.00 - 4.10	4.15 - 4.60
Sodium hyposulphite, lb.		.03½ - .03¾
Sodium nitrate, 100 lb.	2.90 -	3.00 -
Sodium nitrite, lb.	.07½ - .07¾	.07½ - .08
Sodium peroxide, powdered, lb.	.25 - .26	.27 - .30
Sodium phosphate, dibasic, lb.	.04½ - .04¾	.05 - .05½
Sodium potassium tartrate (Rochelle salts), lb.	.12 - .12½	.12½ - .13
Sodium prussiate, yellow, lb.		.12½ - .13
Sodium silicate, solution (40 deg.), 100 lb.	1.00 - 1.15	1.25 - 1.40
Sodium silicate, solution (60 deg.), lb.	.02½ - .03	.03½ - .03¾
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	1.50 - 1.75	2.00 - 2.25
Sodium sulphide, fused, 60-62 per cent (conc.) lb.	.05½ - .05¾	.06 - .06½
Sodium sulphite, crystals, lb.	.03½ - .04	.04½ - .04¾
Strontium nitrate, powdered, lb.	.15 - .15½	.16 - .17
Sulphur chloride, red, lb.	.07 - .07½	.07½ - .08
Sulphur, crude, ton	20.00 - 22.00	
Sulphur dioxide, liquid, cylinders extra, lb.	.08 - .08½	.09 - .10
Sulphur (sublimed), flour, 100 lb.		2.25 - 3.10
Sulphur, roll (brimstone), 100 lb.		2.00 - 2.75
Tin bichloride, 50 per cent, lb.	.18 - .19	
Tin oxide, lb.		.40 - .42
Zinc carbonate, precipitate, lb.	.15½ - .16	.16½ - .17
Zinc chloride, gran., lb.	.11 - .11½	.11½ - .12
Zinc cyanide, lb.	.45 - .49	.50 - .60
Zinc dust, lb.	.11½ - .11¾	.11¾ - .12½
Zinc oxide, XX, lb.	.07½ - .07¾	.08 - .09
Zinc sulphate, 100 lb.	3.00 - 3.25	3.30 - 3.50

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude, lb.	\$1.10 - \$1.15
Alpha-naphthol, refined, lb.	1.25 - 1.30
Alpha-naphthylamine, lb.	.35 - .40
Aniline oil, drums extra, lb.	.20 - .26
Aniline salts, lb.	.25 - .28
Anthracene, 80% in drums (100 lb.), lb.	.75 - 1.00
Benzaldehyde U.S.P., lb.	1.50 -
Benzidine, base, lb.	.85 - 1.00
Benzidine sulphate, lb.	.75 - .85
Benzoic acid, U.S.P., lb.	.60 - .65
Benzoate of soda, U.S.P., lb.	.55 - .60
Benzene, pure, water-white, in drums (100 gal.), gal.	.27 - .32
Benzene, 90%, in drums (100 gal.), gal.	.25 - .28
Benzyl chloride, 95-97%, refined, lb.	.28 - .30
Benzyl chloride, tech, lb.	.20 - .25
Beta-naphthol benzoate, lb.	3.50 - 4.00
Beta-naphthol, sublimed, lb.	.70 - .75
Beta-naphthol, tech, lb.	.35 - .38
Beta-naphthylamine, sublimed, lb.	1.75 - 1.80
Cresol, U. S. P., in drums (100 lb.), lb.	.16 - .18
Ortho-cresol, in drums (100 lb.), lb.	.25 - .27
Cresylic acid, 97-99%, straw color, in drums, gal.	.70 - .80
Cresylic acid, 95-97%, dark, in drums, gal.	.65 - .70
Cresylic acid, 50%, first quality, drums, gal.	.45 - .50
Dichlorobenzene, lb.	.06 - .09
Diethylaniline, lb.	1.20 - 1.25
Dimethylaniline, lb.	.38 - .48
Dinitrobenzene, lb.	.26 - .28
Dinitrochlorobenzene, lb.	.20 - .30
Dinitronaphthalene, lb.	.30 - .40
Dinitrophenol, lb.	.35 - .40
Dinitrotoluene, lb.	.27 - .30
Dip oil, 25%, car lots, in drums, gal.	.40 - .45
Diphenylamine, lb.	.60 - .65
H-acid, lb.	1.20 - 1.30
Meta-phenylenediamine, lb.	1.15 - 1.20
Monochlorobenzene, lb.	.12 - .14
Monoethylaniline, lb.	1.75 - 1.85
Naphthalene crushed, in bbls., lb.	.07 - .08½
Naphthalene, flake, lb.	.07 - .08½
Naphthalene, balls, lb.	.08½ - .09½
Naphthionic acid, crude, lb.	.70 - .75
Nitrobenzene, lb.	.12 - .15
Nitro-naphthalene, lb.	.30 - .35
Nitro-toluene, lb.	.16 - .18
Ortho-amidophenol, lb.	3.10 - 3.20
Ortho-dichlor-benzene, lb.	.15 - .20
Ortho-nitro-phenol, lb.	.80 - .85
Ortho-nitro-toluene, lb.	.15 - .20
Ortho-toluidine, lb.	.20 - .25
Para-amidophenol, base, lb.	1.50 - 1.60
Para-amidophenol, HCl, lb.	1.60 - 1.75

Para-dichlorobenzene, lb.	.15 - .20
Paranitroaniline, lb.	.82 - .90
Para-nitrotoluene, lb.	.85 - .95
Para-phenylenediamine, lb.	1.75 - 2.00
Para-toluidine, lb.	1.25 - 1.40
Phthalic anhydride, lb.	.50 - .60
Phenol, U. S. P., drums, lb.	.09½ - .11
Pyridine, gal.	2.00 - 3.50
Resorcinol, technical, lb.	1.75 - 1.85
Resorcinol, pure, lb.	2.25 - 2.30
Salicylic acid, tech., in bbls., lb.	.19 - .22
Salicylic acid, U. S. P., lb.	.20 - .25
Salol, lb.	.80 - .85
Solvent naphtha, water-white, in drums, 100 gal., gal.	.25 - .28
Solvent naphtha, crude, heavy, in drums, 100 gal., gal.	.14 - .16
Sulphanilic acid, crude, lb.	.30 - .35
Tolidine, lb.	1.25 - 1.35
Toluidine, mixed, lb.	.40 - .45
Toluene, in tank cars, gal.	.25 - .28
Toluene, in drums, gal.	.28 - .31
Xylidines, drums, 100 gal., lb.	.40 - .45
Xylene, pure, in drums, gal.	.40 - .45
Xylene, pure, in tank cars, gal.	.45 -
Xylene, commercial, in drums, 100 gal., gal.	.33 - .35
Xylene, commercial, in tank cars, gal.	.30 -

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark, lb.	\$0.24 - \$0.25
Beeswax, refined, light, lb.	.27 - .28
Beeswax, white pure, lb.	.42 - .45
Carnauba, Florida, lb.	.58 - .60
Carnauba, No. 2, North Country, lb.	.25 - .26
Carnauba, No. 3, North Country, lb.	.13½ - .14
Japan, lb.	.16 - .16½
Montan, crude, lb.	.06½ - .06¾
Paraffine waxes, crude match wax (white) 105-110 m.p., lb.	.03 - .03½
Paraffine waxes, crude, scale 124-126 m.p., lb.	.02½ -
Paraffine waxes, refined, 118-120 m.p., lb.	.03 - .03½
Paraffine waxes, refined, 125 m.p., lb.	.03½ - .04
Paraffine waxes, refined, 128-130 m.p., lb.	.04½ - .04¾
Paraffine waxes, refined, 133-135 m.p., lb.	.05 - .05½
Paraffine waxes, refined, 135-137 m.p., lb.	.05½ - .06
Stearic acid, single pressed, lb.	.09 -
Stearic acid, double pressed, lb.	.09½ -
Stearic acid, triple pressed, lb.	.10 - .10½

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on earload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl., 280 lb.	\$5.10 -
Rosin E-F, 280 lb.	5.20 - 5.45
Rosin K-N, 280 lb.	5.70 - 6.75
Rosin W. G.-W. W., 280 lb.	7.35 -
Wood rosin, bbl., 280 lb.	6.25 -
Spirits of turpentine, gal.	.67½ -
Wood turpentine, steam dist, gal.	.60 -
Wood turpentine, dest. dist., gal.	.58 -
Pine tar pitch, bbl., 200 lb.	 - 7.00
Tar, kiln burned, bbl. (500 lb.), bbl.	 - 11.50
Retort tar, bbl., 500 lb.	 - 11.50
Rosin oil, first run, gal.	.35 -
Rosin oil, second run, gal.	.37 -
Rosin oil, third run, gal.	.41 -
Pine oil, steam dist., sp.gr. 0.930-0.940, gal.	\$1.80 -
Pine oil, pure, dest. dist., gal.	1.50 -
Pine tar oil, ref., sp.gr. 1.025-1.035, gal.	.46 -
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla., gal.	.35 -
Pine tar oil, double ref., sp.gr. 0.965-0.990, gal.	.75 -
Pine tar, ref., thin, sp.gr. 1.080-1.960, gal.	.35 -
Turpentine, crude, sp. gr., 0.900-0.970, gal.	1.20 -
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990, gal.	.35 -
Pine wood creosote, ref., gal.	.52 -

Solvents

73-76 deg., steel bbls. (85 lb.), gal.	\$0.41 -
70-72 deg., steel bbls. (85 lb.), gal.	.39 -
68-70 deg., steel bbls. (85 lb.), gal.	.38 -
V. M. and P. naphtha, steel bbls. (85 lb.), gal.	.30 -

Crude Rubber

Para-Upriver fine, lb.	\$0.16 - .17
Upriver coarse, lb.	.09 - .09½
Upriver cancho ball, lb.	.11½ - .12
Plantation—First latex crepe, lb.	.14 -
Ribbed smoked sheets, lb.	.12 - .12½
Brown crepe, thin, clean, lb.	.15 -
Amber crepe No. 1, lb.	.17 -

Oils

VEGETABLE

The following prices are f.o.b. New York for earload lots.

Castor oil, No. 3, in bbls., lb.	\$0.08½ - \$0.09
Castor oil, AA, in bbls., lb.	.10 - .10½
China wood oil, in bbls. (f.o.b. Pac. coast), lb.	.12 - .12½
Cocanut oil, Ceylon grade, in bbls., lb.	.10 - .10½
Cocanut oil, Cochin grade, in bbls., lb.	.10½ - .11
Corn oil, crude, in bbls., lb.	.07½ - .08
Cottonseed oil, crude (f. o. b. mill), lb.	.07 - .07½
Cottonseed oil, summer yellow, lb.	.07½ - .08½
Cottonseed oil, winter yellow, lb.	.08 -
Linseed oil, raw, ear lots (domestic), gal.	.71 - .72
Linseed oil, raw, tank cars (domestic), gal.	.65 - .66
Linseed oil, in 5-bbl lots (domestic), gal.	.73 - .74

Olive oil, Denatured.....	gal.	\$1.35	—	\$1.45
Palm, Lagos.....	lb.	.06 $\frac{1}{2}$	—	.06 $\frac{3}{4}$
Palm, Niger.....	lb.	.05 $\frac{1}{2}$	—	.05 $\frac{3}{4}$
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.07	—	.07 $\frac{1}{2}$
Peanut oil, refined, in bbls.....	lb.	.10	—	.10 $\frac{1}{2}$
Rapeseed oil, refined in bbls.....	gal.	.88	—	.90
Rapeseed oil, blown, in bbls.....	gal.	.94	—	.95
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.07 $\frac{3}{4}$	—	....
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.06	—	....

FISH

Light pressed menhaden.....	gal.	\$0.42	—	....
Yellow bleached menhaden.....	gal.	.44	—	....
White bleached menhaden.....	gal.	.46	—	....
Blown menhaden.....	gal.	.50	—	....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$24.00	—	30.00
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	22.00	—	26.00
Barytes, crude, 88% @ 94% ba., Kings Creek.....	net ton	10.00	—	12.00
Barytes, floated, f.o.b. St. Louis.....	net ton	26.50	—	28.00
Barytes, crude, first grade, Missouri.....	net ton	7.00	—	....
Blanc fixe, dry.....	lb.	.04 $\frac{1}{2}$	—	.04 $\frac{3}{4}$
Blanc fixe, pulp.....	net ton	45.00	—	55.00
Casein.....	lb.	.08	—	.10
Chalk, domestic, extra light.....	lb.	.04 $\frac{1}{2}$	—	.05
Chalk, domestic, light.....	lb.	.04	—	.04 $\frac{1}{2}$
Chalk, domestic, heavy.....	lb.	.03 $\frac{3}{4}$	—	.04
Chalk, English, extra light.....	lb.	.04 $\frac{1}{2}$	—	.05
Chalk, English, light.....	lb.	.04 $\frac{1}{2}$	—	.05
Chalk, English, dense.....	lb.	.04	—	.04 $\frac{1}{2}$
China clay (kaolin) crude, f.o.b. mines, Georgia.....	net ton	8.00	—	10.00
China clay (kaolin) washed, f.o.b. Georgia.....	net ton	12.00	—	15.00
China clay (kaolin) powdered, f.o.b. Georgia.....	net ton	18.00	—	22.00
China clay (kaolin) crude f.o.b. Virginia points.....	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points.....	net ton	15.00	—	25.00
China clay (kaolin), imported, lump.....	net ton	12.00	—	20.00
China clay (kaolin), imported, powdered.....	net ton	20.00	—	25.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	gross ton	8.00	—	14.00
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27.00	—	30.00
Fullers earth, f.o.b. Mires.....	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Ia.....	net ton	15.00	—	18.00
Fullers earth, powdered, f.o.b. Fla.....	net ton	18.00	—	....
Fullers earth, imported, powdered.....	net ton	24.00	—	27.00
Graphite, Ceylon lump, first quality.....	lb.	.07 $\frac{1}{2}$	—	.08
Graphite, Ceylon chip.....	lb.	.06	—	.06 $\frac{1}{2}$
Graphite, high grade amorphous crude.....	lb.	.02 $\frac{3}{4}$	—	.03
Pumice stone, imported, lump.....	lb.	.04	—	.50
Pumice stone, domestic lump.....	lb.	.05	—	.05 $\frac{1}{2}$
Pumice stone, ground.....	lb.	.06	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore.....	net ton	....	—	10.00
Quartz (acid tower) 1 $\frac{1}{2}$ @2 in., f.o.b. Baltimore.....	net ton	....	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	....	—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange fine.....	lb.	.67	—	....
Shellac, orange superfine.....	lb.	.66	—	.67
Shellac, A. C. garnet.....	lb.	.53	—	.54
Shellac, T. N.....	lb.	.58	—	.60
Soapstone.....	ton	12.00	—	15.00
Sodium chloride.....	long ton	12.50	—	13.00
Talc, paper-making grades, f.o.b. Vermont.....	ton	11.00	—	20.00
Talc, roofing grades, f.o.b. Vermont.....	ton	8.50	—	13.00
Talc, rubber grades, f.o.b. Vermont.....	ton	11.00	—	18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	10.00	—	14.00
Talc, imported.....	ton	30.00	—	40.00
Talc, California talcum powder grade.....	ton	18.00	—	40.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	per ton	\$37.50-40.00		
Carborundum refractory brick, 9-in.	1,000	1250.00		
Chrome brick, f.o.b. Eastern shipping points.....	net ton	60		
Chrome cement, 40-45% Cr ₂ O ₃	net ton	30-32		
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in car lots, f.o.b. Eastern shipping points.....	net ton	33-35		
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	36-40		
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	30-35		
Magnesite brick, 9-in. straight.....	net ton	70		
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	77		
Magnesite brick, soaps and splits.....	net ton	98		
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	42-45		
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	46-50		
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	35-38		

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00	—	\$225.00
Ferrochrome per lb. of Cr. contained, 6-8% carbon, carlots.....	lb.	.14	—	....
Ferrochrome, per lb. of Cr. contained, 4-6% carbon, carlots.....	lb.	.15	—	....
Ferromanganese, 76-80% Mn, domestic.....	gross ton	70.00	—	75.00
Ferromanganese, 76-80% Mn, English.....	gross ton	70.00	—	75.00
Spiegeleisen, 18-22% Mn.....	gross ton	27.00	—	28.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.50	—	....
Ferrosilicon, 10-15%.....	gross ton	40.00	—	42.00
Ferrosilicon, 50%.....	gross ton	68.00	—	70.00
Ferrosilicon, 75%.....	gross ton	135.00	—	138.00
Ferrotungsten, 70-80%, per lb. of contained W.....	lb.	.45	—	.50
Ferroumium, 35-50% of U, per lb. of U content.....	lb.	6.00	—	....
Ferrovandium, 30-40% per lb. of contained V.....	lb.	4.50	—	5.00

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content.....	gross ton	\$8.00	—	\$10.00
Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃	unit	.30	—	.33
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard.....	unit	.30	—	.33
Coke, foundry, f.o.b. ovens.....	net ton	4.00	—	4.50
Coke, furnace, f.o.b. ovens.....	net ton	2.75	—	3.00
Coke, petroleum, refinery, Atlantic seaboard.....	net ton	14.00	—	15.00
Fluorspar, lump, f.o.b. mines, New Mexico.....	net ton	12.50	—	....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	18.00	—	20.00
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01 $\frac{1}{2}$	—	.01 $\frac{3}{4}$
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	.25	—	....
Manganese ore, chemical (MnO ₂).....	gross ton	55.00	—	60.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.55	—	.60
Monazite, per unit of ThO ₂ , c.i.f., Atlantic seaport.....	unit	30.00	—	....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport.....	unit	.14	—	.14
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.14	—	.14
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.12	—	.13
Rutile, 95% TiO ₂ , per lb. ore.....	lb.	.15	—	....
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	2.75	—	3.00
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	3.00	—	3.25
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	1.50	—	2.50
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.25	—	2.50
Vanadium pentoxide, 99%.....	lb.	12.00	—	14.00
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1.00	—	....
Zircon, washed, iron free.....	lb.	.03	—	....

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic.....	12.75
Aluminum, 98 to 99 per cent.....	28.00@28.5
Antimony, wholesale lots, Chinese and Japanese.....	4 $\frac{1}{2}$
Nickel, ordinary (ingot).....	41.00
Nickel, electrolytic.....	44.00
Monel metal, spot and blocks.....	35.00
Monel metal ingots.....	38.00
Monel metal, sheet bars.....	40.00
Tin, 5-ton lots, Straits.....	28.25
Lead, New York, spot.....	4.45-4.50
Lead, E. St. Louis, spot.....	4.30-4.35
Zinc, spot, New York.....	4.60-4.65
Zinc, spot, E. St. Louis.....	4.25-4.30

OTHER METALS

Silver (commercial).....	oz.	\$0.60 $\frac{1}{2}$
Cadmium.....	lb.	1.00-1.25
Bismuth (500 lb. lots).....	lb.	1.50@1.55
Cobalt.....	lb.	3.00@3.25
Magnesium (f.o.b. Philadelphia).....	lb.	1.25
Platinum.....	oz.	72.00@75.00
Iridium.....	oz.	160.00@180.00
Palladium.....	oz.	60.00-65.00
Mercury.....	.75 lb.	45.00-46.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled.....	20.75-21.25
Copper bottoms.....	28.25-28.75
Copper rods.....	19.75-20.00
High brass wire.....	16.75
High brass rods.....	13.75
Low brass wire.....	18.25
Low brass rods.....	18.25
Brazed brass tubing.....	27.00
Brazed bronze tubing.....	31.75
Seamless copper tubing.....	21.00
Seamless high brass tubing.....	18.50

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current	Cleveland	Chicago
Copper, heavy and crucible.....	9.25@ 9.50	9.25	9.50
Copper, heavy and wire.....	8.25@ 8.50	8.50	8.50
Copper, light and bottoms.....	7.25@ 7.75	7.50	7.25
Lead, heavy.....	3.25@ 3.50	3.25	3.25
Lead, tea.....	2.25@ 2.35	2.25	2.25
Brass, heavy.....	4.25@ 4.50	4.50	5.00
Brass, light.....	3.25@ 3.50	3.25	3.50
No. 1 yellow brass turnings.....	4.25@ 4.50	4.25	4.50
Zinc.....	2.00@ 2.50	2.00	2.25

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by $\frac{1}{2}$ in. and larger, and plates $\frac{1}{2}$ in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes.....	\$2.38	\$3.00	\$3.00
Soft steel bars.....	2.28	2.80	2.80
Soft steel bar shapes.....	2.28	2.90	2.90
Soft steel bands.....	2.50	3.20	3.20
Plates, $\frac{1}{2}$ to 1 in. thick.....	2.38	3.00	3.00

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

BIRMINGHAM—E. W. Barrett, Birmingham, and associates are organizing a new company for the construction of a paper mill in this section. The proposed plant is estimated to cost in excess of \$750,000, including machinery.

California

ORANGE—The California Wire Co., recently organized, is planning for the erection of a new local plant, 80 x 135 ft., for the manufacture of wire products. Louis Koth is president.

Connecticut

STAMFORD—The H. & H. Foundry & Machine Co. is planning for the rebuilding of the portion of its plant, destroyed by fire, July 4, with loss estimated at about \$25,000.

Delaware

YORKLYN—The National Fibre & Insulation Co. has awarded a contract to S. W. N. Worrell, Kennett Sq., Chester, Pa., for the erection of a new 2-story building, 139 x 160 ft. Work will be commenced at once.

Florida

APOPKA—The Florida Insecticide Co. is planning for the rebuilding of its plant, recently destroyed by fire with loss estimated at about \$22,000. J. C. Grossenbacher is manager.

JACKSONVILLE—The American Oil Co. is planning for the construction of a new branch plant for the manufacture of oil products. The company will also build a storage works in the Commodore's Point section.

PALATKA—The United Sugar Corp. has preliminary plans under way for the erection of a new refining plant. H. A. Jones is local manager.

Illinois

CHICAGO—The G-A Ball Bearing Mfg. Co., 3051 West Lake St., manufacturer of steel ball bearings, etc., has completed plans for the erection of a 1-story addition, 210 x 230 ft. at Lake and Albany Sts., estimated to cost about \$65,000. Burett H. Stephens, 300 Old Colony Bldg., is architect.

Indiana

WHITING—Fire, July 4, destroyed a large portion of the local plant of the Standard Oil Co. of Indiana, Indianapolis, with loss including equipment, estimated at close to \$2,000,000.

NOBLESVILLE—The N. O. Nelson Mfg. Co., 928 Chestnut St., St. Louis, Mo., manufacturer of enameled plumbing fixtures, etc., is completing plans for extensions and improvements in its plant at Noblesville, to cost about \$50,000. The enameling furnaces at the works will be improved, and a new power house erected. Victor J. Azbe, 2194 Railway Exchange Bldg., St. Louis, is engineer.

TERRE HAUTE—The Turner Glass Co. is reported to be planning for the rebuilding of the portion of its plant destroyed by fire, July 3, with loss estimated at \$40,000.

ELKHART—The American Coating Mills, manufacturer of coated papers, has awarded miscellaneous contracts for the erection and completion of its proposed new 3-story plant at the foot of Division St., to be 50 x 150 ft., with extension, 50 x 50 ft., estimated to cost about \$600,000 with equipment. It will be known as Plant No. 2. James L. Carey, 208 North Laramie St., Chicago, Ill., is engineer.

ALEXANDRIA—The Lippincott Glass Co. has discontinued operations at its local plant for the summer season. Machinery and equipment will be repaired and improved during the curtailment.

Kentucky

ASHLAND—In connection with the erection of its proposed new plant, the Mayo Oil Service Co. will operate a works for the manufacture of soaps, oils and other specialties. It will be located at Front and Eleventh Sts. John C. C. Mayo is president and treasurer.

Maryland

BALTIMORE—The Adamantex Brick Co. of Maryland, recently organized with a capital of \$1,000,000, has plans under way for the erection of a new plant at Arbutus, Md., for the manufacture of sand-cement bricks and affiliated products. It is proposed to develop a capacity of about 240,000 bricks per day. The company is connected with a concern of like name of New York, operating a plant in Brooklyn. It is represented locally by Blum & Makover, Equitable Bldg.

Massachusetts

MALDEN—The Potter Drug & Chemical Corp. is having plans prepared for the erection of a new 2-story building on Medford St., brick and reinforced concrete, 50 x 85 ft.

ABINGTON—Stone & Keller, Brockton, Mass., have leased a local building on Vernon St., and will install equipment at once for the manufacture of rubber cement and kindred specialties. It is proposed to inaugurate operations at an early date.

Mississippi

GULFPORT—The Gulf Coast Oil Refining Co., recently organized with a capital of \$100,000, has leased a site totaling about 20 acres for the erection of its proposed new plant. Initial work will consist of tank installation. George L. Dodds is president, and Charles T. Madison, vice-president and general manager.

Nebraska

ANTIOCH—The Nebraska Potash Works Co. is planning for the rebuilding of the portion of its plant destroyed by fire, July 2, with loss estimated at about \$250,000, including equipment.

New Jersey

MILLVILLE—The F. C. Wheaton Co., specializing in the manufacture of druggists' glassware specialties, has discontinued operations at its plant for the summer season.

New York

LONG ISLAND CITY—The Mirrorlike Mfg. Co., 203 Eighth St., manufacturer of polishes, has acquired property at the Queens Blvd. and Buckley St., 100 x 140 ft., for the erection of a new 2-story building to occupy the entire site.

HUDSON—The International Cement Co., Boston, Mass., has acquired the property and business of the Knickerbocker Portland Cement Co. The company operates a large mill here.

CORNING—Fire, July 7, destroyed a portion of the plant of the Corning Brick, Terra Cotta & Tile Co., with loss estimated at about \$40,000.

SYRACUSE—The Atmospheric Nitrogen Co., affiliated with the Solvay Process Co. and the Semet-Solvay Co., is planning for the early operation of its new local plant, with initial output to total about 20,000 lb. of anhydrous ammonia per day. This first plant unit will represent an investment of close to \$3,000,000, and will be followed at a later date by a number of other plant units, tentative plans for which have been prepared.

NEW YORK—The B. F. Goodrich Co., manufacturer of tires and rubber goods, with plant at Akron, O., has organized a subsidiary company, to be known as the International B. F. Goodrich Co.; the company will take over all plants of the parent organization located at European points, and in the future will operate the properties. The subsidiary is capitalized at \$10,000,000, with local offices at 1780 B'way.

North Carolina

HENDERSON—J. H. Brodie has commenced the erection of a new 1-story plant, 60 x 100 ft., to be equipped for the manufacture of fertilizer products. It is estimated to cost about \$35,000.

Ohio

CLEVELAND—The Noble Refining Co., 706 Canal Rd., has awarded a contract to the Girard Construction Co., Arcade Bldg., for the erection of its proposed new oil-refining plant at Elk Ave. and East Ninth St., to be 1-story and basement, and estimated to cost about \$85,000. A power house will also be constructed. A. Ritman is president.

Pennsylvania

WILLIAMSPORT—William Ditmar, Williamsport, has tentative plans under way for the erection of his proposed new local plant for the manufacture of composition tile products and similar specialties.

JOHNSTOWN—The Lee Strauss Chemical Co., Vine St., has broken ground for the erection of a new 5-story building, 44 x 165 ft., on Levergood St. The Thiele Construction Co., Johnstown, has the building contract. Edward G. Strauss is president.

Tennessee

NASHVILLE—The Victoria Oil & Refining Co. is planning for the rebuilding of the portion of its plant, used for distilling and other service, with loss estimated at about \$25,000.

MT. PLEASANT—The Phosphates Products Co., recently organized, has plans under way for the erection of its proposed new phosphate works, estimated to cost about \$35,000. The plant will have departments for the manufacture of lume material, ground phosphate rock and kindred products. E. E. Fish is secretary and treasurer. James A. Barr, Mt. Pleasant, is construction engineer for the work.

Virginia

MONEY POINT, PORTSMOUTH—Swift & Co., Union Stock Yards, Chicago, Ill., are reported to be planning for the construction of a new plant on a local site, estimated to cost over \$500,000, for the manufacture of fertilizer products. Tentative plans are being drawn.

FRONT ROYAL—Samuel Wine has leased a tract of local property for the development of lead and silver. Machinery for operation will be installed at an early date.

Washington

TACOMA—The National Coconut Oil Co., Tacoma, is now operating at the former plant of the Columbia Brewing Co., and has remodeled the structure to accommodate the new line of business. Production will be devoted to laundry soaps, washing powders, etc. William Virges is president; D. K. Derrickson is secretary and treasurer.

West Virginia

MORGANTOWN—The University of West Virginia has commissioned Architect Paul A. Davis 3rd, 1713 Sansome St., Philadelphia, Pa., to prepare plans for the proposed new chemical laboratory at the institution, estimated to cost about \$400,000.

Quebec

AMOS—The Frank Blais Co. is planning for the rebuilding of its pulpwood plant, recently damaged by fire, with loss estimated at about \$12,000.

New Companies

THE WATERWAY PAPER PRODUCTS Co., 3221 South Kedzie St., Chicago, Ill., has been incorporated with a capital of \$500,000 to manufacture paper goods. The incorporators are John P. Barnes, Guy C. Baltz and Arthur L. Schwartz.

THE CENTRAL WEST GREASE Co., St. Joseph, Mo., has been incorporated with a capital of \$50,000 to manufacture greases, lubricants, etc. A. B. Snoddy is president, and G. F. Bigelow secretary and treasurer, both of St. Joseph.

CRONKHITE, SANDS & Co., Inc., Boston, Mass., has been incorporated with a capital of 500 shares of stock, no par value, to manufacture chemicals, soaps and kindred products. Leonard W. Cronkhite, 142 Berkeley St., is president and treasurer; Warren Sands is vice-president.

THE PENNIE ANTE OIL Co., Los Angeles, Cal., has been incorporated with a capital

of \$200,000 to manufacture petroleum products. The incorporators are L. P. Jones, R. I. Plomert and Joseph M. Howell. The company is represented by David P. Hatch, 1121 I. N. Van Nuys Bldg., Los Angeles.

THE FRANKLIN PAPER BAG MFG. CO., Woodstown, N. J., has been incorporated with a capital of \$300,000 to manufacture paper bags and containers. The incorporators are James M. Clawson, Woodstown; Frank A. Cabeen, Jr., Haverford, Pa.; and James H. Young, Land Title Bldg., Philadelphia, Pa.

THE NEW JERSEY CHEMICAL & RUBBER WORKS, INC., Newark, N. J., has been incorporated with a capital of \$100,000 to manufacture rubber products, chemicals and affiliated specialties. The incorporators are Meyer E. Gusman, Nathaniel Ginsburg and Jacob Janoff. The company is represented by A. Milton Jacobs, 9 Clinton St.

THE OLD COLONY CHEMICAL CO., Avon, Mass., has been incorporated with a capital of \$5,000 to manufacture chemicals and chemical byproducts. William I. Gay is president, and Howard L. Baker, Kingston, Mass., treasurer.

THE NUTINT CO., Philadelphia, Pa., has been incorporated with a capital of \$25,000 to manufacture chemicals and chemical byproducts. M. A. Weisbard, 202 East Allegheny Ave., is treasurer.

THE COMMON SENSE POLISH CO., Los Angeles, Cal., has been incorporated with a capital of \$10,000 to manufacture polishes and kindred specialties. The incorporators are J. E. Lloyd, H. T. Hurley and L. E. Cummings. The company is represented by Wetherbore, Hoyt & Jones, Title Insurance Bldg.

THE SANITARY REDUCTION CO., 35 Central Savings Bank Bldg., Baltimore, Md., has been incorporated with a capital of \$400,000, to manufacture fertilizer products. The incorporators are Joseph G. Johnson and J. Carroll Dailey.

THE BORREGARD CO., New York City, has been incorporated with a capital of \$10,000 to manufacture pulp and paper products. The incorporators are H. Wessel, A. Olafson and A. Marc Barnes, Jr. The company is represented by Barnes, Chilvers & Halstead, 2 Rector St.

THE M. & B. OIL CO., Hoboken, N. J., has been incorporated with a capital of \$100,000 to manufacture and deal in refined oils. The incorporators are Claude M. Morrison, Jesse M. Parshall and Max Blackman. The company is represented by Tackella, Camby & Stiles, 95 River St.

THE ULTRA CHEMICAL CO., 182 Washington St., Newark, N. J., has filed notice of organization to manufacture chemical specialties. E. Manias heads the company.

THE COLUMBUS FOUNDRY CO., Columbus, Ga., has been incorporated with a capital of \$10,000 to manufacture iron and other metal castings. The incorporators are J. B. Knight, Jr., and C. H. Cox, Columbus.

THE S. P. BRICK & TILE CO., Fresno, Cal., has been incorporated with a capital of \$250,000 to manufacture brick, tile and other burned clay products. The incorporators are W. H. Shields, Fresno; W. D. Trewhitt, Hanford, Cal., and L. E. Hayes, Exeter, Cal.

THE BEACON DRUG & CHEMICAL CO., Boston, Mass., has been incorporated with a capital of \$25,000, to manufacture chemicals, byproducts, drugs, etc. Isaac H. Bernstein, 71 Homestead St., Roxbury, Mass., is treasurer; Joseph Golden is president.

THE METAL MATERIALS CO., Asbury Park, N. J., has been incorporated with a capital of \$125,000 to manufacture metalware products. The incorporators are Roscoe G. Tagle, Frank V. B. Young and Isaiah Matlack, 601 Mattison Ave.

THE NATIONAL HUMUS & CHEMICAL CO., Chassell, Mich., has been incorporated with a capital of \$1,000,000 to manufacture fertilizer products. The incorporators are Claude F. Hancock, Chassell; Roy Herlad and Donald I. L. Baugh, Detroit, Mich.

THE SODDER-RITE CO., New York City, has been incorporated with a capital of \$5,000 to manufacture chemical specialties. The incorporators are L. J. Jones, F. E. Lampe and H. Kleinigeris. M. Gollubier, 255 East 149th St., represents the company.

THE WHITTIER POINT OIL CO., Whittier, Cal., has been incorporated with a capital of \$150,000 to manufacture petroleum products. The incorporators are H. H. Witte, Fred G. Phillips and L. F. Ranker, all of Pomona, Cal. The company is represented by E. B. Coil, attorney, Santa Monica, Cal.

THE INTERLOCKING TILE & SEWER PIPE CO., Indio, Cal., has been incorporated with

a capital of \$250,000 to manufacture sewer pipe, tile and other burned clay products. J. A. Gordon is president; J. A. Nelson, vice-president; and J. W. Wilson, treasurer.

THE HOPKINS MASTER CLEANER, INC., Boston, Mass., has been incorporated with a capital of \$20,000 to manufacture cleansing compounds, and kindred products. Alfred Hopkins is president; Howard Knowles, 13 Waterhouse St., Cambridge, Mass., is treasurer.

THE WIS CHEMICAL & DRUG CO., Utica, N. Y., has been incorporated with a capital of \$10,000 to manufacture chemicals and affiliated products. The incorporators are C. C. Allison, P. M. Risinger and C. S. Horsburgh. H. D. Williams, Utica, represents the company.

THE RIVERSIDE BAPTISTE OIL CO., Los Angeles, Cal., has been incorporated with a capital of \$500,000 to manufacture petroleum products. The incorporators are M. W. W. Reitz, J. Sickman and W. H. Dehm, California Bldg.

THE AMERICAN LEATHER MFG. CO., 166 Tichenor St., Newark, N. J., has filed notice of organization to manufacture leather products. John Lipp, 36 Boyd St., heads the company.

THE MIT-SHEL STAMPING & MFG. CO., 510 Jersey St., Quincy, Ill., has been incorporated with a capital of \$50,000, to manufacture stamped metal goods. The incorporators are Edward H. Mitchell, Theodore Schell and William Spohr, Jr.

THE PATUXENT GUANO CO., 407 Vickers Bldg., Baltimore, Md., has been incorporated with a capital of \$75,000 to manufacture fertilizer products. The incorporators are Harry T. Deford, Carroll W. Clark and William E. Gardner.

THE BOONTON CHEMICAL CORP., New York City, has been incorporated with a capital of \$100,000 to manufacture chemicals and chemical byproducts. The incorporators are J. Michaels, H. M. Cassidy and A. M. Hamburg, 63 Wall St.

THE ARDEN CHEMICAL CO., New York City, has been incorporated with a capital of \$500,000 to manufacture chemicals and chemical byproducts. The incorporators are F. O'Leary, F. Delaney and B. Marks, 320 B'way.

THE HIDECKER BRICK CO., Los Angeles, Cal., has been incorporated with a capital of \$10,000 to manufacture brick and other burned clay products. The incorporators are G. C. Hidecker, Charles W. DeWitt and William Lewis, 504 Bryson Bldg.

THE BERG CHEMICAL CO., New York City, has been incorporated with a capital of \$50,000 to manufacture chemicals and chemical byproducts. The incorporators are H. M. Monness, J. Fischer and L. Goldberg. The company is represented by J. Wilzin, 35 Nassau St.

Capital Increases, etc.

THE AMERICAN TANNING CO., 1282 West North Ave., Chicago, Ill., manufacturer of leather products, has filed notice of increase in capital from \$50,000 to \$100,000.

THE MUTUAL CHINA CO., Indianapolis, Ind., has filed notice of increase in capital from \$100,000 to \$200,000.

A petition in bankruptcy has been filed against the ATRIEN CHEMICAL WORKS, 75 John St., New Brunswick, N. J. The liabilities are stated at \$100,000, and assets \$40,000.

THE DESMOND CHARCOAL & CHEMICAL CO., Detroit, Mich., has filed notice of dissolution under state laws.

THE PRESTO CHEMICAL CO., Detroit, Mich., has filed notice of increase in capital from \$25,000 of \$150,000.

THE CENTRAL PENNSYLVANIA OIL CO., Nazareth, Pa., has filed notice of increase in capital from \$200,000 to \$600,000.

THE BECKER PAPER CO., Fort Wayne, Ind., has filed notice of increase in capital from \$50,000 to \$100,000.

THE CENTRAL GLASS CO., Louisville, Ky., has filed notice of increase in capital from \$1,000,000 to \$1,250,000.

THE AMERICAN EAGLE RUBBER CEMENT CO., 3026 South La Salle St., Chicago, Ill., has filed notice of change of name to the Rubber & Cements Co., Inc.

THE NOVELTY LEATHER WORKS, Jackson, Mich., has filed notice of dissolution under state laws.

THE OIL CITY BRASS WORKS, Neaumont, Tex., has filed notice of increase in capital from \$5,000 to \$50,000.

Manufacturers' Catalogs

THE C. W. HUNT ENGINEERING CORP., New York City, calls attention to a four-page booklet on self-aligning all steel troughing belt conveyor idler.

THE READING IRON CO., Reading, Pa., calls attention to Bulletin 2, in which is described, in as simple a manner as possible, the structural difference between wrought iron and steel and their relation to the field of welded pipe. The bulletin has been written to interest the layman as well as the engineer.

HARBISON-WALKER REFRACTORIES CO., Pittsburgh, Pa., announces a leaflet on Metalkase Magnesite Brick for Open Hearth Furnaces.

THE BRITISH ALUMINUM CO., LTD., has published a booklet on "The Casting of Aluminum" which contains information of interest to foundrymen, such as proper mixtures for common aluminum castings, melting practice, precautions in molding, shrinkage allowances, finishing and testing.

THE THWING INSTRUMENT CO., Philadelphia, Pa., desires to announce Bulletin 10. This treats of Type A thermoelectric pyrometers, temperatures from 100 deg. C. (200 deg. F.) to 1,600 deg. C. (2,900 deg. F.), base metal couples in three alloys, and platinum couples for highest temperatures. It describes full equipment and furnace mountings, such as protection tubes, junction boxes, selector switches and high resistance galvanometers, both indicating and recording.

THE WILL CORP., Rochester, Mass., has recently published two bulletins. The first, entitled "Water Stills," presents an outline of laboratory stills now in use and goes into the merits of the various makes and types. The second, entitled "The Ion-O-Meter," is a descriptive pamphlet on the measurement of hydrogen ions and the practical application of the Ion-O-Meter to industrial and laboratory problems.

THE WEBSTER MFG. CO., Chicago, Ill., in its June, 1921, issue of "Webster Method" has illustrated articles on "Perkins Pivoted Bucket Carrier in a Modern Cement Plant," "Conover-McHenry Grain Elevator," and "A Five-Track Steel Coal Tipple."

Coming Meetings and Events

AMERICAN CERAMIC SOCIETY's summer meeting will be held at Canton, Alliance, Sebring and East Liverpool, Ohio, July 25 to 27. Headquarters will be at the Hotel Courtland, Canton, Ohio.

AMERICAN CHEMICAL SOCIETY, THE SOCIETY OF CHEMICAL INDUSTRY and the American Section of the latter society will hold a joint meeting in New York, Sept. 6 to 10.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in Lake Placid, N. Y. Sept. 29 and 30, and Oct. 1.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its fall meeting at Wilkes-Barre, Pa., Sept. 11 to 17.

AMERICAN MINING CONGRESS AND NATIONAL EXPOSITION OF MINES AND MINING EQUIPMENT will hold its twenty-fourth annual convention in the Coliseum, Chicago Oct. 17 to 22.

AMERICAN SOCIETY FOR STEEL TREATING will hold its third annual convention and exhibition Sept. 19 to 24 at Indianapolis.

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SEVENTH) will be held during the week of Sept. 12 in the Eighth Coast Artillery Armory, New York City.

NEW JERSEY CHEMICAL SOCIETY has discontinued meetings for the summer and will resume them in October.

SOCIETY OF CHEMICAL INDUSTRY (BRITISH) at the invitation of the Montreal section will hold its annual meeting in Montreal and other Canadian cities during the week of Aug. 29, 1921. Details will be printed in this magazine from time to time.

SOCIETY OF INDUSTRIAL ENGINEERS will hold its fall meeting at Springfield, Mass. Oct. 5 to 7.

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY will hold its fall convention with the American Pulp and Paper Mill Superintendents' Association, at Washington, Philadelphia, Spring Grove, York, York Haven, Pa., and Wilmington, Del. Oct. 18 to 20.

CHEMICAL & METALLURGICAL ENGINEERING

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A consolidation of
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Assistant Editors
CHESTER H. JONES
Industrial Editor
J. S. NEGRU
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A Serious Economic Problem

EUROPE is now offering to help the United States obtain the sum due under reparation arrangements for actual destruction of American property by Germany. The effort appears to be to assist the United States in getting about three-fourths of a billion dollars due its citizens in order that the United States will in turn assist Europe in collecting the 70 billion payable to the Allies under the treaty. Despite its apparent selfishness, the attitude appears to be diplomatic and fair to the United States. However, underlying all this there is an economic problem of vital significance to chemical as well as other industries.

Already the effort of Germany to meet its financial obligations has resulted in a curtailment of its luxury imports which is proving to be almost fatal to the French wine industries. One famous international statesman has also ascribed the British coal-mine strike directly to the reparation requirement that Germany supply given tonnages of coal to France, Italy, Belgium and others. If so early in the plan two large industrial disasters are caused by compliance with treaty obligations, what can we expect when Germany is well under way in the effort to meet the total obligation of 70 billion dollars?

That this question is of industrial importance, as well as of banking or credit significance, at once appears when we realize that the payment must be made in goods. It cannot be made in money or credit of any sort whatsoever.

Germany recognizes one economic principle and may undertake to apply it in the chemical industries to American disadvantage. This principle is that only a small percentage surplus above the market demand often, if not invariably, results in a large decrease in market prices. What would happen, for example, in the American chemical industry if Germany would see to it that there were always available in the United States markets about 10 to 15 per cent more of a particular chemical than the market was currently able to absorb?

That Germany may be quite capable of this, both industrially and morally, is well recognized.

Presumably the liquidation of credits and the restoration of buying power in the United States will proceed surely, even though slowly, to better times. It is well known that agriculture, representing perhaps one-fourth of the population, and labor out of work, representing with its dependents 10 or 15 per cent more, cannot buy much beyond the bare necessities right now. But times will improve even without the artificial stimulant of legislation, subsidy or governmental co-operation. We can expect something like normal relationships.

On the other hand, we can be sure that Germany cannot last indefinitely on a basis which provides from the Government a subsidy for industry to the extent

of a billion and a half dollars per year gold (figuring the mark at five or six cents). To continue that scheme indefinitely would be lifting oneself by one's own economic boot straps, a thing which does not work in economic affairs any better than in physics. When the subsidy is eliminated, the relationship between Germany and the rest of the world will be more favorable than now to the rest of the world.

In the meantime the main essential for America is recognition of the need for better technology in all processes, closer industrial co-operation all the way from resource to user, and plain hard work.

The Bottom of The Chemical Market

IN DANGEROUS channels the wise skipper takes many soundings. To steer a safe course down the harbor, he must occasionally have an answer to the important question, How near the bottom are we? So, too, the course of the buyer or seller in the chemical market is influenced by similar considerations. He wants to know: How near the bottom are our chemical prices? How do chemicals stand in relation to the products of other industries? Has the process of deflation been completed?

Fortunately, some "soundings" recently made by the Department of Commerce may be of help in answering these perplexing questions. The price indexes, compiled in connection with the monthly studies of industrial movements, show the relative changes in the wholesale prices of chemicals and drugs during 1920 and the first five months of 1921 and afford a valuable means of comparing these articles with other commodities of commerce.

Using the average for 1913 as a base of 100, the relative index for the wholesale prices of chemicals during the first three months of 1920 was 197, for the second three months 215, for the third 218, and for the fourth 204. The maximum for the year was reached in September, and since that time there has been a gradual and continuous falling off, until for May, 1921, an index of 166 is reported. This means, in other words, that during that month the particular chemicals and drugs studied were selling for two-thirds more than in 1913.

How then do chemicals compare with other commodities? The price indexes during the same month of May, 1921, were 117 for farm products, 133 for food, 138 for metals, 181 for clothing, 194 for fuel, 202 for building materials, 263 for housefurnishings, and the average for all was 151. Thus it would appear that the prices of chemicals have fallen somewhat less than those of metals or food products, but are nevertheless at a level comparable with the average for all commodities. Building materials, house furnishings, clothing and fuel, all of which directly affect the consuming public,

remain at higher levels and apparently have not yet taken their proportionate share in the general process of deflation.

These price indexes do not give us an answer to all our inquiries, but they are soundings which should not be disregarded as we are approaching the bottom of chemical prices.

Metallurgical Literature

IN RESPONDING to the Fritz Medal Award, Sir ROBERT HADFIELD made a brief address of thanks, which was supplemented by the distribution of printed pamphlets, appropriate to his desire to convey his high appreciation of the honor. In this pamphlet, after a brief account of his discoveries in alloy steels, for which the medal was given, and the influence of such special steels on the advancement of science, Sir ROBERT passes on to a consideration of the history and works of the Royal Society since its incorporation 260 years ago. He also remarks that the quality and amount of literature in a particular branch of science generally show the relative position it occupies in the world.

This is well illustrated in the science of metallurgy. Starting with AGRICOLA there is with a few exceptions little contained in the books of the chief writers of metallurgy up to 1880 which is of present value, even though the list comprises such authors as DUD DUDLEY (1665), REAUMUR (1722), SWEDENBORG (1734), RINMAN (1782), BERTHOLET (1789), BERZELIUS (1833), DAVID MUSHET (1840), FARADAY (1842), PERCY (1861), HOLLEY (1865), WHITWORTH (1866), GRUNER (1872), and LEDEBUR (1877). Aside from building a sure foundation of chemical analysis, and producing PERCY'S admirable treatises on practice, the preceding years had merely constructed a body of empirical rules-of-thumb, discovered by the method of trial and error. Too often such a discovery was hid within an iron-works and closely guarded as a trade secret, until it was found that everyone else had discovered the same thing.

The decade 1875-1885 witnessed the renaissance of metallurgy. That marvellous series of mechanical appliances which have revolutionized blast furnace practice, steel making and fabricating were devised and put into use. The invention of manganese steels opened a vista of possibilities in alloying which will never become exhausted. Men turned to the physicist and borrowed his microscopes and electrical indicators, and leaned more heavily upon the familiar chemist. But best of all, the profession profited immeasurably by a long list of notable contributions to the *Transactions* of the British Iron and Steel Institute, and the American Institute of Mining Engineers. Indeed, the literature as represented by texts on General Metallurgy and on its specialized branches, has not yet had a chance to overcome the long lead established by periodical literature, represented by society transactions and the technical press. Practice is advancing by such leaps and bounds that "book knowledge" may be permanently outdistanced.

Tens of thousands of metallurgists throughout the world are devoting their attention to scientific and practical metallurgy, and smaller societies now abound. And all this has come about in but 50 years! One wonders what would have been the situation without a vigorous and prolific literature, available to the student young or old, who is intent upon widening his knowledge and skill.

Time to

Change Doctors

DR. POLITICS prescribed an old remedy for a new ailment and a great many people are becoming skeptical of its efficacy. The tariff in the old days was the Republican panacea for all industrial ills but with the changed industrial conditions surrounding our present international situation, it is beginning to be apparent that the time has arrived to change doctors. We regard it as a sign of the times, therefore, that the Senate may be asked to pigeon-hole the tariff bill just passed by the House, and we hope that it will not be revived until the public can make certain that there is not a better and more constructive way to meet the situation.

Tariff revision has been under way for almost a year, and while there has been a gradual and growing opposition, most of us have been content to wait in hopes that somehow and in some way the Ways and Means Committee would report out some wonderful measure that would accomplish the miraculous. The failure of the emergency bill to relieve the plight of the farmers caused many to lose faith in the tariff. And finally the Fordney bill with its radical rates and objectionable features and the high-handed manner in which it was forced through the House, have aroused a nation-wide storm of protest and disgust.

The failure of the dye bill is of most concern to the chemical industry even though our views may differ as to the need for tariff revision at this time. CHEMICAL & METALLURGICAL ENGINEERING has always taken the stand that a complete and well-balanced dye industry is essential to this or any other country concerned with its national defense. Whether or not an embargo is necessary to accomplish this, we can not say, but we do believe that the industry warrants more than usual consideration. If this is to be received from the Senate, the industry must see that many false charges are answered and many unfavorable impressions corrected.

Princeton

In the Saddle

AND now comes Princeton with its school of engineering, four years for a bachelor's degree and one year more for that of engineer. The course is to include a good grounding in physics, chemistry, mathematics, languages, literature, philosophy, economics and sociology. The young man is to achieve, if teaching can give to him, a broad outlook on everyday problems; and the endeavor, according to the announcement made in the July 15 number of *Science*, will be to make an engineer rather than a specialist. Professor ARTHUR M. GREENE, JR., of the Rensselaer Polytechnic Institute is to be dean of the new school and professor of mechanical engineering. He will take up his duties in the fall of 1922.

It's curious, and there's a touch of comedy in it withal, that a considerable group of self-styled humanists, like cherubim and seraphim continually do cry over these developments. That engineering, or the use of science, should enter into higher education as one of its constituent features seems to them the end of intellectual joy. What they fail to recognize is their own modernness in presenting their views. They are shining examples of the defects of modern education for the reason that they are narrow specialists. They weep like children for more and more dead languages and they lack the art to make them alive.

Let us analyze the situation in regard to Greek and Latin, the teaching of which has been going on for a very long time and over which there is the most continuous rumpus. We start as boys, learning declensions and conjugations in Latin and after a year of memorizing we begin with CAESAR'S Commentaries. From the standpoint of human history these looting expeditions are not of prime importance, but the study is not even pursued as history; it is followed as an almost (to the boy) interminable series of exercises in Latin Grammar. Then comes VIRGIL, about 20 lines a day, again with no thought of the legends, the history, the poetry or anything else but the letter without the spirit of the thing. About this time the boy starts with Greek, and XENOPHON'S interesting history is used solely for parsing lessons; and then comes HOMER with the same story better told in Greek than VIRGIL told it in Latin, and this again is seldom much more than a series of parsing lessons. So we go on as boys with parsing lessons in Latin and Greek for about twelve years—and at the end of that time we do not know either the language or its literature.

If we were to teach science that way, without any purpose beyond "the mental exercise" of so much memorizing—there wouldn't be any science. But if the Latin class were to study Latin as a living thing and then even in secondary schools address itself to rendering into English excerpts from the great store of mediaeval records, the boys themselves would get a sense of research, of discovery, of the service of learning—and they would have a working understanding of the language. We can recall the day when the learned clergyman who could converse in Greek was a distinguished scholar. That day is past. Nearly every peanut vendor on the street can converse in Greek. Not very elegant Greek perhaps—but it is Greek. By less worry about the irregularities of verbs and more study of the classic Greek drama as literature and as great cartoons of life, students would acquire the very qualities of mind, would grasp the relations of cause to effect and effect to cause, would sense the inviolability of Nature's laws, and know the fundamental truths which underlie human intercourse that men of science most urgently need.

We urge upon the moaning company of pseudo-classicists the merit of drying their tears. Princeton has not fallen from grace. Engineering has become a part of the life of today. It is not a substitute for history or philosophy or the study of mankind. Engineering alone does not give a man a liberal education—nor does a knowledge of Greek give culture to the peanut wallah. The greatest effort of present day, earnest men of science is toward making their successors persons of large understanding and culture, and above all things to help them develop into men of character so that they may fashion their careers unto righteousness. But more and more the fact is being brought out that engineering is needed in daily life. We need it if we intend to do things and most sound boys, thank GOD, want to do things. We need it also in archaeology and in the study of human history. It is the index of civilization.

The Greeks, by the way, were excellent engineers and the Romans copied from them. In the days of the renaissance—well, there was LEONARDO DA VINCI. After a letter of several pages in which he told in detail to the Pope many of the things he could do, including almost every branch of engineering then known, he concluded with the sentence, "I can also paint."

Fluctuations and Drifts in Prices

WE HAVE all seen by experience that commodity prices fluctuate. They did that even before the war showed us how violently they could move upon sufficient provocation. There has been question, however, as to the general drift, that is, the general tendency when a smooth curve is drawn through the graph plotted from recorded prices.

The statistician of the Russell Sage Foundation, Dr. RALPH G. HURLIN, has carried back to 1810 an index number of commodity prices and back to 1820 the average wage rate of common labor and a composite wage rate of five classes of artisans—carpenters, house painters, machinists, blacksmiths and compositors. This information is definite and useful. The graph of wholesale commodity prices, from 1810 to 1920, is hardly what one would expect. The striking thing is not a general trend or drift. The impressive thing is three immense peaks, of approximately equal height, one for our war of 1812, or rather our little branch of the Napoleonic wars, a second for the Civil War and a third for the year 1920. After 1815 and 1865 prices showed a generally recessive trend for approximately 30 years in each case. The general drift is a trifle difficult to pick out. The trough between 1890 and 1900 is considerably lower than the trough between 1840 and 1850, but on the other hand there is but a slight ascent in the 15 years or so before the Civil War while there is rather a sharp ascent between 1896 and 1914. Certainly the last war did not forecast its shadow in that manner.

However, one man's composite or budget is not another man's. Timber would certainly show a general sweep upwards in the past century while watches, up to the time of the watch that made the dollar famous, would show an equally impressive downward trend. The proper generalization probably is that on account of the increasing volume of media of exchange, the trend of values is upward over long periods while improvements in the art of producing many things exerts an influence in the opposite direction, and the two may balance or be slightly out of balance according to the selection of articles that go to make up one's weighted average of "commodities in general."

Dr. HURLIN'S wage showing, on the other hand, admits of no argument. The trend was almost continuously upward from 1820 to 1910, the chief irregularity being a bulge at the time of the Civil War, most of which came off in the industrial depression of 1873-8. Wages approximately tripled from 1820 to 1910. The recent war bulge makes almost a vertical line in the graph and of course that peak is going to come off. A very interesting feature of the showing is that the artisans' average ran quite uniformly at about 80 per cent above the common labor rate, and approximately that percentage is likely to be restored.

Counting out the influence of wars, then, there does not seem to be any very marked drift in commodity values, measured by gold, over long periods of time. Wages and salaries have a strong drift upward, which means that relative to the earnings of the individual, commodity prices trend downward, as a result of improvements in methods and appliances. But the greatest thing of immediate concern is that in two conspicuous cases, one 56 years ago and the other more than a century ago, it took fully 30 years for prices to recede completely from their peak. We had a precisely similar peak in 1920.

Italian Chemical Industries

FROM OUR SPECIAL CORRESPONDENT

GENOA, Italy, June 30, 1921.

SOME recovery in foreign exchange took place during June that averted a further reduction in many prices, despite the continuance of the crisis in all industries and the consequent financial difficulties. These caused the chemical industrials at a meeting held in Milan to cancel last November's agreement with their employees to give three months' notice in case of dismissals. The representatives of the labor organizations objected and it was agreed to give the months of July, August and September as notice to the workpeople and to discuss new agreements in October. The shortage of English coal continued, which was in many cases made up by American, Belgian and French coal. The shortage had little effect, owing to the exceedingly low demand for combustibles on the part of industry in general and to the reduced maritime traffic.

ITALIAN MATCH INDUSTRY

The Italian match industry during June went through a very severe crisis, caused by the Italian government failing to draw several large lots of matches and by the fact that the government abolished the monopoly existing during the war too late to prevent other nations invading the foreign markets which Italy formerly supplied. The Italian phosphorus match industry dates from 1831, when wood matches were manufactured for the first time in a works established at Empoli. In 1894 the industry was subjected to a special tax that brought an income of 7,000,000 lire to the Italian government.

ITALIAN QUININE MANUFACTURE

The extraction of quinine and the working of quinine salts was tried in Italy, but till the war the infant industry was suffocated by German competition which by selling under cost killed Italian endeavor in this direction. The government has now undertaken the production of quinine and of its different salts in a works of its own and is also trying to get plantations of cinchona in other countries so as not to be obliged to depend for its raw materials on foreign markets. Quinine and its salts are of great importance to Italy and its colonies where these products are largely employed in combating malarial fevers.

PROHIBITION ON IMPORTATION OF DYESTUFFS

A law has been promulgated prohibiting the importation of dyestuffs from any source whatever. This law gives the Minister of Finances power to grant individual importation permits for products which cannot be produced in Italy or which cannot be produced in sufficient quantity.

DEVELOPMENTS IN HYDRO-ELECTRIC PLANTS IN THE SILA PLAINS

There is much activity in all parts of Italy for increasing the electric energy obtained through water power. Work is being conducted with great intensity on the high Sila plains, where construction has been begun on a large dike which will make possible the utilization of a large artificial lake formed by abundant waterfalls. It is expected that this will supply energy for the electrification of all the railways and industries in southern Italy. Powerful auto lorries are used to

convey the construction materials from Cotrone, Catanzaro and Cosenza.

A NEW HYDRO-ELECTRIC COMPANY

A recent decree authorized the formation at Unide of a new firm of great importance for the whole region north of the Veneto. This firm, bearing the name of Forze Idrauliche del Friuli, is authorized by the government to utilize all the hydraulic forces of the River Tagliamento, its effluents, and of any other river in the region. The company will undertake the construction of electric plants and provide electric energy for them. No limit is placed on its capital, and some of the most important banks will finance it.

ITALIAN FERTILIZER NECESSITIES

Owing to the ground having suffered impoverishment in phosphorus during the war, when the peasant neglected his fields, reducing or discontinuing entirely the treatment of them with fertilizers, a campaign has been started for an extensive use of superphosphates during the next season. It is pointed out that the consumption of phosphorus, which was 1,000,000 tons annually before 1914, fell to 500,000 tons during the war, rising to only 600,000 tons in 1918 and 650,000 tons in 1920. The limited yield of the Italian works during the first months of this year left no stocks on hand, but arrivals of superphosphates were very fair, reaching 56,485 tons in March and 47,697 tons in April.

ITALIAN SULPHUR INDUSTRY

The Italian sulphur industry suffered during June in consequence of the wave of reduction that affected all other industries. The sales of the nine months ended in April last reached only 140,000 tons, against 206,000 tons during the twelve months preceding. Up to nearly the beginning of this century Sicily had a world monopoly as regards sulphur. However, after the discovery of the Louisiana sulphur mines the situation changed completely, and a great deal of business was lost through the competition of these mines, which had the advantage of being more modernly worked, while in Sicily little change had been introduced and old-fashioned methods of extraction were used. At present Italian sulphur is competing with difficulty against the American product not only in the American market but also in Europe. Through the initiative of the proprietors of Sicilian sulphur mines a new firm has been founded at Palermo having a capital of 3,000,000 lire, and sulphur refineries close to the sites of extraction will be built.

Italian Imports and Exports During 1920

The values of imports and exports for 1920 by great groups of commodities are given in the following table:

Group	Imports —Millions, Lire—			Exports —Millions, Lire—		
	1913	1919	1920	1913	1919	1920
Raw materials.....	1,387	5,302	5,014	360	758	989
Semi-manufactured materials..	705	2,842	3,249	591	2,153	2,269
Manufactured articles.....	851	2,616	3,365	798	2,191	3,292
Foodstuffs and live animals...	703	5,864	4,233	762	963	1,253
Total.....	3,646	16,624	15,861	2,511	6,065	7,803

In the matter of exports more or less notable gains have been made to all countries, with the exception of France and Tripoli, the largest increases being to the Argentine Republic, Switzerland, the United States, Brazil, Egypt, British India, and Spain, in the order named.



BRICK KILNS ARRANGED FOR BYPRODUCT RECOVERY

Hardwood-Distillation Industry—I

Importance of Hardwood-Distillation Products in Industrial Life—Periods in the History of This Industry —Commercial Methods of Distillation—Relation Between the Composition of Wood and Its Distillation Products

BY L. F. HAWLEY*

THE United States is by far the greatest producer and consumer of wood-distillation products. The only other countries which have an output large enough to make a showing in a table of statistics are Austria, Germany and Canada. The following table gives the estimated annual production of the four countries for the period just previous to 1914:

	Acetate, Tons	Methanol, Gal.	Wood, Cords
United States.....	80,000	9,000,000	1,000,000
Germany and Austria ¹	25,000	2,800,000	300,000
Canada.....	8,500	950,000	110,000

Aside from these countries, England, Sweden, France, Japan and Italy are known to have small wood-distillation industries. During the war great efforts were made in England to develop this industry, and several small plants were built; but the combined output of these plants would not be greater than that of one medium-sized plant in this country. In 1917 the output of methanol and acetate of lime in Sweden was about equal to the output of a single plant with a capacity of 50 cords of hardwood per day. Sweden has several well-built wood-distillation plants, and the explanation of the small output is that hardwoods are not abundant and resinous wood is the raw material commonly used, resulting in a low production of methanol and acetic acid. In 1915 Japan had developed an industry which gave an output equivalent to about one 50-cord plant. France has had a small industry of this kind for some

time, and Italy has been doing some preliminary work along this line. A very small industry started in Argentina, and shipments of wood-distillation apparatus to India from this country have been recently reported. Government officials and representatives of private companies have been sent to this country from Australia to investigate wood-distillation for the purpose of establishing plants in that country, but no construction has been started as yet.

The large capacity of the wood-distillation industry in the United States is probably due to the great supply of good-quality hardwoods available for this purpose, as well as to the increasing demand for the products.

The immense supplies of hardwood in the tropics have not been touched yet for the purpose of wood-distillation and we have no information in regard to their suitability.

IMPORTANCE OF HARDWOOD-DISTILLATION PRODUCTS IN INDUSTRIAL LIFE

Charcoal.—Charcoal has been known and used as a fuel since prehistoric times, but at present it has only special fuel uses. Probably the largest single use of this kind is in blast furnaces for the manufacture of charcoal iron. Many wood-distillation plants are built in connection with blast furnaces, and their entire output of charcoal is used for this purpose. It is also used largely as a special domestic fuel, and considerable quantities are still employed in the manufacture of black powder. Charcoal has also a large number of miscellaneous uses, such as in stock and poultry foods, in case-hardening compounds, and as a deodorizer and insulator.

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¹The United States Tariff Commission report dated 1921 shows that about 1,800,000 gal. of methanol was exported for Austria-Hungary in 1913. Most of the crude products were manufactured in what is now Czecho-Slovakia.

Acetic Acid.—Acetic acid has a wide use in the chemical industry in the preparation of various inorganic acetates such as lead, copper, and sodium acetates, and in the preparation of white-lead pigment. It is used widely in the organic chemical industry, especially in the preparation of cellulose acetate for films, lacquers, plastics and artificial silk; and in the preparation of various organic acetates, such as methyl, ethyl and amyl acetates which are used as solvents. It enters in the manufacture of various synthetic organic chemicals, even though the acetyl group may not appear in the final product. It has also several miscellaneous uses, such as in textile plants in the dyeing process and on rubber plantations for coagulating the latex.

Acetone.—Acetone is used largely as a solvent, and for certain purposes of this kind it seems to be almost indispensable. This is especially the case with certain cellulose acetate films and lacquers, which require a large proportion of acetone in the solvent for obtaining the best results. The standard high-explosive used by the British—cordite—requires the use of acetone as a solvent in its manufacture. Large quantities of acetone have also been used as a solvent for acetylene in portable lighting and welding outfits.

Methanol.—Methanol has a large number of uses for which there seems to be no substitute possible. Formerly the largest use of methanol in this country was as a solvent in the manufacture of varnishes and lacquers,

is also the base used in the rapidly increasing production of synthetic resins, such as Bakelite and Redmanol. Methanol is now used in the preparation of certain dyes which require the presence of the methyl group. Methyl acetate and methyl salicylate, or artificial oil of wintergreen, and other similar methyl esters require methanol in their production.

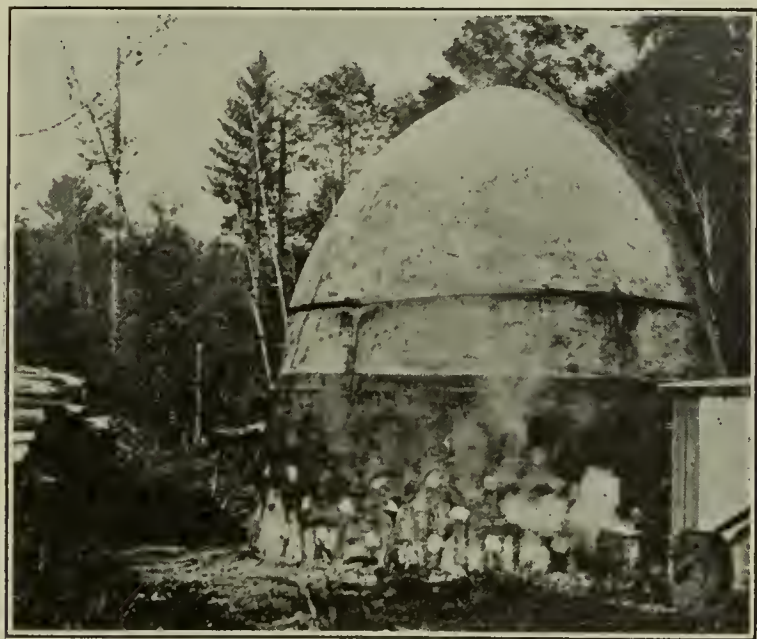
Methyl Acetone.—Methyl acetone, which is a mixture of methanol, acetone, methyl acetate and other impurities in small quantities, is obtained during the refining of methanol. This material naturally varies in composition as produced at different refining plants, but it has the same general uses in all cases—namely, as a solvent. It has solvent properties very similar to acetone and in general superior to those of pure methanol. Its special use, however, is in the denaturing of ethyl alcohol.

Wood Tar.—Wood tar has not yet become an important product of wood distillation, although there has been considerable development along this line within the last few years. Flotation oils, solvent oils, heavy tar oils for paints, stains, preservatives and insulating pitch are some of the important products obtained from wood tar. One important product for which wood tar is the only raw material is the medicinal beechwood creosote which has been manufactured to a considerable extent in this country since 1915.

PERIODS IN THE HISTORY OF THE HARDWOOD DISTILLATION INDUSTRY

There are several periods which stand out distinctly in the development of the hardwood distillation industry, as determined by the change in the demand for certain products. For a long time the industry was given an indirect subsidy by the Government in the form of a tax placed on ethyl alcohol for industrial purposes. This made it possible for methanol to be used and sold at a price much higher than the cost of manufacture of ethyl alcohol. It was during this period that the great use of methanol as a solvent was developed in the manufacture of spirit varnishes, in the hat-making industry and in many other places where its solvent action made it a good substitute for ethyl alcohol.

In 1906 the denatured-alcohol legislation was passed making it possible to use ethyl alcohol for industrial purposes without paying the excise tax. This put methanol in direct competition with ethyl alcohol in cases where solvent action only was required, and the market price of the product immediately dropped to about the same level as that of grain alcohol. Conditions in the hardwood distillation industry were very unfavorable for some time; but slightly increased prices for charcoal and acetate of lime helped the situation, and there continued to be a fair demand for methanol, although at a very reduced price. This condition continued until about 1915, when the demand for acetate of lime began to increase rapidly, owing to the fact that one of the main explosives used by the British Government required acetone in the process of manufacture. After the reserve stocks on hand were used up the price of acetate of lime increased very rapidly, and for some time was held at \$7 a hundredweight, when the maximum price previous to the war had been \$2.50. This demand for acetate was much greater after the entrance of this country into the war, since both acetone and acetic acid were important constituents of the airplane-wing "dope" required in large quantities by our airplane program. Methanol did not have such



BEEHIVE CHARCOAL KILN WITHOUT BYPRODUCT RECOVERY

especially those containing shellac. This use has, however, declined very rapidly of late, and only small quantities of methanol are now being used for this purpose. The uses in which methanol enters into chemical reaction with other materials have been rapidly growing.

A recently developed use of methanol as a solvent is in connection with the manufacture of moving-picture films. Its main chemical use is probably in the manufacture of formaldehyde, as it is the only raw material from which formaldehyde has been produced commercially. Formaldehyde is a standard disinfectant for general use in hospitals and sick-rooms. An even more important use for formaldehyde, however, is found in the eradication of various fungus diseases which attack seed grains. The Department of Agriculture has recommended the use of formaldehyde treatment for potatoes and for many grains, in order to prevent these diseases and increase the yields of the products. Formaldehyde

important war uses, and its price was not greatly affected. Both of these products, however, were commandeered by the Government, and the selling price was fixed. After the Government restrictions were removed the price of methanol increased, while that of acetate of lime decreased.

The change in price for acetate of lime was due to two causes. One of these was the large stocks which had been stored during the war and the other was the competition which had been developed through new processes developed during the war for the manufacture of acetic acid and acetone.

The increase in the price of methanol was due to the rapidly increasing use of this material in chemical



WOOD-DISTILLATION RETORTS

manufacture. Our newly established dye industry required considerable quantities of methanol, and the various other chemical uses for this product had increased greatly. The recent decrease in demand is difficult to explain, except by general business conditions.

Methyl acetone obtained in the refining of methanol has also shown great changes in demand. At the time it was first produced it had practically no value, because its solvent properties were not well known and both the odor and color of the product were unpleasant, but it gradually developed that this material had very unusual solvent properties, and as the color and odor were improved it was used more and more. Since the denatured alcohol bill went into effect in 1907 there has also been a slowly increasing demand for this material as a denaturant. Charcoal has also had many ups and downs following the demand for charcoal iron to a great extent, but these have not occurred in well-defined periods like the other products.

COMMERCIAL METHODS OF WOOD-DISTILLATION— RETORTS, KILNS AND OVENS

The distillation of wood has long been an industry in the form of the manufacture of charcoal without the recovery of any byproducts. This was accomplished by kilns in which the heat required for the distillation of wood was furnished by a partial combustion of the wood and its distillation products by means of a regulated draft of air through the kiln.

In this country there were two paths by which the charcoal industry progressed toward the modern wood-distillation industry in which the chemical byproducts are the chief products. One of these was the brick byproduct kiln, in which the same method of heating was continued, but the draft was regulated artificially and the products of combustion and distillation were carried through condensers and recovered. The yield of chemicals from the byproduct kilns was only about one-half of that which can be obtained by the distilla-

tion of the wood in closed vessels with heat applied from the outside. Nevertheless the byproduct kilns continued in use, particularly in northern Wisconsin and Michigan, where large quantities of charcoal were required for use in charcoal-iron furnaces. Several such plants are still in operation, but no new ones have been built recently and some of them have already been remodeled into modern oven plants.

The other path by which the wood-distillation process advanced from the kiln process to the modern methods was by way of the retort process. These retorts were cylindrical, horizontal, and about 5 ft. in diameter by 9 ft. in length. They were commonly set in furnaces with one firebox for two retorts. The wood was loaded into the retort by hand, and the hot charcoal was raked out also by hand labor. In the eastern part of the wood-distillation district these retort plants were very common, and they became the standard distillation apparatus for a time.

The modern oven for wood-distillation is at present the standard type of distillation apparatus, and all of the new plants recently built have been of this type. The ovens were developed with the main purpose of decreasing the amount of labor required, and they were very successful in this direction, since the wood was run into the ovens on cars and the charcoal removed from the retorts on the same cars without requiring any handling. From this point of view the ovens are very efficient, and the yields obtained per cord of wood are also as great as have been obtained in the other commercial forms of distilling apparatus. The ovens are about 6 ft. by 8 ft. in cross-section, and the wood on the cars does not touch the sides of the oven at any point.

The great disadvantage in the use of such ovens is that in order to bring the center of the charge up to the



LOADING BUGGIES WITH WOOD

required temperature it is necessary that the retort surface be heated to a considerably higher temperature than necessary for the distillation of the wood, which results in high depreciation on the ovens in cases where extreme care is not taken in the control of the fire.

ARTIFICIAL DRYING OF THE WOOD

The wood is commonly air-dried from twelve to eighteen months previous to distillation. This is necessary on account of the fact that green wood not only requires more fuel and a longer time to distill but the



WOOD GOING INTO DISTILLATION OVENS

liquors are also increased in amount by the moisture in the wood, with the result that during the refining process larger capacity apparatus and more fuel would be required.

There is considerable disagreement in regard to the effect of moisture in the wood in the yields of methanol and acetic acid; but it is generally considered that, even if moisture does increase the yields, it is not enough to make up for the increased costs of distillation and refining.

The cost of air-drying is considerable, since the interest on the value of eighteen months' wood supply is a large item of expense, and the handling of the wood in piling it for drying and in loading on the cars after drying is also expensive.

Within the last three or four years methods for artificially drying distillation wood have been worked out, and the same general method with modifications is in use at three plants. The woodyard for drying purposes is replaced by what are called pre-driers. These consist of brick or tile buildings, holding from one to three days' supply of wood on cars, in which the wood is heated and dried by direct contact with the flue gases from the retort stacks. The flue gases are taken from the stacks by means of fans and distributed along the hot end of the pre-drier, usually by flues underneath the cars. Some trouble was encountered at first with sparks carrying over from the flues and igniting the wood on the cars; but by using baffles for stopping the sparks and by determining the maximum safe temperature at which the gases could enter the driers this difficulty has been avoided.

As the drying of wood takes place very much more rapidly through the ends of a stick than in the direction at right angles to the grain, it was naturally found that the wood could be dried more rapidly and completely when cut into blocks instead of being left in the usual 4-ft. lengths of cordwood. At two plants the wood is cut into blocks and the blocks are loaded into cars from hoppers without being touched after sawing. At one plant the wood is still being dried in 4-ft. lengths, although the drying is then not so complete.

Short blocks of wood dumped into a car by gravity feed from a hopper will give more weight of wood in

a car than can be loaded into the same car by hand in the form of 4-ft. cordwood.

The labor required for handling the wood in the storage yards and the interest on the investment, insurance, taxes, etc., on stored wood are expenses which are entirely eliminated by the use of pre-driers. It also makes the plant more independent of weather conditions and it is possible for a new plant to start without the necessity of collecting a wood supply eighteen months before the plant is ready for operation.

RELATION BETWEEN THE COMPOSITION OF WOOD AND ITS DISTILLATION PRODUCTS

The two main constituents of wood—namely, cellulose and lignin—are very different in their yields of wood-distillation products. Cellulose when distilled by itself furnishes no methanol, but gives a comparatively high yield of acetic acid.² Lignin has not been distilled by itself, but apparently it is the only source of methanol in the original wood.

The chemical composition of wood is usually expressed in terms of certain groups of substances which have special solubilities or give certain reactions. For instance, "methoxy group," "acetic acid by hydrolysis," "alkali soluble," "water soluble" and "ether soluble" are common terms used in reporting a wood analysis.

The methoxy group is the one of most interest in wood distillation. Its determination is not a direct measure of the amounts of methanol which can be obtained by destructive distillation of the wood; but, in general, the woods which give the higher methoxy determinations give also the largest yield of methanol. The ratio between the percentage of methoxy group and percentage of methanol obtained by distillation is approximately 3 to 1, and this indicates the possibility of obtaining considerably higher yields of methanol from wood by some method of modifying the source of the distillation.

The acetic acid content as obtained by hydrolysis varies considerably with different species, but does not seem to have a direct relation to the amount of acetic acid obtained by destructive distillation. The acid obtained by hydrolysis is also less than the amount obtained by distillation and therefore does not indicate a possibility of larger yields of acid. It is possible, however, to decompose wood in such a manner as to obtain larger yields of acetic acid than have ever been obtained by destructive distillation. Thus a treatment with a large proportion of caustic soda at a temperature of about 200 deg. C. may yield as high as 15 per cent of acetic acid.³ Apparently, therefore, there is nothing in the composition of wood substances which makes it impossible to obtain considerably increased yields of both methanol and acid by some modification of the process of distilling.

The other constituents of wood, such as "water soluble," "ether soluble," etc., are not of much importance in connection with wood-distillation, since these constituents occur usually only in small amounts. In cases where the resins occur in large quantity these become important by themselves; and, as in the case of "lightwood" from longleaf pine, they form the basis of a special distillation industry.

Parts II and III will be published in subsequent issues.

²Klason, von Heidenstam and Norlin, "Arkiv för Kemi, Mineralogi och Geologi, 1907," *Z. Angew. Chem.* vol. 25, p. 1205 (1909).

³Mahood and Cable, *J. Ind. Eng. Chem.*, 1919.

Comparison of the Fusing Temperature of Coal and Coke Ash

BY HAROLD J. ROSE

A knowledge of the fusing temperature of ash has proved to be of considerable value in comparing the clinkering tendencies of various fuels. Although a large amount of reliable information has been published on the fusing temperature of ash of United States coals,

results have been obtained. All determinations were made according to the American Society for Testing Materials 1920 "Tentative Method for Determination of Fusibility of Coal Ash.":

The permissible difference allowed in duplicate determinations by the A.S.T.M. 1920 Tentative Method is as follows: Same analyst, 54 deg. F.; different analyst, 90 deg. F.

It is evident from the results obtained that the fus-

Description of Sample			Per Cent	Per Cent	Fusing Temp. of Ash		Coal Ash F. T.
State	County	Seam	Ash in Coal	Sulphur in Coal	Coal Deg. F.	Coke Deg. F.	Mirus Coke Ash F. T. Deg. F.
Penna.....	Fayette.....	Pittsburgh.....	9 11	1 28	2,507	2,480	27
Penna.....	Fayette.....	Pittsburgh.....	7 73	1 03	2,399	2,448	49
Penna.....	Westmoreland.....	Pittsburgh.....	13 59	1 85	2,354	2,354	0
W. Virginia.....	Marion.....	Pittsburgh.....	9 28	1 97	2,120	2,102	18
W. Virginia.....	Harrison.....	Kittanning.....	11 72	1 84	2,282	2,273	9
Kentucky.....	Pulaski.....	No. 4.....	9 86	1 05	2,354	2,399	45
Kentucky.....	Harlan.....	Harlan.....	5 34	0 84	2,520	2,475	45
Kentucky.....	Harlan.....	Harlan.....	6 25	0 86	2,581	2,563	18
Illinois.....	Franklin.....	No. 6.....	8 44	1 13	2,245	2,273	28
Nova Scotia.....	Cape Breton.....	.....	2 98	1 50	2,075	2,057	18
80% Penna.....	Westmoreland.....	Pittsburgh.....	11 48	1 00	2,595	2,595	0
20% Penna.....	Somerset.....	U. Kittanning.....					
80% Penna.....	Westmoreland.....	Pittsburgh.....					
20% Penna.....	Somerset.....	U. Kittanning.....	.....	.....	2,615	2,615	0
Average.....			.....	.....	2,387	2,386	1

very little information is available regarding the fusing temperature of coke ashes.

A series of tests has been made to determine whether it is permissible to assume that the fusing temperature of a coke ash is identical with that of the ash of the coal from which the coke was made. The following

ing point of coal ash is not affected by the coking process, and that either coal ash or coke ash may be used for determining the fusing temperature of ash of the coal in question.

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Physical Tests on Sheet Nickel Silver*

Nickel Silvers Both High and Low in Nickel Were Studied — Cold-Worked High Nickel Is Softer and Works Better and Requires a Higher Temperature for Recrystallization, After Which It Has Higher Strength and Less Elongation Without Damaging Its Cold-Working Properties

BY WILLIAM B. PRICE AND PHILIP DAVIDSON†

WE PRESENT a survey of some of the physical properties of sheet nickel silver, when subjected to cold rolling and when annealed at a variety of temperatures extending from 350 deg. C. throughout the commercial annealing range.

PREPARATION OF SPECIMENS

A number of alloys were taken from stock and analyzed. Four of these, representing low-nickel and high-nickel both with and without lead were chosen for the tests. The analyses follow:

Alloy	Per Cent Cu	Per Cent Pb	Per Cent Fe	Per Cent Ni	Per Cent Mn	Per Cent Zn
A.....	64.68	Trace	0.194	6.73	0.06	Remainder
B.....	65.82	1.27	0.227	6.17	0.06	Remainder
C.....	65.44	Trace	0.345	17.83	0.08	Remainder
D.....	65.60	1.08	0.238	17.77	0.06	Remainder

These alloys were then rolled in accordance with the regular mill practice to approximately No. 6 B. & S. gage. At this stage all of the bars (which were

then coiled) were annealed together in a mill muffle. After the annealing treatment, the bars were pickled in a 10 per cent sulphuric acid solution and cold-rolled in stages of approximately one number (B. & S.) at a time. After each stage suitable samples were set aside for physical tests. Additional samples were also chosen for tests after prescribed annealing treatment. The method of sampling is indicated below:

ROLLED SERIES	ANNEALED SERIES
No. 6, annealed in Mill	Samples were taken at the indicated stages and annealed together in the mill muffle. After pickling, they were finished on 0 050-in. gage yielding a series of specimens 2, 4, 6 and 8 numbers hard for the subsequent annealing tests.
Rolled to No. 6 1/2 B. & S. Gage	
Rolled to No. 7	
Rolled to No. 8 (sampled)	
Rolled to No. 9	
Rolled to No. 10 (sampled)	
Rolled to No. 11	
Rolled to No. 12 (sampled)	
Rolled to No. 13	
Rolled to No. 14 (sampled)	
Rolled to No. 15	
Rolled to No. 16	
Rolled to No. 17	
Rolled to No. 18	

Tensile test-pieces 9 x 1 in. were cut from both lots and the central portion was milled to give a test section 2 1/2 in. long by 1/2 in. wide. A distance of 2 in. was marked off on the edge of each specimen with light punch marks. Erichsen test-pieces 4 x 2 1/2 in. were

*Presented in part before the 1920 Columbus meeting of the Institute of Metals Section, American Institute of Mining and Metallurgical Engineers.
†Chief chemist and metallurgist, and metallurgist, respectively, Scovill Manufacturing Co., Waterbury, Conn.

also taken from the annealed alloys, along with the tensile specimens.

METHODS OF TESTING

Brinell tests were made with an Olsen hydraulic machine as preliminary tests on the tensile test-pieces, using pressure of 500 kg. for 30 seconds with a 10-mm.

ball. The tensile tests were made on a 50,000-lb. Olsen testing machine adjusted to take a maximum load of 5,000 lb. The yield point was considered as that load necessary to produce a permanent set of 0.001 in. in 2 in. and was obtained by measuring the elongation of the specimen during the test with a pair of dividers.

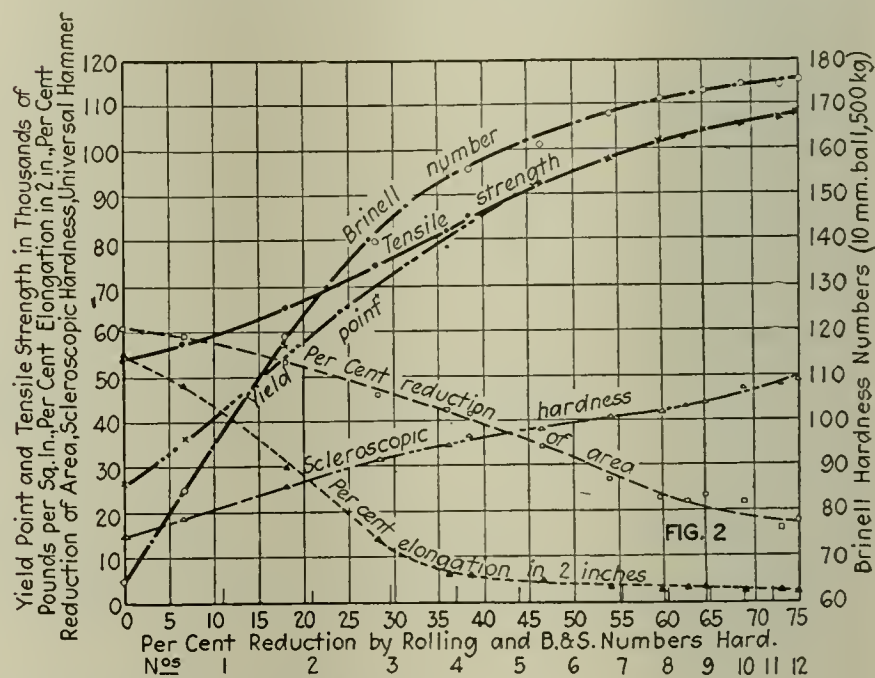
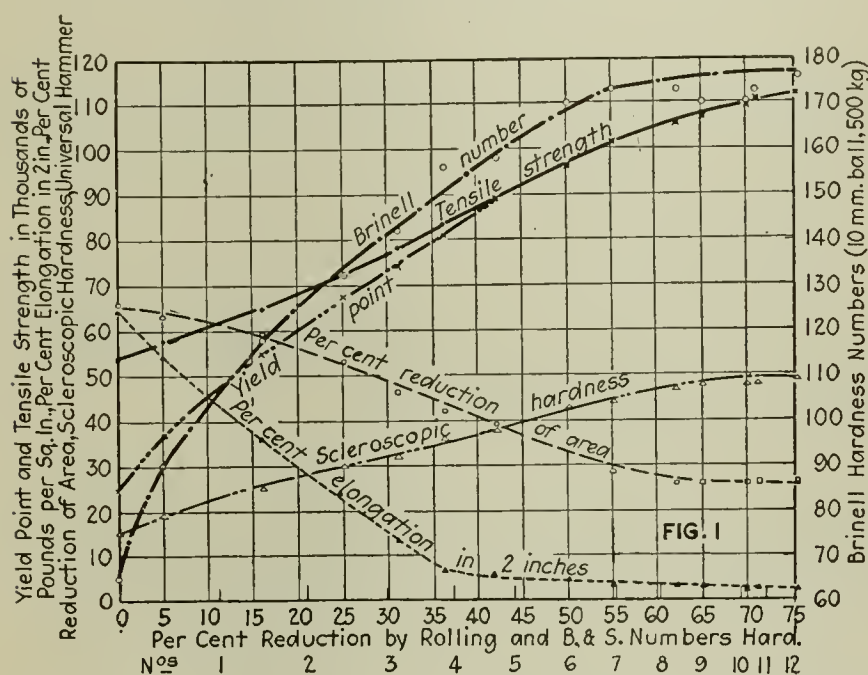
Scleroscopic hardness tests were also made on the

TABLE I. PHYSICAL TESTS ON THE COLD-ROLLED MATERIAL
Alloy A.—Analysis: Copper, 64.68 per cent; lead, trace; iron, 0.194 per cent; nickel, 6.73 per cent; manganese, 0.06 per cent; zinc, remainder.

Gage	Per Cent Red. by Rolling	Yd. Pt., Lb. per Sq. In.	Ten. Str. Lb. per Sq. In.	Per Cent Elong., in 2 In.	Per Cent Red. of Area	Scler. Hard.	Brin. No.
0.1545	Mill anneal	24,666	53,767	64.5	65.7	15	65
0.1465	5.17	37,233	57,467	54.7	63.0	19	90
0.1295	16.18	54,933	64,533	35.8	59.5	25	118
0.1165	24.59	67,400	71,400	23.7	53.1	30	132
0.1065	31.06	74,000	77,800	13.3	46.3	32	142
0.0985	36.24	80,733	83,267	6.8	42.3	36	156
0.090	41.74	84,550	88,733	5.8	39.1	38	158
0.0775	49.83	96,367	96,367	4.7	34.1	43	170
0.0645	58.25	101,500	101,500	3.5	28.5	44	173
0.0585	62.13	105,533	105,533	3.2	26.2	47	173
0.054	65.04	106,867	106,867	3.2	26.2	48	170
0.0465	69.9	109,733	109,733	2.5	26.3	48	170
0.0445	71.19	110,967	110,967	2.8	26.6	48.5	174
0.038	75.41	112,300	112,300	2.5	26.5	49	176

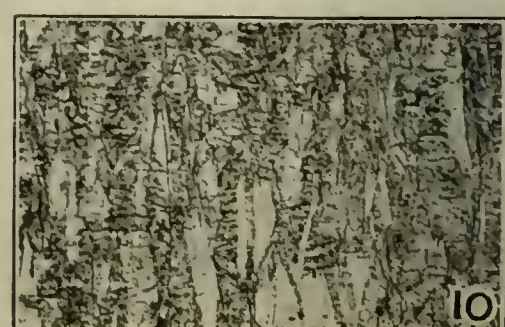
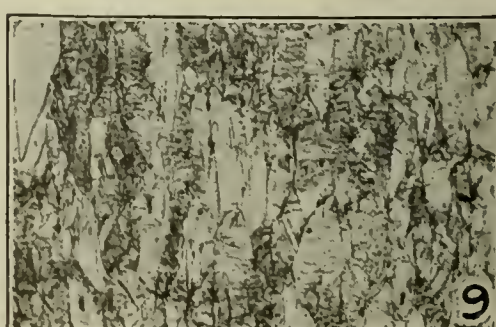
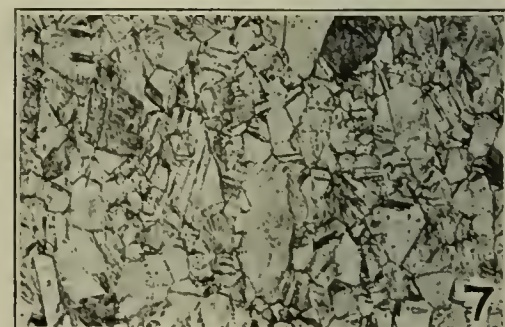
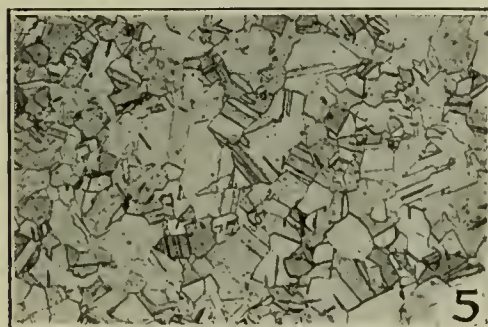
TABLE II. PHYSICAL TESTS ON THE COLD-ROLLED MATERIAL
Alloy B.—Analysis: Copper, 65.82 per cent; lead, 1.27 per cent; iron, 0.227 per cent; nickel, 6.17 per cent; manganese, 0.06 per cent; zinc, remainder.

Gage	Per Cent Red. by Rolling	Yd. Pt. Lb. per Sq. In.	Ten. Str., Lb. per Sq. In.	Per Cent Elong., in 2 In.	Per Cent Red. of Area	Scler. Hard.	Brin. No.
0.1555	Mill anneal	26,633	53,700	55.2	61.2	15	65
0.1455	6.44	36,300	57,333	48.3	59.1	19	85
0.1275	18.0	57,033	65,367	30.7	53.6	26.3	119
0.1115	28.29	67,667	74,200	14.2	45.9	32	140
0.0995	36.01	78,633	82,167	6.7	42.5	35	155
0.095	38.90	82,800	85,067	6.2	41.9	37	156
0.0835	46.30	92,033	92,033	5.0	34.7	38.5	161
0.0715	54.02	97,833	97,833	3.5	27.0	41	168
0.0625	59.80	101,467	101,467	3.3	23.0	42	171
0.0585	62.37	102,267	102,267	3.3	22.2	43.5	171
0.0555	64.38	103,900	103,900	3.3	23.7	44	173
0.0485	68.81	105,267	105,267	2.2	22.1	47.5	174
0.0425	72.66	106,533	106,533	2.5	16.7	48.5	174
0.0395	74.53	107,767	107,767	2.2	18.0	49	175



FIGS. 1 AND 2. PHYSICAL TESTS ON COLD-ROLLED MATERIAL

Fig. 1—Alloy A. Analysis: Copper, 64.68%; lead, trace; iron, 0.194%; nickel, 6.73%; manganese, 0.06%; zinc, remainder.
Fig. 2—Alloy B. Analysis: Copper, 65.82%; lead, 1.27%; iron, 0.227%; nickel, 6.17%; manganese, 0.06%; zinc, remainder.



FIGS. 5 TO 10. MICROSTRUCTURE OF ROLLED SERIES, ALLOY A

Analysis: Copper, 64.68%; lead, trace; iron, 0.194%; nickel, 6.73%; manganese, 0.06%; zinc, remainder. Etched with $\text{NH}_4\text{OH} + \text{H}_2\text{O}_2$. $\times 75$. Fig. 5—Mill anneal. Fig. 6—16.18% reduction. Fig. 7—31.06% reduction. Fig. 8—41.74% reduction. Fig. 9—62.13% reduction. Fig. 10—75.41% reduction.

tensile test-pieces, using the Shore universal hammer. Erichsen ductility tests were carried out with a special machine equipped with standard Erichsen tools, but so designed that the pressure required to produce a cup was measured on the Olsen testing machine. The ad-

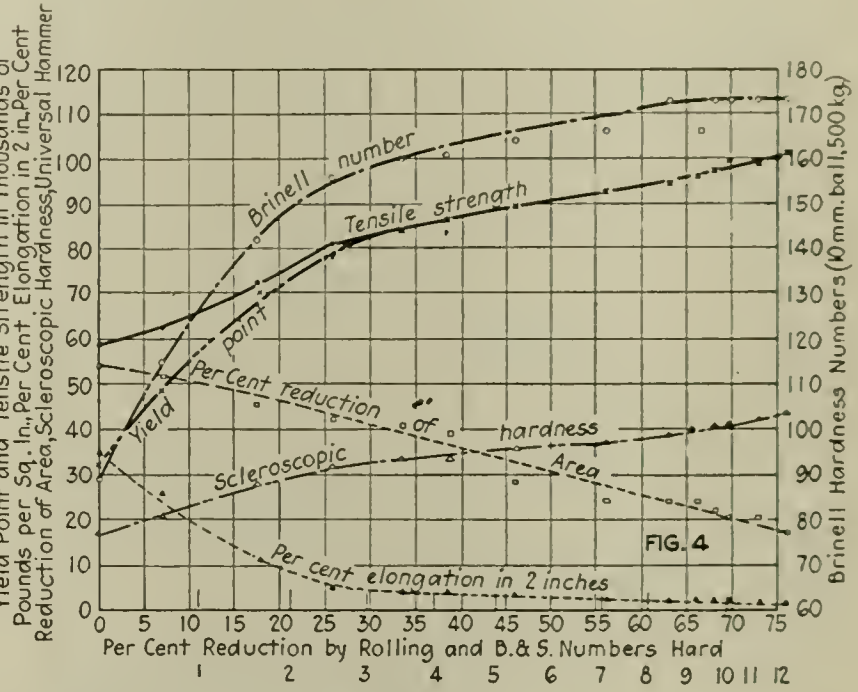
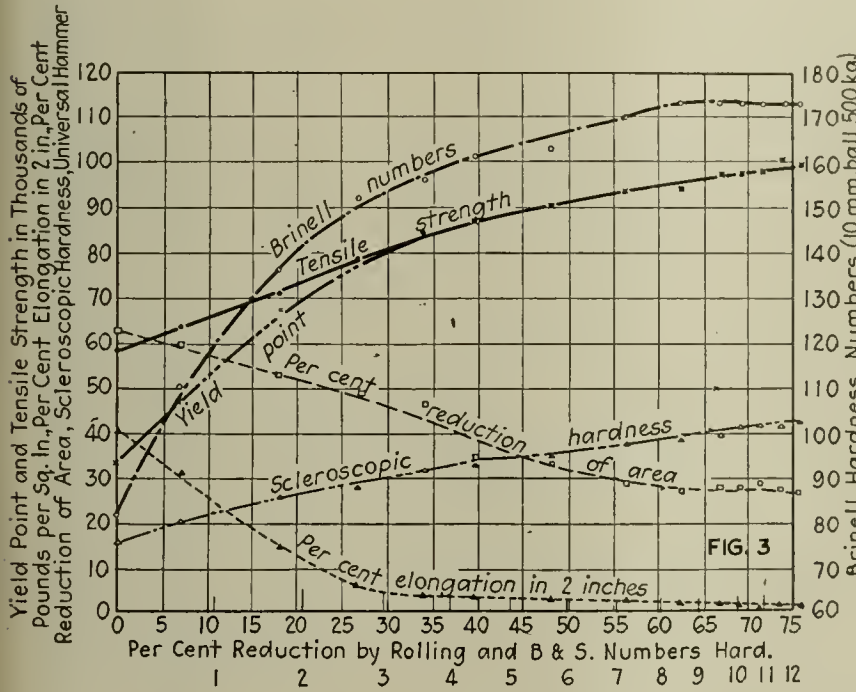
vantages of such a machine over the standard Erichsen machine are that the speed of cupping can be made very uniform, the end point is very sharp, and finally the load necessary to cup the material can be measured with precision.

TABLE III. PHYSICAL TESTS ON THE COLD-ROLLED MATERIAL.
Alloy C.—Analysis: Copper, 65.44 per cent.; lead, trace; iron, 0.345 per cent; nickel, 17.83 per cent; manganese, 0.08 per cent; zinc, remainder.

Gage	Per Cent Red. by Rolling	Yd. Pt. Lb. per Sq. In.	Ten. Str., Lb. per Sq. In.	Per Cent Elong., in 2 In.	Per Cent Red. of Area	Scler. Hard. No.	Brin. No.
0.1605	Mill anneal	33,033	58,133	40.2	62.5	15.8	82
0.149	7.16	46,900	63,100	31.2	59.6	20.3	110
0.132	17.75	66,267	70,800	14.7	52.8	26.0	136
0.1175	26.79	76,733	78,333	6.5	48.7	28.0	152
0.106	33.95	81,300	84,067	4.3	46.7	32.0	156
0.097	39.56	86,367	86,367	3.7	34.9	33.0	161
0.0835	47.97	90,133	90,133	3.2	33.3	35.0	163
0.070	56.38	93,633	93,633	3.2	29.4	38.0	170
0.0605	62.30	94,133	94,133	2.7	27.6	39.0	173
0.0535	66.66	97,333	97,333	2.5	28.3	40.0	173
0.0495	69.15	97,500	97,500	2.2	28.2	42.0	173
0.046	71.53	97,900	97,900	1.5	29.1	42.0	173
0.0425	73.52	100,500	100,500	2.3	27.7	42	173
0.0385	76.01	99,767	99,767	2.0	27.2	43	173

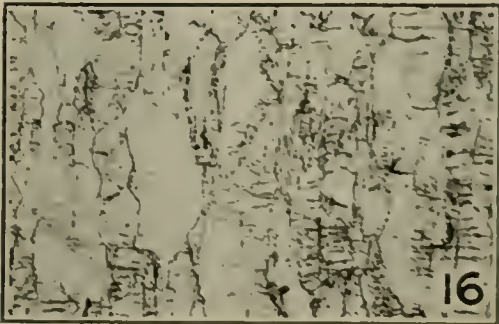
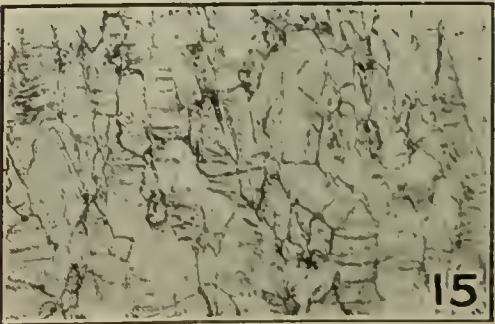
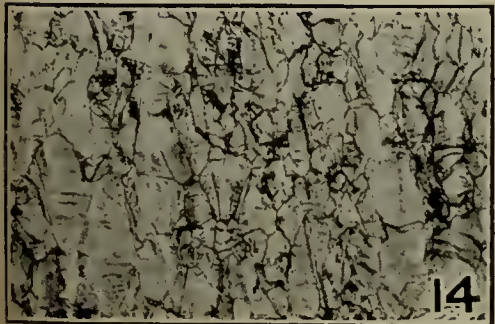
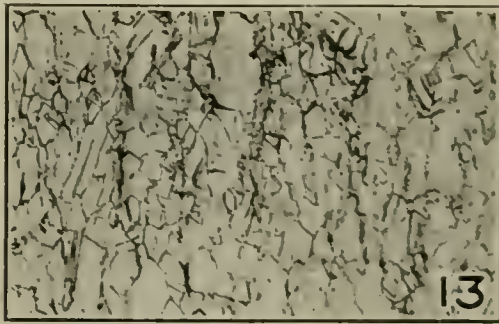
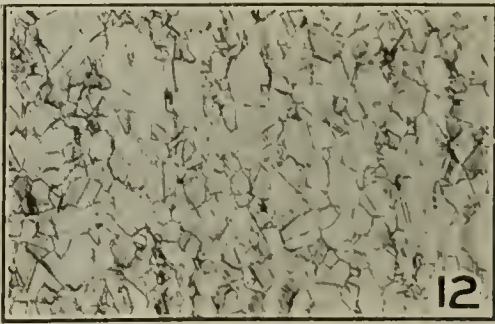
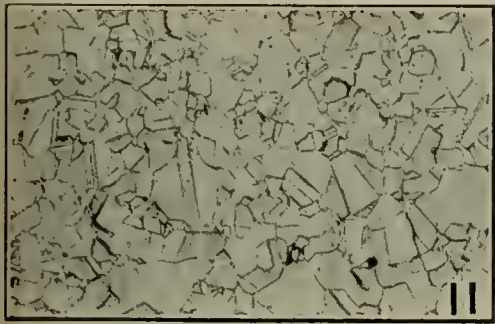
TABLE IV. PHYSICAL TESTS ON COLD-ROLLED MATERIAL.
Alloy D.—Analysis: Copper, 65.60 per cent; lead, 1.08 per cent; iron, 0.232 per cent; nickel, 17.77 per cent; manganese, 0.06 per cent; zinc, remainder

Gage	Per Cent Red. by Rolling	Yd. Pt. Lb. per Sq. In.	Ten. Str., Lb. per Sq. In.	Per Cent Elong., in 2 In.	Per Cent Red. of Area	Scler. Hard. No.	Brin. No.
0.1585	Mill anneal	32,367	59,133	35.0	54.2	17	89
0.1475	6.94	48,900	62,600	26.0	51.9	21	115
0.1305	17.66	70,500	72,600	11.3	45.5	28	142
0.1175	25.86	78,750	81,067	5.0	42.2	32	156
0.1055	33.43	83,767	83,767	4.2	40.8	33.5	160
0.0975	38.48	86,567	86,567	4.0	39.5	33.8	161
0.0855	46.05	89,433	89,433	3.5	28.3	36	164
0.0695	56.15	92,733	92,733	2.8	24.0	37.5	166
0.0585	63.09	94,467	94,467	2.5	24.2	39	173
0.0535	66.24	95,933	95,933	2.5	23.8	40.5	166
0.0505	68.13	97,400	97,400	2.2	22.3	41.2	173
0.048	69.71	99,767	99,767	2.3	20.7	41.5	173
0.0425	73.18	99,100	99,100	1.8	20.6	42.5	173
0.038	76.02	101,733	101,733	1.5	17.0	43.7	173

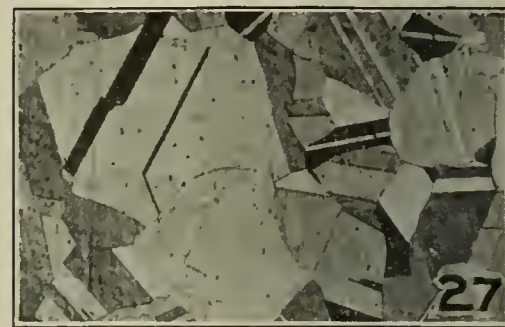
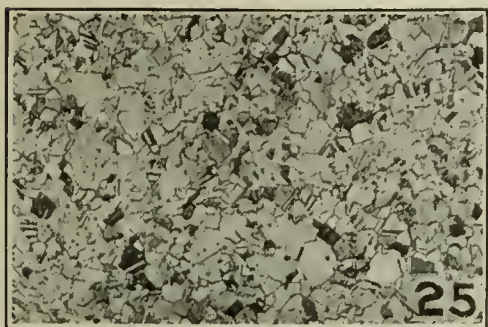
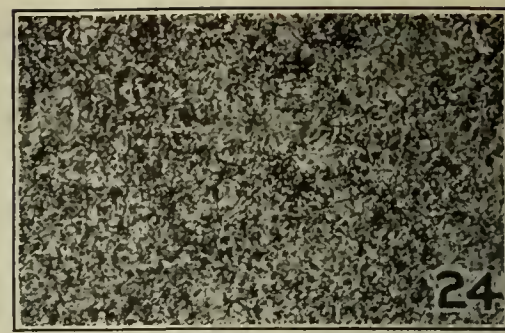
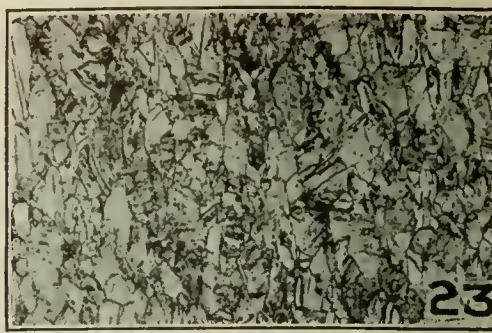
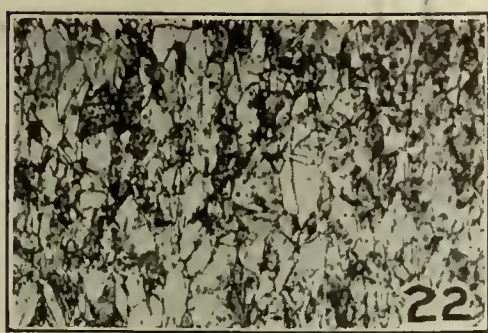


FIGS. 3 AND 4. PHYSICAL TESTS ON COLD-ROLLED MATERIAL

Fig. 3—Alloy C. Analysis: Copper, 65.44% ; lead, trace; iron, 0.345% ; nickel, 17.83% ; manganese, 0.08% ; zinc, remainder.
Fig. 4—Alloy D. Analysis: Copper, 65.60% ; lead, 1.08% ; iron, 0.238% ; nickel, 17.77% ; manganese, 0.06% ; zinc, remainder.



FIGS. 11 TO 16. MICROSTRUCTURE OF ROLLED STEEL SERIES, ALLOY C
Analysis: Copper, 65.44% ; lead, trace; iron, 0.345% ; nickel, 17.83% ; manganese, 0.08% ; zinc, remainder. Etched with FeCl₃ × 75.
Fig. 11—Mill anneal. Fig. 12—17.75% reduction. Fig. 13—33.95% reduction. Fig. 14—47.97% reduction. Fig. 15—66.66% reduction. Fig. 16—76.0% reduction.



FIGS. 22 TO 27. MICROSTRUCTURE OF ANNEALED SERIES, ALLOY A

Analysis: Copper, 64.68% ; lead, trace ; iron, 0.194% ; nickel, 6.73% ; manganese, 0.06% ; zinc, remainder. Etched with $\text{NH}_4\text{OH} + \text{H}_2\text{O}_2$. $\times 75$.
 Fig. 22—51.9% reduction. Fig. 23—Annealed at 350 deg. C. Fig. 24—Annealed at 425 deg. C. Fig. 25—Annealed at 575 deg. C. Fig. 26—Annealed at 650 deg. C. Fig. 27—Annealed at 835 deg. C.

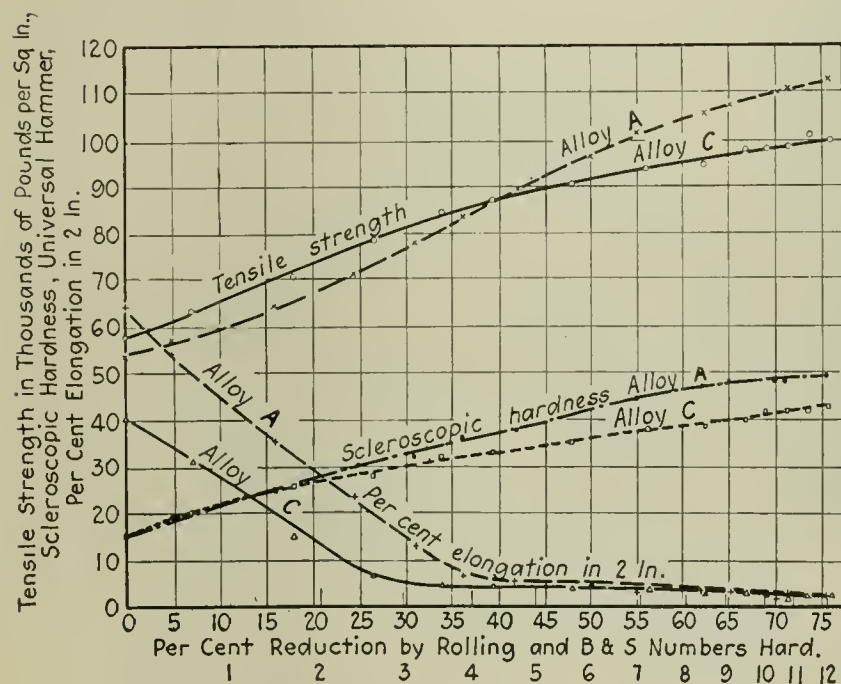
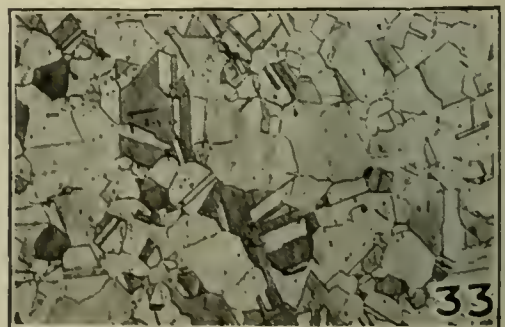
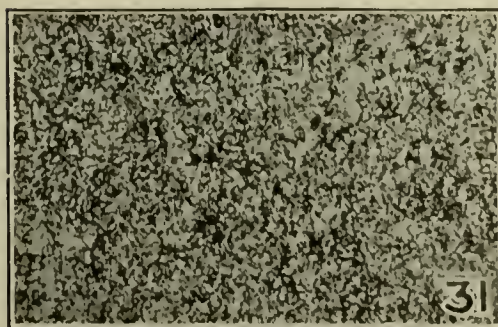
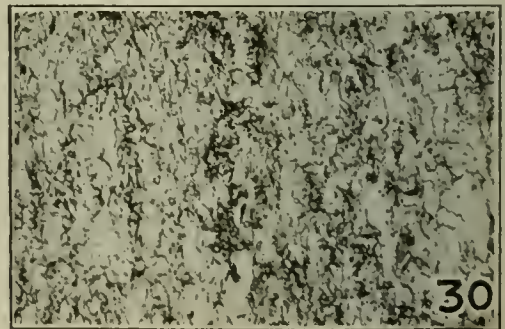
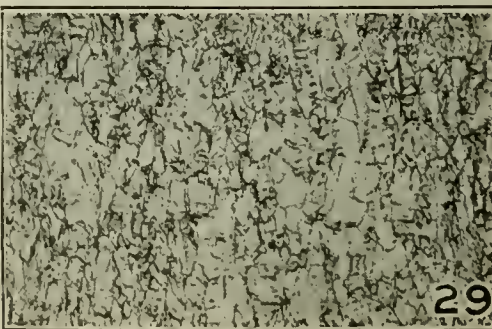
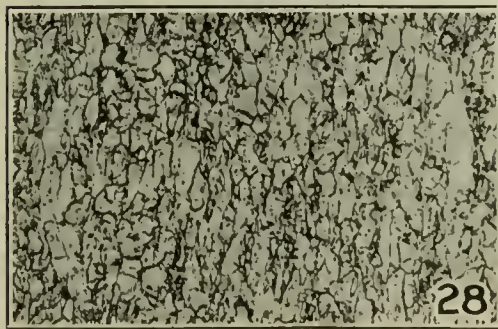


FIG. 17. COMPARISON OF THE PHYSICAL PROPERTIES OF COLD-ROLLED ALLOYS A AND C

Specimens for microstructure were also taken from the ends of the test specimens before pulling. Alloys A and B were etched with $\text{NH}_4\text{OH} + \text{H}_2\text{O}_2$, while dilute acidified ferric chloride solution was used in the case of alloys C and D. All micrographs were made at a magnification of 75 diameters.

The results of the physical tests made on the rolled specimens are shown in Tables I, II, III and IV, each item representing the average of three determinations. They are represented graphically in Figs. 1, 2, 3 and 4. Representative micrographs of alloys A and C are shown in Figs. 5 to 16 inclusive.

The significance of these results may be best appreciated by an examination of the accompanying curves, Figs. 1, 2, 3 and 4. In a general way the nickel silvers with the lower nickel content are slightly harder than brass subjected to similar treatment. The nickel silvers with the higher nickel content, however, although slightly harder when in the annealed condition, do not harden as rapidly under severe cold-rolling as those



FIGS. 28 TO 33. MICROSTRUCTURE OF ANNEALED SERIES, ALLOY C

Analysis: Copper, 65.44% ; lead, trace ; iron, 0.345% ; nickel, 17.83% ; manganese, 0.08% ; zinc, remainder. Etched with FeCl_3 . $\times 75$.
 Fig. 28—52.7% reduction. Fig. 29—Annealed at 429 deg. C. Fig. 30—Annealed at 500 deg. C. Fig. 31—Annealed at 575 deg. C. Fig. 32—Annealed at 750 deg. C. Fig. 33—Annealed at 835 deg. C.

with the lower nickel content. The comparison is shown graphically in Fig. 17. In works practice, as a matter of fact, alloys with the higher nickel content are considered more amenable to cold-working operation in general than those with the lower nickel content.

The presence of about 1 per cent of lead in either alloy does not appear to affect the physical properties to any great extent.

As stated above, samples approximately 2, 4, 6 and 8 numbers (B. & S.) hard at 0.050-in. gage were obtained from each of the four alloys. Three tensile and three Erichsen specimens from each lot (making forty-eight tensile and forty-eight Erichsen specimens) were

placed on a small pan 11 x 14 in. and carefully annealed in a nichrome wound electric muffle furnace 12 in. wide x 8 in. high x 28 in. deep. The temperature was controlled by means of a platinum thermocouple used in conjunction with an Engelhardt millivoltmeter. The specimens were annealed for half-hour periods at the temperature designated plus a preheating period averaging 1 hour and 17 minutes.

The physical test results are given in Tables V to VIII inclusive. The tensile test values are shown plotted against the temperature in Figs. 18, 19, 20 and 21.

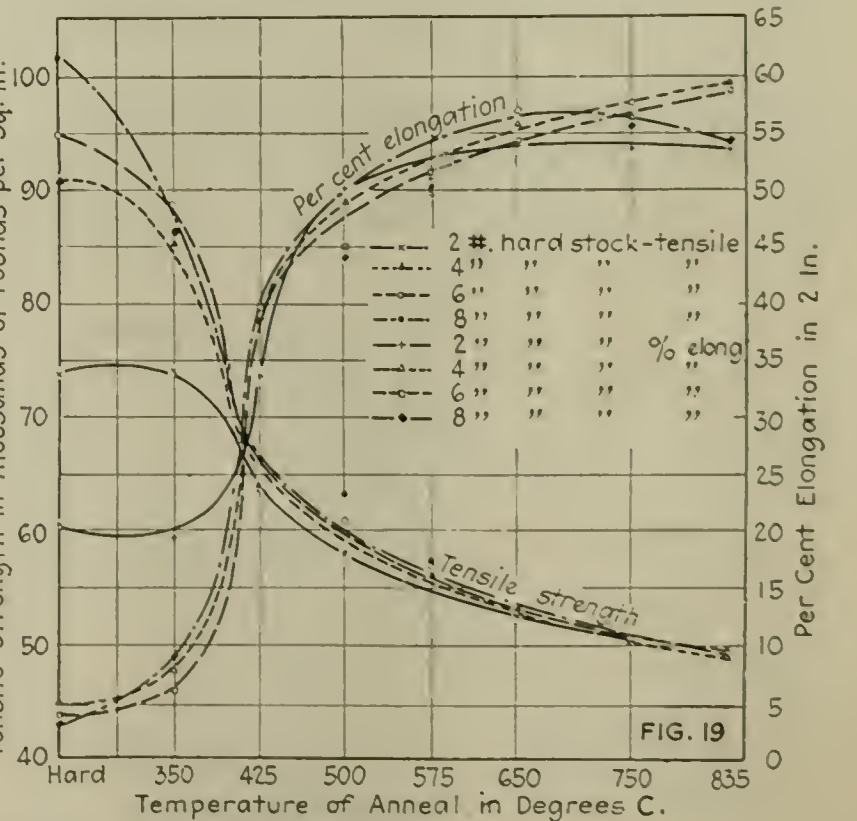
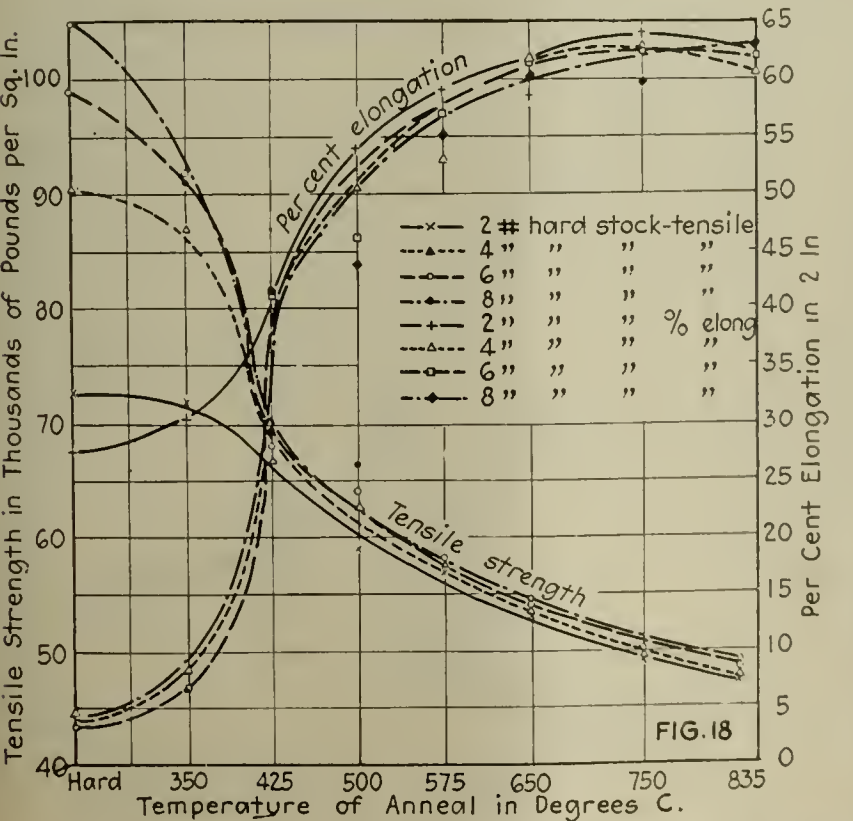
The Erichsen ductility values and the scleroscopic

TABLE V. PHYSICAL TESTS OF ANNEALED MATERIAL.
Alloy A—Analysis: Copper, 64.68 per cent; lead, trace; iron, 0.194 per cent; nickel, 6.73 per cent; manganese, 0.06 per cent; zinc, remainder.

Treat-ment	Yield Pt., Lb. per Sq. In.	Ten. Str., Lb. per Sq. In.	Per Cent Elong., 2 In.	Per Cent Red. Area	—Erichsen— Press., Lb.	Cup Depth, mm.	Scler.
Original Sample Reduced 19.55 Per Cent by Rolling:							
Original	53,267	72,667	27.8	49.3	5,263	586	8.97
350° C.	64,133	71,800	30.2	45.1	5,311	563	9.47
425° C.	45,866	66,100	39.8	52.7	5,573	636	8.76
500° C.	31,433	59,167	54.3	52.8	6,393	535	11.94
575° C.	26,667	56,700	59.2	54.6	6,364	528	12.07
650° C.	22,633	53,200	58.5	55.7	6,214	479	12.96
750° C.	20,633	49,133	64.0	54.3	5,796	451	12.85
835° C.	18,533	46,967	62.5	50.4	5,569	399	13.97
Original Sample Reduced 44.4 Per Cent by Rolling:							
Original	90,433	90,433	4.8	35.4	4,485	709	6.33
350° C.	82,267	87,100	8.5	33.7	4,576	673	6.80
425° C.	44,967	66,667	41.5	47.4	6,047	621	9.74
500° C.	38,000	62,567	50.7	49.2	6,294	591	10.66
575° C.	28,267	57,633	55.25	53.0	6,068	512	11.85
650° C.	22,033	53,367	62.0	55.5	5,689	453	12.57
750° C.	22,400	49,433	62.8	54.5	5,504	422	13.03
835° C.	17,667	47,400	60.3	53.2	5,320	397	13.39
Original Sample Reduced 51.9 Per Cent by Rolling:							
Original	99,167	99,167	3.5	29.5	2,140	645	3.33
350° C.	77,550	91,850	6.8	31.8	3,835	771	4.98
425° C.	44,900	67,900	41.2	49.6	6,383	638	10.01
500° C.	40,133	64,267	46.2	51.0	6,271	607	10.33
575° C.	28,367	57,733	57.0	51.7	6,053	520	11.66
650° C.	22,567	53,833	61.5	56.1	5,978	479	12.49
750° C.	21,033	49,933	62.3	53.5	5,588	438	12.75
835° C.	19,800	48,333	62.0	53.6	5,377	404	12.66
Original Sample Reduced 60.5 Per Cent by Rolling:							
Original	104,967	104,967	4.2	27.9	1,664	641	2.60
350° C.	74,767	91,133	8.8	34.5	3,704	760	4.87
425° C.	48,200	69,667	41.5	47.3	6,516	631	10.33
500° C.	42,800	66,333	44.2	48.2	6,543	636	10.29
575° C.	29,067	58,400	55.3	54.4	6,419	538	11.92
650° C.	21,633	53,666	62.7	56.9	6,180	499	12.38
750° C.	19,933	50,067	59.7	54.2	5,825	463	12.57
835° C.	20,233	48,867	63.7	54.4	5,611	414	13.55

TABLE VI. PHYSICAL TESTS ON ANNEALED MATERIAL.
Alloy B—Analysis: Copper, 65.82 per cent; lead, 1.27 per cent; iron, 0.227 per cent; nickel, 6.17 per cent; manganese, 0.06 per cent; zinc, remainder.

Treat-ment	Yield Pt., Lb. per Sq. In.	Ten. Str., Lb. per Sq. In.	Per Cent Elong., 2 In.	Per Cent Red. Area	—Erichsen— Press., Lb.	Cup Depth, mm.	Scler.
Original Sample Reduced 18.4 Per Cent by Rolling:							
Original	60,700	73,667	20.5	43.2	4,025	587	6.87
350° C.	66,533	74,233	19.5	48.0	4,049	566	7.14
425° C.	44,933	63,633	33.3	46.8	4,268	561	7.61
500° C.	29,200	58,300	50.2	56.8	5,648	506	11.17
575° C.	25,900	55,833	51.0	58.8	5,590	477	11.71
650° C.	23,267	53,600	54.0	59.7	5,525	459	12.05
750° C.	20,133	50,566	53.7	50.9	5,293	417	12.68
835° C.	20,833	49,533	53.75	49.4	5,330	407	13.12
Original Sample Reduced 44.4 Per Cent by Rolling:							
Original	90,850	90,850	4.8	32.7	1,864	504	3.71
350° C.	73,000	85,250	7.8	38.1	1,824	542	3.36
425° C.	40,833	64,033	40.0	51.6	5,182	550	9.42
500° C.	34,900	61,000	49.0	56.2	5,505	515	10.70
575° C.	27,767	56,000	50.0	56.7	5,420	477	11.36
650° C.	22,100	53,050	55.8	58.0	5,342	431	12.39
750° C.	21,467	50,900	58.25	57.8	5,300	405	13.09
835° C.	21,233	49,033	59.7	56.1	5,090	401	12.69
Original Sample Reduced 49.75 Per Cent by Rolling:							
Original	95,100	95,100	4.0	28.3	1,203	506	2.39
350° C.	71,200	88,733	6.0	35.0	1,346	518	2.60
425° C.	42,300	65,500	39.8	51.9	5,403	554	9.76
500° C.	34,033	61,033	45.0	52.0	5,390	527	10.23
575° C.	28,967	57,133	51.3	56.2	5,433	468	11.62
650° C.	21,600	53,233	54.2	55.1	5,130	444	11.57
750° C.	19,133	50,866	57.5	54.4	5,208	417	12.51
835° C.	19,333	49,000	58.7	54.8	5,188	397	13.05
Original Sample Reduced 59.75 Per Cent by Reduction:							
Original	101,633	101,633	3.3	23.1	1,014	446	2.28
350° C.	74,367	86,267	9.3	40.8	1,515	544	2.79
425° C.	43,867	66,567	38.8	52.9	5,493	601	9.15
500° C.	40,033	63,467	44.0	54.3	5,698	546	10.44
575° C.	29,033	57,200	50.7	56.9	5,613	481	11.68
650° C.	22,400	53,333	57.2	60.5	5,450	455	11.98
750° C.	19,433	50,700	55.7	58.1	5,358	416	12.89
835° C.	20,600	49,333	54.0	53.6	5,167	409	12.64



FIGS. 18 AND 19. PHYSICAL TESTS TAKEN ON ANNEALED STEEL.
Fig. 18—Alloy A. Analysis: Copper, 64.68%; lead, trace; iron, 0.194%; nickel, 6.73%; manganese, 0.06%; zinc, remainder. Original samples reduced 19.55, 44.4, 51.9 and 60.5% respectively. Fig. 19—Alloy B. Analysis: Copper, 65.82%; lead, 1.27%; iron, 0.227%; nickel, 6.17%; manganese, 0.06%; zinc, remainder. Original samples reduced 18.4, 44.4, 49.75 and 59.75% respectively.

hardness values are shown in plotted form in Figs. 34, 35, 36 and 37. It is interesting to note that these curves are very similar to the tensile strength and elongation curves of the preceding Figs. 18, 19, 20 and 21; the Erichsen curve parallels the per cent elongation curve, while the scleroscopic hardness curve is similar to the tensile strength curve.

Nickel silver is similar to brass with respect to its grain characteristics excepting that grain growth is retarded by the presence of nickel. Severely worked material with the lower nickel content—alloys A and B—shows a beginning of recrystallization at 350 deg. C., which is about 50 deg. C. higher than in the case of alpha brass. In the case of the nickel silvers with the higher nickel content—alloys C and D—the first signs

of recrystallization on the hard-rolled specimens is observed at 500 deg. C.

The great differences in tensile strength, per cent elongation, etc., which are seen in the samples reduced various amounts by rolling are approximately equalized by an anneal at 425 deg. C. in the case of alloys A and B and at 575 deg. C. with alloys C and D.

EFFECT OF NICKEL ON TENSILE STRENGTH AND ELONGATION

Comparative tensile properties of the four alloys are shown in Fig. 38, which gives the annealing characteristics of material originally 4 numbers hard. It will be seen that the effect of nickel is to raise the tensile strength and lower the per cent elongation. This

TABLE VII. PHYSICAL TESTS OF ANNEALED MATERIAL.

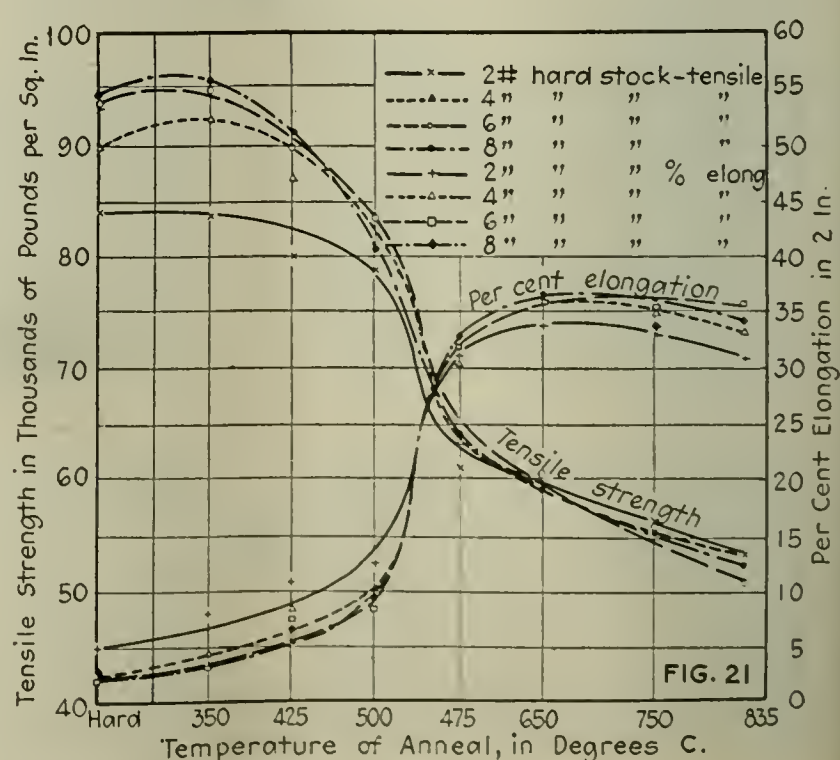
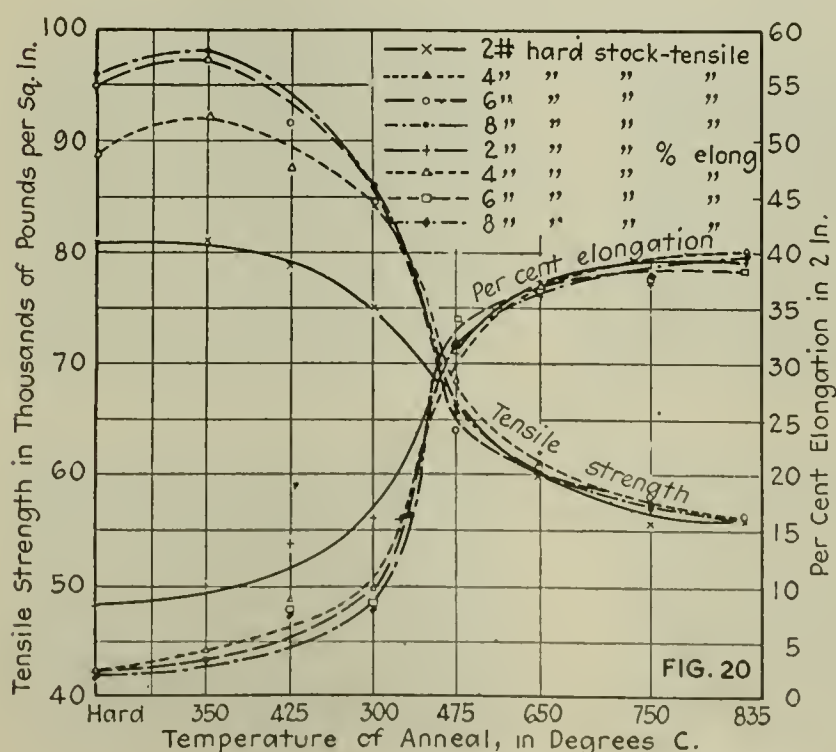
Alloy C—Analysis: Copper, 65.44 per cent; lead, trace; iron, 0.345 per cent; nickel, 17.83 per cent; manganese, 0.08 per cent; zinc, remainder.

Treat- ment	Yield Pt., Lb. per Sq. In.	Ten. Str., Lb. per Sq. In.	Per Cent Elong., 2 In.	Per Cent Red. Area	—Erichsen— Press., Lb. per mm.	Cup Depth, mm.	Scler.
Original Sample Reduced 16.6 Per Cent by Rolling:							
Original	67,000	80,766	8.0	40.7	4,712	574	8.21
350° C.	77,900	80,933	9.8	39.9	4,750	632	7.52
425° C.	70,233	78,433	13.7	40.0	4,875	604	8.07
500° C.	65,500	75,000	16.0	43.75	4,837	577	8.38
575° C.	46,566	66,660	30.7	44.6	4,865	553	8.80
650° C.	29,000	59,933	37.5	44.9	5,535	502	11.03
750° C.	24,067	55,567	37.3	45.7	5,433	498	10.92
835° C.	21,100	55,867	39.3	45.7	5,490	463	11.87
Original Sample Reduced 40.3 Per Cent by Rolling:							
Original	88,933	88,933	2.3	30.9	4,434	617	7.19
350° C.	89,600	92,300	4.2	33.7	4,248	693	6.13
425° C.	83,800	87,700	8.7	35.0	4,517	663	6.82
500° C.	79,300	84,567	9.8	38.9	4,499	629	7.17
575° C.	42,533	65,967	28.7	45.5	5,275	528	10.01
650° C.	30,667	61,067	37.0	49.8	5,142	504	10.21
750° C.	24,000	57,700	37.2	42.5	5,358	471	11.37
835° C.	21,767	55,900	40.3	44.6	5,237	434	12.06
Original Sample Reduced 52.7 Per Cent by Rolling:							
Original	95,000	95,000	2.3	30.8	3,555	688	5.16
350° C.	89,533	97,533	3.7	31.0	2,444	639	3.82
425° C.	87,133	91,667	7.7	35.3	3,932	710	5.56
500° C.	78,800	86,000	8.5	37.9	4,423	657	6.73
575° C.	39,333	64,266	34.3	49.3	5,418	534	10.15
650° C.	29,350	60,950	36.8	44.9	5,147	521	9.88
750° C.	26,750	57,800	37.8	44.7	5,300	473	11.21
835° C.	22,900	56,250	38.5	47.3	5,304	447	11.94
Original Sample Reduced 62.0 Per Cent by Rolling:							
Original	96,167	96,167	2.0	29.3	2,012	665	3.03
350° C.	96,633	98,333	3.2	30.5	1,794	642	2.79
425° C.	86,867	93,533	7.3	34.7	2,038	699	2.93
500° C.	80,200	85,933	8.2	37.5	4,316	685	6.30
575° C.	43,867	65,933	31.7	44.6	5,360	549	9.78
650° C.	34,300	62,067	36.3	44.3	5,420	526	10.30
750° C.	24,567	57,100	37.7	45.5	5,483	482	11.37
835° C.	22,067	56,167	39.8	43.6	5,368	442	12.15

TABLE VIII. PHYSICAL TESTS ON ANNEALED MATERIAL

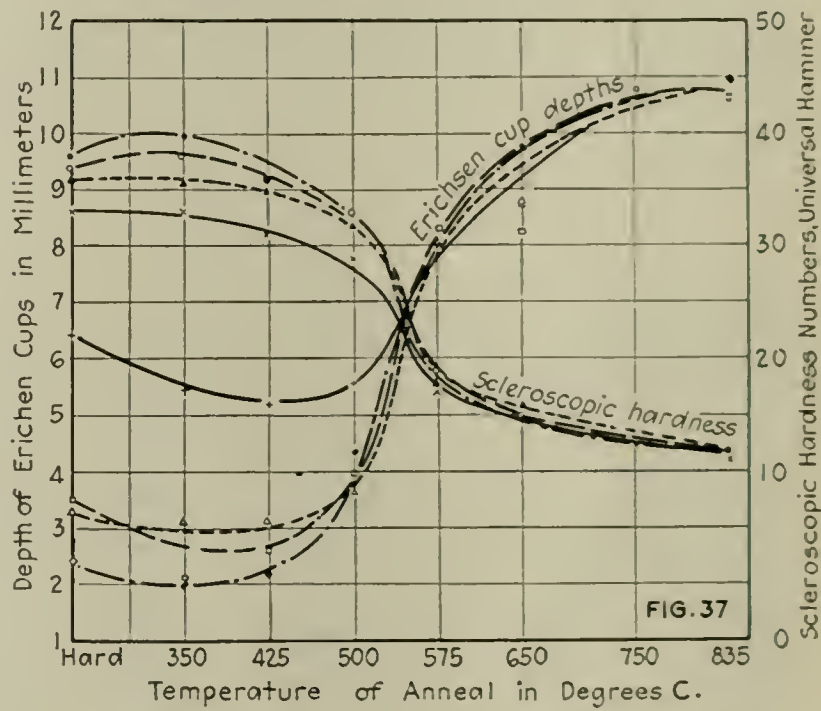
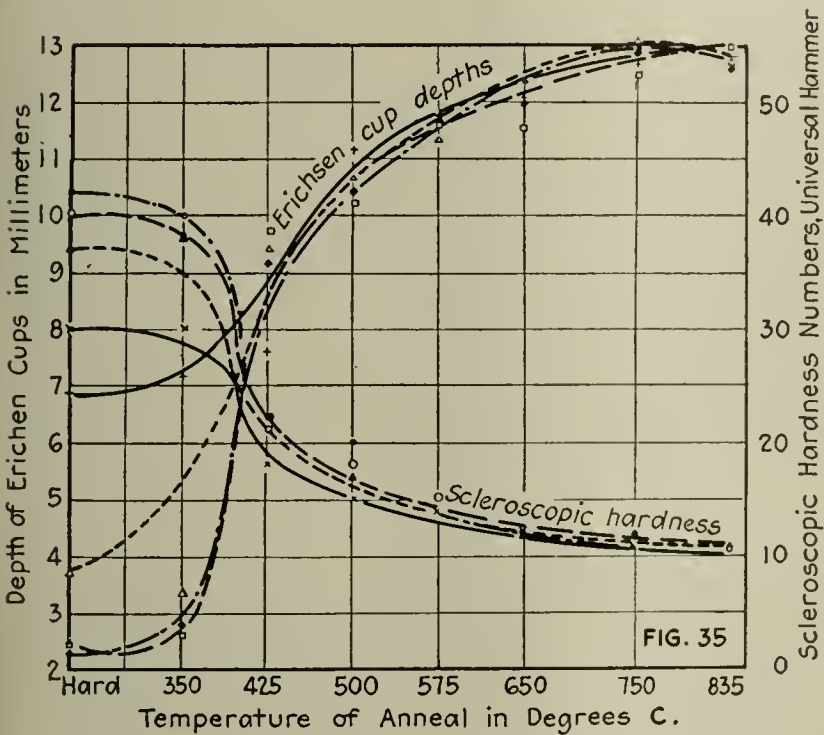
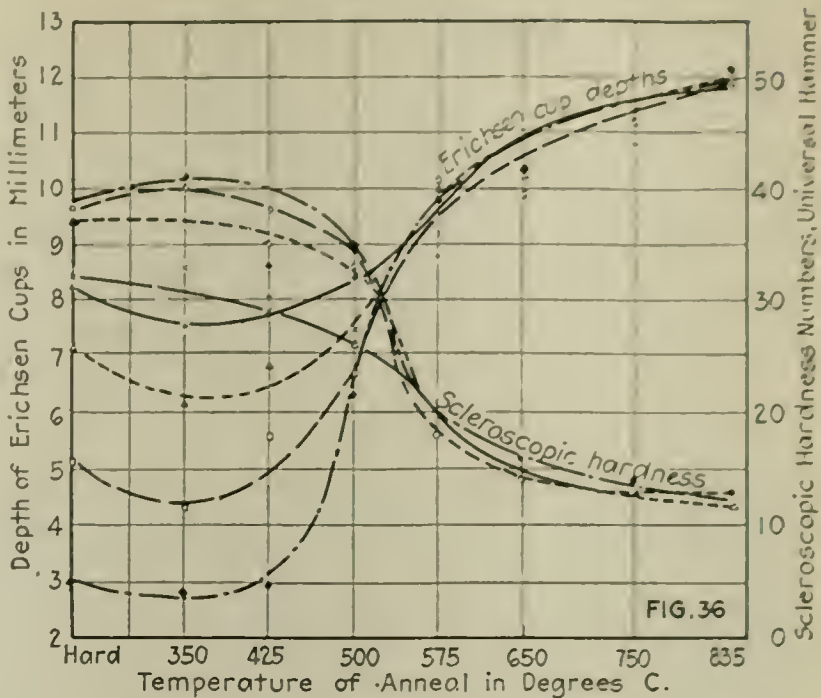
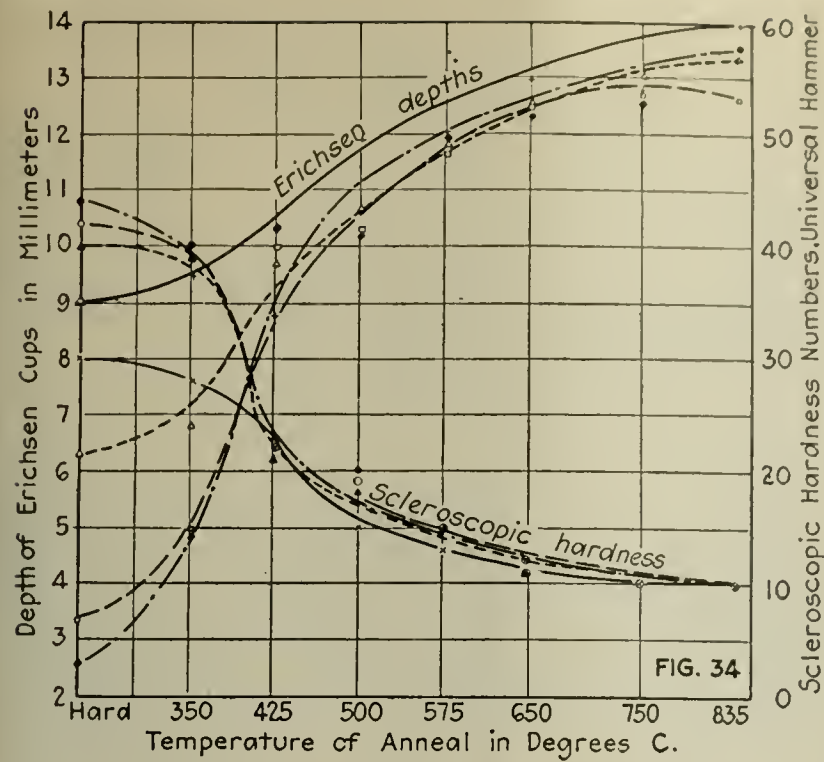
Alloy D—Analysis: Copper, 65.60 per cent; lead, 1.08 per cent; iron, 0.238 per cent; nickel, 17.77 per cent; manganese, 0.06 per cent; zinc, remainder.

Treat- ment	Yield Pt., Lb. per Sq. In.	Ten. Str., Lb. per Sq. In.	Per Cent Elong., 2 In.	Per Cent Red. Area	—Erichsen— Press., Lb. per mm.	Cup Depth, mm.	Scler.
Original Sample Reduced 16.95 Per Cent by Rolling:							
Original	58,167	83,933	5.2	33.0	3,490	540	6.46
350° C.	82,600	83,533	8.2	33.2	3,761	723	5.21
425° C.	76,100	80,133	11.2	34.5	3,577	693	5.16
500° C.	72,767	79,000	12.7	34.7	3,783	683	5.54
575° C.	33,433	61,233	32.2	46.7	4,813	610	7.89
650° C.	29,933	60,233	34.2	48.1	5,036	574	8.77
750° C.	26,633	56,767	33.5	46.6	5,063	480	10.55
835° C.	21,533	55,500	31.3	45.8	4,980	454	10.97
Original Sample Reduced 42.4 Per Cent by Rolling:							
Original	90,100	90,100	2.5	28.7	1,513	458	3.31
350° C.	87,367	92,500	4.5	28.0	1,665	537	3.10
425° C.	83,467	87,167	8.5	29.5	1,915	625	3.07
500° C.	71,600	83,367	9.8	31.2	2,227	620	3.58
575° C.	38,733	63,733	30.7	45.3	4,843	605	8.01
650° C.	30,967	60,767	36.0	47.6	4,770	542	8.81
750° C.	25,633	55,800	35.5	46.8	4,745	450	10.55
835° C.	21,933	53,533	33.5	44.4	4,715	431	10.95
Original Sample Reduced 52.7 Per Cent by Rolling:							
Original	94,167	94,167	2.2	26.9	1,357	396	3.48
350° C.	84,550	95,333	3.3	25.9	1,369	662	2.07
425° C.	84,900	89,950	7.5	29.2	1,405	549	2.56
500° C.	74,467	83,400	8.7	32.0	2,702	693	3.95
575° C.	41,667	65,467	32.3	46.4	4,881	588	8.30
650° C.	30,333	60,800	36.2	46.0	4,531	551	8.23
750° C.	24,900	56,133	35.7	48.0	4,781	445	10.75
835° C.	21,767	51,433	36.2	46.8	4,600	433	10.62
Original Sample Reduced 62.5 Per Cent by Rolling:							
Original	94,533	94,533	2.0	24.0	1,261	517	2.45
350° C.	95,900	95,900	2.7	23.1	1,164	580	2.01
425° C.	86,400	91,333	6.7	26.6	1,236	578	2.14
500° C.	72,433	80,867	9.5	32.9	2,823	651	4.34
575° C.	40,250	63,800	33.0	47.7	4,927	594	8.30
650° C.	28,950	59,600	36.8	46.8	4,857	497	9.79
750° C.	24,333	55,767	34.2	47.5	4,759	451	10.55
835° C.	21,367	52,700	34.5	46.6	4,707	430	10.95



FIGS. 20 AND 21. PHYSICAL TESTS TAKEN ON ANNEALED MATERIAL

Fig. 20—Alloy C. Analysis: Copper, 65.44%; lead, trace; iron, 0.345%; nickel, 17.83%; manganese, 0.08%; zinc, remainder. Original samples reduced 16.6, 40.3, 52.7 and 62.0% respectively.
Fig. 21—Alloy D. Analysis: Copper, 65.60%; lead, 1.08%; iron, 0.238%; nickel, 17.77%; manganese, 0.06%; zinc, remainder. Original samples reduced 16.95, 42.4, 52.7 and 62.5% respectively.



—x— 2# hard stock, scler. —o— 6# hard stock, scler.
—d— 4" " " " —+— 8" " " " "

—+— 2# hard stock, Erichsen —o— 6# hard stock, Erichsen
—d— 4" " " " " —+— 8" " " " "

FIGS. 34 TO 37. ERICHSEN DUCTILITY AND SCLEROSCOPE HARDNESS TESTS

Fig. 34—Alloy A, annealed series. Fig. 35—Alloy B, annealed series. Fig. 36—Alloy C, annealed series. Fig. 37—Alloy D, annealed series.

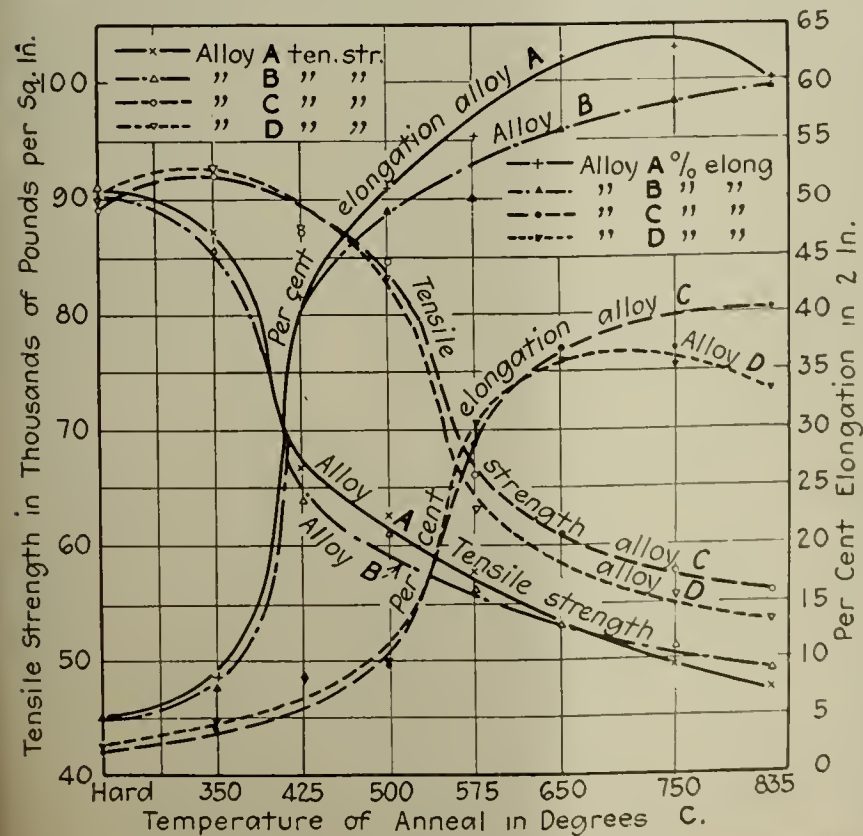


FIG. 38. TENSILE STRENGTH AND PER CENT ELONGATION OF ANNEALED SAMPLES ALLOYS A, B, C AND D, PREVIOUSLY ROLLED 4 NUMBERS HARD

specifically higher initial strength and lower elongation are evidently not unfavorable from the cold-working standpoint, as indicated by the behavior of the metal in practice when subjected to severe reduction by rolling.

MICROSTRUCTURE

Representative micrographs of the structures of alloys A and C, originally about 6 numbers (B. & S.) hard, are shown in Figs. 22 to 33 inclusive. Referring to Fig. 23, it will be seen that alloy A shows incipient recrystallization after an anneal at 350 deg. C. At 425 deg. C. the recrystallization is complete (Fig. 24). The grains grow as the temperature rises, but it is clear that the grain size is consistently smaller than that of brass treated in a similar way. Referring to Fig. 30, it is apparent that partial recrystallization of alloy C has begun at 500 deg. C., while complete recrystallization first occurs at 575 deg. C. (Fig. 31.)

These micrographs illustrate very clearly that in order to attain a given grain size the 18 per cent nickel silver requires an annealing temperature about 100 to 150 deg. C. higher than will suffice in the case of the 7 per cent alloy.

Scovill Manufacturing Co.,
Waterbury, Conn.

Statistics of Fats and Oils, First Quarter, 1921

The factory production of fats and oils (exclusive of refined oils and derivatives) during the three-month period ended March 31, 1921, as compiled by the Bureau of the Census, was as follows: Vegetable oils, 652,230,449 lb.; fish oils, 1,037,781 lb.; animal fats, 512,557,342 lb.; and grease, 89,312,244 lb.; a total of 1,255,137,816 lb. Of the several kinds of oils and fats covered by the inquiry the greatest production, 481,778,873 lb. appears for cottonseed oil. Next in order, edible and neutral lard with 430,238,669 lb.; linseed oil with 118,786,819 lb.; tallow with 80,989,879 lb. and coconut oil with 23,062,246 lb.

Nearly all the crude vegetable oils are passed through a refining process, although some virgin oil is expressed. The production of refined oil during the three-month period was as follows: Cottonseed, 424,315,821 lb., coconut, 36,554,004 lb.; peanut, 6,523,996 lb.; soya bean, 2,289,969 lb., and corn, 11,550,768 lb.

The data for the production, consumption, imports, exports and stocks of fats and oils and for the raw materials used in the production of vegetable oils for the three-month period appear in the following statements:

PRODUCTION, CONSUMPTION AND STOCKS OF FATS AND OILS

Kind	— For the Quarter Ending— March 31, 1921		Stocks Held March 31, 1921 Lb.
	Production, Lb.	Consumption, Lb.	
Vegetable oils:			
Cottonseed, crude.....	481,778,873	459,679,817	166,077,770
Cottonseed, refined.....	424,315,821	203,997,084	367,232,310
Peanut, virgin and crude.....	6,825,456	11,213,049	18,847,639
Peanut, refined.....	6,523,996	11,941,597	5,375,502
Coconut or copra, crude.....	23,062,246	61,531,261	65,447,081
Coconut or copra, refined.....	36,554,004	41,586,031	19,644,349
Corn, crude.....	15,669,550	13,394,679	5,469,271
Corn, refined.....	11,550,768	1,514,742	9,160,609
Soya-bean, crude.....	.....	9,215,295	17,135,825
Soya-bean, refined.....	2,289,969	5,400,691	3,699,120
Olive, virgin and crude.....	763,495	402,702	6,229,106
Olive, refined.....	59,425	160,328	1,526,717
Palm-kernel, crude.....	1,327,382	241,228	1,908,419
Palm-kernel, refined.....	.....	163,120	58,414
Rapeseed.....	15,000	1,602,763	3,648,241
Linseed.....	118,786,819	38,134,250	122,307,905
Chinese wood or tung.....	.....	5,918,985	15,417,919
Castor.....	3,611,809	1,024,043	4,786,270
Palm.....	.....	4,818,493	4,407,777
Chinese vegetable tallow.....	.....	682,068	681,260
All other.....	389,819	3,407,179	5,439,460
Fish oils:			
Cod and cod-liver.....	116,328	937,894	2,141,980
Menhaden.....	.....	8,206,843	27,516,534
Whale.....	64,500	1,066,907	10,810,825
Herring.....	86,412	157,518	2,623,027
Sperm.....	43,046	191,673	6,684,816
All other (including marine animal).....	727,495	633,104	3,518,812
Animal fats:			
Lard, neutral.....	21,245,978	8,026,511	9,953,106
Lard, other edible.....	408,993,291	64,286,516	115,467,838
Tallow, edible.....	8,569,272	5,913,233	5,303,491
Tallow, inedible.....	72,420,007	74,920,537	97,682,401
Neat's-foot oil.....	1,328,794	292,423	1,618,596
Greases:			
White.....	18,723,511	6,889,201	10,865,556
Yellow.....	12,156,352	8,155,827	11,117,985
Brown.....	8,334,846	7,650,765	14,226,646
Bone.....	5,957,916	1,072,700	8,048,759
Tankage.....	24,464,559	3,672,115	17,265,825
Garbage or house.....	14,114,330	7,529,025	24,407,150
Wool.....	1,050,341	305,483	1,547,791
Recovered or deg.....	3,211,420	1,990,522	2,512,392
All other.....	1,298,969	802,428	4,641,109
Derivatives:			
Acidulated soap stocks.....	14,419,846	12,915,898	17,382,635
Cottonseed foots.....	43,695,487	35,471,562	27,187,928
Cottonseed foots (distilled).....	3,890,287	1,788,555	7,922,627
Other vegetable foots.....	5,033,019	4,399,665	1,979,257
Other vegetable foots (distilled).....	.....	5,250	413,804
Fatty acids.....	18,521,429	19,104,682	8,567,362
Fatty acids (distilled).....	19,197,121	11,322,009	7,278,768
Glycerin, crude 80% basis.....	12,255,577	10,787,416	7,003,260
Glycerin, dynamite.....	4,567,373	7,024,796	10,138,412
Glycerin, chemically pure.....	6,652,993	446,787	4,484,220
Hydrogenated oil.....	42,404,313	13,607,919	32,189,758
Lard oil.....	3,294,700	1,300,137	4,155,778
Oleo oil, edible.....	39,227,067	11,025,343	25,091,827
Red oil.....	6,145,547	3,443,295	8,472,902
Stearic acid.....	4,076,405	1,186,976	7,303,013
Animal stearin, edible.....	19,497,413	11,610,325	7,705,704
Animal stearin, inedible.....	2,104,796	5,086,544	4,491,623
Tallow oil.....	2,146,926	6,805,915	3,005,558
Vegetable stearin.....	5,508,227	4,755,636	3,803,221
Miscellaneous soap stock.....	255,866	4,556,726	2,759,368

Note.—In some cases products are prepared by a continuous process, and intermediate products, which sometimes appear on the market under their own names are not reported.

RAW MATERIALS USED IN THE PRODUCTION OF VEGETABLE OILS

Kind	— Tons of 2,000 lb. — Consumed		Kind	— Tons of 2,000 lb. — Consumed	
	Jan. 1 to Mar. 31	On Hand Mar. 31		Jan. 1 to Mar. 31	On Hand Mar. 31
Cottonseed.....	1,478,606	299,976	Olives.....	2,567	30
Peanuts (hulled).....	2,822	4,021	Flaxseed.....	177,611	30,063
Peanuts, in the hull.....	8,889	48,425	Castor.....	3,829	2,879
Copra.....	17,372	3,100	Mustard seed.....	943	1,102
Coconuts and skins.....	256	111	Palm kernel.....	978	.....
Corn germs.....	22,978	441	Other kinds.....	93	82

IMPORTS AND EXPORTS OF FATS AND OILS

(For the quarter ended March 31, 1921)

Imports of Foreign Fats and Oils			
Kind	Lb.	Kind	Lb.
Cottonseed oil.....	438,241	Sulphur oil or olive foots.....	1,010,814
Coconut oil.....	44,846,135	Other vegetable oils (value).....	86,542
Peanut oil.....	576,510	Cod and cod-liver oil.....	1,346,115
Soya-bean oil.....	3,121,903	Tallow.....	64,366
Olive oil, inedible.....	317,175	Oleo stearin.....	60
Olive oil, edible.....	3,788,242	Glycerin, crude.....	436,648
Rapeseed oil.....	1,997,130	All other animal.....	400,905
Chinese-nut oil.....	4,062,578	Greases not elsewhere speci- fied.....	3,714,996
Linseed oil.....	554,235		
Palm oil.....	6,654,536		
Palm kernel.....	145,614		

Exports of

Domestic Fats and Oils		Foreign Fats and Oils	
Kind	Lb.	Kind	Lb.
Cottonseed oil.....	146,178,632	Coconut oil.....	633,493
Coconut oil.....	1,259,888	Cottonseed oil.....	3,750
Soya-bean oil.....	1,363,186	Olive oil.....	45,165
Peanut oil.....	425,008	Soya-bean oil.....	62,200
Linseed oil.....	1,177,658	Palm oil.....	72,804
Corn oil.....	1,011,464	Peanut oil.....	76,560
Other vegetable oil (value).....	\$174,731	Chinese-nut oil.....	182,678
Vegetable stearin.....	997,737	Sulphur oil or olive foots.....	43,689
Fish oil.....	146,595	Other vegetable oils (value).....	\$13,885
Lard, edible.....	250,642,768	Cod and cod-liver oil.....	30,382
Lard, neutral.....	7,535,276		
Tallow.....	3,178,705		
Oleo oil.....	32,687,123		
Lard oil.....	266,872		
Other animal oils.....	723,285		
Animal stearin.....	5,520,464		
Glycerin.....	380,857		
Soap stock and other greases (value).....	\$1,060,417		

Alcohol as Locomotive Fuel in Brazil

Consul C. R. Cameron, of Pernambuco, reports that there are in his district approximately 80 modern cane-sugar factories, which have about 800 miles of railway, of from 0.75 to 1 meter gage, operated at present by wood-burning locomotives. The fuel problem, however, is becoming a serious one and as a result the sugar-mill operators are turning their attention to the matter of reducing wood consumption and finding substitutes. Consequently great interest is being shown in the substitution of alcohol, which is produced in large quantities on the sugar plantations from the molasses finals. Pernambuco has recently adopted the use of alcohol to which 5 per cent gasoline has been added as an automobile fuel. The manufacturers are, therefore, naturally interested in using their own inexpensive product for their railways. The current price of alcohol is about \$0.22 per gallon, but the cost to the producer is much less.

Production of Sugar in France During the 1920-21 Season

A recent report from the office of the commercial attaché at Paris states that the total quantity of sugar delivered by the 72 factories in France from September 1, 1920, to the end of April, 1921, reached, 294,260,142 kilos, as compared with 156,377,837 kilos during the corresponding season of the previous year. The stocks remaining at the factories at the end of April amounted to 25,338,609 kilos, as compared with 6,977,050 kilos for the previous year.

The Dependence of the Lime Industry Upon Nature and Science*

An Essay Upon the Occurrence of Calcium Carbonate in Nature and Upon the Origin of the Limestone Deposits Which Form the Basis of the Lime Industry—Indebtedness of the Industry to Science—Technical and Personnel Research Problems

By ARTHUR D. LITTLE

A BUSINESS which consists essentially of quarrying and burning one of our commonest rocks and barreling and distributing the product does not at first sight seem to involve much of either science or romance. I hope to be able to convince you that it is replete with both.

In its relation to your business you think of limestone as the raw material of lime and are prone to overlook the fact that it is in reality an ore, and a most abundant one, of the metal calcium. The freshly-cut surface of the latter has a brilliant silvery luster, which upon exposure to the air is quickly dulled by the rusting or oxidation of the metal to its oxide, lime, from which through the Latin, *calx*, *calcis*, the metal takes its name. It is obviously one of the alkaline earth metals and closely resembles barium and strontium and to a lesser degree magnesium. Its specific gravity is about 1.5; it melts at about 800 deg. C. and it burns in the air with a white light to lime. It combines directly with most elements, including even nitrogen, with which it forms a nitride which, upon contact with water, evolves ammonia. A ton of pure limestone contains approximately 800 lb. of the metal, and chemically pure lime is over 70 per cent calcium. Science will ultimately find broad uses for a metal so interesting and abundant. It was discovered in 1806 by Sir Humphry Davy, who obtained an amalgam of calcium by the electrolysis of a mixture of lime and mercuric oxide. It remained a laboratory curiosity until 1900 and even as late as 1904 was quoted at £110 a pound. A year later an improved electric process brought the price to 12 shillings a kilo, or about \$1.30 a pound.

The Various Forms of Calcium Carbonate

CALCITE

Calcium carbonate, or carbonate of lime, exhibits in its various occurrences an extraordinary number of protean aspects. As calcite it is, next to quartz, the most widely distributed of minerals and notable for the beauty and remarkable variety of its crystalline forms. A number of highly important optical instruments, like the polariscope used for testing sugar, derive their usefulness from the property of double refraction possessed by calcite in the form of Iceland spar. For many years the world derived its supply of these crystals of suitable optical quality from a single quarry, a cavity in basalt in Iceland, 12 yd. long by 5 yd. wide and 10 ft. high, which yielded enormous crystals, some a yard in length.

Carbonate of lime is soluble in water containing car-

bonic acid gas, but is deposited from solution when the gas escapes. By the drip of water so charged there are built up in caves the deposits in widely fantastic shapes of stalactites and stalagmites. Carbonated springs in limestone districts may become so highly impregnated with lime as to build up terraces and basins of remarkable beauty by its subsequent deposition. Those at Mammoth Hot Springs in Yellowstone Park are doubtless familiar to many of you. Mexican onyx is another variety, and a vast deposit at Tivoli supplied much of the building stone for ancient Rome. The alabaster of the Orient was stalagmitic limestone.

LIMESTONE AND ITS ORIGIN

But ignoring such exceptional forms and speaking generally, all limestone is of organic origin, the result of the life processes of inconceivable myriads of animal organisms, and the story of its formation is at once a triumph and romance of science.

When I was a boy in Portland, Me., I spent much of my time in studying the marine life of the harbor; the starfish and anemones on the piles beneath the wharves; the sea urchins, whose projecting spines showed in section under the microscope a limestone mosaic of such wonderful symmetry and color as to make me realize for the first time how much the world contains of beauty that is hidden from most eyes; the jellyfish, big ones with sweeping tentacles and tiny ones with opalescent bands of waving cilia; the barnacles with their rhythmical projection of feathery hands in search of food. A dredge, dragged on the bottom behind my boat, brought up many treasures: among them none more wonderful than the fragile, beautifully constructed, chambered, calcareous shells of foraminifera with perforated walls. So tiny were they that a hand glass and much pains were needed for their separation, and their exquisite details of structure were revealed only under the higher powers of the microscope.

Now it is bad enough to call such tiny creatures foraminifera, but I must even ask you to remember that the commonest of them is further burdened with the more distinctive name of globigerina, for the globigerina are at least as directly concerned in the business of making lime as any of you here.

CHALK BEDS

If you rub down a piece of chalk to a thin paste with water you will find upon microscopical examination that it is composed almost entirely of the shells of foraminifera, and some common chalks are built up almost wholly of globigerina shells. Such are the chalk beds of England, which, often more than a thousand feet in thickness, extend across the island for 280 miles and at the coast line rise in those white cliffs to which

*Address delivered at the third annual convention of the National Lime Association, New York, June 16, 1921.

England owes her name of Albion. But the chalk bed stretches far beyond the coast of England, over much of France, through Denmark and Central Europe, south to Africa, and even into Central Asia. In our own country true chalk is found in Kansas, Iowa, Texas and elsewhere. As localities change, however, other types of foraminifera than globigerina become predominant in its substance. Thus the miliola, so called from its resemblance to millet seed, has built up the enormous beds of limestone in the vicinity of Paris. Certain beds of carboniferous limestone in Russia are entirely made up of the remains of another and peculiar type of foraminifera, spindle-like in shape and called because of that fusulina.

NUMMULITIC LIMESTONE

The Latin word for a coin was *nummus* and for a reason which will presently appear it gives its name to the nummulitic limestones, which extend over vast areas of North America and in a band often 1,800 miles in breadth and of enormous thickness from the Atlantic shores of Europe and Africa through western Asia to northern India and China. Of it the pyramids were builded, and from it was quarried and chiseled that memorial of antiquity, Cleopatra's Needle, which stands in Central Park.

This variety of limestone has been formed by the slow accretion of innumerable billions of the shells of foraminifera of the genus nummulites, which is characterized by shells of an extraordinary complexity of structure and a disk or coinlike form. They are remarkable also for their relatively vast size, the usual range of which is from one-half inch to an inch in diameter, though many are as large as a half-dollar and some even 4½ in. across. The significant fact is that, like the globigerina and other foraminifera, the nummulites are marine animals, and the genus is still represented, though by smaller types, in the ocean life of today.

Chalk is now forming on the ocean bottom, and there has been an unbroken continuity of chalk formation from Cretaceous times until now, while through the ages continents slowly rise.

Beneath that portion of the ocean which we call the North Atlantic lies a vast unbroken plain, which stretches from east to west for 1,700 miles. The mud and ooze brought up by dredges dragged along this plain consist almost entirely of globigerina shells or fragments of them, the tiny creatures passing their life cycle in the ocean depths where they are found. Here and elsewhere on the globe the globigerina ooze is forming chalk over 50,000,000 square miles of ocean bottom at an average depth of 2,000 ft. The overwhelming evidence is, therefore, that limestone, wherever found, is the product of aquatic life. Its common occurrence and broad distribution in the rock structure of the continents is proof that the regions of its occurrence were once beneath the sea, from which it has slowly emerged with the uplift of the land.

To those of you who think that science lacks poetry or romance or that the common things of life make no appeal to the imagination, I commend this passage from Huxley's lecture "On a Piece of Chalk":

Thus there is a writing upon the wall of cliffs at Cromer, and whoso runs may read it. It tells us, with an authority which cannot be impeached, that the ancient sea-bed of the chalk sea was raised up, and remained dry land, until it was covered with forest, stocked with the great game whose spoils have

rejoiced your geologists. How long it remained in that condition cannot be said; but "the whirligig of time brought its revenges" in those days as in these. That dry land, with the bones and teeth of generations of long-lived elephants hidden away among the gnarled roots and dry leaves of its ancient trees sank gradually to the bottom of the icy sea, which covered it with huge masses of drift and boulder clay. Sea-beasts, such as the walrus, now restricted to the extreme north, paddled about where birds had twittered among the top-most twigs of the fir-trees. How long this state of things endured we know not, but at length it came to an end. The upheaved glacial mud hardened into the soil of modern Norfolk. Forests grew once more, the wolf and the beaver replaced the reindeer and the elephant; and at length what we call the history of England dawned.

CORAL ISLANDS AND REEFS

But we do not look alone to the chalk for the origin of limestone. Its formation is still proceeding on the grand scale through the agency of the coral polyp in many of the warmer waters of the globe. Two and a half million square miles of ocean bottom is covered with coral mud and sands. The gigantic structures of the coral islands and the barrier reefs, of which one extends for a thousand miles along the Australian coast, are the work of tiny bits of animated jelly, which abstract lime from the sea water and so deposit it that it reproduces their own radiated anatomy. A similar type of limestone, which is well represented by the coral reef at Alpena, Mich., is the product of bryozoa, compound coral-like animals that are regarded as primitive mollusks. They build frondlike structures, developing ultimately into reefs and limestone.

Much of the history of the earth and much of the effort of the living organisms which it has borne is thus written into the material on which the lime industry is based. All the structural works of man fade into nothingness when compared with the results of the life activities of the minute foraminifera and the coral polyp.

PEARLS

The amazing capacity of carbonate of lime to assume forms of varied character and often of surpassing beauty is its most striking characteristic. The pearly shell of the chambered nautilus inspired Holmes to write one of the most elevating poems in the language. In the hope of securing a few grains of carbonate of lime rounded to form a pearl great companies of men shorten their lives by groping at the bottom of the sea. Curiously, the oyster forms the pearl around the dead body of an invading parasite so that, as a French writer has said, the ornament associated in all ages with beauty and riches is nothing but the brilliant sarcophagus of a worm. For myself, I prefer to derive encouragement from the fact that even so lowly a creature as the oyster can rise superior to misfortune and convert his troubles into pearls. It will interest you to know that in the Peabody Museum at Cambridge are pecks of fresh-water pearls which our Indians or their predecessors had thrown on sacrificial fires and that even today seed pearls are calcined in India and China for lime to prepare the betel nut for chewing.

MARBLE

In its metamorphosed form of marble, which, by the way, has given its name to one of the most ancient of children's games, limestone exhibits the widest possible range of texture, color and degree of purity. The marble from Mt. Pentelicus at Athens was chiseled by Greek

sculptors into forms that remain unrivalled in their classic beauty. Unhappily, much of the best Greek sculpture and architectural detail was broken up by the Turks and burned for lime. The finest works of Michael Angelo and Canova are executed in that other famous marble from Carrara. The onyx marble of Algeria was largely used in the buildings which were the glory of Carthage and of Rome. It is clouded with yellow and brown, like that found in Mexico at Tecali in large deposits. Wrought into the exquisite structure of the supremely beautiful Taj Mahal, marble gleams in the moonlight and is reflected in the pool like the fabric of an artist's dream.

A piece of limestone lying in the quarry seems a crude and simple thing, but when its history and associations are even thus partially reviewed, we find it something elaborate and complex, and rich in interest and suggestion.

Science and the Lime Industry

Similarly, the process of burning lime is at first sight a simple operation, which was successfully carried out for many centuries before the world had heard of science. It involves, nevertheless, a highly complicated series of molecular motions, changes and forces, which can be controlled to best advantage only through the agency of science. The results obtained on burning are influenced by many factors, such as the proper sizing of the limestone charge, the chemical composition of the stone, its physical structure, porosity and grain, the nature of the fuel, its heating power and sulphur content, the extent of the combustion area and the composition of the gases leaving the kiln, the volume of air admitted, the temperature of the several zones within the kiln, the flow of gases and the counter movement of the lime, the rate of cooling, the conditions of heat transference, the distribution of incoming air, and all the variations in kiln design. These are all factors which science can control. It can also produce accurate information as to the quality of the product for the aim in view.

MARKETS FOR LIME DEVELOPED BY SCIENCE

It is one thing to make good lime, but quite a different thing to find a market for it. The creation of the broad market which exists in normal times is due in large measure to scientific research. There was a time when practically the only outlet for lime was through the mortar bed. Today its use for building purposes accounts for only 28½ per cent of the lime produced for sale in the United States. About 12 per cent more goes to agriculture, the total thus accounted for being only 40 per cent. The allotment of the remaining 60 per cent is distributed among forty-one separate items, and if from them we omit the single item of calcimine, every one is available as the direct result of modern chemical research.

Let us devote a moment to a demonstration of the thesis:

The pulp and paper mills are now credited with using over 10 per cent of the domestic production of lime. They do so because Watt and Burgess developed the soda process for pulping wood, which requires lime to causticize the soda ash; because Tilghman studied the action of solutions of calcium bisulphite on wood chips and gave the world the sulphite process, by which 14,000 cords of wood are daily reduced to fiber in the sulphite pulp mills of the country. The alkali works

consume 145,000 tons of lime a year¹ because Leblanc, during the stress of the Napoleonic wars, sought and found the first cheap process for making alkali from salt and because Solvay by refined investigation developed that other method, by which salt, dissolved in strong ammonia water, is precipitated as bicarbonate of soda when the solution is charged with carbonic acid gas. In the course of the reaction the ammonia is converted into chloride, from which it is recovered by digestion with lime. Eighty-seven thousand tons goes to calcium carbide because the researches of Willson enriched the world by cheap carbide and acetylene, to which those of Franck added cyanamide. Thousands of tons of lime goes to the market as bleaching powder because Tennant solved the problem of fixing chlorine in a form convenient for transportation. Equally as the result of chemical research, lime is used in sugar factories and ammonia works, by the makers of soap and silica brick and phenol, in the gas works and at the coke oven, by makers of explosives and by the distillers of wood.

TECHNICAL PROBLEMS OF THE INDUSTRY

Fortunately for its continued progress, the lime industry is beset with many problems. In their solution lies the opportunity of the sagacious members of this association. The burning of lime is a chemical operation, and most of the problems connected therewith are fundamentally chemical problems, for the solution of which you must ultimately look to the chemist or chemical engineer. Why is it generally believed that wood is the best fuel for lime burning? Is it because its chemical composition and physical character confer upon it any singular property as a combustible? Or is it merely because it has been found to be foolproof? Now with wood rapidly becoming less and less available, how should the practice be changed to make available the much greater heating power of coal? If sulphur in coal is really seriously objectionable in its influence on operations, how may the sulphur be eliminated or its deleterious effect avoided? Doubtless we are still far from the ultimate design of kilns, but that ultimate design will not be reached until the physical chemist is taken into partnership, for it is the laws of physical chemistry that determine the effectiveness of such design.

Still more obviously must chemical research be depended upon for the better control of the quality and characteristics of the product and the elimination of those anomalies which are now the cause of irritation and complaint. Since 60 per cent of the country's production of lime is utilized for chemical purposes, it is especially important to consider more carefully the actual availability for such purposes of the lime that is produced. Of two limes it often happens, for example, that not over 80 per cent of the actual calcium oxide content of the lime as furnished is satisfactorily available within a reasonable period of time as a causticizing agent. The remainder seems to be sintered together by overheating or in combination with impurities. Of two limes apparently identical one may absorb 25 per cent more chlorine than the other. They may show radical differences when used in the causticizing plants. One may effect a quick reaction, forming a precipitate that settles rapidly, while the use of the other may be

¹This figure represents only lime sold to alkali works. In addition, about 1,500,000 tons of lime a year is produced by the alkali manufacturers for their own use.

impracticable because of the nature of the precipitate and its slow rate of settling. If used in the tanning industry for dehairing hides, one may be very active, while the other lime of identical analysis may require considerable excess to accomplish the same work. Lime from one locality may cause much trouble from irritation of the skin and the throats of workmen in the hydrate mill, whereas in other sections the dust in the air of the hydrate mill handling lime of practically identical chemical analysis has little or no such effect upon the workmen.

PLASTICITY A FUNDAMENTAL PHYSICAL PROPERTY OF LIME

In many instances it is not so much the chemical as the physical properties of the lime that determine its availability for special purposes. This is especially true as regards the proportion of lime putty formed and the plasticity or amount of sand the lime will carry when used by the building trades. Research alone can determine the fundamental cause of this variation—whether it is due to differences in size of particles, crystal structure, the presence of colloidal impurities, or what not. The problem is especially difficult to attack because of the lack of a definite and satisfactory measure of plasticity, for until we can measure a property accurately we cannot determine what tends to augment or decrease that property. Mere trial by an experienced plasterer will not yield the kind of evidence which leads to progress. It may even, I think, be questioned whether the newly developed plasticimeter of the Bureau of Standards is, after all, more than a refined and excellent practical test. Prof. Bingham of Lafayette more nearly approaches the fundamental problem when he separates plasticity into its two essential factors—mobility and yield point—and brings order out of the hazy chaos which has hitherto enveloped the word "plasticity."

FACTORS INFLUENCING THE PROGRESS IN THE LIME INDUSTRY

Research in modern industry is somewhat like a highly complicated and sensitive mechanism. It will not function properly unless care is taken in choosing the men who are to conduct it: not so much from the standpoint of their general qualifications as scholars, scientists and engineers as from the standpoint of their ability to unite into one compact body the various elements essential to constructive thinking plus its application in a concrete way in specified cases.

In the lime industry notable progress has been made in the design of kilns and in the mechanical features involving the transportation of materials from one point to another. A modern limekiln is a highly sensitive organ, which must be treated with proportionate care if results that measure its true ability are to be obtained. It is the result of careful research and stands today not as an experiment, but as a proved illustration of the value of modern research in industry. Although operating data are hard to obtain on kilns of earlier types, it is not unreasonable to suppose that a ratio equivalent to 2 lb. of lime per lb. of coal used would have been regarded as a highly efficient one. Today modern kilns properly operated often do better than 6 lb. of lime per lb. of coal over long-range periods of operation. Although the historic lime burner may have gathered his fuel from the surrounding woods at a cost which, to him, was measured by the amount of energy

personally expended, the cost to civilization in the long run has to be calculated on the basis of carbon content of the matter actually destroyed in the process. We may fairly say then that modern development in limekilns has done its bit to conserve the existing fuel supplies of the world and produce a product at a much decreased economic cost.

PERSONNEL

But it is not enough to have a highly developed instrument without adequate mentality to guide and control it. The type of lime superintendent of today is often a man who has come up through thirty years of rapidly changing conditions and is frequently disposed to regard refinements and developments with an austere eye, largely because he does not understand them. Their conception is fundamentally so different from his point of view that it is very difficult, if not impossible, for him to change his attitude of mind. The abuse of modern kilns in some instances has been so marked that one of the most prominent individuals in the lime industry today states emphatically that he prefers engineers who have never seen a lime plant in operation for technical superintendents to individuals who have had long experience in handling the older types of kilns. Criticism of this sort is an accusation against the balanced and co-ordinated development of research and indicates that the tool is more efficient than the operator.

The problems of research in its broadest sense include this problem of operating personnel, for the true significance of modern development is often poorly understood on account of the weakness of this link in the chain. One way in which every one can help, and particularly those who have been instrumental in bringing science into the lime industry, is by aiding the modern kiln to get a square deal in operation. The place for Orsat apparatus and pyrometer is not in the storeroom, but near the kiln stack, and until chemical control is intelligently used throughout a large portion of the industry much good money, that might be saved and available as profits, will continue to go up in smoke and be a loss.

France's Foreign Trade in the First Four Months of 1921

The April figures of the foreign trade of France are as follows:

	First 4 Months		Difference Francs
	1920 Francs	1921 Francs	
Imports:			
Foodstuffs.....	2,739,651,000	1,598,000,000	—1,141,651,000
Raw materials.....	5,199,976,000	3,559,000,000	—1,640,976,000
Manufactured goods.....	2,714,930,000	1,961,000,000	—753,930,000
Total.....	10,654,557,000	7,118,000,000	—3,536,557,000
Exports:			
Foodstuffs.....	474,522,000	700,000,000	+ 225,478,000
Raw materials.....	1,237,971,000	1,762,000,000	+ 524,029,000
Manufactured goods.....	2,861,362,000	4,520,000,000	+ 1,658,638,000
Postal parcels.....	197,041,000	418,000,000	+ 220,959,000
Total.....	4,770,896,000	7,400,000,000	+ 2,629,104,000

The trade balance is:

First four months 1920: Adverse—5,883,661,000 f.
First four months 1921: Favorable—282,000,000 f.

In connection with the above figures, it is noteworthy that the favorable trade balance of 129,000,000 f. which France accumulated in the first three months of the current year has been increased to 282,000,000 f. in the month of April and that a total adverse trade balance of 5,883,661,000 f. (1920) has been changed into a favorable trade balance of 282,000,000 f. (1921).

Determining Factors for the Life of a Pneumatic Tire*

BY WILLIAM G. NELSON

THERE are five very important and very decisive factors for determining the life of a pneumatic tire. Each has a direct bearing upon the other and a weakness in any one will prove a deathblow to the ultimate mileage which a tire is supposed to give. These five factors are: Rubber and compounding materials, fabric, construction, vulcanization and usage.

RUBBER AND COMPOUNDING MATERIALS USED FOR TIRES

The rubber and compounding materials are comprised of rubber, fillers, softeners, accelerators and vulcanizing agents. A mixture of rubber, sulphur and other materials is called a compound. There are various kinds of compounds used in a tire, as tread, carcass friction and skim coat, breaker friction and skim coat, and side wall. The tread must have good wearing qualities, good appearance and co-ordination with the carcass. By this last phrase is meant the ability to adhere properly to the remainder of the tire. Good wearing qualities are obtained by properly compounding suitable materials and curing agents with high-grade wild or plantation rubber. The most finely divided fillers, such as zinc oxide, gas- and lamp-black and similar mineral fillers, are extensively used due to their microscopical fineness, which gives high tensile strength, good stretch and resistance to abrasion, cutting and aging. Friction and skim coat stocks are so compounded as to give good adhesion to the fabric and a cushioning effect between the plies of fabric. These stocks are composed almost entirely of rubber, softeners, sulphur and accelerators. The vulcanizing agent, which is sulphur, and accelerators are, excepting the rubber, the most important parts of a compound. An accelerator is a material which accelerates the chemical combination of the sulphur with the rubber; since their action is so erratic in mixing, calendering and vulcanizing, only experienced men should undertake the handling of these agents. The side wall must have good appearance, as it holds one of the most conspicuous places on the tire. It is used for the protection of the fabric against chafing and moisture. Since it is continually exposed to atmospheric conditions it must have good aging qualities rather than high tensile strength or long stretch.

All compounds that come in contact with another must have good adhesion after vulcanization. The factors that bear upon this condition are: Type of rubbers selected; kind and amount of fillers, sulphur and accelerators; mixing and calendering of the compound; building of the tire, and finally the degree of vulcanization.

FABRIC

Fabric is the foundation upon which the tire is built. It is used to give stability and strength. There are two well-known classes of tires: the square-woven fabric and the cord fabric. In the square-woven fabric tire the threads in each ply run in both directions, alternating over and under as in a piece of ordinary cloth. In the cord fabric tire the threads or cords in each ply run parallel with the exception of a few

small cross threads, used simply to hold the cords in place while they are being impregnated with the rubber compound. The life of a tire would be greatly increased if internal friction could be eliminated. The internal friction caused by intermittent distortion of the tire in use is the result of the friction of the threads upon one another and the strains and stresses set up in the rubber compound. Naturally the fabric which gives the least amount of internal friction will accordingly give the longest life to the tire. Since square-woven fabric cannot be thoroughly impregnated with rubber compound the places where threads cross will be left bare and at these points flexing will cause a sawing action and the generating of frictional heat.

INFLUENCE OF HEAT ON THE LIFE OF TIRES

It has been demonstrated very clearly by experiment that when the temperature resulting from mechanical action reaches 230 deg. F. vulcanized rubber ceases to function as an adhesive compound, crumbles into minute particles which fail to resume their original condition, causing the compound to lose its function in the tire. This causes separation, weakness, and finally a blow out.

It may be interesting to know that 265 deg. F. is not an uncommon temperature reached in a tire when driven at high speed over the road; this is particularly true of large truck tires. In the case of cord fabric each thread is imbedded in the rubber compound and the internal friction is reduced to a minimum. The ideal condition would be to have each cotton fiber of the thread imbedded in rubber, but of course this is not practical and on account of weaving difficulties has not been accomplished.

CORD VS. SQUARE-WOVEN FABRIC

Since cord fabric comes closer to the ideal condition, the time is not far distant when it will entirely supplant square-woven fabric in the carcass of the tire. A step in this direction will be made when the cost of producing cord tires is sufficiently reduced to successfully compete with the square-woven tire. A brief summary of the advantages derived from the use of cord tires would include easier riding, due to greater resiliency; saving of gasoline and oil; saving of machinery, and more miles per dollar.

Fabric is also used in the breaker and chafing strips. The breaker fabric is covered with a rubber compound that will act as a binder between the soft-cushion stock and the stiff-tread stock. The breaker fabric is used to give stability to this compound and therefore to decrease the separation between the tread compound and the cushion. The chafing strips are used for protection and reinforcement.

MIXING AND CALENDERING

At this point something should be said about the mixing of the rubber and ingredients, and the calendering or application of the compound to the fabric. There are so many factors that enter into the mixing that they can be only briefly described here. Breaking down of the rubber by mechanical action changes it from a tough, hard state to a tacky, plastic condition. This influences the impregnation of the fabric, tackiness, blooming and other physical qualities, and also the vulcanization. The thoroughness of incorporation of the compounding elements has an influence upon uniform vulcanization and wearing conditions. In

*Read before the American Institute of Chemical Engineers, Detroit, June 23, 1921.

order to eliminate to the highest degree the variable conditions inherent to milling, calendering, building operations and vulcanizing it is necessary to have every process standardized and a rigid inspection to hold to a minimum the factor of the human element. Therefore all reputable manufacturers analyze thoroughly all compounding materials and rigidly inspect all fabric before these elements enter into the tire and also carefully control the degree of vulcanization in the finished product.

TIRE CONSTRUCTION

Tire construction is an art in itself. It is like the building of a machine and just as much care must be used in designing a tire as is used in designing a finely adjusted machine. As nearly every tire is built on an iron core and is vulcanized in a mold the space occupied by the tire is constant and is filled with a unit composed of many variables. Therefore when the fabric is frictioned and skim coated it is held to a gage of a maximum or minimum variation of 0.002 or 0.003 in. Likewise all other parts as top cushion, breaker, tread, bead and side wall are held to a maximum or minimum gage. The proportion of the fabric to the rubber compound must be properly balanced. The addition of an extra ply or the increase of the thickness of rubber compound may destroy this balance and materially weaken instead of strengthen the tire. It has been demonstrated many times by actual service tests that the correct distribution of rubber compound in the tire will increase its life several thousand miles; or the changing of the sulphur one-half of one per cent in a single compound will cause an equal variation in the mileage. There are many faults in a finished tire that can be attributed to improper construction, as excessive overflow, wrinkling of breaker and plies, incompletely filled molds, and weakness in the beads. These are usually remedied by changing the construction but in some instances the proper results can be obtained by changing the compound, the process of vulcanizing, or redesigning the equipment.

VULCANIZATION

There is probably no phase of tire manufacture that receives more attention than the vulcanization of the tire, and still there is no phase that is more problematical. The proper degree of vulcanization is an empirical condition existing in the various components of a tire which is determined by results obtained by road tests. Either an under-vulcanized or an over-vulcanized tire will give low mileage; even if a single part, such as cushion, breaker or tread compound, is over- or under-vulcanized, the entire tire will give poor results.

The controlling factors in a compound to obtain this empirical state are the sulphur, accelerators, rubbers, milling and calendering, time and temperature of the cure. Any one of these conditions will materially affect the state of vulcanization. The proper manipulation of these variables is a chemist's job and requires great care, thought and experience. It is absolutely essential for the chemist to have a laboratory fully equipped to make comparative physical and chemical analyses, to develop new compounds and try out new compounding ingredients. Various types of rubbers made by different methods of coagulating, washing and drying have different vulcanizing ranges and optimum cures—that is, the state of maximum efficiency when

vulcanized—therefore great care must be exercised in their selection for a compound.

Furthermore the optimum cures of all compounds must be so adjusted that in the finished product every component of the tire has simultaneously reached its maximum efficiency. Excessive milling causes the compound to vulcanize more slowly but more uniformly; decreases the tensile strength, and increases the stretch. These actions can be explained by the breaking down of the rubber molecule into its polymeric stages, each stage having its own particular range and optimum cure with its corresponding tensile and stretch. The slower a compound is vulcanized to its optimum cure the better resistance to aging it will have; therefore low vulcanizing temperature and long time is preferable for quality of product, but owing to the demands of quantity production higher temperatures and shorter times are resorted to. The scientific explanation of the effect of time, temperature and mechanical action upon quality of product is a problem of research and it is high time that some of these problems were given proper investigation by the scientific men of today.

USAGE

If the tire is neglected and abused while in service, all the care used in testing and selecting the rubbers and the compounding materials, analyzing the fabrics, standardizing the operations and maintaining an experienced organization in order to make the most uniform and perfect product will be of no avail. A pneumatic tire is designed and built to contain air or an inert gas under pressure, and there are no recommendable substitutes for it on the market today. The greatest danger that befalls a tire in service is under-inflation. Proper inflation is to the life of a pneumatic tire what proper food is to the life of a living being.

CAUSES FOR PREMATURE FAILURES OF TIRES

Eighty per cent of the failures in tires can be traced to under-inflation. Briefly the results of under-inflation are early separation in all parts of the tire, rim cutting, abnormal development of frictional heat, greater power and fuel consumption, rupturing of the fabric, splitting of tread and abnormal strain throughout the tire. The Society of Automotive Engineers, the Tire and Rim Association and all the large manufacturers of tires have agreed upon standard pressures to be used in tires and these pressures should be adhered to religiously in order to obtain the highest mileage. Overloading is another abuse that is often imposed upon a tire which causes an early breakdown of the carcass and finally a blow out. Other causes for premature failures are: Improperly fitting rims, which cause rim cutting, thus exposing the fabric to moisture and chafing; misalignment of wheels, which causes excessive tread abrasion; running over curbs, deep ruts, stones, nails and glass, which causes breaks and cuts in the tread and carcass; sudden braking, which causes tread abrasion and separation; turning corners at high speed, which causes excessive strains on the fabric and later a rupture; overheating, which causes separation, and sun exposure, which causes checking.

The ultimate desire of every motorist is to obtain the most miles per dollar per tire with the advantages of riding on a cushion of air, and the only way for him to obtain his desire and retain these advantages is to use common sense in the use and care of the pneumatic tire.

Artificial Seasoning of Steels

Review of Available Data on Length Changes and Spontaneous Generation of Heat in Hardened Steels, Together With Results of Preliminary Experiments on Artificial Seasoning by Different Methods of Several Types of Steels Used for Making Limit Gages

BY H. J. FRENCH, MET. E.

THE fact that steels, under certain conditions of work and thermal treatments, undergo changes with time at ordinary atmospheric temperatures has long been known or suspected, and it has also been definitely established that these changes can be hastened by suitable heat-treatment or other artificial seasoning methods. Very little is known, however, regarding the nature of such changes, and there are relatively few publications available which deal with this question.

So-called tempering of hardened steels in hot water (aging) has long been used. While the discovery of the fact that hardening is effected by quenching from 100 deg. C. is credited to Langley and Metcalf¹ (1892), Hetzel² calls attention to earlier experimental work carried out along similar lines by H. Carron in 1872-73.

Schottky³ has noted spontaneous generation of heat in hardened carbon steels when tempered at 100 deg. C., the magnitude of this effect apparently depending upon the carbon content and quenching temperature as well as on other factors.

BRUSH'S WORK ON HEAT GENERATION

Brush⁴ has also shown that high-carbon tool-steel and chromium-tungsten "high-speed" steel spontaneously generate heat in appreciable quantity for at least several weeks after water-quenching from a high temperature and that the rate of generation steadily diminishes with time. Samples of hardened carbon tool-steel likewise shrank progressively when tempered to "straw color," to "light blue" and finally annealed, while after hardening, certain samples gave evidence of spontaneous shrinkage for many days in measurable amount. The behavior of these latter specimens was similar to that of the former in the gradual decrease in magnitude of the observed effect, which suggested a relationship between the two phenomena. Contraction was not considered the prime cause of the spontaneous heat generation, because calculations showed it to be inadequate in amount.

In more recent experiments carried out by Brush and Hadfield⁵ specimens of a nickel-chromium steel behaved similarly when quenched from a temperature just above that of decalescence. The magnitude of the observed heat-effect was increased by a repeated treatment and persisted even when the specimen was

heated for a third time and allowed to cool very slowly to a temperature where complete recovery of magnetic susceptibility was attained before quenching. Because of this anomaly further investigation by Brush, Hadfield and Main⁶ was undertaken and some interesting facts were brought to light.

Attention is called to the fact that absorption of heat resulted from quenchings made at rising temperatures which generally had not previously been exceeded and that carbon tool-steel showed none of the eccentricities of the nickel-chromium steel when quenched below the hardening temperature; but when quenched above they behaved very much alike. It was also found that the rate of contraction of quenched steels followed the same law as the rate of evolution or absorption of heat which, after a short initial period, is approximately in inverse ratio to the time after quenching. It is generally considered that such contraction is due, at least in good part, to completion of the partly suppressed allotropic transformation.

JAPANESE STUDIES ON AGING

Matsushita⁷ has studied the nature of the slow contraction of hardened Krupp carbon steels and concludes that in well-hardened samples there is always a gradual contraction, whereas in imperfectly hardened steels there is a gradual elongation or an elongation associated with a subsequent contraction. It is stated that elongation results from the imperfect A₁ transformation, while contraction is ascribed to the separation of an unstable cementite from its solid solution (martensite) which does not affect the hardness. Complete separation of the first unstable carbide at room temperature requires several months or longer, while the same separation follows within two hours by heating the steel to 100 deg. C. The author also reports that the elongation or contraction of hardened steel is always accompanied by heat evolution.

Low elongation and reduction of area values have been noted by Reinhardt and Cutler⁸ in tensile tests made immediately after heat-treatment and machining of test-bars taken from 5½-in. square steel billets containing 0.49 to 0.55 per cent carbon. Aging at room temperatures for twelve to twenty-four hours sometimes increased ductility more than 100 per cent, whereas similar beneficial effects were obtained in very much shorter time by heating to 120 deg. C. (248 deg. F.). Evidence is presented that complete restoration of

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²Discussion of paper by A. McCance, "A Contribution to the Theory of Hardening," *J. I. & S. Inst.*, 1914, No. 1, p. 250.

³E. Hetzel, "Tempering in Hot Water," *Rev. Metal.*, vol. 12 (1915), p. 584.

⁴H. Schottky, "On a Thermometrically Recognizable Tempering of Quenched Steel at 100 deg. C.," *Ferrum*, vol. 10 (1912), p. 274.

⁵C. F. Brush, "Spontaneous Generation of Heat in Recently Hardened Steel," *Proc. Am. Phil. Soc.*, vol. 54 (1915), p. 154.

⁶C. F. Brush and Sir R. A. Hadfield, "Spontaneous Generation of Heat in Recently Hardened Steel," *Proc. Roy. Soc. (London)*, vol. 93A (1917), p. 188.

⁷C. F. Brush, Sir R. A. Hadfield and S. A. Main, "Further Experiments on Spontaneous Generation of Heat in Recently Hardened Steel," *Proc. Roy. Soc. (London)* (abstract), vol. 95 (1918), p. 120.

⁸T. Matsushita, "On the Slow Contraction of Hardened Carbon Steels" (abstract), *Proc. Tokyo Math.-Phys. Soc.*, vol. 9 (1917-18), p. 312.

⁹G. A. Reinhardt and H. L. Cutler, "Effect of Time and Low Temperature on Physical Properties of Medium-Carbon Steel," *Bull. A.I.M.E.*, vol. 151 (1919), p. 1091.

ductility, which required about sixteen days at room temperatures, could be obtained at 120 deg. C. in twenty-five hours.

Honda and S. Saito⁹ have recently studied the effects of two artificial seasoning treatments on the properties of K. S. magnet steel of the following composition:

	Per Cent
Carbon.....	0.40—0.80
Cobalt.....	30.0—40.0
Tungsten.....	5.0—9.0
Chromium.....	1.5—3.0

Residual magnetism was not appreciably diminished by prolonged heating for 10-hour intervals at 100 deg. C. (212 deg. F.), while mechanical aging, carried out by dropping a bar 850 times on a concrete floor from a height of 1 m., decreased the magnetization by 6 per cent of its initial value.

NATURE OF SPONTANEOUS CHANGES

Undoubtedly the spontaneous evolution of heat, dimensional changes and other observed effects such as have been described above are directly associated with the initial stresses and suppression of the transformations resulting from rapid cooling (quenching). As recently pointed out by Jeffries,¹⁰ the presentation of an adequate explanation of such phenomena offers extraordinary difficulties. Admittedly an atomic rearrangement takes place in hardened steels at room temperature and because of the resistance of mechanical cohesion the time factor is pronounced.

If the character of the dimensional changes (contraction or elongation) occurring in quenched steels is dependent upon the adequacy of hardening as reported by Matsushita,⁷ it would appear that for each steel there would be a critical time-temperature relationship in quenching which would at least decrease the magnitude of such changes, and investigation of this point might well be undertaken.

STABILITY OF GAGES

Dimensional changes with time are often encountered in hardened reference gages, and their magnitude and occurrence have been found to vary considerably in gages produced from the same materials under similar conditions of manufacture. In this case, where the steel is used as a standard of measurement, changes in length and planeness of the order of 0.00005 in., which ordinarily might be neglected, become of considerable importance, as do also the methods capable of hastening their completion.

During 1919, at the request of the Ordnance Department, U. S. A., a systematic investigation of the effects of seasoning of gage blocks was planned, using five steels already employed in the manufacture of gages or those which appeared to offer possibilities for such work. A large number of gages were produced and seasoned in various ways, following which changes in dimensions were noted over an extended period. While it is not possible to draw any definite general conclusions from the results obtained, it is believed that presentation of the following data will be of interest and possibly benefit those who may at some future time elect to investigate this subject, or perhaps it will bring to light existing information not yet published.

⁹K. Honda and S. Saito, "On K. S. Magnet Steel," *Proc. Phys.-Math. Soc. Japan*, 3d series, vol. 2, No. 3, p. 32.
¹⁰Zay Jeffries, "Physical Changes in Iron and Steel Below the Thermal Critical Range," *Mining Met.* (Feb. 1920), vol. 158, section 20.

All gages used were prepared in the gage section of the Bureau of Standards, while the actual work in carrying out the various heat-treatments was performed by H. R. Yerger, formerly of the staff, who also planned the investigation in consultation with various members of the metallurgical division, gage section and optics division. C. G. Peters and assistants of the interferometry section of the last named division of the Bureau have carried out all the measurements for flatness and length of the gages as reported in this paper.

MATERIALS AND PROCEDURE

Five steels were chosen for the work on permanence as shown in Table I. They were received in the form of 1-in. hot-rolled rounds and were first annealed and then examined microscopically for excessive non-metallic inclusions and surface decarburization. As a result of this examination a few bars were discarded, while the remainder were machined and ground into rough gages. These latter were then hardened by heating in a lead bath (equipped with suitable pyrometric control) and quenched in oil. After grinding, the blocks were seasoned in various ways and the gages were then finished in accordance with the Hoke method.¹¹

The hardening treatments used for the five steels are shown in Table II. Temperatures chosen are not very different from those ranges recommended by the manufacturers, though in one case preliminary quenching experiments were also carried out to determine what would be a suitable treatment. In selecting the various seasoning treatments listed in Table III, time and temperature variations as well as relatively rapid changes between temperatures above and below that of the room

¹¹H. L. VanKeuren, "Manufacture of Hoke Precision Gages at the Bureau of Standards," *Am. Mach.*, April 3, 1919, p. 625.

TABLE I. COMPOSITION OF STEELS TESTED

Code Letters	Chemical Composition, per Cent									Suggested for Investigation B. cause of
	C	Mn	P	S	Si	Cr	Ni	W	V	
HC	0.96	0.35	0.014	0.017	0.25	1.31	0	....	..	Use for bearings requiring high hardness, permanence, wear resistance, etc.
K	0.87	1.10	0.017	0.10	0.23	0.46	0	0.43	0.12	Avoidance of cracking and warping in hardening.
DR	1.18	0.20	0.016	0.013	0.21	0.08	0	....	....	High hardness obtainable in heat - treatment.
ST	0.29	0.36	0.009	0.014	0.70	13.20	0	....	....	Non-corrodible qualities.
DB	1.18	2.20	0.008	0.026	0.26	18.10	0	....	....	Non-deforming qualities and high cutting value.

TABLE II. HARDENING OF THE STEELS TESTED

Code Letters	Oil Quenched from		Remarks
	Deg. C.	Deg. F.	
HC	850	1,562	Note.—Temperatures approximating those recommended by the manufacturer have been used.
K	800	1,472	
DR	800	1,472	
ST	955	1,751	
DB	955	1,751	

TABLE III. SEASONING TREATMENTS USED

Code Letter	Description of Treatment
A	No treatment after hardening.
B	Heated in oil 3 hr. at 100° C. (212° F.) and air-cooled.
C	Heated in oil 3 hr. at 150° C. (302° F.) and air-cooled.
D	Heated in oil 3 hr. at 200° C. (392° F.) and air-cooled.
E	10 alternate 5-minute dips in oil at 200° C. (392° F.), and water at 0 to -5° C. (32 to 23° F.)
F	80 alternate dips as for E above.
G	44 alternate dips of 3 minutes in gasoline at 35 to 20° C. (-31 to -4° F.) and 7 minutes in oil at 200° C. (392° F.).
H	Heated in oil 1 hr. at 275° C. (527° F.).
I	Heated in oil 4 hr. at 275° C. (527° F.).

were considered important. The latter class of treatments may or may not involve a change in state depending upon the hardening conditions, whereas the former is considered to decrease the resistance of mechanical cohesion.

In making tests for planeness (flatness), the usual opticians' method of testing plane surfaces was used. Length tests were made by comparing the gages with the standard precision gages at the Bureau of Standards. The standard and unknown gage were brought into close contact with a plane glass surface and the difference in length was determined from the displacement of the interference fringes occurring when a second glass plane was made to form wedge-shaped films of air over the upper surfaces of the gages, and the film illuminated by monochromatic light at nearly perpendicular incidence. This method for testing gages is described by Peters and Boyd.¹²

IMPORTANCE OF EARLY OBSERVATIONS

A summary of the results of these measurements over an extended period, together with records of Shore scleroscope hardness and intervals between date of hardening, first and last measurements, is given in Tables IV and V for each of the five steels under considera-

¹²C. G. Peters and H. S. Boyd, "The Calibration and Dimensional Changes of Precision Gage Blocks," *Am. Mach.*, Sept. 30 and Oct. 7, 1920.

tion. It would have been desirable to have the first measurement made on each gage on the day of seasoning, which in turn might have been carried out after a definite number of days from the day of hardening. However, this was not found possible on account of the number of operations and length of time required in finishing the blocks and because of the large number of measurements for length and planeness which would of necessity have to be made on any given day. A schedule approximating this procedure as closely as possible was therefore adhered to. Though others are perhaps not in agreement with this, the writer is of the opinion that under these conditions a very important period for studying permanence (the time immediately following the hardening and finishing of the gages) has, by force of circumstances, been neglected, assuming that the changes in any given short time interval (a few days

TABLE V. PLANENESS CHANGES IN 1/4 INCH GAGES IN MILLIONTHS OF AN INCH

Steel	First Meas., No. of Days After Hardening	No. of Days Between First and Last Measurements	Ave. of 4 Gages	Max. of 4 Gages	Min. of 4 Gages
K	14	211	7	17	0
	8	227	29	58	5
	8	227	5	23	0
DR	8	227	13	69	0
	8	227	6	23	0
	8	227	8	34	0

TABLE IV. SUMMARY OF DIMENSIONAL CHANGES IN QUENCHED 2-IN. REFERENCE GAGES WITH AND WITHOUT SEASONING TREATMENTS AND SHORE HARDNESS VALUES

Each seasoning treatment was applied to 4 gages. Where no changes in length or planeness occurred equal to or greater than 0.00001 in., no figures are given.

—Seasoning Length Changes in Millionths of an Inch*—

Steel	Annealing	Hardening Heated in Lead Bath to	Treatment	No. of Days After Hardening	No. of Days Between First and Last Measurements	Average of 4 Gages	Max. of 4 Gages	Min. of 4 Gages	Shore Hardness of Seasoned Gages		
									Average of 4 Gages	Max. of 4 Gages	Min. of 4 Gages
HC	900° C. air-cooled then 800° C. furnace cooled.....	850° C. and oil quenched....	A	2	217	70	80	50	93	95	92
			B	2	217	17	20	10	96	98	94
			C	2	217	10	20	0	92	95	89
			D	2	217	7	20	0	84	87	81
			E	2	217	7	20	0	90	92	84
			F	13	245	—7	—20	0	89	94	82
			G	13	245	—7	—20	0	86	90	80
			H	13	245	—7	—20	0	86	88	85
			I	13	245	—7	—20	0	84	85	81
K	830° C. air-cooled then 800° C. furnace cooled.....	800° C. and oil quenched....	A	12	212	—140	180	0	85	88	83
			B	12	212	—2	—10	0	89	90	88
			C	12	212	—2	—10	0	88	91	83
			D	12	212	—2	—10	0	85	88	83
			E	12	212	—2	—10	0	87	88	85
			F	12	212	—2	—10	0	85	85	83
			G	14	216	—2	—10	0	78	85	75
			H	14	216	—2	—10	0	84	88	80
			I	14	216	—2	—10	0	86	87	85
ST	900° C. air-cooled then 800° C. furnace cooled.....	955° C. and oil quenched....	A	16	212	5	10	—10	66	67	65
			B	16	212	17	30	—10	72	75	69
			C	16	212	12	20	0	68	69	67
			D	16	212	7	30	0	68	72	65
			E	16	212	2	10	0	70	73	68
			F	16	212	2	10	0	71	75	67
			G	13	220	10	20	0	64	68	60
			H	13	220	5	20	0	68	70	65
			I	13	220	12	30	0	65	70	60
DR	800° C. air-cooled, then 770° C. furnace cooled.....	800° C. and oil quenched....	A	12	229	5	20	0	73	75	72
			B	12	229	5	20	0	78	85	70
			C	12	229	12	20	0	79	88	75
			D	12	229	5	20	0	79	85	75
			E	12	229	5	20	0	75	78	72
			F	12	229	5	20	0	80	83	76
			G	14	219	25	40	20	68	72	65
			H	14	219	22	30	20	71	72	70
			I	14	219	20	20	20	71	72	70
DB	900° C. air-cooled, then 880° C. furnace cooled.....	955° C. and oil quenched....	A	12	229	5	20	0	66	70	60
			B	12	229	5	20	0	70	75	65
			C	12	229	12	20	0	84	88	80
			D	12	229	5	20	0	66	71	60
			E	12	229	5	20	0	75	85	65
			F	12	229	5	20	0	81	87	75
			G	12	229	5	20	0	70	75	65
			H	12	229	5	20	0	68	70	66
			I	12	229	5	20	0	73	75	70

* Negative signs before length changes refer to decrease; all other figures to an increase.

NOTE.—The 2-in. gages DB3 and DB4, subjected to treatment A, which showed no change in surface up to the time of the fifth measurements, became so badly deformed thereafter that no further measurements could be made, as detailed in the text. Attention is drawn to the fact that blocks of steel ST, DB and DR are in general considerably softer than those usually employed in production of gages. Blocks of steel HC and K are nearer the low limit of hardness generally used.

or weeks) are within the limits of experimental error of measurement. That this assumption may be in error is indicated by the behavior of gages DB3 and DB4, which received no artificial seasoning treatments (treatment A Steel DB of Table IV). These gages, which up to the time of their fifth measurements had shown no change in surface, became so badly deformed during the period between their fifth and sixth measurements that they could not be made to adhere to the glass plate at the later date. It was found that the surfaces had become cup-shaped, the inner half being fairly plane, but sloping irregularly upward to the edges, the depth of the cup-shaped figure being from 0.0001 to 0.0002 in. for DB4 and from 0.0002 to 0.0005 in. for DB3.

The work of earlier investigators as briefly discussed in the introduction further supports the writer's contention that early changes are more rapid than those occurring at a later date.

CONCLUSIONS

Based on total change from first to last measurements, the following conclusions may be drawn:

(a) The short gages ($\frac{1}{2}$ in.) showed no appreciable changes in length with or without artificial seasoning over a period of approximately seven months (first measurement one to two weeks after hardening). No appreciable changes in planeness occurred in the long gages (2 in.) with the exception of the two unseasoned blocks DB3 and DB4 mentioned above.

(b) Longer gages than those used (2 in.) would be more desirable for studying length changes with time, because of the extremely small variations actually occurring. About 6 to 8 in. is recommended.

(c) Variation in behavior of duplicate gages is confirmed by the K steel blocks subjected to no artificial seasoning treatment. One of these blocks showed no dimensional changes in 217 days between first and last measurements, while a duplicate decreased 0.00018 in. in the same period. Likewise duplicate artificially seasoned gages show differences as illustrated by steel ST, treatment D, Table IV.

(d) Except in the case of the plain carbon steel (DR) the changes in planeness are not appreciable.

(e) Gages produced from steels ST, DR and DB are softer than reference blocks ordinarily used. The latter are kept between about 90 to 100 Shore hardness. From this standpoint, steel ST is unsatisfactory, as it is not possible with ordinary treatment to maintain the hardness within the limits described. A higher-carbon alloy of this type would be more desirable, with possibly a decrease in chromium content so as not to impair its stain resistance and at the same time reduce production costs.

(f) The plain-carbon steel DR (containing 1.18 per cent carbon) appears to be the least desirable from the standpoint of permanence, showing in the main the greatest changes in length and planeness during a period approximating seven months from first to last measurements. Probably the most desirable are steels HC and K subjected to definite seasoning treatments, the former being the steel generally used in production of reference gages at the Bureau of Standards and closely agreeing with the composition of Johanssen blocks.

(g) None of the seasoning treatments applied has been effective in preventing dimensional changes (within the limits of measurement) in all five steels. Also all seasoning treatments applied appear to effect permanence in Steel DB (containing 1.18 per cent C, 2.20 per

cent Mn and 18.10 per cent Cr). Treatments H and I, however, have decreased the hardness.

RECOMMENDED HEAT-TREATMENT

(h) Seasoning treatments E and F, consisting respectively of ten and eighty alternate 5-minute dips in oil at 200 deg. C. (392 deg. F.) and ice water at 0 to -5 deg. C. (32 to 23 deg. F.) are the most generally effective treatments tried for obtaining permanence. Probably less than eighty would in many instances suffice to bring the steel in a state of rest under conditions of treatment and manufacture as previously outlined.

Measurements made at intervals of approximately one and two weeks, one, two, four and seven months after initial readings of length and planeness do not give very much information regarding the progress of the changes taking place. Unsuitable steels exhibiting the greatest instability in either length or planeness appear to increase progressively in error with time. In many cases of more suitable steels possessing great constancy these changes seem to occur in the intervals immediately following the first measurement, the gages thereafter remaining constant. However, no very definite statements may be made in this respect.

SHRINKAGE IN STEEL

In a majority of the blocks examined showing dimensional changes there is an elongation, but in the case of steel K shrinkage only is observed. This is unusual, as the changes observed in hardened blocks are usually of the latter type—i.e., decrease in length. Four unsea-

TABLE VI. PROGRESSIVE SHRINKAGE IN RECENTLY HARDENED STEEL

Chemical composition, per cent, C, 0.87; Mn, 1.10; Cr, 0.46; W, 0.43; V, 0.12.			
Sample No.	Date of Measurement	Length in Inches	Shrinkage in Inches
K17	Sept. 8, 1919	1.89995	
	Sept. 25, 1919		0.00004
	Oct. 24, 1919		0.00007
	Dec. 26, 1919		0.00012
	April 7, 1920		0.00018
K18	Sept. 8, 1919	1.89996	
	Sept. 25, 1919		0.00002
	Oct. 24, 1919		0.00003
	Dec. 26, 1919		0.00006
	April 7, 1920		0.00008
K19	Sept. 8, 1919	1.89995	
	Sept. 25, 1919		0.00003
	Oct. 24, 1919		0.00005
	Dec. 26, 1919		0.00008
	April 7, 1920		0.00014
K20	Sept. 8, 1919	1.89996	
	Sept. 25, 1919		0.00004
	Oct. 24, 1919		0.00006
	Dec. 26, 1919		0.00011
	April 7, 1920		0.00016

soned gages produced from this latter material (containing 0.87 per cent C, 1.10 per cent Mn, 0.46 per cent Cr, 0.43 per cent W, 0.12 per cent V) will illustrate progressive shrinkage in hardened steel over an extended period. (Table VI.)

No satisfactory explanation for such difference in behavior can be given at this time, but it is of interest to note that microscopic examination indicates more complete hardening of the K steel blocks (martensite-troostite throughout) than is obtained by oil-quenching the carbon-steel gages (DR) which show a less uniform structure consisting of troostite and sorbite at the surface and sorbite in the interior, indicating but local and partial suppression of the transformations and less complete hardening. In view of this fact the work of Matsushita¹ and his conclusions that the type of dimensional change (elongation or shrinkage) is related to the character of hardening becomes of particular interest.

Legal Notes

BY WELLINGTON GUSTIN

Churchward Patents Held Not Invention—Prior Art and History of Vanadium Alloys

In holding the Churchward patents, 845,756, claim 1, and 868,327, claims 1 and 3, each for an alloy of steel, void for want of invention, the United States Circuit Court of Appeals, Third Circuit, discussed the history and growth of the metallurgical art in alloy steel. (Bethlehem Steel Co. vs. Churchward International Steel Co., 268 Federal, 361.) James Churchward, the inventor, secured the patents in 1907 and assigned them to the Churchward International Steel Co., wherein the Carnegie Steel Co. intervened. The U. S. District Court sustained the claims in the patents and found them to be infringed, whereupon the Bethlehem Steel Co. appealed. The Court of Appeals reversed the District Court.

It was said that in the manufacture of steel from alloys in countless combinations and proportions it became known that small quantities of alloying metals and small differences in their proportions frequently make considerable difference in the properties of the resultant steel. Investigation of the metal vanadium, discovered in 1830 in a specimen of iron obtained from ores at Taberg, Sweden, was continued with its widening production from the slags of the Taberg blast furnaces and from mines later found in Scotland and Mexico.

INTRODUCTION OF VANADIUM IN AN ALLOY

Since about 1890 to 1900, when alloy steels became established, the use of vanadium as an alloying metal has grown apace with the discovery and development of its properties. It was discovered that vanadium lay between carbon and chromium in the properties it impresses upon steel and that small amounts, ranging from 0.10 per cent to 0.50 per cent, increase substantially the tenacity, elastic limit, tensile strength and the fatigue resistance of the metal, and also its malleability and hardness after tempering. Hence its adaptability in alloy steels where, as in armor plates, especially hard surfaces are required, and where, as in automobile and locomotive parts, shock and vibration are constant and metal fatigue inevitable.

So the use of vanadium as an alloying ingredient in alloy steel increased in the metallurgical art as these properties were revealed. Before vanadium thus came into use the art contained a variety of alloy steels named and known by the essential ingredients composing them. Aside from carbon and manganese steels, whose controlling ingredients were present by nature, or when desired were increased by additions, the patent records and the literature of the art showed nickel steels, chrome steels, nickel-chrome and chrome-nickel steels, whose characteristics were those inherent in their dominant alloying materials. Later vanadium was added to these, and in consequence there came into the art vanadium-carbon steels, vanadium-nickel steels, chrome-vanadium steels, "whose distinctive characteristics reflected the dominance of their alloying elements."

This was the state of the art, as was said, when Churchward entered it with his two patents. It was claimed that these inventions showed for the first time, in addition to the natural alloying elements of carbon and manganese, the three added elements of nickel, chromium and vanadium, thus establishing, as it was contended, the first vanadium-nickel-chrome alloy steel.

Both of the patents in suit relate to alloy steels as distinguished from carbon steels or normal steels. Both claim an alloy containing, in different proportions, the same alloying metals of steel (with varying carbon content), nickel, chromium, manganese and vanadium. In neither patent is it clear whether the invention disclosed is in the alloying metals or in their proportions or in both. So also in neither is it claimed that the resultant product contains or has in higher development the properties known to characterize the constituent alloying ingredients either separately or in combination.

The only new property, says the court, claimed for the alloy of the patent is found in the following language:

"It is believed that the alloying elements named react on each other to produce chemical and molecular changes of such a nature that the tungsten, chromium and manganese are permitted to harden the steel, while the *vanadium removes or prevents brittleness and imparts toughness without softening the alloy*. . . . In cases where the product is to have extreme toughness and hardness the tungsten may be omitted"—as it is from the claim in suit.

The specification of the second patent differs little from the first. The same theory of chemical reaction and molecular change described in the first patent is repeated in the second, differing from the first only in addition of nickel to the element of vanadium in effecting removal or prevention of brittleness without softening the alloy. On comparison it is seen that the alloying metals are the same in both patents, the proportions of those in the second patent covering the proportions of those in the first. The proportion of each ingredient in each patent begins at the same minimum, and in the second patent the proportion of each ingredient comes up to that of the first patent and passes on to a higher maximum, producing, as the only difference, as the court saw, a range wider in the second than in the first, without any claimed difference in results, properties or performance of the two alloys.

While the patents are *prima facie* evidence that the alloys constitute invention, still such is open to attack should they lack new and advantageous properties over the prior art, said the court. And so the defendant attacked the *prima facie* case.

COURT'S DICTUM ON PATENTABLE NOVELTY

The court said patentable novelty may reside either in the elements of alloys or in the proportion of the elements. If novelty of elements is claimed on the first patent, that patent falls when it is proved that before Churchward vanadium was used with chromium, nickel, manganese and carbon in alloy steels. If novelty of elements is claimed in the second, that patent likewise falls as the first. Therefore novelty in the invention must be found in the proportion of the elements. On this issue the defendant showed that in endeavoring to determine experimentally the value of vanadium in nickel-chrome-manganese steel alloys it had used the elements of the patent alloys in substantially the same

proportions specified by the patents before Churchward's alleged inventions. However, the court said this was not taken as conclusive of anticipation, for it was possible that the defendant, in employing the same elements in the same proportions, may not, because of difference in heat-treatment, have obtained the alloys of the patents. (Pittsburg Steel & Iron Co. vs. Seaman-Sheeth Co., 248 Fed., 705.)

But novelty of proportions in the sense of the patent law involves something more than figuring out proportions differing from any that were known before. It involves new results from new proportions, developing a new metal, or, it may be, an old metal with new characteristics of structure or performance, embracing entirely new, or at least substantially enhanced, qualities of utility. (Miami Copper Co. vs. Minerals Separation, Ltd., 244 Fed., 752.) To prove that the alloys of the patents in the proportions specified lack patentable novelty the defendant produced evidence, which in the absence of contradiction, the court said, must be accepted as conclusive.

DEFENDANT'S EVIDENCE UNCONTRADICTED

On the issue whether the alloys of the patent contain advantageous properties over alloys of the prior art made from the same elements in different proportions, or whether they contain properties different from those of the prior art, the defendant offered evidence to prove that while vanadium has a beneficial effect in carbon steels, in nickel steels and particularly in chrome steels, it has no such effect in chrome-nickel steels; that instead of producing the only new and useful property in the resultant steel claimed for it in the two patents—the removal and prevention of brittleness—vanadium increases brittleness, that it (Bethlehem Steel Co.), after using vanadium in nickel-chrome-manganese alloys within the range of the proportions of the patents, found that vanadium introduced a detrimental condition in the product and in consequence abandoned its use; that Carnegie Steel Co. (though under license of the patents and free to continue) found it troublesome to get out tonnage when adding vanadium to a nickel-chrome-manganese alloy and likewise abandoned its use; and that Midvale Steel Co. after experiments was not sufficiently encouraged to begin its use.

The plaintiff controverted none of this evidence, and the defendant's evidence was taken as truth. Neither did the plaintiff produce evidence that the alloys of the patent were novel or that they contained new elements of utility, in that they were different from or better than prior nickel-chrome-manganese-vanadium alloys either in metallurgical or physical characteristics or in performance. It rested first on the presumption of utility of the alloys arising from the fact that defendant had made such alloys. While this is valid evidence, it alone does not prove in the light of the case that the utility of the patented alloys was greater than or different from that of kindred alloys made before the patents. Vanadium was an alloying metal of the prior art and free to be used by anyone desiring to use it.

To constitute invention in the continued use of vanadium it must appear, said the court, that some new property had thereby been attained or some newly useful result had been achieved.

Again the patent owners relied on proof that Carnegie Steel Co. had paid it the substantial sum of \$275,000 in settlement of infringement litigation and for licenses

under the patents. But the court said that unless it were to substitute the opinion of the experts in metallurgical knowledge of the Carnegie Steel Co. for its own judgment, without knowing what evidence was before them but well knowing the evidence before it was not before the Carnegie experts, it must resolve the issues as the case has been made by the evidence. And this was done by finding that the evidence was against invention.

Chemical Company Obtains Reversal of Decree Under Workmen's Compensation Act in Maine

In a compensation case the Supreme Judicial Court of Maine has said that the Industrial Accident Commission, while primarily a judicial body, exercises certain judicial functions and in the exercise of these functions it acts judicially, and, while it determines finally the trustworthiness and weight of testimony, its findings must be based on evidence.

Further, it is said the findings of fact under the workmen's compensation act by the Industrial Commission cannot be disturbed by the courts in the absence of fraud, but such findings must be grounded upon evidence presented under such circumstances as to afford full opportunity for comment, explanation and refutation. (113 Atlantic, 28.)

The case involved proceedings by M. Gauthier under the act to obtain compensation for the loss of a leg in the employ of the Penobscot Chemical Fiber Co. There was an award of compensation and the chemical company appealed, resulting in the Supreme Court reversing the decree.

The Maine statute, chap. 50, sec. 21, authorizes certain medical testimony to be taken ex parte, but, says the court, such is not to be made the foundation of a decree until it is produced in evidence, so that either party may have an opportunity to explain or contradict it.

Wages in German Metal Industry

The Union of German Metal Workers is the largest trade-union in Germany and includes more than 1,600,000 members. This union has a statistical bureau which has collected statistics of wages and of cost of living in the metal industry, including in its investigation not only the members of its union but many other workers in the metal industry, so that the investigation covered a total of about 2,300,000 workers. It has published the results of its investigation in the *Metallarbeiter*, which is the organ of this powerful union.

According to the statistics of this union about 63 per cent of these workers are receiving wages which are more than 800 per cent greater than those of 1914, about 36 per cent are receiving wages from 500 to 800 per cent greater than in 1914, and the remainder are receiving wages which have not increased as much as 500 per cent since 1914. It is impossible from these statistics to arrive at an average wage increase for the whole of this group of workers.

The trade-unions estimate that the entire cost of living for a family of four has increased about 1,550 per cent since 1914, while Calwer's Bureau (a private statistical bureau), which usually makes use of official statistics, estimates that the cost of food alone for a family of four has increased about 1,470 per cent since 1914.

Quantitative Determination of Potash by the Spectrum

BY D. PAUL ROGERS

THE value of a quantitative determination depends upon three factors; time, cost and accuracy. The fundamental purpose of this experiment is to lessen the time for the determination, to reduce the cost of the chemicals and apparatus and to have a favorable degree of accuracy.

As a result of several determinations in 1918, it was found that the average time for the determination was one hour. This is a saving of time from 50 to 95 per cent over the old standard method of chloroplatinic acid method.

A very inexpensive chemical is substituted for the valuable platinum salt which is used in the "chloroplatinate method." An ounce of potassium nitrate when made into solutions is sufficient for hundreds of determinations. When water-soluble potash alone is wanted, there are no chemicals needed. Calcium carbonate and ammonium chloride are the only chemicals needed for determination of total potash. The total cost of chemicals for a determination would not exceed 5c.

Two sets of determinations were made on samples of flue dust containing potash in variable amounts. One of the samples was of a known content. The potash content of another sample was unknown. The latter sample was determined at the same time that an umpire chemist was analyzing by the "chloroplatinate method." These results checked up very reasonably.

SPECTRUM METHOD FOR POTASH

This method for determining potash is quite simple in that it measures the intensity of the potassium flame. The method that I worked out requires an accurate eye. The intensity of the potassium flame of various solutions of known content were very accurately recorded. The intensity of the unknown samples were likewise recorded and compared with those of the known potash content.

For a determination of water-soluble potash a 10-g. sample was taken and boiled in about 30 c.c. of water for about half an hour. It was then filtered and concentrated to 10 c.c. For a total potash determination a smaller portion is sintered by the J. Lawrence Smith method, using 0.5 g. of ammonium chloride and 5 g. calcium carbonate. The sintered mass is digested in water and then filtered. The strength of the solution is brought to the same concentration as the above.

A round loop was made on the end of a platinum wire by wrapping it around the lead of a pencil. The purpose of this loop is to have a uniform amount of solution on the film. Satisfactory blue spectacles were used to observe the potassium flame against a white background in a dark room.

Five solutions of potassium nitrate of different strength were made so that they should have a potash equivalent of 5, 7.5, 10.0, 12.5 and 15.0 per cent. For the 5 per cent solution 3.219 g. of the salt was dissolved in 30 c.c. water; 4.8285 g. for the 7.5 per cent; 6.438 g. for the 10.0 per cent; 8.0475 g. for the 12.5 per cent, and 9.657 g. for the 15.0 per cent solution, all in the same amount of water.

Two samples of flue dust of 10 g. each were treated with boiling water for about thirty minutes. The solutions were filtered and concentrated to 10 c.c.

The time of the duration of the potassium flame was determined by dipping the loop of the platinum wire into the solution and then into the flame. Twenty trials on each solution were completed before taking up the next solution. Then the same procedure was used on each of the samples to be analyzed. Each test showed the numbers of seconds of duration of the potassium flame. The following results were obtained:

Trial No.	5 per Cent. Seconds	7.5 per Cent. Seconds	10.0 per Cent. Seconds	12.5 per Cent. Seconds	15.0 per Cent. Seconds	Sample 1, Seconds	Sample 2, Seconds
1	3	5	4	4	5	3.5	3
2	4	4	4	4	5	3.5	3
3	5	3	3	4	5	4	3
4	3	4	4	4	4	4	4
5	2	3	4	4	5	3.5	3
6	3	3	4	3	5	3.5	3
7	3	3.5	5	3	5	4	3
8	3	3	4	4	5	4	3
9	2	3	5	4	5	3.5	3
10	3	2.5	5	5	5	4	3
11	3	3.5	4	5	5.5	4	3
12	4	3	5	4	5	3.5	3
13	2.5	2.5	3	5	5	4	3
14	2.5	4	3	5	5.5	4	3
15	3	4	4	6	4.5	4	3.5
16	2	3.5	4	5	5.5	4	3.5
17	3	3	3	5	5.5	4	3
18	2.5	4	4	6	5.5	5	3.5
19	3.5	3	3	4	5	4.5	3.5
20	3	4	4	5.5	5.5	5	3.5
Total.....	60	68.5	79	89.5	101.5	79.5	63.5
Average...	3	3.43	3.95	4.48	5.08	3.98	3.18

The average number of seconds of the various samples of solutions of potassium nitrate of known potash content are in progressive order as follows: 3 seconds, 3.5, 4.0, 4.5, 5.0, 4.0, 3.2.

The difference in the above series is only half a second. This half a second is equivalent to 2½ per cent of potash. The average of one-tenth a second will therefore be equivalent to half a per cent of potash.

Sample 1 of the unknowns produced a flame for an average of four seconds. Either calculating or looking

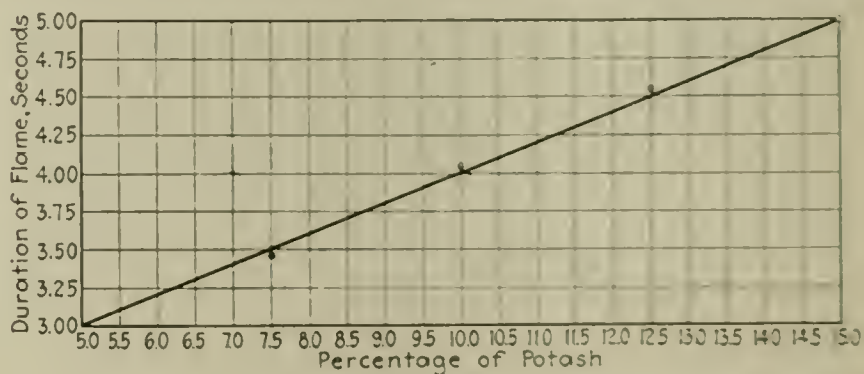


FIG. 1

up the value on the chart of Fig. 1, the percentage of potash in the sample is 10 per cent.

Sample 2 had a flame duration of three and two-tenths seconds. The value of potash here is 6 per cent.

Each one of the samples of the above results was run for the entire twenty trials before taking up the next one. In this way there were no contaminations to interfere with the results obtained.

A second series of determinations of samples 1 and 2 in addition to the solutions of known potash content was made. The following results were obtained:

Solutions	5%	7.5%	10.0%	12.5%	15.0%	No. 1	No. 2
Flame Av., sec.....	3	3.6	4.15	4.6	5.1	4.2	3.15
Progressive order, sec.....	3	3.5	4.0	4.5	5.0	4.2	3.1

From the chart, Fig. 1, the potash of sample 1 is 11 per cent and sample 2 is 5.75 per cent potash.

The average of these results compares accurately with analysis of the standard chloroplatinate method.

	Spectrum No. 1	Spectrum No. 2	Chloroplatinate Method
K ₂ O.....	10.00%	6.00%	No. 1
K ₂ O.....	11.00%	5.75%	No. 2
Average.....	10.50%	5.88%	10.46%
			5.90%

Harrisburg, Pa.

Laboratory Furnace for Deformation Temperature of Refractories

BY LEON R. OFFICE

FOR a good many years laboratories that have been testing high-grade refractories, as fireclay, fireclay and silica bricks, silica cements, etc., have been confronted with the problem of a suitable type of furnace that is both cheap in construction and simple of operation and one that can be depended upon day in and day out, without much loss of time for repairs.

The author has in mind such a furnace for which he claims no originality of principle, but which was developed through four years of experience in obtaining the softening and deformation temperatures of various refractories. Innovations were tried, such as: different sized chambers, various types of burners, length of burner, thickness of walls, insulation features, etc., and the type to be described seemed to work advantageously. It is not so difficult to deform pyrometric cone 32 (approx. 1,705 deg. C.) but to reach cones 34 and 35 is more troublesome.

R. T. Stull and J. M. Knoté¹ describe a small "pot" furnace of the muffle type, with a combination of up and down draft. It has been the writer's experience that while the temperature may be a trifle more uniform in the muffle, it is also one to three cones lower than in an open furnace and muffle shapes are just complicated enough as to be out of condition most of the time.

C. E. Fulton² describes a pot furnace of the "open flame" type, with one burner which gives the flame a spiral motion. This furnace was used in our laboratories for several years and was the basis of the type used at present.

The furnace consists of two parts, the furnace proper and the preheater. Fig. 1 shows the details.

The furnace proper consists of a pot 12 in. wide and 13 in. high, with a chamber 6½ in. in width and 10½ in. in depth. It was found that a deep and narrow chamber produced the best results, since it has a "stack-effect" of drawing the gases and flame upward with a swirling motion. None of the gas would burn in the center. The pedestal could be varied in height, just so it was above

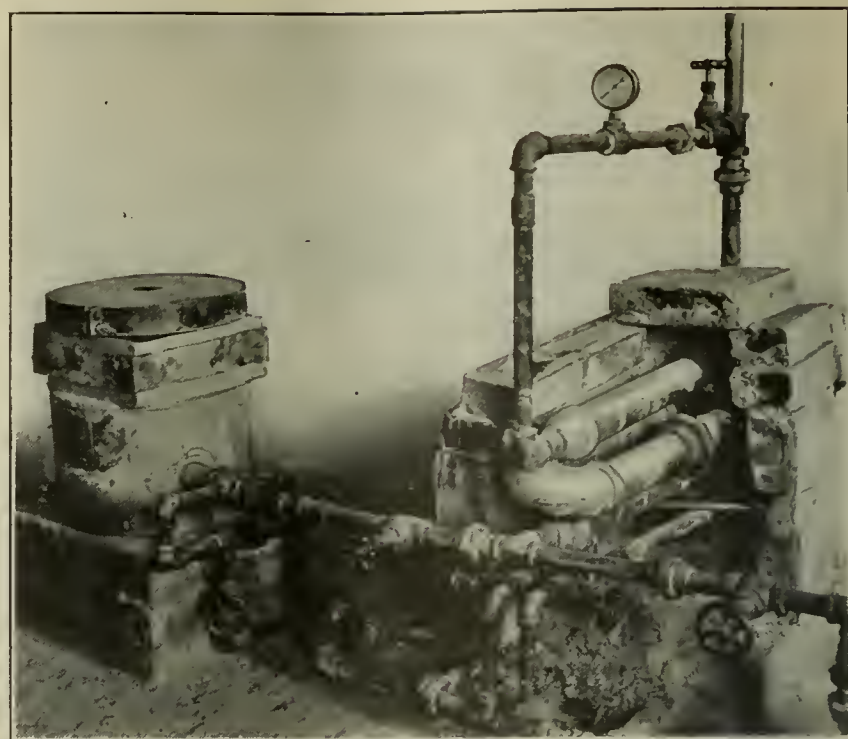


FIG. 2. FURNACE AND AIR PREHEATER

the gas inlet. The "pot" containing the cones is placed on top of the pedestal. The top is one piece, 1½ in. thick, with a 2-in. inspection hole in the center. If banded with a heavy iron band, its life will be increased several hundred per cent. The furnace must also have an iron band which can be slipped over and bolted on one side.

A high-grade fireclay or a mixture of calcined bauxite and plastic fireclay can be used in making the furnace. The better the material the longer and more satisfactory will be its life.

The preheater consists of four lengths of 2-in. iron pipe, connected at the ends with U's and spaced so that the flame from the gas burners below will surround them. The air was not sent through the preheater until the furnace had attained a good red heat, as it increases the temperature too rapidly. Just as soon as air was sent through the preheater into the furnace, the temperature could not be regulated until almost a white heat was reached. With the preheater used, the air reached a temperature of 250 deg. F. at the burner.

Several types of burners on the market were tried, but proved less satisfactory than the homemade one shown in Fig. 1. The nozzle was 1½-in. heavy iron pipe, 6 in. long, connected to a reducing cross which acted as the mixer. Gas entered the mixer through ¾-in. pipes on two sides. A reducing bushing was placed in the rear end of the mixer, with six ⅛-in. holes, equally spaced. The air entered through a ¾-in. pipe, the opening of which extended just beyond the gas inlets, in order to prevent back pressure on the gas. The air, coming in at high pressure, tended to suck the gas with it and also excess outside air through the six holes in the back of the mixer. With air at 25 to 30 lb. pressure and natural gas in the Pittsburgh district under a pressure of about 2½ lb., a temperature sufficient to melt cone 35 in forty-five minutes was attained. Fig. 2 shows a picture of the apparatus.

This furnace, when made of a good refractory material, is very sturdy and can be used for fifty to sixty runs. Cracks can be instantly patched with Norton's alundum cement and, after several heats, a glaze develops on the inside surface which protects the pot from further attack by the flame.

Pittsburgh, Pa.

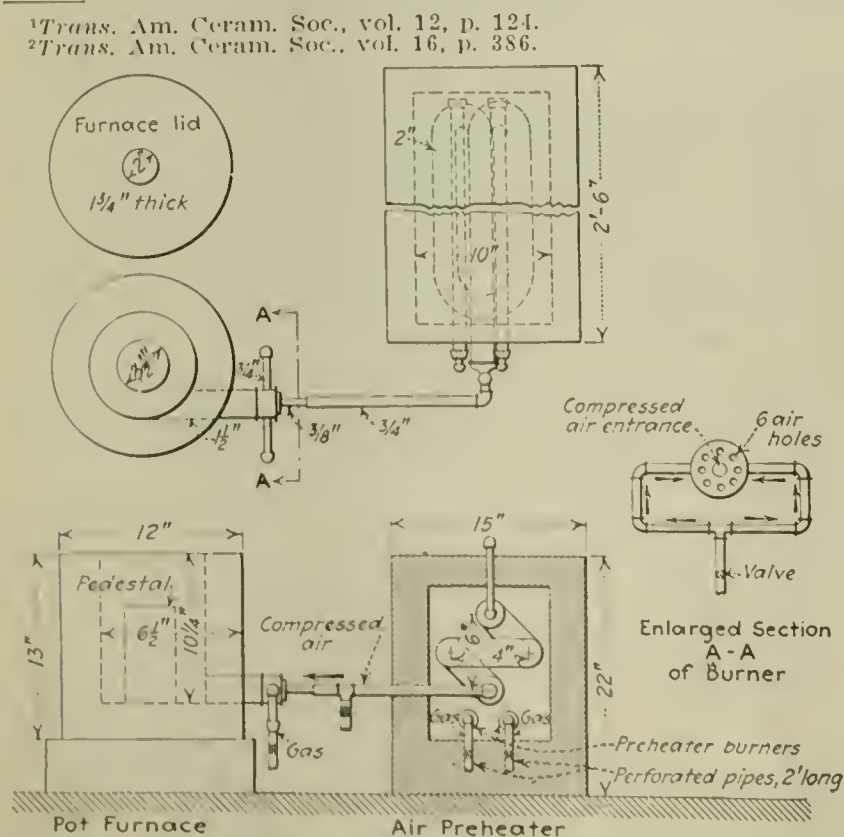


FIG. 1. DETAILS OF FURNACE CONSTRUCTION

¹Trans. Am. Ceram. Soc., vol. 12, p. 124.

²Trans. Am. Ceram. Soc., vol. 16, p. 386.

Biakmetal

During 1919, it was reported in *CHEMICAL & METALLURGICAL ENGINEERING* (vol. 21, p. 632), an Italian succeeded in producing a new alloy of zinc and copper, to which the name of Biakmetal was given. For this new alloy it was claimed that it possessed:

- (1) The highest known breaking point;
- (2) The highest limit of elasticity;
- (3) Perfect homogeneity;
- (4) High resistance to thermic action;
- (5) High resistance to chemical action.

It was further claimed that the new alloy had already proved especially useful in aëronautic and marine construction on account of its light weight, its unusual strength and its anti-corrosive qualities. It was stated that a company with a capital of 12,000,000 lire had been formed to engage in the manufacture of the alloy.

On the strength of these reports, one of the bureaus of the Government which was interested in securing a light metal of great strength obtained through official channels samples of Biakmetal for test. The samples submitted were too small for any tests other than chemical analysis, but this revealed that a variety of different alloys were grouped under the single trade name. Biak No. 2 was an ordinary 60:40 brass containing a little manganese. Biak No. 3 was the same with Ni instead of Mn. Biak No. 4 was a high red brass containing both Ni and Mn. Biak No. 6, was a high-aluminum: zinc: copper alloy, containing a little silicon. Biak No. 9 and No. 19 were high-zinc: aluminum: copper alloys such as have come into use in France for extruding purposes and as bearing metals.

Impact Strength of Carbon Steel

As an addendum to a paper on "Impact Tests on Cast Steel" read before the last meeting of the American Society for Testing Materials, F. C. Langenberg presented a useful table of impact strength of rolled and heat-treated steels. The results given in the table were obtained from specimens cut from bar stock approximately 1 in. in diameter, after various heat treatments. The table shows the composition of the several bars as well as the heat treatment.

- Heat-treatment was as follows:
- A — Original, as received, probably hot rolled.
 - B — Annealed just above A_{c_3} .
 - C — Hardened in water from just above A_{c_3} .
 - D — Hardened in oil from just above A_{c_3} .
 - E — Quenched in oil from just above A_{c_3} , drawn at 375 deg. C.
 - F — Quenched in oil from just above A_{c_3} , drawn at 460 deg. C.
 - G — Quenched in oil from just above A_{c_3} , drawn at 560 deg. C.
 - H — Quenched in oil from just above A_{c_3} , drawn at 650 deg. C.

Recent Developments in the German Chemical Industries

A recent report of the German dye trust states that during 1920 its gross profits amounted to 531.7 million marks. The bulk of this, according to the report, was made mainly during the first half of 1920, since there was a decided drop in business during the latter half of the year. The six works of the trust shared in the gross profits as follows:

	Marks
Badische Anilin- und Soda-Fabrik	144,246,000
Farbwerke vorm. Meister Lucius & Brüning (Hochst) ..	111,200,000
Farbenfabriken vorm. Friedr. Bayer & Co.	99,700,000
Actien-Gesellschaft für Anilin-Fabrikation	55,000,000
Griesheim-Elektron	41,000,000
Weiler-ter-Meer	21,000,000

The balance sheets of the individual companies make it appear that large reserves have been set aside and that the actual profits were in fact much higher. It must be considered, however, that notwithstanding the fact that the 1920 profits were more than five times as large as in the prosperous year of 1912, they are, when expressed in gold marks, but slightly more than one-third as large. The following figures show the returns for 1912 and 1920 when compared on a gold basis:

	Value in Gold Marks	
	1912	1920
Badische Anilin- und Soda-Fabrik	27,791,000	12,900,000
Farbwerke vorm. Meister Lucius & Brüning ..	22,973,000	7,510,000
Farbenfabriken vorm. Friedr. Bayer & Co. ...	28,746,000	6,650,000
A.-G. für Anilin-Fabrikation	9,738,000	4,070,000
Weiler-ter-Meer	3,379,000	2,790,000
Griesheim-Elektron	8,516,000	1,600,000
Total	101,173,000	35,520,000

All of the individual members of the trust have lately raised their capital stock, ostensibly for the purpose of developing the nitrogen works, although it has been somewhat of a puzzle to observe that this large amount of capital has been set aside for no other visible purpose. This puzzle has now been solved by the recent announcement that arrangements have been made to purchase the stock of the firm of Leopold Cassella & Co., which is the largest German dye manufacturer outside of the combine. The stock of the company is to be taken over by the members of the trust in proportion to their own capital stock.

The dye trust has also assumed complete control of Germany's nitrogen production. This industry was started by the Badische Anilin- und Soda-Fabrik of Ludwigshafen with the works at Oppau, to which were later added the Merseburg and Leuna works. The completion of these plants proved too much of a burden for a single company and for some time past the other members of the dye trust have been contributing necessary funds, although all of the stock was held, at least nominally, by the Badische company. This state of affairs has now been rectified by the formation of the nitrogen combine, equipped with a capital of 500,000,000 marks, held solely by the members of the dye trust. The further capital investment required for completing the works is over 2 billion marks.

RESULTS OF CHARPY TESTS ON FORGED STEELS, CHARPY VALUES IN FT.-LB

Chemical Composition, per cent.						Charpy Values in ft.-lb. for Various Heat-Treatments							
C	Mn	S	P	Si	Cr	A	B	C	D	E	F	G	H
0.14	0.45	0.035	0.018	0.131	...	45 39	28 01	38 10	47 18	47 95	49 50	48 34	52 61
0.18	0.56	0.043	0.024	0.132	...	41.51	30 72	35 69	46 24	45 00	44 62	46 87	50 51
0.32	0.51	0.027	0.009	0.128	...	22 96	15 20	10 94	18 85	19 24	19 86	22 34	26 30
0.46	0.40	0.050	0.020	0.144	...	10.70	7 99	...	14 04	13 96	13 89	15 67	16 60
0.49	0.60	0.028	0.013	0.127	...	12 72	10 32	...	16 06	14 51	14 35	17 53	19 34
0.57	0.65	0.028	0.012	0.167	...	8.38	7 91	...	12 57	10 86	11 17	12 02	14 04
0.71	0.67	0.035	0.027	0.147	...	4 42	2 48	...	...	4 73	7 60	10 32	15 67
0.83	0.55	0.028	0.018	0.152	...	1.31	1 39	...	...	3 42	3 33	4 34	6 36
1.01	0.39	0.029	0.016	0.160	...	2 09	1 47	...	...	3 25	3 18	4 19	4 42
1.22	0.34	0.031	0.025	0.181	...	1.39	1 31	...	...	2 48	2 09	2 63	2 63
1.39	0.20	0.029	0.015	0.191	...	0.93	0 85	...	...	1 86	1 31	1 47	1 62
1.46	0.20	0.035	0.011	0.133	0.35	0.77	1 24	...	...	1 94	2 01	2 01	1 94

The nitrogen works are reported to be operating at full capacity with the exception of the Leuna works, which have not yet recovered from the communistic riots of last March. Their production has already made Germany practically independent of the imports of Chilean nitrate and of the large quantities of nitrogen salts formerly received from Norway, Sweden and Switzerland. The imports from Chile, which in 1913 amounted to 774,000 tons, had decreased during the first nine months of 1920 to 31,000 tons. Nitrogen salts from Norway, Sweden and Switzerland fell off from 86,000 tons to 2,500 during the same period.

The world monopoly enjoyed by the German potash industry before the war has been shattered and the industry is now going through a critical period. The competition of Alsace and the heavy freight rates have caused a considerable reduction in exports and the industry is now on the point of shaping a new business policy. It is likely that the future policy will be to export only the richest grades of the crude materials and the refined salts, such as potassium chloride and sulphate.

Due to the short-sighted policy of the Kali Syndikat, which rationed the business in hand according to the number of pits in operation, there has been a large increase in the number of mines, and during the present business depression this has naturally resulted in overproduction. The National Kali Council, which is now the supreme body in control of the industry, has therefore ordered the closing down of all works which by their results show that they cannot operate economically. As a result of the recent amalgamations and purchases the Kali Syndikat now consists of 17 individual members, comprising 175 mines, and representing nearly 80 per cent of the total output.

Synopsis of Recent Chemical & Metallurgical Literature

Subdivision in Sections of the Société de Chimie Industrielle.—At a meeting of the Société de Chimie Industrielle Paul Kestner, the president of the society, described the new subdivisions in sections which, it is expected, will contribute to a better study of the various particular chemical problems. The new sections are: Installation of plants; installation of laboratories, gas and coke; hydrocarbons, petroleum; wood distillation and derivatives; refrigerating; metallurgy and electrometallurgy; precious metals; heavy chemicals; electrochemistry; lime, cement and building material; glass ceramics and enamelled ware; general chemicals; rare earths; radioactivity; dyes; pharmaceuticals; photographic products; powders and explosives; essences, natural and synthetic perfumes; resins, paints, lacquers, varnishes and waxes; rubber and its substitutes; fatty materials, soap, candles, glycerine; cellulose, paper; plastic materials, artificial textiles; bleaching and dyeing; tinctorial and tanning extracts; tanning and allied industries; fermentation sugar, starch and allied industries; dairy industry; food industry. All these sections combined will hold only one annual general meeting.

He also stated that the Société de Chimie Industrielle will co-operate henceforth on a more active scale with the Fédération Nationale des Associations de Chimie and with the Union Internationale de la Chimie Pure et Appliquée.

The National Federation of the Chemical Associations, founded in 1919, consists of the following individual societies: Chemical Society, Society of Chemical Industry,

Association of Sugar and Distillery Chemists, Society of Expert Chemists, Society of Physical Chemistry, Society of Biological Chemistry and the Association of Textile Chemistry.

The International Union of Pure and Applied Chemistry, founded also in 1919 (see *CHEMICAL & METALLURGICAL ENGINEERING*, vol. 20, No. 11, p. 561, June 1, 1919), has now accredited members from twelve countries—namely, Belgium, Canada, Czechoslovakia, Denmark, France, Great Britain, Greece, Holland, Italy, Poland, Spain and the United States. (*La Technique Moderne*, May, 1921.)

Case-Hardening.—Some of the facts and fallacies connected with the subject of case-hardening were dealt with recently in a lecture by Dr. L. Aitchison before the Birmingham Metallurgical Society and reported in the *Ironmonger*, June 11, 1921. The purpose of case-hardening is to enable the use of a material both easy to machine and cheap to produce. The first point to be decided was whether case or core played the more important part, and on this question there was great divergence of opinion, many authorities holding that the former took precedence by reason of its being the actual working part. Referring to the essential properties of both case and core, the lecturer pointed out that "hardness" was the generally accepted term for defining the necessary quality of the case, but "toughness" was really a more suitable word, since it implied a capacity for wear without brittleness. Such toughness could be obtained by the introduction of carbon and other alloys. The core, on the other hand, should emphatically be soft to admit of easy machinability and consequent cheapness in handling; it must also be capable of assuming varying degrees of strength, with a possible range of 60,000 to 170,000 lb. per sq.in.

As to the problem of testing the durability of the treatment, though numerous methods were known, there is not a really satisfactory one available. The degree of surface hardness could be to some extent approximated by scratching with a file; but, at the same time, a steel containing about 5 per cent nickel and 0.2 per cent carbon is readily susceptible to scratching, and yet withstands wear remarkably well, so that the most useful test is microscopic examination, which reveals the nature of the crystalline structure and the depth of hardening. There had been some controversy as to the desirability of a strong or weak core, and it was noteworthy that in aeronautical and automobile engineering where lightness is an essential, strength must not be obtained by increasing weight. There is a certain amount of truth in the popular idea that "once the case is broken the core does not matter"—at all events, an alteration of the strength of the core does not affect the tensile or compressive strength, though it has been found that fracture always occurs at a point corresponding with the core's yield point. Consequently, the raising of this yield point reinforces the case and improves the quality of the whole section. Undoubtedly the impact test pointed to the need of a strong core, and was generally used for measuring toughness. In such an article as a camshaft, where the cam faces alone were hardened, and the intermediate parts unhardened, a high degree of tensile strength is desirable. In determining toughness, which the lecturer considered a very difficult property to define, "fiber" certainly plays an important part, but a fibrous core, while standing up well under a tensile test, does not necessarily resist impact when measured at right angles to the fiber, and therefore the structure should be, as far as possible, of a homogeneous nature.

Dr. Aitchison emphasized the comparative values of cooling methods, mentioning the opinion held by some metallurgists that "when once the temperature attained in refining the core has brought about the required construction, the cooling method is immaterial." From an engineering viewpoint, however, water-cooling has given strengths amounting to 6,000 to 8,000 lb. higher than those resulting from air-cooling. In earlier days, when very mild steels were employed, water-cooling had been universally employed, though steels are now of such vastly improved quality that air-cooling gives satisfactory results in the majority of cases, and is to be recommended whenever possible.

Current Events

in the Chemical and Metallurgical Industries

Dye Embargo Eliminated as Tariff Passes the House

As predicted by the Committee at the time the tariff bill was introduced, it passed the House of Representatives on July 21 by a substantial majority. In the final vote of 289 to 127, the division was almost completely along party lines. The Longworth embargo on dyes, which was the first of the five sections to receive the separate vote of the entire House, was defeated by the scant majority of 16 votes. Oil, hides, cotton and asphalt all remained on the free list of the bill in its final form. The measure now goes to the Senate when it is reported that the Finance Committee will hold extended hearings and will probably postpone final action on the bill until fall, pending consideration of tax legislation.

The chemical schedule came in for somewhat more than its share of discussion, for under the special cloture rule obtained by the Committee, three of the five sections open to amendment related to chemical products. These were dyes, petroleum and asphalt. The great preponderance of debate centered on the Committee's proposed 3-year embargo on dyes and coal-tar chemicals. After three days of heated debate, the House on July 16, voting as a committee of the whole, refused to accept any amendments to the section by a vote of 122 to 109. When the entire bill was called up before the House proper on July 21, however, Representative Frear moved that all of par. 27 which provided for the embargo control be eliminated from the chemical schedule. A number of Democrats, who had previously supported the measure, swung to the opposition and succeeded in defeating the embargo by a vote of 209 to 193. In the bill as passed by the House, coal-tar crudes remain on the free list, intermediates receive a protective duty of 30 per cent plus 7c. per lb., and dyes and finished coal-tar products are dutiable at 35 per cent plus 7c. per lb.

CHANGES IN CHEMICAL SCHEDULE

Among other last-minute changes in the bill was the increase in the duty on citrate of lime from 2½c. to 7c. per pound. Citric acid, which should logically have received a greater compensatory duty, was raised only to 12c. An important change was made in the rate on camphor which the Committee had fixed at 25 per cent ad valorem. Crude camphor remained dutiable at 1c. per lb. as in the present law while the rates on refined and synthetic were increased to 6c. per lb. The duty on ethyl alcohol was changed to 15c. per proof gallon. The quicksilver tariff was increased 500 per cent on the recommendation of the Secretary of War and a compensating increase on vermilion reds was approved.

The provision for a duty on imported petroleum oil was defeated after a sharp conflict between representatives from New England and from Oklahoma and Kansas, the centers for the independent oil producers. Following the reading of a letter from President Harding, Representative Treadway, of Massachusetts, succeeded in obtaining the passage of an amendment to return petroleum to the free list.

Asphalt was also returned to the free list after the House had rejected various proposed duties ranging from 50 cents to \$3 per ton. The committee later introduced some 200 so-called "perfecting" amendments, most of which were designed to correct spelling and other minor inconsistencies although in certain cases substantial increases in rates were included.

Following the scathing denunciation of the dye bill in his recent minority report, Congressman Frear of Wisconsin led a vigorous attack on the measure and was supported on

the floor of the House of Representatives by Burroughs of New Hampshire, Black of Texas, Fish of New York, Tague of Massachusetts and Moore of Virginia.

DYE EMBARGO DEFENDED BY LONGWORTH AND OTHERS

The bill was ably defended in speeches by Representatives Longworth, Copley and Hadley, who composed the sub-committee in charge of chemicals. Others to take up the fight in favor of special protection for the dye industry included Green of Iowa (who was largely responsible for the legal features of the measure); Treadway of Massachusetts, Graham of Illinois, Snyder and Magee of New York, and Tilson of Connecticut.

Representative Frear on a number of occasions charged that the dye industry was a half-billion dollar monopoly, represented largely by the Chemical Foundation, which was characterized as a private company that had defrauded the government of \$10,000,000 worth of patents. Frear also continued his attack on the officials of the Foundation.

In replying to Mr. Frear, Representative Longworth pointed out that only a very small proportion of the dyes produced in this country were affected by the Foundation's patents, and while offering no defense of the corporation, he explained its organization and principles. The Tariff Commission's report on dyes in 1920 which is referred to on page 166 of this issue, was quoted to show that no monopoly existed in the industry. In referring to the important relation to the National Defense, reference was made to the messages of former President Wilson, and the following letter from General Pershing was read:

GENERAL OF THE ARMIES,

Washington, July 15, 1921.

Hon. NICHOLAS LONGWORTH,

House of Representatives, Washington, D. C.

DEAR MR. LONGWORTH: With reference to the protection for the dye industry in this country, it can be stated that the coal-tar products, of which dyes are the most important at present in peace, is the base of practically all of our high explosives and most of our war gases.

Our shortage of chemical plants in general, and dye plants in particular, prior to the World War, made it difficult for us to obtain a supply of high explosives and gases until we had been in the war for several months.

From the above the importance of the chemical industry from a military standpoint will be readily seen.

Sincerely yours,

JOHN J. PERSHING.

PROTESTS AGAINST POTASH AND OTHER DUTIES

An idea of the opposition certain to meet the potash duty in the Senate may be gained from the remarks in the House—where it did not come up for a separate vote—by Representative Larsen, of Georgia. "The domestic potash industry," said Mr. Larsen, "has been in existence five years. For four years, it has enjoyed a complete monopoly and prices have been the highest in the history of the country, yet it has never produced more than twenty per cent of our normal demand. If at \$500 per ton, the industry were able to produce only 20 per cent of the normal demand, how is it going to produce potash under present conditions so it will be profitable to the industry or to the consumer?"

Among other duties to be protested are the proposed levies on vegetable oils, including olive oil. The soap manufacturers and other consumers have organized a bureau of free raw materials and have appealed to the President for more liberal tariff treatment for the materials entering into the manufacture of soap, lard and butter substitutes, paints, leather and allied materials.

Census of Dyes and Coal-Tar Chemicals for 1920

The fourth annual report on the production of dyes and other coal-tar products during 1920, which has been issued recently by the United States Tariff Commission, shows remarkable developments in these important industries. The progress made during the year is evidenced by the fact that the output of dyes increased over 40 per cent, reaching a total of 88,263,776 lb., valued at \$95,613,749. This exceeds the imports of 1914 by 92 per cent. In general the dyes used in large quantities were made in amounts sufficient to supply American needs. A number were made in considerable excess of domestic requirements and this contributed to the development of a large export trade in dyes during 1920. The American manufacturer, having met the demand for the dyes consumed in largest quantities, is now turning his attention toward the production of the many so-called "specialties," which while of secondary importance as far as quantity is concerned, are nevertheless essential to the establishment of a well-rounded and self-contained dye industry.

INTERMEDIATES AND DYES

The quantity of intermediates produced in 1920 showed an increase of 45 per cent over the output in 1919. The total production was 257,726,911 lb., valued at \$95,291,686. Of the more fundamental intermediates, aniline oil increased 61 per cent over the 1919 figure; beta-naphthol, 147 per cent; dimethylaniline, 53 per cent; gamma-acid, 170 per cent; H-acid, .35 per cent; alpha-naphthylamine, 233 per cent; paranitraniline, 63 per cent; and benzidine base, 91 per cent.

The production of anthraquinone increased from 294,260 lb., valued at \$547,787, in 1919 to 539,619 lb., valued at \$894,418. This increase is due in part to the development of synthetic anthraquinone from phthalic anhydride and benzene.

Triphenylphosphate and tricesylphosphate, used as substitutes for camphor in pyroxylin plastics, first appeared in 1920. It is doubtful whether these products can replace camphor for all purposes, but they at least offer a possible means of becoming independent of the Japanese camphor monopoly.

There were 360 or more different dyes produced by eighty-two American manufacturers in 1920. The output of these dyes, by classes according to their method of application, is shown in the accompanying diagram, which also offers a means of comparing this production with that of previous years (1917, 1918 and 1919) and with the imports for 1914 and 1920. The pre-war imports, which in many

cases have been more than doubled, are exceeded for all classes except for "vat dyes other than indigo." That real progress was made in this class, however, is evidenced by the increase from an output of 389,158 lb. in 1919 to 1,159,868 lb. in 1920. The output of indigo, 18,178,231 lb., valued at \$13,497,981, exceeds the production of 1919 by 105 per cent and is 116 per cent greater than the importations during 1914. Sulphur black, which has previously been the first color in quantity produced, ranks second in 1920 with an output of 16,305,037 lb.

PRODUCTION AND IMPORTS

A significant fact shown by the Tariff Commission's report is that of the 360 dyes produced in 1920, 108 individual colors, representing 92 per cent of the total output, were each manufactured by three or more firms. Of still greater significance is the fact that thirty-five dyes amounting to 52 per cent of the total, were each manufactured by seven or more separate firms. The dyes manufactured by only one firm numbered 200, but their output represented only 5 per cent of the total domestic production.

It is interesting to note that a consideration of the value of production, imports and exports shows that the value of the domestic output in 1920 was equal to at least 120 per cent of the domestic consumption, or exactly double the 60 per cent requirement of the tariff act of Sept. 8, 1916.

Among the other finished products derived from coal tar, there were conspicuous increases in the output of synthetic tanning materials, color lakes, perfume materials and synthetic phenolic resins. Some progress was reported in the manufacture of photographic chemicals, but there were marked decreases in the case of coal-tar medicinals and flavors.

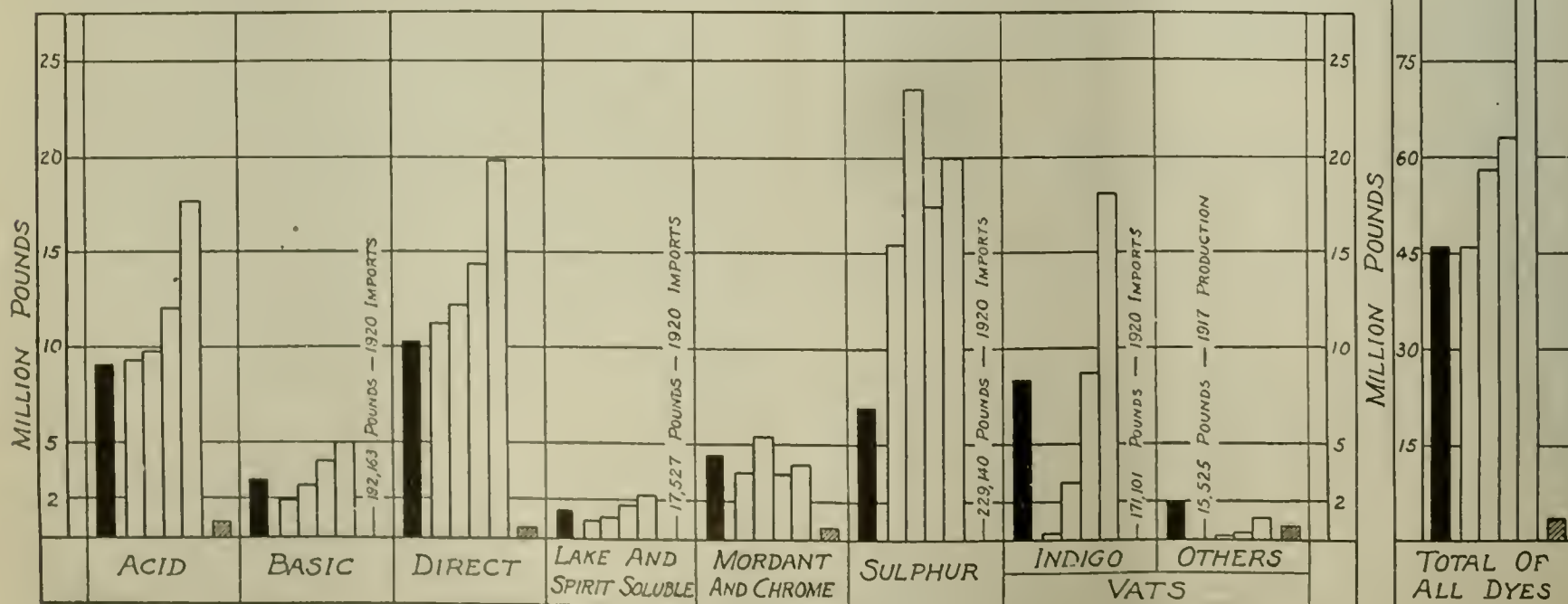
In addition to the detailed production statistics, the report contains an analysis of dye importations, which classifies the foreign colors according to Schultz numbers and shows their manufacturers, quantities imported, invoice values and countries of origin. The results of this study had already been outlined in a preliminary statement by C. R. DeLong of the Tariff Commission's staff, which was published in *CHEM. & MET.*, vol. 24, p. 845, May 11, 1921.

Other features of the report include the studies of rates of pay to employees with and without technical training, and also the amounts spent for research by the different manufacturers. The proportion of the monthly output of the German dye plants which is reserved for the option of the Reparations Commission is shown for the last eleven months of 1920 and the first three months of 1921. The appendix of that report includes a directory of the domestic manufacturers of coal-tar products during 1920.

FIG. 1. — COMPARISON OF PRODUCTION AND IMPORTS OF DYES BY CLASSES

■ IMPORTS 1914 FISCAL YEAR ▨ IMPORTS 1920 CALENDAR YEAR
□ PRODUCTION 1917 TO 1920 INCLUSIVE

C. R. DELONG. 6-15-21.



Fixed Nitrogen Research Laboratory

The Department of Agriculture has authorized the following official statement in connection with the transfer of the Fixed Nitrogen Research Laboratory from the War Department to the Department of Agriculture. The statement follows in its entirety:

By an order of the President, the Fixed Nitrogen Research Laboratory in Washington, D. C., established for war purposes in 1919, has been transferred from the War Department to the Department of Agriculture. This means that the research work to discover methods of fixing nitrogen from the air and making it available for use will be continued, and the results will be available for agricultural and chemical purposes.

The War Department, in making the transfer, included a provision, which was approved by the President, that the work of the laboratories should be available for the War Department at such times as national defense should make it imperative. A personnel of 110 to 120, including 50 of the best-trained experts in the world in nitrogen fixation and the application of the product, is transferred from the War Department to the Department of Agriculture, with the assurance that this carefully selected group of workers will be kept together instead of drifting into private occupation.

Dr. R. C. Tolman, Director of Fixed Nitrogen Research, will remain in the same position. The method of control of the research work under the Department of Agriculture has not been worked out in detail. The sum of \$500,000 made available from funds in the control of the President is transferred for the maintenance of the work for the next two years.

The laboratory is located on the grounds of the American University on Massachusetts Ave., Washington, making use of buildings and equipment formerly used by the Research Division of the Chemical Warfare Service. The largest building in use is loaned by the American University.

The Fixed Nitrogen Research Laboratory was founded by an order of the Secretary of War dated March 29, 1919, and has been operated with a budget of \$300,000 a year, the funds being provided under the National Defense Act of June 3, 1916, which authorized the President of the United States to "cause to be made such investigations as in his judgment are necessary to determine the best, cheapest, and most available means for the production of nitrates and other products for munitions of war and useful in the manufacture of fertilizers and other useful products, by water power or any other power, as in his judgment is the best and cheapest to use."

WORK OF THE LABORATORY

The main work of the laboratory has been to study the fixation of nitrogen by the cyanamide, the Haber and the arc processes, and to study the methods of transforming the various forms of nitrogen-containing products so as to make them most available for military, agricultural or industrial uses.

The cyanamide process is the one designed to be used at the Muscle Shoals plant in Alabama, and the Haber process in the smaller Sheffield plant in the same state, while the arc process is regarded as one of the most important processes of nitrogen fixation from a military point of view, since it can be most rapidly installed in case of war, and since it provides nitrogen at once in the nitrate form without the necessity of any oxidation from the ammonia form. The Government owns no arc plant, and for this reason less attention has so far been given to this process than to the others.

The cyanamide process is one of the best-known and best-established methods of fixing nitrogen, and the laboratory has completed more work in connection with this process than with the other methods of nitrogen fixation. The cyanamide process is at present the only process by which nitrogen can be fixed in America in case of emergency. The work on cyanamide was originally undertaken at the specific direction of the Fixed Nitrogen Administrator, Arthur Graham Glasgow, because of the Government ownership of the great Muscle Shoals plant, which is expected to produce 220,000 tons of cyanamide per annum.

The main purpose of this work has been to study cyanamide and its various possible transformation products from the point of view of their utility in agriculture, explosives and the arts. The laboratory has already collected an enormous amount of information as to the various compounds which can be prepared from this material. A large amount of further information is now coming through in the form of additional reports, and a number of important experimental investigations are being brought to a close. Experts in the Washington laboratory believe that the cyanamide process will remain an important method of fixing nitrogen for many years to come.

The Haber process, which under certain industrial conditions can displace the cyanamide process, has never been commercially operated outside of Germany. It has very great inherent difficulties connected with handling large quantities of flammable gas at high pressure and high temperatures.

While the research laboratory was established under the War Department and with a particular view to working out explosives problems, the necessity of obtaining a nitrogen supply for agricultural purposes has been kept constantly in mind. Pot and field tests have been carried on in co-operation with the Bureau of Plant Industry of the Department of Agriculture and at the two Alabama plants, where 20 acres were given over to agricultural tests in 1920. The closest co-operation has been maintained between the two departments in this work, and Dr. R. O. E. Davis, Scientist in Charge of Soil Physical Investigations of the Bureau of Soils, has been assigned for some time to co-operate with the work at the laboratory. Samples of fertilizer material for next year's tests at the plants are now being prepared by the laboratory.

Owing to the great variability in the results obtained in field tests, the experts are very anxious to continue the work for another year. The laboratory has already collected very important information as to the behavior of about 10 nitrogen-containing substances to these field tests.

NEEDS OF NITROGEN SUPPLY

Nitrogen is one of the three great elements necessary in fertilizers for plants, the others being phosphoric acid and potash. Nitrogen forms an essential constituent of explosives, of fertilizers, of dyestuffs, and many other substances used in the arts. In time of war the necessity of importing Chilean saltpeter, with its attendant uncertainties and tie-up of carrying capacity, was very serious. In time of peace the use of nitrogen in fertilizers is limited only by the supply and, if available, larger quantities would be used for increasing the food and other crops necessary for the country's welfare. It has been estimated by a high authority that the total loss of nitrogen from the arable land under cultivation in the United States is equivalent to 15 to 20 million tons of ammonium sulphate a year, representing a material work of about \$1,000,000,000.

A peculiarity of nitrogen fixation research in contrast to many other lines of scientific investigation is the rigid secrecy maintained by each country because of the great advantage of a supply of fixed nitrogen in time of war. Thus, although Germany has carried on extensive research for years, the results have not been made available and it has been necessary for the American scientists to start from rather rudimentary beginnings and build. The laboratory and personnel are considered the best on this continent, and possibly in the world.

Slate Industry Utilizing Waste

Theories for utilizing waste at slate quarries are being put into practice quite generally, according to Dr. Oliver Bowles, of the U. S. Bureau of Mines, after a visit to a number of quarries in the East and in New England. One large quarry is at this time installing a grinding plant to produce a 200-mesh product for filler purposes. There is an increasing demand for this type of material for filler in roofing and linoleums, and in asphalt mixtures.

While the activities at slate quarries are at a low point at present, steps are being taken in preparation for an increased volume of business which it is believed is certain to come with the increase in building activities.

Secretary Hoover Comments on Ford's Muscle Shoals Offer

The Secretary of Commerce revealed on July 18 that Henry Ford is not the only private interest considering the Muscle Shoals power proposition. Secretary Hoover stated that various chemical and power companies were considering the matter and indicating an active interest in it.

The Henry Ford proposition, and this has been confirmed at the Department of Commerce, is as follows: Mr. Ford offers to lease for 100 years the Wilson dam and the nearby No. 3 dam, along with the electrical installation, when the project is completed. It is estimated that an additional \$28,000,000 must be expended for the completion of the dam. On that sum, Mr. Ford proposes to pay interest at the rate of six per cent, and to amortize not only this sum but the entire cost of both dams over a period of 100 years. In addition he offers \$5,000,000 for the outright purchase of nitrate plant No. 2, its auxiliary steam plant, the land necessary to the operation and other appurtenances. He agrees to operate the nitrate plant for the production of fertilizers and to make the necessary conversion of the plant. He agrees also to maintain the plant so that it may be converted promptly for the manufacture of explosives in case of war. The plant is to be kept up to date in both arts. He agrees also to limit the profits of the fertilizer plant to eight per cent.

Mr. Ford expects to use a part of the power not needed for the nitrate plant for some of his own manufacturing enterprises and in addition it is assumed that he will undertake to find buyers for the surplus power. The Secretary of Commerce authorized the following statement in regard to Mr. Ford's proposal:

"The acceptance of the offer is matter for decision by Congress and that body will no doubt be greatly guided by Secretary Weeks' views in the matter. Mr. Ford has made a genuine proposal. It shows courage to agree to pay out \$5,000,000; to spend further sums upon large works and besides to take an annual obligation for about \$1,500,000 for 100 years and to agree to maintain a nitrate plant in reserve for the government for that period. Whatever may be the result, Mr. Ford's offer does prove what the public associations have contended—that the completion of this project has a commercial value."

Minerals Separation North American Corporation a Party to Miami Suit

On July 15, 1921, Judge Morris, in the U. S. District Court, Wilmington, Del., granted the petition of Minerals Separation, Ltd., and Minerals Separation North American Corporation that the latter company be made party in the suit in Minerals Separation, Ltd., vs. Miami Copper Company.

The granting of such a petition is of very little general interest since it matters not just which of the various corporate organizations of Minerals Separation, Ltd., are or are not parties in this suit.

But had Judge Morris, upon the other hand, found, as was claimed by the Miami Copper Company, that Minerals Separation had upon July 8, 1913, actually transferred its legal interest in its patents to the American corporation some very interesting and possibly far-reaching questions would have arisen as to the status of the suit now being prosecuted and also as to the disclaimer made by Minerals Separation, Ltd., as to certain claims of patent 835,120.

Stanley Patent Bill Again Delayed

The Stanley patent bill, requiring foreigners who take out American patents to undertake manufacture within the United States, was reached on the Senate calendar July 18, but was not considered, due to objection on the part of Senator Smoot, of Utah. Senator Smoot said that he had taken up some phases of this legislation with the Commissioner of Patents and is awaiting a reply. Pending receipt of that reply, he asked that the legislative consideration of the bill be postponed.

Another Moses Amendment

In explaining an amendment, which he has offered to the section of the Fordney tariff bill relating to dyes and coal-tar products, Senator Moses said:

"I propose to eliminate the embargo feature which the monopolistic dyestuff makers of America insist upon having in violation of the promises repeatedly made to committees of Congress in both Houses, and to give them instead a straight tariff protection in an amount wholly sufficient to cover the adverse labor costs obtaining in European countries, and adding a sufficient protection to give American dyestuff makers a consistent advantage in those markets. I intend to amplify this amendment in the course of the debate in the Senate when the tariff bill comes to us; and my only comment is that any manufacturer desiring a larger measure of protection than my amendment provides for him is a consummate hog."

The tariff protection provided in Senator Moses' amendment is accomplished by substituting for the ad valorem rates on dyes and intermediates, a special duty equal to the amount by which the American selling price plus 20 per cent of such price shall exceed the foreign market value to which has been added the specific duty of 7 cents per pound and certain non-dutiable charges for shipping and packing. In other words, the duty provides for the spread between the foreign and domestic prices and then adds an additional 20 per cent of the latter price. A foreign dye, under such an arrangement, will cost at least 20 per cent more than the identical American product. In case there is no comparable American dye or the foreign market value can not be determined, the amendment proposes alternative procedures based on costs of production.

The United States Tariff Commission is to supply the Secretary of the Treasury with the information required by the collectors of customs for the administration of the suggested measure.

Fall Meeting, American Electrochemical Society

In accordance with its policy of planning technical sessions well in advance so that members having research under way or papers in prospect will have an opportunity to complete them, the American Electrochemical Society has decided to hold a symposium on gases of the electrochemical industries at its spring meeting in 1922. The subject will include gases produced directly by electrolysis, their properties and uses; byproduct gases, their properties and uses; gas produced from electrochemical and electrothermal products, their generation, properties and uses. W. S. Landis, 511 Fifth Ave., New York City, is in charge of the symposium. Particular attention should be paid to new processes of generation, new uses and particularly to a compilation of newly discovered properties or of revised constants of the various gases in question.

It is announced that plans for the Lake Placid meeting, September 29, 30 and October 1, are proceeding satisfactorily. Lake Placid is recognized as a delightful mountain resort, and members of the society will find this meeting highly enjoyable. Plans are under way for outdoor sports in addition to the technical sessions. The latter will include symposia on non-ferrous electrometallurgy and electrodeposition.

Plans for Fall Meeting, Dye Division, A.C.S.

On Wednesday and Thursday, September 7 and 8, the Dye Division of the American Chemical Society will hold its fall meeting in New York City. This and other divisional meetings will be held in the buildings of Columbia University.

In addition to the usual scientific program, there will be an election of officers, and also discussion relating to matters of interest to the Dye Division.

An unusual effort will be made this fall to have the scientific papers read before the division of considerable interest. The secretary, R. Norris Shreve, 43 Fifth Ave., New York City, asks members to let him know at once about any papers which they can present, pertaining to the chemistry of the manufacture, use or application of dyes and intermediates.

Fermogas Promoter Sent to Prison

Stanislaus C. Papp, 41 years old, a chemist, who in May, 1920, caused a stir when he announced he had discovered that the juice of corn stalks, plus a little sugar, could be made into a substitute for gasoline in the operation of automobiles, was sentenced to from two and a half to five years in Sing Sing when arraigned before Judge McIntyre on July 19.

He had pleaded guilty to six indictments charging him with posing as "Professor F. John Chassler" when he induced many poor Hungarians and others to purchase stock in the Fermogas Company, a \$1,000,000 corporation, which he organized after he had given several fraudulent demonstrations of his "discovery" to army officers, bankers and capitalists in Ramsey, N. J.

Assistant District Attorney Lazarus told Judge McIntyre that the "professor" opened an office at 10 East Thirty-ninth Street for the disposal of stock in his "fermogas" company to victims, and that he maintained a "laboratory" at his home at 5,614 Second Avenue, Brooklyn. He gave a demonstration of his "product," Mr. Lazarus said; but it was found later that the "professor" had an old pipe running to the vat containing the ingredients for the gasoline substitute which pumped perfectly good gasoline into the automobile in which he gave his demonstration.

New York Meeting, American Chemical Society

The fall meeting of the American Chemical Society will be held with the New York Section, Tuesday September 6 to Saturday, September 10. This will probably be the largest meeting of the American Chemical Society that has ever been held. Aside from the 2,500 members of the New York Section itself, many thousands are within a four or five hours' ride of New York. In addition to the usual features the society will have as guests at this time a considerable number of British and Canadian members of the Society of Chemical Industry who will have held their annual meeting in Canada, will be greeted at the border by the Governor of the State, and will arrive in New York on Wednesday morning, September 7. After being the guests of the American Section of the Society of Chemical Industry at a Luncheon September 7, they then become the guests of the American Chemical Society for the remainder of the week. At least three or four hundred of these British and Canadian friends are expected, besides three or four thousand from the American Chemical Society. All members of the American Chemical Society are invited to the meeting in Montreal, beginning August 29th.

A further reason for this being a large and successful meeting is the opening of the National Exposition of Chemical Industries on September 12, immediately after the close of the meeting. A great many guests from all over the United States who visit this Exposition each year, will come a few days earlier to attend the meeting of the American Chemical Society.

DIVISIONAL PROGRAMS

All Divisions will meet. Meetings are also announced of Sections of Sugar Chemistry, Cellulose Chemistry, Leather Chemistry, Petroleum Chemistry, and Chemical Education. All Divisions and Sections will have two full days at their disposal.

The Division of Industrial and Engineering Chemistry calls especial attention to two items on its program: First, a symposium on filtration, being organized by D. R. Sperry of Batavia, Ill.; and second, a symposium on gas chemistry being organized by a committee of which R. S. McBride, Colorado Building, Washington, D. C., is secretary.

Notice of the Dye Division's plans will be found elsewhere in this issue.

The Division of Chemistry of Medicinal Products will devote the largest portion of their time to a discussion of the "newer synthetics as used in medicine."

The Division of Biological Chemistry will hold an all-day symposium on vitamins with Prof. H. C. Sherman as chairman. Tentative plans include discussion of fat-soluble A, water-soluble E, antineuritic vitamin, antiscorbutic vita-

mine, stable forms of vitamin, the physical chemistry of vitamins, and vitamins from the standpoint of structural chemistry. Among the speakers will be such authorities as Mendel, Osborne, Hess, McCollum, Emmett, Seidell, Steenbock, Funk, Dutcher, Williams, La Mer, and Blunt. The great interest in the vitamin papers presented at Rochester has led the officers of the division to anticipate an unusually interesting symposium and valuable discussions.

The Cellulose Section will hold a symposium on cellulose esters. Reports by the committee on viscosity standards and by the committee on the preparation of a standard cellulose will be received.

The Leather Section already has some twenty-five papers in hand for the meeting of that section.

The meeting of a Section on Chemical Education with Edgar F. Smith as chairman and Neil E. Gordon as secretary has been authorized for the New York meeting.

The Petroleum Section will hold a symposium on emulsification problems in the petroleum industry.

Bureau of Chemistry Directorship Unattractive to Many

In feeling out a considerable number of men prominent in the field of agricultural and food chemistry and in organic research, officials of the Department of Agriculture are finding that few of these chemists are in a position to accept appointment as Chief of the Bureau of Chemistry at \$5,000 a year. In private industry a chemist capable of directing the work of 300 technical men and 400 other assistants receives a salary of several times \$5,000. Many chemists of this type would be glad to do public service if they could afford it, but it is apparent from the investigation which the department has made that not many men are in a position to make this sacrifice.

The resignation of Dr. C. L. Alsberg became effective July 15. At the request of the Secretary of Agriculture he remained in Washington for a number of days after that date but the fact that his new duties at Leland Stanford require his early presence in California precludes his devoting more time to the bureau. This is expected to hasten the matter of selecting the new chief. The problem admittedly is simply one of persuading some properly qualified chemist to work for \$5,000 a year.

Chemical Exposition Notes

FILTERS

In the approved methods of today efficiency in every branch of factory or plant is demanded. In filters, the advantages looked for are labor saving, saving of filter cloths, perfect filtration, low cost of maintenance, perfectly clear filtrate, clean installation, high capacities, low moisture content.

All of these requirements have been met by exhibitors of filters at the Seventh National Exposition of Chemical Industries, Eighth Coast Artillery Armory, New York, Sept. 12 to 17. An open tank filter which requires only one man to operate hundreds of square feet of filter area will be one of the exhibits.

A rotary continuous suction filter, superior for handling mud from hot, caustic solutions from continuous causticizing and lime recovery is a typical American product.

Large sums are spent annually by manufacturers experimenting with the clarity and keeping quality of their products. The opportunities for research and investigation at the exposition will be invaluable in obtaining filtering efficiency.

Platinum Theft at Sierra Magnesite Co.

The Sierra Magnesite Co., Porterville, Cal., reports the theft of platinum from its laboratories some time during the night of June 14, comprising three platinum crucibles weighing, respectively, 12.1 g., 12.328 g., 14.307 g. In addition to these there was taken one palau crucible weighing 14.491 g.

Personal

DR. HARDEE CHAMBLISS has been placed in charge of the Department of Chemistry of the Catholic University, Washington, D. C. He will be in immediate charge of the Martin-Maloney laboratory. Dr. Chambliss was graduated from Johns Hopkins University in 1900. He has devoted practically his entire time since in chemical research and instruction. During the war he was in charge of the Government's nitrate plant No. 1 at Sheffield, Alabama. Dr. Chambliss succeeds Rev. John J. Griffin, who has been in charge of the University's Department of Chemistry since 1895. Dr. Griffin was compelled to abandon the work on account of ill health.

W. J. CROOK, formerly chief metallurgist of the Pacific Coast Steel Co., has been appointed associate professor of metallurgy at Stanford University. Mr. Crook is retained by the steel company in a consulting capacity.

DR. GRAHAM EDGAR of the University of Virginia is associated with the research work of the Fixed Nitrogen Research Laboratories, American University, Washington, for the summer. Dr. Edgar previously was connected with this organization and has returned to the work to round out some of the investigations in which he has been engaged previously.

O. B. HOFSTRAND, metallurgical engineer, of Salt Lake City, Utah, has recently returned after having completed an extensive investigation of the Tintic Milling Company's plant and process at Silver City, Utah.

DR. R. B. MOORE, chief chemist of the U. S. Bureau of Mines, will leave Washington August 2nd for a month's trip during which he will look over the chemical phases of the work being done at Bureau of Mines experiment stations at Pittsburgh, Columbus, St. Louis, Denver, Salt Lake City, Reno, and San Francisco.

DR. WALTER F. RITTMAN is to assume duty as head of the Department of Commercial Engineering, Carnegie Institute of Technology, Pittsburgh, Pa., next fall.

WELD, LIDDELL & LAZENBY have dissolved the partnership. Messrs C. Minot Weld and Donald M. Liddell will continue to practice as consulting engineers and economists under the name of Weld and Liddell, at 2 Rector Street, New York. Paul H. Lazenby will continue his practice independently in transportation business, public utilities and economics, with offices at 2 Rector Street, New York.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, July 22, 1921.

Chemicals are finding a quiet outlet in most instances and price changes have been confined to comparatively few items. Second hands have been kept moderately active, but they are not getting any real assistance from consumers who prefer to operate only for necessary requirements. Prices advanced slightly at intervals then declined to where they were previously. The movement depended chiefly on whether the principal wanted to buy or sell. Looking at the big basic chemicals, we find a slight shading of prices for resale *caustic soda* at the works. This is not due entirely to speculative short selling, as some of the more prominent dealers have sold down to 3½c. per lb. against a 4c. price at the close of the previous week. The market has been well restricted on resale stock to the range of 3½@4c. per lb. Offerings of large tonnages of German *caustic soda* at \$3.35 per hundred lbs. attracted considerable attention and found ready buyers. *Soda ash* has not been altered to any noticeable extent on spot. Prices

ranged from \$2.05@\$2.10 per 100 lb. and closed at the inside figure in single bags in most resale quarters. *Bleaching powder* was handled to some extent for paper mills at \$2@\$2.10 per lb. f.o.b. works and closed rather firm at these prices which were named by large dealers. *Bichromate of soda* showed a slight decrease at the close of the week. *Oxalic acid* remained fairly steady and appeared to be somewhat under control. Aside from tartaric acid, the smaller items were quite steady with camphor, quinine and menthol showing a disposition to strengthen. *Prussiate of soda* slumped about ½c. per lb. under keener competition. *Caustic potash* was easy while imported *chlorate of potash* seemed a bit steadier. *Copper sulphate* was in moderate request remained steady. Second hands are quoting producers' prices on standard quality and it looks as though resale supplies of this chemical have been well liquidated.

Textile mills are buying some material and a better feeling has developed in the tanning industry. The usual depression in business has been reported from the glass plants where summer slackness has been in order. Paper mills seem to be buying more freely and quite a few inquiries have resulted in the placing of some large orders. There are distinct indications of a moderate increase in the volume of the general merchandise business. The building trade has taken a decidedly better turn and this condition has developed an increased demand for building materials. There has been some noteworthy improvement in the credit situation. All danger of a credit strain has definitely passed. The general condition of business in this country is greatly disjointed, but there is no serious alarm for a general depression. Although the copper mines are closed down and the steel industry is operating at 25 per cent capacity, these industries as well as others cannot through any possibility remain permanently stagnant.

CHEMICALS

Producers of *acetate of soda* report sales on the basis of 4c. per lb. and quote the market 4@4½c. depending on quantity. This is the lowest price quoted in the open market so far this year and compares with a high price of 12½c. established in May, 1920, and a high price of 6½c. recorded in January and February, 1921. First hand sales of *bicarbonate of soda* are going through on the basis of 2½c. per lb. f.o.b. works in barrels and 2½c. per lb. in kegs. Dealers are offering prime material at \$2.35 per 100 lb. in bbls. ex-store and report a rather calm market. Spot *bichromate of soda* appeared somewhat steadier at the close and 8c. per lb. was the minimum for standard material. Sellers reported quiet trading at 8@8½c. per lb. Most dealers of *caustic soda* quoted the market for standard brands at \$4@\$4.15 per 100 lb. ex-store N. Y. At the works dealers quoted 3½@4c. per lb. depending upon the quantity. Contracts are quoted by producers at 3½c. per lb., basis 60 per cent, f.o.b. works. Moderate trading has featured the market and transactions have been along conservative line in most instances. Some German *caustic soda* was offered at \$3.65 per 100 lb. ex dock N. Y. Manufacturers report sales of *hyposulphite of soda* at 3½c. per lb. in bbls. for carload lots. Smaller quantities are moving at prices ranging up to \$3.85 per 100 lb. A fair inquiry has reached the market during the past week. Spot *nitrate of soda* was offered at 7@7½c. per lb., while some sellers are asking above this figure. Light trading is about the best that can be said of the market at present and the desire to secure new business has prompted slight price shading in some directions. Lower prices are reported for *prussiate of soda* on spot. Sales have been rumored down to 11½c. per lb., but the general quotation was 11½@12c. per lb. according to quantity. This is another chemical that has felt the depressing influence of selling competition. Buyers are chiefly interested in small lots. Dealers' prices on resale light *soda ash* in single bags range from \$2.05@\$2.10 per 100 lb. Barrels were offered at \$2.40@\$2.50 according to seller and quantity. Resale offerings at the works were quoted at \$1.85@\$1.95 per 100 lb. First hand prices at the works were heard at \$1.60 per 100 lb. for single bags, basic 48 per cent. Imported ash was obtainable in limited quantities at \$1.55 per 100 lb. ex-dock N. Y. Prime domestic *sulphide of soda*, fused, is quoted by producers at 6½c. per

lb. which resale material has been offered at prices ranging from 5@5½c. per lb. The broken variety is quoted at 5½@6½c. per lb.

Business in *barium chloride* has shown a little more activity of late with dealers holding spot material at \$59@ \$60 per ton. Sales for immediate shipment from abroad were reported at \$55@\$57 per ton. Producers of *bleaching powder* continue to ask 2¼c. per lb. for large drums at the works regardless of rumors to the effect that lower prices have been named. Prominent dealers quote the market at \$2@\$2.10 per 100 lb. f.o.b. works and 2¼@2½c. per lb. for small drums. Miscellaneous inquiries have resulted in some additional business being placed, but buyers seem to be far enough under sellers' ideas to prevent extensive business. Producers report sales of *glaubers salt* in bags at 1½c. per lb. in carload lots. These interests are asking 1¾c. per lb. for smaller quantities. Spot oxalic acid is quoted from 18@19c. per lb. according to seller and quantity. It is somewhat possible to purchase a few odd lots at 17¾c. per lb. Producers quote the market at 17¾c. per lb. and upward f.o.b. works. The tone of the general market is steady with a fair number of inquiries reported in several quarters.

COAL-TAR PRODUCTS

There is a growing disposition among the larger producers to maintain prices more firmly, not so much with the idea of holding the market at present prices, as to stabilize conditions and drive out all superfluous resale stock which threatened for a time to cause a serious depression in present prevailing prices. *Benzene* and *toluene* are firm, with an actual scarcity of benzene. England has been a consistent bidder for benzene for the past few months, but the fact that the facilities for loading tank steamers are controlled by the big oil firms together with curtailment of production due to the closing of many coke-ovens prevent shipments of material. One large factor reports that an average of several orders a week are being turned down due to the above causes. Prices on benzene are firm at 27@33c. per gal., with very small supplies available. Inquiries are numerous, but sales are necessarily restricted. Imports of *cresylic acid* have been more sufficient to meet requirement and surplus stocks are available, but sellers are firm in their views of 68@75c. per gal. for the 97-99 per cent and 65@70c. on the 95 per cent. The English market is steady and present replacement costs allow little room for further price concessions. The demand for *cresol* is light and the market is barely firm at 16@18c. per lb. for the U. S. P. grade. The demand for *naphthalene* from the drug field has slackened and a consequent easing of the market is noted. Flakes are offered at 7c. per lb., balls at 8@10c. Most business is in resale goods. Producers of *toluene* quote 28@32c. per gal. Although the demand for this product has been quite strong recently, supplies remain limited.

The general inside quotation on *aniline oil* is 18c. per lb. with prices ranging up to 21c. on small lots. Sales of moderate quantities at the lower price is reported. Sellers of *benzaldehyde* show considerable variance in their price views with technical at 45c. per lb., U. S. P. material at \$1.00@\$1.25 per lb. and F. F. C. at \$1.85 per lb. The demand remained dull. Producers of *benzyl chloride* report the market more active at lower prices, with the 95-97 per cent firm at 25@27c. per lb. and the technical at 20@23c. Small lot selling of *dimethylaniline* was done at 40c. per lb. and in some cases at 39c. The demand is light. Reduction on the base variety of *para-amidophenol* to \$1.40 per lb. was made. The HCl was steady at \$1.60@\$1.75 per lb. Supplies are abundant and prices show the effect of surplus stocks. A decline to \$1.60 per lb. was noted for *resorcinol* under keener competition. The demand is steady. Strong selling pressure in *beta-naphthol* is reducing prices. Supplies are more than sufficient to meet the current light demand. Prices range from 33@38c. per lb., with prospects of shading on actual business. In spite of foreign inquiries, the market on *para-nitroaniline* is easier and 75c. per lb. has been done on passing business. Current quotations range to 80c. per lb., but the lower figure is attracting all the business.

The St. Louis Market

ST. LOUIS, Mo., July 21, 1921.

The drug and fine chemical market during the past two weeks has been rather quiet and featureless, nothing of importance having transpired recently. Inquiries are still numerous but not of large volume, and the consuming trade for the present moment are not disposed to take on more than for their immediate requirements. While the movement of heavy chemicals has also been slow the past two weeks, a number of inquiries on quite a few of the items gave the market a more optimistic tone, and it is to be hoped these inquiries are but the forerunner of a general activity on all heavy chemicals. Heavy importations of foreign chemicals continue to be noted and apparently importers are endeavoring to bring in as much of the foreign material as is possible before the new tariff becomes effective. The proposed tariff has not stimulated business to any noticeable extent.

Caustic soda remains quiet with a strict adherence to the manufacturer's schedule. The inquiry on *soda ash* has been very fair and while round lots are still quoted at \$2.95 per 100 lb., sales have been reported at \$2.60 per 100 lb. *Sal soda* and *sodium bicarbonate* remain inactive.

Carbon bisulphide continues to be one of the active items with a constant flow of inquiries resulting in quite a little business. *Hypo* continues to enjoy a routine demand. *Sulphur* holds its routine demand with price remaining at \$2 per 100 lb., and less shading being reported.

DRUGS AND PHARMACEUTICALS

No change has occurred in the position of *ammonia water* 26 deg. and it continues to maintain its present schedule. Heavy importations of *bromides* are still being noted which have a very ill bearing on the domestic product and the situation at the present moment is not very promising. *Cream of tartar* is still in limited demand. *Epsom salts* is being quoted in carlots at \$2.35@\$2.50 per 100 lb., delivered, and less than carlots at \$2.60@\$2.75 per 100 lb., delivered. Factors have reduced their price on *ether* and a fair volume of business is being transacted. *Glycerine* is quoted at 14¾c. per lb., with a routine demand. The keen competition of secondhands on *iodides* seems to be gradually disappearing and giving ease to the situation. Manufacturers are hopeful that this commodity will again become firmer and on sounder basis. The *salicylates* are a seasonable article and a good volume of business is being enjoyed. A sudden and brisk demand has been experienced lately for *silver nitrate* and manufacturers are in position to meet this unexpected movement. At present *sodium benzoate* is moving slowly. However, it is anticipated that this condition should improve very shortly, in view of the approaching preserving and canning season. Quite a few inquiries for large quantities of *sulpho-carboates* have been received the past week indicating that consumers' stocks are exhausted. A steady demand for *zinc stearate* still prevails. *Zinc oxides* remain firm since their last decline. The lead-free continues in fair demand by the rubber industry while the leaded zinc oxides remain in poor demand on account of the unusually dull period the paint trade is experiencing.

ACIDS

Heavy acids are more active than in the past with a fair increase in business. *Carbolic acid* remains at its present schedule with a fair demand. Although extremely warm weather has prevailed during the past few weeks over the entire country and no doubt considerable quantities of soft drinks have been consumed, there has been no indication of an increase for the demand of *citric acid* and the situation today does not give any better appearance than some few weeks past. There has been no improvement in the call for *tartaric acid* since the last reduction.

VEGETABLE OILS AND PAINT MATERIALS

Linseed oil, after falling off a few cents, has risen sharply and holds firm at 81c. basis raw, in cooperage, ex warehouse. *Castor oil* still holds at 10½c. per lb. in drums with routine demand.

Lithopone continues to be the only pigment with a sustained demand. The price remains at 7¼c. per lb., in carlots with a 25c. per 100 lb. freight allowance.

The Iron and Steel Market

PITTSBURGH, July 22, 1921.

The Steel market has undergone a sweeping change in character. The change has occurred quietly and realization that the market is on quite a new basis may not be universal. There is a slight increase in the total volume of demand upon the mills, and prices in general average a shade lower than a week ago.

The great change is that no mill now has a fixed price. There have been times when all mills had the same price, and other times when some mills had a certain price and other mills were cutting that price by an amount which each mill determined for itself. Now there is little difference between mills but much difference between quotations on different classes of orders. A mill may quote a certain price on a carload, then quote a materially lower price on 500 tons, and then quote the first price on a carload lot again. The desirability of the order is what counts. Mills are not counting upon profits, but are weighing the loss if an order is taken against the loss if the order is not taken. The cost of production including overhead exceeds any price now obtainable, but if a mill is entirely idle there is also a loss.

Another important change in the market is that "Pittsburgh plus" or the system of basing delivered prices all over the country on a basic price at Pittsburgh, rail freight from Pittsburgh to point of delivery being added, has disappeared in several commodities that are produced in large tonnages in different districts are likely to develop a separate market price for each district.

Market prices are therefore not clear cut, since different prices are obtainable on different sizes and degrees of attractiveness of orders. Quite an ordinary order could be placed at 1.90c. for plates, shapes or bars, while a larger order would probably draw the greatest concession in plates and the least in bars.

DEMAND INCREASED

The turn has been rounded in the matter of demand upon the mills, although it requires close scrutiny to discern the change. The long decrease is interrupted and it requires no enthusiastic temperament to predict that the lowest point in demand is entirely passed, since that lowest point represented a demand less than 20 per cent of the productive capacity.

A study of the bookings, in the form of new orders and of specifications against contracts shows that the demand is widespread as to classes of buyers and also geographically, also that the bulk of the demand is in small orders, with specifications decidedly mixed in character. There is evidently represented some further progress in the liquidation of stocks of steel in the hands of jobbers and manufacturing consumers and of stocks of finished wares in the hands of manufacturing consumers. There is no improvement in railroad buying and there is evidence that the general industrial activity of the country has increased. In other words, demand upon the mills for steel was below a natural relation to the general business activity of the country, and has now begun to trend towards the natural relation, which eventually may represent something like a 40 per cent operation of the steel industry. Operations since July 1 have hardly averaged 20 per cent.

CELERITY IN SHIPMENT A DECIDING FACTOR

Prices are not a vital factor in the steel business now being placed, celerity of shipment being the important matter. The buying is hand to mouth in character and the buyer wishes to realize on the material purchased within the smallest number of days possible after he has committed himself with the mill to take the material.

Pig iron continues to recede slowly, bessemer being quotable at \$20.50, valley, basic at \$19, valley and foundry at \$19.50, valley, representing declines in the week of \$1 in foundry and 50c. in bessemer and basic. Freight to Pittsburgh is \$1.96, but some nearby furnaces would probably name lower prices delivered than the valley market plus the freight.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots		Less Carlots	
Acetic anhydride.....lb.			\$0.40 -	\$0.45
Acetone.....lb.	\$0.12½ -	\$0.12½	.13 -	.13½
Acid, acetic, 28 per cent.....100 lbs.	2.50 -	2.75	3.00 -	3.25
Acetic, 56 per cent.....100 lbs.	4.00 -	4.25	4.50 -	5.50
Acetic, glacial, 99½ per cent, carboys, 100 lbs.	9.75 -	10.00	10.25 -	10.50
Boric, crystals.....lb.	.13½ -	.14	.14½ -	.15
Boric, powder.....lb.	.15 -	.15½	.16 -	.16½
Citric.....lb.			.46 -	.47
Hydrochloric.....100 lb.	1.25 -	1.50	1.60 -	1.75
Hydrofluoric, 52 per cent.....lb.	.12½ -	.12½	.12½ -	.13
Lactic, 44 per cent tech.....lb.	.10 -	.11	.11½ -	.12
Lactic, 22 per cent tech.....lb.	.04½ -	.05½	.06 -	.07
Molybdic, C. P.....lb.	4.00 -	4.50	4.50 -	5.00
Muriatic, 20 deg. (see hydrochloric).....lb.			.07 -	.07½
Nitric, 40 deg.....lb.	.06½ -	.06½	.07 -	.07½
Nitric, 42 deg.....lb.	.07 -	.07½	.07½ -	.07¾
Oxalic, crystals.....lb.	.18 -	.18½	.18½ -	.19
Phosphoric, 50 per cent solution.....lb.	.13½ -	.14	.14 -	.18
Picric.....lb.	.20 -	.25	.27 -	.35
Pyrogallol, resublimed.....lb.			1.90 -	2.15
Sulphuric, 60 deg., tank cars.....ton			11.75 -	14.00
Sulphuric, 60 deg., drums.....ton			13.00 -	15.00
Sulphuric, 66 deg., tank cars.....ton	18.00 -	20.00		
Sulphuric, 66 deg., drums.....ton	21.00 -	22.00	22.50 -	23.00
Sulphuric, 66 deg., carboys.....ton				
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	21.00 -	22.00		
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	23.00 -	23.50	24.00 -	24.50
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	31.00 -	32.00	33.00 -	34.00
Tannic, U. S. P.....lb.			.90 -	1.00
Tannic (tech.).....lb.	.45 -	.48	.50 -	.55
Tartaric, crystals.....lb.			.29 -	.30
Tungstic, per lb. of WO.....lb.			1.30 -	1.40
Alcohol, Ethyl.....gal.			4.80 -	5.00
Alcohol, Methyl (see methanol).....gal.				
Alcohol, denatured, 188 proof.....gal.			.31 -	.36
Alcohol, denatured, 190 proof.....gal.			.38 -	.42
Alum, ammonia lump.....lb.	.03½ -	.03½	.04 -	.04½
Alum, potash lump.....lb.	.03½ -	.04	.04½ -	.04¾
Alum, chrome lump.....lb.	.10 -	.11	.11½ -	.12½
Aluminum sulphate, commercial.....lb.	.01½ -	.02	.02½ -	.02¾
Aluminum sulphate, iron free.....lb.	.03 -	.03½	.03½ -	.04
Aqua ammonia, 26 deg., drums (750 lb.).....lb.	.07 -	.07½	.07½ -	.08
Ammonia, anhydrous, cyl. (100-150 lb.).....lb.	.30 -	.32	.33 -	.35
Ammonium carbonate, powder.....lb.	.08 -	.08½	.09 -	.10
Ammonium chloride, granular (white sal-amoni ac).....lb.	.06½ -	.06½	.07 -	.07½
Ammonium chloride, granular (gray sal-amoni ac).....lb.	.06½ -	.06½	.07 -	.07½
Ammonium nitrate.....lb.	.07 -	.07½	.07½ -	.08½
Ammonium sulphate.....100 lb.	2.70 -	2.75	2.80 -	3.00
Amylacetate.....gal.			4.00 -	4.25
Amylacetate tech.....gal.			2.50 -	3.00
Arsenic oxide, (white arsenic) powdered lb.	.06½ -	.07	.07½ -	.08
Arsenic, sulphide, powdered (red arsenic) lb.	.11 -	.11½	.12 -	.13
Barium chloride.....ton	59.00 -	59.50	60.00 -	62.00
Barium dioxide (peroxide).....lb.	.20 -	.21	.22 -	.23
Barium nitrate.....lb.	.07½ -	.07½	.08 -	.08½
Barium sulphate (precip.) (blanc fixe).....lb.	.04 -	.04½	.04½ -	.05½
Bleaching powder (see calc. hypochlorite).....lb.				
Blue vitriol (see copper sulphate).....lb.				
Borax (see sodium borate).....lb.				
Brimstone (see sulphur, roll).....lb.				
Bromine.....lb.	.41 -	.42	.43 -	.45
Calcium acetate.....100 lbs.	2.00 -	2.05		
Calcium carbide.....lb.	.04½ -	.04½	.05 -	.05½
Calcium chloride, fused, lump.....ton	23.50 -	24.00	24.50 -	25.50
Calcium chloride, granulated.....lb.	.01½ -	.02	.02½ -	.02¾
Calcium hypochlorite (bleach powder) 100 lb.	2.15 -	2.25	2.35 -	2.50
Calcium peroxide.....lb.			1.40 -	1.50
Calcium phosphate, tribasic.....lb.			.15 -	.16
Camphor.....lb.			.75 -	.78
Carbon bisulphide.....lb.	.06½ -	.07	.07½ -	.08
Carbon tetrachloride, drums.....lb.	.10½ -	.10½	.11 -	.12
Carbonyl chloride (phosgene).....lb.			.60 -	.75
Caustic potash (see potassium hydroxide).....lb.				
Caustic soda (see sodium hydroxide).....lb.				
Chlorine, gas, liquid-cylinders (100 lb.).....lb.	.08 -	.09	.09½ -	.10
Chloroform.....lb.			.38 -	.43
Cobalt oxide.....lb.			3.00 -	3.10
Copperas (see iron sulphate).....lb.				
Copper carbonate, green precipitate.....lb.	.19 -	.19½	.20 -	.21
Copper cyanide.....lb.			.50 -	.62
Copper sulphate, crystals.....lb.	.05½ -	.06	.06½ -	.06¾
Cream of tartar (see potassium bitartrate).....lb.				
Epsom salt (see magnesium sulphate).....lb.				
Ethyl Acetate Com. 85%.....gal.			.85 -	1.00
Ethyl Acetate pure (acetic ether 98% to 100%).....lb.			.50 -	.52
Formaldehyde, 40 per cent.....lb.	.13 -	.13½	.13½ -	.14
Fusel oil, ref.....gal.			3.00 -	3.25
Fusel oil, crude.....gal.			1.75 -	2.00
Glauber's salt (see sodium sulphate).....lb.				
Glycerine, C. P. drums extra.....lb.			.15 -	.15½
Iodine, resublimed.....lb.			3.65 -	3.75
Iron oxide, red.....ton			.10 -	.20
Iron sulphate (copperas).....ton	19.00 -	20.00	21.00 -	22.00
Lead acetate.....lb.			.11½ -	.13½
Lead arsenate, paste.....lb.	.09 -	.09½	.10 -	.11
Lead nitrate.....lb.			.15 -	.20
Litharge.....lb.	.08½ -	.08½	.08½ -	.09
Lithium carbonate.....lb.			1.30 -	1.40
Magnesium carbonate, technical.....lb.	.09 -	.09½	.10 -	.11
Magnesium sulphate, U. S. P.....100 lb.	2.40 -	2.75		
Magnesium sulphate, technical.....100 lb.			1.20 -	1.75
Methanol, 95%.....gal.			.83 -	.85
Methanol, 97%.....gal.			.86 -	.88
Nickel salt, double.....lb.			.12 -	.12½
Nickel salt, single.....lb.			.14 -	.14½
Phosgene (see carbonyl chloride).....lb.				
Phosphorus, red.....lb.	.45 -	.46	.47 -	.50
Phosphorus, yellow.....lb.			.35 -	.37
Potassium bichromate.....lb.	.11½ -	.11½	.12 -	.12½

	Carlots	Less Carlots
Potassium bitartrate (cream of tartar)..... lb.	\$. . . \$	\$0 30 - \$0 31
Potassium bromide, granular..... lb.		.16 - .25
Potassium carbonate, U. S. P..... lb.	.35 - .40	.45 - .50
Potassium carbonate, 80-85%..... lb.	.05 - .051	.06 - .07
Potassium chlorate, crystals..... lb.	.071 - .071	.08 - .12
Potassium cyanide..... lb.		.26 - .28
Potassium hydroxide (caustic potash)..... lb.	.05 - .051	.051 - .06
Potassium muriate, 80% K.C.I..... ton	45.00 - 50.00	
Potassium iodide..... lb.		2 75 - 3 00
Potassium nitrate..... lb.	.091 - .091	.10 - .121
Potassium permanganate..... lb.	.29 - .30	.31 - .32
Potassium prussiate, red..... lb.	.28 - .29	.29 - .30
Potassium prussiate, yellow..... lb.	.22 - .221	.23 - .231
Potassium sulphate (powdered)..... per unit		1 50 - 1 75
Rochelle salts (see sodium potas tartrate).....		
Salammoniac (see ammonium chloride).....		
Sal soda (see sodium carbonate).....		
Salt cake..... ton		20 00 - 25 00
Silver cyanide..... oz.		1 35 - 1 38
Silver nitrate..... oz.		.40 - .41
Soda ash, light..... 100 lb.	2.05 - 2 10	2 15 - 2 45
Soda ash, dense..... 100 lb.	2.35 - 2 40	2 45 - 2 70
Sodium acetate..... lb.	.04 - .04	.04 - .05
Sodium bicarbonate..... 100 lb.	2.25 - 2 40	2 50 - 2 75
Sodium bichromate..... lb.	.08 - .081	.081 - .09
Sodium bisulphate (nitre cake)..... ton	5.00 - 5 25	5 50 - 6 50
Sodium bisulphate powdered, U.S.P..... lb.	.05 - .051	.051 - .06
Sodium borate (borax)..... lb.	.06 - .061	.061 - .07
Sodium carbonate (sal soda)..... 100 lb.	1.90 - 2 00	2 10 - 2 40
Sodium chloride..... lb.	.071 - .071	.08 - .081
Sodium cyanide..... lb.	.191 - .21	.22 - .30
Sodium fluoride..... lb.	.111 - .12	.121 - .131
Sodium hydroxide (caustic soda)..... 100 lb.	3.90 - 4 00	4 10 - 4 50
Sodium hyposulphite..... lb.		.031 - .031
Sodium nitrate..... 100 lb.	2 50 -	2 60 -
Sodium nitrite..... lb.	.07 - .071	.071 - .08
Sodium peroxide, powdered..... lb.	.25 - .26	.27 - .30
Sodium phosphate, dibasic..... lb.	.041 - .041	.05 - .051
Sodium potassium tartrate (Rochelle salts) lb.		.26 - .27
Sodium prussiate, yellow..... lb.	.111 - .12	.121 - .121
Sodium silicate, solution (40 deg.)..... 100 lb.	1.00 - 1 15	1 25 - 1 40
Sodium silicate, solution (60 deg.)..... lb.	.021 - .03	.031 - .031
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	1 50 - 1 75	2 00 - 2 25
Sodium sulphide, fused, 60-62 per cent (conc.) lb.	.05 - .051	.051 - .061
Sodium sulphite, crystals..... lb.	.031 - .04	.041 - .041
Strontium nitrate, powdered..... lb.	.15 - .151	.16 - .17
Sulphur chloride, red..... lb.	.07 - .071	.071 - .08
Sulphur, crude..... ton	20 00 - 22 00	
Sulphur dioxide, liquid, cylinders extra..... lb.	.08 - .081	.09 - .10
Sulphur (sublimed), flour..... 100 lb.		2 25 - 3 10
Sulphur, roll (brimstone)..... 100 lb.		2 00 - 2 75
Tin bichloride, 50 per cent..... lb.	.18 - .19	
Tin oxide..... lb.		.40 - .42
Zinc carbonate, precipitate..... lb.	.151 - .16	.161 - .17
Zinc chloride, gran..... lb.	.11 - .111	.111 - .12
Zinc cyanide..... lb.	.45 - .49	.50 - .60
Zinc dust..... lb.	.111 - .111	.111 - .121
Zinc oxide, XX..... lb.	.071 - .071	.08 - .09
Zinc sulphate..... 100 lb.	3 00 - 3 25	3 30 - 3 50

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude..... lb.	\$1 10 - \$1 15
Alpha-naphthol, refined..... lb.	1 25 - 1 30
Alpha-naphthylamine..... lb.	.35 - .40
Aniline oil, drums extra..... lb.	.18 - .21
Aniline salts..... lb.	.25 - .28
Anthracene, 80% in drums (100 lb.)..... lb.	.75 - 1 00
Benzaldehyde U.S.P..... lb.	1 00 - 1 25
Benzidine, base..... lb.	.85 - 1 00
Benzidine sulphate..... lb.	.75 - .85
Benzoic acid, U.S.P..... lb.	.60 - .65
Benzoate of soda, U.S.P..... lb.	.55 - .60
Benzene, pure, water-white, in drums (100 gal.)..... gal.	.27 - .32
Benzene, 90%, in drums (100 gal.)..... gal.	.25 - .28
Benzyl chloride, 95-97%, refined..... lb.	.25 - .27
Benzyl chloride, tech..... lb.	.20 - .23
Beta-naphthol benzoate..... lb.	3 50 - 4 00
Beta-naphthol, sublimed..... lb.	.70 - .75
Beta-naphthol, tech..... lb.	.33 - .38
Beta-naphthylamine, sublimed..... lb.	1 75 - 1 80
Cresol, U. S. P., in drums (100 lb.)..... lb.	.16 - .18
Ortho-cresol, in drums (100 lb.)..... lb.	.25 - .27
Cresylic acid, 97-99%, straw color, in drums..... gal.	.68 - .75
Cresylic acid, 95-97%, dark, in drums..... gal.	.65 - .70
Cresylic acid, 50%, first quality, drums..... gal.	.45 - .50
Dichlorobenzene..... lb.	.06 - .09
Diethylaniline..... lb.	1 20 - 1 25
Dimethylaniline..... lb.	.38 - .48
Dinitrobenzene..... lb.	.26 - .28
Dinitrochlorobenzene..... lb.	.20 - .30
Dinitronaphthalene..... lb.	.30 - .40
Dinitrophenol..... lb.	.35 - .40
Dinitrotoluene..... lb.	.27 - .30
Dip oil, 25%, car lots, in drums..... gal.	.40 - .45
Diphenylamine..... lb.	.60 - .65
H-acid..... lb.	1 15 - 1 25
Meta-phenylenediamine..... lb.	1 15 - 1 20
Monochlorobenzene..... lb.	.12 - .14
Monoethylaniline..... lb.	1 75 - 1 85
Naphthalene crushed, in bbls..... lb.	.07 - .081
Naphthalene, flake..... lb.	.081 - .091
Naphthalene, balls..... lb.	.70 - .75
Naphthionic acid, crude..... lb.	.12 - .15
Nitrobenzene..... lb.	.30 - .35
Nitro-naphthalene..... lb.	.16 - .18
Nitro-toluene..... lb.	3 10 - 3 20
Ortho-amidophenol..... lb.	.15 - .20
Ortho-dichlor-benzene..... lb.	.80 - .85
Ortho-nitro-phenol..... lb.	.15 - .20
Ortho-nitro-toluene..... lb.	.20 - .25
Ortho-toluidine..... lb.	1 40 - 1 45
Para-amidophenol, base..... lb.	1 60 - 1 75
Para-amidophenol, HCl..... lb.	

Para-dichlorobenzene..... lb.	15 - 20
Paranitroaniline..... lb.	.75 - .80
Para-nitrotoluene..... lb.	.45 - .95
Para-phenylenediamine..... lb.	1 75 - 2 40
Para-toluidine..... lb.	1 25 - 1 40
Phthalic anhydride..... lb.	.50 - .60
Phenol, U. S. P., drums..... lb.	.091 - .11
Pyridine..... gal.	2 00 - 3 50
Resorcinol, technical..... lb.	1 60 - 1 65
Resorcinol, pure..... lb.	2 25 - 2 30
Salicylic acid, tech., in bbls..... lb.	.19 - .22
Salicylic acid, U. S. P..... lb.	.20 - .25
Salol..... lb.	.80 - .85
Solvent naphtha, water-white, in drums, 100 gal..... gal.	.25 - .28
Solvent naphtha, crude, heavy, in drums, 100 gal..... gal.	.14 - .16
Sulphanilic acid, crude..... lb.	.30 - .35
Tolidine..... lb.	1 25 - 1 35
Toluidine, mixed..... lb.	.40 - .45
Toluene, in tank cars..... gal.	.25 - .28
Toluene, in drums..... gal.	.28 - .31
Xyldines, drums, 100 gal..... lb.	.40 - .45
Xylene, pure, in drums..... gal.	.40 - .45
Xylene, pure, in tank cars..... gal.	.45 - .45
Xylene, commercial, in drums, 100 gal..... gal.	.33 - .35
Xylene, commercial, in tank cars..... gal.	.30 - .35

Waxes

Prices based on original packages in large quantities

Beeswax, refined, dark..... lb.	\$0 24 - \$0 25
Beeswax, refined, light..... lb.	.27 - .28
Beeswax, white pure..... lb.	.40 - .45
Carnauba, 1-lb..... lb.	.58 - .60
Carnauba, No. 2, North Country..... lb.	.25 - .26
Carnauba, No. 3, North Country..... lb.	.131 - .14
Japan..... lb.	.16 - .161
Montan, crude..... lb.	.061 - .061
Paraffine waxes, crude match wax (white) 105-110 m.p..... lb.	.03 - .031
Paraffine waxes, crude, scale 124-126 m.p..... lb.	.021 - .021
Paraffine waxes, refined, 118-120 m.p..... lb.	.03 - .031
Paraffine waxes, refined, 125 m.p..... lb.	.031 - .031
Paraffine waxes, refined, 128-130 m.p..... lb.	.04 - .041
Paraffine waxes, refined, 133-135 m.p..... lb.	.041 - .05
Paraffine waxes, refined, 135-137 m.p..... lb.	.051 - .06
Stearic acid, single pressed..... lb.	.09 - .09
Stearic acid, double pressed..... lb.	.091 - .091
Stearic acid, triple pressed..... lb.	.10 - .101

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on earload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl..... 280 lb.	\$5 10 -
Rosin E-I..... 280 lb.	5 20 - 5 45
Rosin K-N..... 280 lb.	5 70 - 6 75
Rosin W. G.-W. W..... 280 lb.	7 35 -
Wood rosin, bbl..... 280 lb.	6 25 -
Spirits of turpentine..... gal.	.59 -
Wood turpentine steam dist..... gal.	.57 -
Wood turpentine, dest. dist..... gal.	.55 -
Pine tar pitch, bbl..... 200 lb.	
Tar, kiln burned, bbl. (500 lb.)..... bbl.	
Retort tar, bbl..... 500 lb.	
Rosin oil, first run..... gal.	.35 -
Rosin oil, second run..... gal.	.37 -
Rosin oil, third run..... gal.	.41 -
Pine oil, steam dist., sp.gr. 0.930-0.940..... gal.	\$1 80 -
Pine oil, pure, dest. dist..... gal.	1 50 -
Pine tar oil, ref., sp.gr. 1.025-1.035..... gal.	.46 -
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla..... gal.	.35 -
Pine tar oil, double ref., sp.gr. 0.965-0.990..... gal.	.75 -
Pine tar, ref., thin, sp.gr. 1.080-1.060..... gal.	.35 -
Turpentine, crude, sp. gr. 0.900-0.970..... gal.	1 20 -
Hardwood oil, f.o.b. Mich., sp.gr. 0.960-0.990..... gal.	.35 -
Pinewood creosote, ref..... gal.	.52 -

Solvents

73-76 deg., steel bbls. (85 lb.)..... gal.	\$0 41 -
70-72 deg., steel bbls. (85 lb.)..... gal.	.39 -
68-70 deg., steel bbls. (85 lb.)..... gal.	.38 -
V. M. and I' naphtha, steel bbls. (85 lb.)..... gal.	.30 -

Crude Rubber

Para-Upriver fine..... lb.	\$0 16 - .17
Upriver coarse..... lb.	.09 - .091
Upriver cauche ball..... lb.	.111 - .12
Plantation First latex crepe..... lb.	.14 -
Ribbed smoked sheets..... lb.	.12 - .121
Brown crepe, thin, clean..... lb.	.15 -
Amber crepe No. 1..... lb.	.17 -

Oils

VEGETABLE

The following prices are f.o.b. New York for earload lots.

Castor oil, No. 3, in bbls..... lb.	\$0 081 - \$0 09
Castor oil, AA, in bbls..... lb.	.10 - .101
China wood oil, in bbls. (f.o.b. Pac coast)..... lb.	.12 - .121
Cocanut oil, Ceylon grade, in bbls..... lb.	.10 - .101
Cocanut oil, Cochiti grade, in bbls..... lb.	.101 - .11
Corn oil, crude, in bbls..... lb.	.08 - .081
Cottonseed oil, crude (f. o. b. mill)..... lb.	.071 - .071
Cottonseed oil, summer yellow..... lb.	.091 - .091
Cottonseed oil, winter yellow..... lb.	.091 - .091
Linseed oil, raw, ear lots (domestic)..... gal.	.77 - .78
Linseed oil, raw, tank cars (domestic)..... gal.	.71 - .72
Linseed oil, 5-bbl lots (domestic)..... gal.	.75 - .80

Olive oil, Denatured.....	gal.	\$1.30	—	\$1.40
Palm, Lagos.....	lb.	.06	—	.06½
Palm, Niger.....	lb.	.05	—	.05½
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.07	—	.07½
Peanut oil, refined, in bbls.....	lb.	.10	—	.10½
Rapeseed oil, refined in bbls.....	gal.	.90	—	.92
Rapeseed oil, blown, in bbls.....	gal.	.94	—	.95
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.08	—	....
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.06½	—	....

FISH

Light pressed menhaden.....	gal.	\$0.42	—	....
Yellow bleached menhaden.....	gal.	.44	—	....
White bleached menhaden.....	gal.	.46	—	....
Blown menhaden.....	gal.	.50	—	....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$24.00	—	30.00
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	22.00	—	26.00
Barytes, crude, 88% @ 94% ba., Kings Creek.....	net ton	10.00	—	12.00
Barytes, floated, f.o.b. St. Louis.....	net ton	26.50	—	28.00
Barytes, crude, first grade, Missouri.....	net ton	7.00	—	....
Blanc fixe, dry.....	lb.	.04½	—	.04½
Blanc fixe, pulp.....	net ton	45.00	—	55.00
Casein.....	lb.	.06½	—	.07½
Chalk, domestic, extra light.....	lb.	.04½	—	.05
Chalk, domestic, light.....	lb.	.04	—	.04½
Chalk, domestic, heavy.....	lb.	.03½	—	.04
Chalk, English, extra light.....	lb.	.04	—	.05
Chalk, English, light.....	lb.	.04½	—	.05
Chalk, English, dense.....	lb.	.04	—	.04½
China clay (kaolin) crude, f.o.b. mines, Georgia.....	net ton	8.00	—	10.00
China clay (kaolin) washed, f.o.b. Georgia.....	net ton	12.00	—	15.00
China clay (kaolin) powdered, f.o.b. Georgia.....	net ton	18.00	—	22.00
China clay (kaolin) crude f.o.b. Virginia points.....	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points.....	net ton	15.00	—	25.00
China clay (kaolin), imported, lump.....	net ton	12.00	—	20.00
China clay (kaolin), imported, powdered.....	net ton	20.00	—	25.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	gross ton	8.00	—	14.00
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27.00	—	30.00
Fullers earth, f.o.b. Mines.....	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Pa.....	net ton	15.00	—	18.00
Fullers earth, powdered, f.o.b. Fla.....	net ton	18.00	—	....
Fullers earth, imported, powdered.....	net ton	24.00	—	27.00
Graphite, Ceylon lump, first quality.....	lb.	.07½	—	.08
Graphite, Ceylon chip.....	lb.	.06	—	.06½
Graphite, high grade amorphous crude.....	lb.	.02½	—	.03
Pumice stone, imported, lump.....	lb.	.04	—	.50
Pumice stone, domestic lump.....	lb.	.05	—	.05½
Pumice stone, ground.....	lb.	.06	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore.....	net ton	....	—	10.00
Quartz (acid tower) 1½ @ 2 in., f.o.b. Baltimore.....	net ton	....	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	....	—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange fine.....	lb.	.58	—	.60
Shellac, orange superfine.....	lb.	.73	—	.74
Shellac, A. C. garnet.....	lb.	.46	—	.47
Shellac, T. N.....	lb.	.47	—	.48
Soapstone.....	ton	12.00	—	15.00
Sodium chloride.....	long ton	12.50	—	13.00
Talc, paper-making grades, f.o.b. Vermont.....	ton	11.00	—	20.00
Talc, roofing grades, f.o.b. Vermont.....	ton	8.50	—	13.00
Talc, rubber grades, f.o.b. Vermont.....	ton	11.00	—	18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	10.00	—	14.00
Talc, imported.....	ton	30.00	—	40.00
Talc, California talcum powder grade.....	ton	18.00	—	40.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	per ton	\$37.50-40.00		
Carborundum refractory brick, 9-in.	1,000	1,250.00		
Chrome brick, f.o.b. Eastern shipping points.....	net ton	60		
Chrome cement, 40-45% Cr ₂ O ₃	net ton	30-32		
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in car lots, f.o.b. Eastern shipping points.....	net ton	33-35		
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	36-40		
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	30-35		
Magnesite brick, 9-in. straight.....	net ton	70		
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	77		
Magnesite brick, soaps and splits.....	net ton	98		
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	42-45		
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	46-50		
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	35-38		

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00	—	\$225.00
Ferrochrome per lb. of Cr. contained, 6-8% carbon, earlots.....	lb.	.14	—	....
Ferrochrome, per lb. of Cr. contained, 4-6% carbon, earlots.....	lb.	.15	—	....
Ferromanganese, 76-80% Mn, domestic.....	gross ton	70.00	—	....
Ferromanganese, 76-80% Mn, English.....	gross ton	70.00	—	....
Spiegeleisen, 18-22% Mn.....	gross ton	27.00	—	28.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.50	—	....
Ferrosilicon, 10-15%.....	gross ton	40.00	—	42.00
Ferrosilicon, 50%.....	gross ton	65.00	—	68.00
Ferrosilicon, 75%.....	gross ton	135.00	—	138.00
Ferrotungsten, 70-80%, per lb. of contained W.....	lb.	.45	—	.50
Ferroumadium, 35-50% of U, per lb. of U content.....	lb.	6.00	—	....
Ferrovandium, 30-40% of U, per lb. of contained V.....	lb.	4.50	—	5.00

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content.....	gross ton	\$8.00	—	\$10.00
Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃	unit	.30	—	.33
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard.....	unit	30	—	33
Coke, foundry, f.o.b. ovens.....	net ton	4.00	—	4.50
Coke, furnace, f.o.b. ovens.....	net ton	2.75	—	3.00
Coke, petroleum, refinery, Atlantic seaboard.....	net ton	14.00	—	15.00
Fluorspar, lump, f.o.b. mines, New Mexico.....	net ton	12.50	—	....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	20.00	—	....
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01½	—	.01½
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	.21	—	....
Manganese ore, chemical (MnO ₂).....	gross ton	50.00	—	55.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.55	—	.60
Monazite, per unit of ThO ₂ , c.i.f., Atlantic seaport.....	unit	30.00	—	....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport.....	unit	.14	—	.14
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.14	—	.14
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.12	—	.13
Rutile, 95% TiO ₂ per lb. ore.....	lb.	.15	—	....
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	2.75	—	3.00
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	3.00	—	3.25
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	1.50	—	2.50
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.25	—	2.50
Vanadium pentoxide, 99%.....	lb.	12.00	—	14.00
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1.00	—	....
Zircon, washed, iron free.....	lb.	.03	—	....

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic.....	12.25 @ 12.50
Aluminum, 98 to 99 per cent.....	24.5 @ 25
Antimony, wholesale lots, Chinese and Japanese.....	4½
Nickel, ordinary (ingot).....	41.00
Nickel, electrolytic.....	44.00
Monel metal, spot and blocks.....	35.00
Monel metal, ingots.....	38.00
Monel metal, sheet bars.....	40.00
Tin, 5-ton lots, Straits.....	26.50
Lead, New York, spot.....	4.35-4.40
Lead, E. St. Louis, spot.....	4.20-4.25
Zinc, spot, New York.....	4.50-4.55
Zinc, spot, E. St. Louis.....	4.15-4.20

OTHER METALS

Silver (commercial).....	oz.	\$0.59½
Cadmium.....	lb.	1.00-1.25
Bismuth (500 lb. lots).....	lb.	1.50 @ 1.55
Cobalt.....	lb.	3.00 @ 3.25
Magnesium (f.o.b. Philadelphia).....	lb.	1.25
Platinum.....	oz.	72.00 @ 75.00
Iridium.....	oz.	160.00 @ 180.00
Palladium.....	oz.	60.00-65.00
Mercury.....	75 lb.	44.00-45.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled.....	20 75-21 25
Copper bottoms.....	28 25-28 75
Copper rods.....	19 75-20.00
High brass wire.....	16 75
High brass rods.....	13 75
Low brass wire.....	18 25
Low brass rods.....	18 25
Brazed brass tubing.....	27.00
Brazed bronze tubing.....	31.75
Seamless copper tubing.....	21.00
Seamless high brass tubing.....	18.50

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current	Cleveland	Chicago
Copper, heavy and crucible.....	9 25 @ 9 50	9 25	9 50
Copper, heavy and wire.....	8 25 @ 8 50	8 50	8 50
Copper, light and bottoms.....	7 25 @ 7 75	7 50	7 25
Lead, heavy.....	3 25 @ 3 50	3 25	3 25
Lead, tea.....	2 25 @ 2 35	2 25	2 25
Brass, heavy.....	4 25 @ 4 50	4 50	5 00
Brass, light.....	3 25 @ 3 50	3 25	3 50
No. 1 yellow brass turnings.....	4 25 @ 4 50	4 25	4 50
Zinc.....	2 00 @ 2 50	2 00	2 25

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ½ in. and larger, and plates ½ in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes.....	\$2 23	\$3 00	\$3.00
Soft steel bars.....	2 18	2 80	2 80
Soft steel bar shapes.....	2 18	2 90	2 90
Soft steel bands.....	2 50	3 20	3 20
Plates, ½ to 1 in. thick.....	2 18	3 00	3 00

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

GADSDEN—The Stringer Brothers Foundry Co., 109 North Dearborn St., Chicago, Ill., manufacturer of brass and iron goods, has commenced the construction of a new plant at Gadsden, to be operated as a branch works. An extensive iron and brass foundry will be installed. It is planned to inaugurate operations at an early date. Charles C. Stringer is president.

GADSDEN—The Gadsden Clay Products Co., recently organized, will operate a local plant for the manufacture of building tile and other burned clay products. The initial works will be enlarged at a later date and new machinery installed. Robert Riley is president and Gordon Hood, treasurer.

California

OAKLAND—The Moore Shipbuilding Co., foot of Adeline St., has filed plans for the erection of a new 1-story brass foundry at its plant.

Delaware

WILMINGTON—The Atlas Powder Co., du Pont Bldg., is taking bids for the construction of a new 1-story experimental laboratory at Gray St., and Lancaster Ave., 60x80 ft.

District of Columbia

WASHINGTON—A. L. Flint, general purchasing officer, the Panama Canal, will receive bids until 10:30 a.m., August 3, for chemicals, lime, creosote oil, calcium chloride, varnish, linseed oil, and other materials and equipment, as set forth in Circular 1453, for Canal Zone service.

Florida

TAMPA—The United Paper Co., Atlanta, Ga., has awarded a contract to E. W. Parker, Curry Building, Tampa, for the erection of a new local plant, 100x100 ft., for the manufacture of paper specialties. It is estimated to cost about \$50,000, including machinery. N. Sargent Hamilton, Atlanta, is architect. Louis Wellhouse is president.

MADISON—The Producers' Co., manufacturer of peanut oil and kindred products, has resumed production at its local plant after a curtailment of several months duration. The company is giving employment to about 75 operatives, and plans to increase this force to 100 persons. It is proposed to operate under full time for an indefinite period.

Illinois

CHICAGO—Curt, Teich & Company, 1745 Irving Park Boulevard, manufacturer of paper specialties, has awarded a contract to Peter Hamel, 6401 South Campbell St., for the erection of a 2-story plant addition, 125x125 ft., estimated to cost about \$100,000 with machinery. Ground will be broken at an early date.

CHICAGO—The Wheeling Corrugating Co., 2547 Arthington Ave., is taking bids for the erection of a new 1-story plant addition, 80x125 ft., estimated to cost about \$40,000.

Indiana

MICHIGAN CITY—The Triangle Steel Products Co., care of T. C. Casse, 163 Washington St., has plans under way for the erection of a new 1-story and basement plant at Michigan City, 250x500 ft., estimated to cost about \$75,000 with machinery.

Louisiana

NEW ORLEANS—Fire, July 6, destroyed a portion of the Richardson chemistry building at the Tulane University, with loss estimated at about \$17,000. The structure will be rebuilt.

COLEMAN—D. C. Nelson, Fort Worth, Tex., and associates, are organizing a new

company to build and operate a local oil refining plant. Details and estimates of cost are being made.

NEW ORLEANS—The Marland Refining Co., Ponca City, Okla., has acquired property at St. Charles Parish, about 20 miles from New Orleans, and has plans under way for the erection of a new oil terminal plant to cost in excess of \$1,000,000, including equipment.

CARGAS—The United Oil & Natural Gas Products Co., Monroe, La., is planning for the erection of a new local plant for the manufacture of gasoline to cost about \$30,000.

Maryland

BALTIMORE—Fire, July 9, destroyed the plant of the Meadowbrook Dye Works, Caton Ave., with loss estimated at about \$30,000. It is said that the plant will be rebuilt.

Mississippi

MERIDAN—The Texas Oil Co. and the Gulf Refining Co. are planning for the rebuilding of the portions of their local oil plants, destroyed by fire, June 28, with loss estimated in excess of \$100,000, including equipment.

Missouri

KANSAS CITY—The Central Chemical & Supply Co., has leased a local building, 3-story, totaling about 20,000 sq. ft. of space, for the establishment of a new works for the manufacture of paints and kindred products. Machinery will be installed at an early date. C. H. Hughes is head.

CLINTON—The Terrill Tire & Rubber Co., 1512 McGee St., Kansas City, Mo., has awarded a contract to Frank Woodruff, Clinton, for the erection of its proposed new local plant, to be 2-story and basement, 90x150 ft., and estimated to cost about \$32,000. A. C. Terrill is president.

ST. LOUIS—The Fleischmann Yeast Co., 1535 Market St., has filed plans for the erection of its proposed local plant on Forest Park Boulevard, 1-story, 75x170 ft., estimated to cost about \$50,000. H. K. Stephens is local manager.

New Jersey

NEWARK—The United Butchers' Fat Rendering Co., Robert H. Bayerl, 302 Jackson Ave., Jersey City, N. J., president, is having plans prepared by David M. Ach, 1 Madison Ave., New York, architect, for its proposed new rendering plant on Doremus Ave., Newark, for fertilizer, glue, tallow and affiliated manufacture. It will be 2-story and is estimated to cost about \$50,000. Bids will be taken at an early date.

FLORENCE—The Florence Pipe Foundry & Machine Co., has awarded a contract to the Austin Co., Bulletin Bldg., Philadelphia, Pa., for the erection of a new 1-story building at its plant, 40x100 ft., estimated to cost about \$25,000. C. L. Reeves is head.

New York

BUFFALO—Fire, July 10, destroyed a portion of the plant of the Archer-Daniels Linseed Co., Hamburg Turnpike, with loss estimated at about \$50,000, including equipment.

BUFFALO—The Towns Paint Co., Inc., has established a new plant at 127 Erie St. and has arranged for immediate manufacture, with production to include paints, varnishes, etc. Joseph C. Alonzo, formerly chief chemist and assistant superintendent of the Campbell Paint & Varnish Co., St. Louis, Mo., will be in charge of operations.

NIAGARA FALLS—The Sinclair Consolidated Oil Corp., 120 Broadway, New York, is reported to have purchased a local site, comprising a large acreage, for the erection of a new oil refining plant, estimated to cost in excess of \$2,500,000 with machinery.

NEW YORK—The Tide Water Oil Co., 11 Broadway, has taken over the property of the Guffey-Gillespie Oil Co., including refineries and oil plants, and will operate the business in the future. The name of

the company will be changed to the Tide Oil Co.

LONG ISLAND CITY—The Textile Alliance, New York, has leased for a long term, the factory building now being erected on a site 95x190 ft., on Van Alst Avenue near Harris Ave., Long Island City, for dye operations, including departments for production, rehandling, reconditioning, etc.

North Carolina

RUTHERFORDTON—The Schenck Gold Mining Co., recently incorporated with a capital of \$250,000, is planning for the development of gold properties in this section, recently acquired. The tract totals about 225 acres, and will be provided with a complete mining and operating plant. L. A. Warrick, is president and general manager.

Ohio

CORTLAND—The Quinby Magnesia Co., 306 Federal Bldg., Youngstown, Ohio, has completed foundation work for a new plant at Cortland, to be 2-story, 100x50 ft., and will commence the erection of superstructure at an early date. J. C. Quinby is president and mechanical engineer for the work.

CLEVELAND—The Sterling Brass Co., 4619-12 St. Clair Ave., has rejected bids recently received for the erection of its proposed new brass foundry at St. Catherine and East 93 Streets. Revised plans will be drawn and new bids asked. The plant, with machine shop, will be 2-story, 145x200 ft., and is estimated to cost about \$100,000. S. L. Weil is head.

Pennsylvania

CHESTER—The American Chemical & Sugar Machinery Co., Colonial Trust Building, Philadelphia, Pa., has acquired the local plant of the Harrison Chemical Co., and will commence the erection of superstructure for a new plant. Machinery will be installed at an early date. It is proposed to give employment to about 200 operatives. The plant has been shut-down for some time past, and at time of erection was used as a foundry.

PHILADELPHIA—Samuel McDowell, manufacturer of chemicals, has acquired a local plant, formerly occupied by the Providence Worsted Mills, for a new factory. Equipment will be installed at once, and the works operated as a branch of the present chemical plant.

South Carolina

ORANGEBURG—The Common Council is considering the erection of a new municipal gas plant, estimated to cost about \$100,000. Edward Hawes, engineer, City Bldg., is preparing preliminary plans.

Texas

WACO—W. A. Rogers, Houston, Tex., and associates, have acquired the local oil refinery of the Ryan & Fisher Refinery & Production Co. Plans are under way to increase the capacity of the plant from 500 to 1,000 bbl. a day.

CISCO—The Cisco Clay & Coal Co. is considering the erection of a new local plant for the manufacture of brick and tile. At a later date an extension will be constructed to be devoted to the manufacture of paving brick and other burned clay products. C. B. Bush is president.

Utah

SALT LAKE CITY—Fire July 5 destroyed a portion of the plant of Acme White Lead & Color Works, 255 Edison St. Plans for rebuilding are said to be under way.

West Virginia

HUNTINGTON—The Melick Petroleum & Coal Co., recently organized with a capital of \$5,000,000, is planning for the erection of a new oil-refining plant to cost close to \$1,000,000 with equipment. David L. Melick is president and general manager.

Wisconsin

NEENAH—The Valley Paper Mills, 5 Caswell Block, are having plans prepared by Edward A. Wettengel, 578 Pierce Ave., Appleton, Wis., for the erection of their proposed new local paper manufacturing plant, estimated to cost close to \$500,000 with machinery. A. C. Ehlmann is president.

Quebec

KIPPEWA—The Riordan Paper Co. is planning for the rebuilding of the portion of its local mill, destroyed by fire, June 22, with loss reported at about \$25,000.

New Companies

THE PUBLIC OIL Co., Room 720, 10 South LaSalle St., Chicago, Ill., has been incorporated with a capital of \$50,000, to manufacture oil products. The incorporators are Paul Vitek and George Kucharik.

THE PINNACLE PAINT Co., Sault Ste. Marie, Mich., has been incorporated with a capital of \$15,000, to manufacture paints, oils, varnishes, etc. The incorporators are Pearson S. Conrad Jr., Campbell E. Lyons and Walter H. McKinney, Sault Ste. Marie.

THE KEMOSHYNE PRODUCTS, INC., Camden, N. J., has been incorporated with a capital of 4,000 shares of stock, no par value, to manufacture polishes, oils and kindred products. The incorporators are Thomas B. Kenworthy, M. G. Black and Delbert S. Bacon. The company is represented by Walter R. Carroll, Fourth and Market Streets, Camden.

THE PLYMOUTH CHEMICAL Co., New York, N. Y., has been incorporated with a capital of \$20,000, to manufacture chemical and chemical by-products. The incorporators are E. Stark, F. F. Jones and M. Rothman. The company is represented by J. D. Campbell, 200 Fifth Ave.

THE COMMERCIAL TALC Co., Lincoln, R. I., has been incorporated with a capital of \$300,000, to operate talc properties and talc refining plants. The incorporators are George R. Price, John P. Sheern and George Messenger, 650 Broad St., Providence, R. I.

THE MOUNTAIN CITY CHEMICAL Co., Fairmont, W. Va., has been incorporated with a capital of \$100,000, to manufacture chemicals and chemical by-products. The incorporators are Brooks S. Hutchison and J. V. Abbott, Fairmont.

THE ALLAN MFG. Co., St. Paul, Minn., has been incorporated with a capital of \$50,000, to manufacture soaps and kindred products. The incorporators are E. M. Hagan, H. K. Null and George W. Allan, St. Paul.

C. H. FINGERHOOD, INC., New York, N. Y., has been incorporated with a capital of \$20,000, to manufacture industrial alcohol and affiliated products. The incorporators are E. Nelson, F. and C. H. Fingerhood, 911 Southern Boulevard.

THE SAMOSET OIL Co., Boston, Mass., has been incorporated with a capital of \$300,000, to manufacture refined oil products. Charles M. Bergul is president, and Michael A. Dunn, 11 High St., Framingham, Mass., treasurer.

THE EASTERN PETROLEUM CORP., New York, N. Y., has been incorporated with a capital of \$180,000, to manufacture petroleum products. The incorporators are G. A. Ross, F. C. Sumner and J. W. Seemans. The company is represented by J. R. Meany, 205 West 91st St.

THE PARKO MFG. Co., Rochester, N. Y., has been incorporated with a capital of \$250,000, to manufacture soaps, polishing compounds, etc. The incorporators are J. G. Rispor, L. C. Graves and C. F. Wray. The company is represented by Stull Bros., attorneys, Rochester.

THE BRONSON CHEMICAL Co., 234 1/2 Broad St., Providence, R. I., has filed notice of organization to manufacture chemical products. The company is headed by Moody D. Holmes.

THE CENTRAL OIL & GREASE Co., INC., Williamsport, Pa., has been incorporated with a capital of \$50,000, to manufacture oils, greases, compounds, etc. Frank W. Kosh, South Williamsport, Pa., is treasurer.

THE PYRO COLOR CORP., Richmond, Va., has been incorporated with a capital of \$1,250,000, to manufacture colors, chemicals, dyes, etc. The incorporators are Lee B. Horey and W. C. Faulkner, Richmond.

THE KENTUCKY MIDLAND PIPE LINE AND REFINING Co., New York, N. Y., has been incorporated under Delaware laws with a capital of \$5,000,000, to manufacture refined oil products. The company is represented by Arthur W. Britton, 65 Cedar St.

THE HARRISVILLE ORE & STEEL CORP., New York, N. Y., has been incorporated with a capital of \$500,000, to operate iron ore properties, and manufacture steel and other metal products. The incorporators are H. G. Conway, E. G. Kerr and M. F. Dudek. The company is represented by Penslee & Compton, 501 Fifth Ave.

THE ORANGEVILLE BRICK & SHALE PRODUCTS Co., Orangeville, Ohio, has been incorporated under Pennsylvania laws with a capital of \$100,000, to manufacture brick and other burned clay products. E. W. Hyde, Orangeville, is treasurer.

THE MODERN CHEMICAL Co., Chelsea, Mass., has been incorporated with a capital

of \$10,000, to manufacture chemicals, and chemical byproducts. Samuel Leabman is president, and David Glassman, 99 Shurtleff St., Chelsea, is treasurer.

THE WEBACO OIL Co., Webster (Monroe Co.), N. Y., has been incorporated with a capital of \$100,000, to manufacture refined oil products. The incorporators are G. B. and E. Kittelberger, and C. E. Sutter, Webster.

THE FLORIMER CHEMICAL CORP., New York, N. Y., has been incorporated with a capital of \$20,000, to manufacture chemicals and chemical byproducts. The incorporators are M. Levin, P. J. Rassler and T. T. Schwalbe. The company is represented by A. J. Halprim, 41 Park Row.

THE CONVERSE TIRE Co., Malden, Mass., has been incorporated with a capital of \$1,000,000, to manufacture automobile tires and mechanical rubber goods. Marquise M. Converse is president; Hugh Bullock, 392 Pearl St., Malden is treasurer.

THE DUNCAN LUBRICANT OIL WORKS, INC., Duncan, Okla., has been incorporated with a capital of \$50,000, to manufacture lubricating oils, compounds, etc. The incorporators are J. R. Frensley, and Roy K. Wilson, Duncan.

THE MISSOURI VALLEY OIL Co., Sioux City, Ia., has been incorporated with a capital of \$100,000, to manufacture petroleum products. The incorporators are M. P. Summers, C. E. Naughton and C. T. Mauller, Sioux City.

THE ARGONNE CHEMICAL AND DRUG Co., New York, N. Y., has been incorporated with a capital of \$50,000, to manufacture chemicals, chemical byproducts, drug compounds, etc. The incorporators are J. and P. Dondero and C. McLester. The company is represented by Ryan, Heffernan & Dowan, 25 West 45 St.

THE STANDARD CHEMICAL CORP., 723 Calvert Bldg., Baltimore, Md., has been incorporated with a capital of \$300,000, to manufacture chemical specialties. The incorporators are Luther E. Mellen, Jacob L. Rosenfield and J. Charles Fagan.

THE PENN RUBBER PRODUCTS CORP., Philadelphia, Pa., has been incorporated with a capital of \$500,000, to manufacture rubber specialties. The company is represented by F. R. Hansell, Land Title Bldg.

MASON & URNER, INC., Newark, N. J., has been incorporated with a capital of \$125,000, to manufacture refined oil products. The incorporators are Thomas T. Gray, Frank A. Urner and Frank B. Mason, 961 Frelinghuysen Ave.

THE SAMOLINE CORP., Room 2134, 6 North Clark St., Chicago, Ill., has been incorporated with a capital of \$350,000, to manufacture paints, oils, varnishes and kindred products. The incorporators are Samuel R. Olmsted, Martin Skarie and Thomas A. Weldon.

THE LIBERTY PETROLEUM CORP., 1119 Fidelity Building, Baltimore, Md., has been incorporated with a capital of \$2,500,000, to manufacture petroleum products and hydrocarbons. The incorporators are Edward M. and E. H. Hammond and Harry E. Karr.

THE LA PREME IVORY NOVELTY Co., Bloomfield, N. J., has been incorporated with a capital of \$25,000, to manufacture celluloid and other composition products. The incorporators are Richard Webster and G. A. Breite, Passaic Ave. and Center St.

THE CORTLAND DRUG & CHEMICAL CORP., New York, N. Y., has been incorporated with a capital of \$100,000, to manufacture chemicals, drug compounds, etc. The incorporators are R. Cairone, W. S. Berman and H. Herzog. The company is represented by C. Firestone, 299 Broadway.

THE NITRO FOUNDRY Co., Nitro, W. Va., has been incorporated with a capital of \$50,000, to manufacture iron, steel and other metal castings. The incorporators are Ralph Matthews, M. S. Aldrich and W. A. O'Neill.

THE PROCESS PAPER Co., Lockport, N. Y., has been incorporated with a capital of \$50,000, to manufacture paper products. The incorporators are G. E. Greene, G. F. McEndoe and G. C. Lewis, Lockport.

THE NOVO LABORATORIES, INC., Perth Amboy, N. J., has been incorporated with a capital of \$125,000, to manufacture chemicals and chemical byproducts. The incorporators are Samuel Cutler, M. A. Fenwick and Boris I. Rabiner, 651 Catherine Street, Perth Amboy.

THE LINCOLN CONNER CORP., New York, N. Y., has been incorporated with a capital of \$60,000, to manufacture inks, dyes, chemicals and affiliated products. The incorporators are D. Greenebaum and L. and B. F. Conner. The company is represented by S. Wasserman, 51 Chambers Street.

THE WESTFIELD CHEMICAL CORP., New York City, has been incorporated with a capital of \$25,000 to manufacture chemicals and affiliated products. The incorporators are G. Giofre, C. Cacetta and F. A. Brune, 395 B'way.

THE PURITY CHEMICAL PRODUCTS Co., Jeffersonville, Ind., has been incorporated with a capital of \$5,000 to manufacture chemicals and chemical byproducts. The incorporators are J. B. Doherty, G. H. Haas and D. C. Peyton, Jeffersonville.

Capital Increases, etc.

THE WISCONSIN LIME & CEMENT Co., 133 West Washington St., Chicago, Ill., manufacturer of cement, lime products, etc., has filed notice of increase in capital from \$200,000, to \$1,000,000.

THE RICH STEEL PRODUCTS Co., Battle Creek, Mich., is arranging for a decrease in its capital from \$250,000 to \$100,000.

THE SUPERIOR FLUOR SPAR Co., Evansville, Ind., has filed notice of dissolution under state laws.

L. MUNDET & SON, INC., Ferris St., Brooklyn, N. Y., manufacturer of cork products, has filed notice of increase in capital from \$350,000 to \$2,500,000.

THE CUMBERLAND HYDRAULIC CEMENT & MFG. Co., Cumberland, Md., has filed notice of increase in capital from \$200,000 to \$450,000.

THE COLE CHEMICAL Co., 406 Market St., St. Louis, Mo., has filed notice of increase in capital from \$50,000 to \$1,000,000.

THE DETROIT COPPER & BRASS ROLLING MILLS INC., North Jefferson Street, Chicago, Ill., has filed notice of dissolution under state laws.

THE ELGIN RUBBER ACE Co., Elgin, Ill., has filed notice of increase in capital from \$150,000 to \$500,000.

THE KINZIE RUBBER & MFG. Co., 1514 West Kinzie St., Chicago, Ill., has filed notice of increase in capital from \$350,000 to \$412,500.

THE PACIFIC-TEXAS PETROLEUM Co., Mineral Springs, Tex., has filed notice of increase in capital from \$1,000,000 to \$4,000,000.

Coming Meetings and Events

AMERICAN CERAMIC SOCIETY's summer meeting is being held at Canton, Alliance, Sebring and East Liverpool, Ohio, July 25 to 27. Headquarters are at the Hotel Courtland, Canton, Ohio.

AMERICAN CHEMICAL SOCIETY, THE SOCIETY OF CHEMICAL INDUSTRY and the American Section of the latter society will hold a joint meeting in New York, Sept. 6 to 10.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in Lake Placid, N. Y., Sept. 29 and 30, and Oct. 1.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its fall meeting at Wilkes-Barre, Pa., Sept. 12 to 17.

AMERICAN MINING CONGRESS AND NATIONAL EXPOSITION OF MINES AND MINING EQUIPMENT will hold its twenty-fourth annual convention in the Coliseum, Chicago, Oct. 17 to 22.

AMERICAN SOCIETY FOR STEEL TREATING will hold its third annual convention and exhibition Sept. 19 to 24 at Indianapolis.

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SEVENTH) will be held during the week of Sept. 12 in the Eighth Coast Artillery Armory, New York City.

NEW JERSEY CHEMICAL SOCIETY has discontinued meetings for the summer and will resume them in October.

SOCIETY OF CHEMICAL INDUSTRY (BRITISH) at the invitation of the Montreal section will hold its annual meeting in Montreal and other Canadian cities during the week of Aug. 29, 1921. Details will be printed in this magazine from time to time.

SOCIETY OF INDUSTRIAL ENGINEERS will hold its fall meeting at Springfield, Mass., Oct. 5 to 7.

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY will hold its fall convention with the American Pulp and Paper Mill Superintendents' Association, at Washington, Philadelphia, Spring Grove, York, York Haven, Pa., and Wilmington, Del., Oct. 18 to 20.

CHEMICAL & METALLURGICAL ENGINEERING

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R. S. McBRIDE
CHARLES N. HULBERT
Assistant Editors
CHESTER H. JONES
Industrial Editor
J. S. NEGRU
Managing Editor

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A Leaf Out Of the Past

THE London *Times* lately told a few things about the Royal Institution of Great Britain which are worth remembering—and worth pondering over as well. It was founded by a few Fellows of the Royal Society in 1799 of whom Count RUMFORD provided the initial funds. Its purpose was to “diffuse knowledge of useful mechanical improvements” and to “teach the application of science to the useful purposes of life.” It was to be popular and practical enough to satisfy anybody. But its administrators soon discovered that the only way to be practical in things scientific is to engage in research. The reason should be patent to everyone, although unfortunately it is not. Science is not static; it does not stand still; it is dynamic; it is pressing forward and according to Dr. SARTON it presses forward in the ratio of human development. The history of science he says is the history of human progress and he gives a galaxy of evidence to prove his thesis. If then we are to “diffuse” or “teach” this moving thing we cannot stand still ourselves. If we do, it will move away from us. Our only method therefore is to get aboard the research van and to move along with it. Otherwise we shall teach something that has gone on and left us behind.

On the other hand, if we merely set somebody to work in a laboratory and call it the prosecution of research we are not of necessity accomplishing anything. We are doomed to failure unless we have wisdom—and use it. The Governors of the Royal Institution proved themselves to be of the elect in this respect. By July, 1801, they had established THOMAS YOUNG as the first resident professor, who as the *Times* puts it, “was the father of all our knowledge of color vision and of the properties of the lens of the human eye, the discoverer of ‘interference’ and the first to define ‘energy.’” The statement may be a little broad, but let’s pass it on without discussion. The same year they engaged HUMPHRY DAVY at a salary of 100 pounds a year, a room, coal and candles. In return for this he gave popular lectures which became the talk of London, and his contributions have become classic. He was succeeded by MICHAEL FARADAY, whose name is writ high in the heavens of science, and the present resident professor is Sir JAMES DEWAR. The mere mention of these names conjures up the living soul of science today.

The only recorded static aid to the Royal Institution was a Civil List pension of £300 annually to FARADAY for a few years. The whole cost of the Royal Institution during the entire nineteenth century, including professors, attendants, the maintenance of laboratories and the purchase of apparatus and materials, was £100,620, or a little over £1,000 a year. Gifts and

donations have been few; the revenue to support the institution has been almost wholly derived from admission fees paid by the public to hear the lectures.

What a record this is! No begging, no pulling and stripping of the legs of millionaires, nobody getting personally rich out of it and nobody made poor, and yet what a benefit to all humanity! FARADAY was so interested in his work that he refused a fortune for himself in order to provide wealth and happiness for generations then unborn. Sometimes it seems as though in some respects we hadn’t kept up with those memories of grace that came over from the eighteenth century, lasted into the nineteenth for a while, and then, somehow, went into eclipse.

Prohibition and Industrial Alcohol

WEBSTER defines a fanatic as “a person affected by excessive enthusiasm; one who indulges in wild and extravagant notions; a visionary zealot.” A zealot, according to the same authority, is “one who engages warmly in any cause and pursues his subject with earnestness and ardor.” Can it be possible that with rare prescience Mr. WEBSTER was giving us a character delineation of Mr. VOLSTEAD? We infer as much from comments in the daily press and from the laws for prohibition enforcement proposed by the honorable Congressman.

The exact wording of the Eighteenth Amendment escapes us for the moment, but we are under the impression that it prohibits the manufacture and sale of alcoholic liquor for *beverage* purposes. No mention is made of industrial or medicinal purposes, and as far as we are aware there was no intention to affect those legitimate uses of alcohol. It is not surprising, therefore, that in the recent debate on Mr. VOLSTEAD’S supplementary bill for prohibition enforcement several Senators reminded their colleagues that industrial and medicinal uses of alcohol are outside the pale of the Eighteenth Amendment; that there is a large and legitimate industrial alcohol industry quite apart from the business that is prohibited. In support of this contention it is worth noting that the failure of the British Government to give its dye industry duty-free alcohol is ascribed by the *Chemical Age*, London, as one of the two major causes contributing to the failure of the early efforts to establish a dye industry in England. Germany, on the other hand, recognizing the importance of industrial alcohol, fostered the industry by removing restrictions and handicaps and otherwise built up the greatest coal-tar industry the world has ever seen. If Mr. VOLSTEAD can become less obsessed with the iniquity of “booze” and more impressed with the essential and legitimate uses of alcohol, numerous and varied industries will breathe more freely.

Business Revival

And Our Export Trade

IN THESE days when foreign trade and the tariff figure so prominently in our schemes for business revival, it is perhaps time to take an inventory and pass judgment on the relative importance of these factors. Foreign trade has been emphasized to such an extent of late that we are apt to lose sight of the fact that even in the balmiest years when exports were at their peak, they amounted to less than eight per cent of the total sales of the country. We often fail to realize that over ninety per cent of business as a whole was done in the domestic market.

The resumption of exports must depend, to a large extent, upon the foreign buyer's ability to pay us for our goods. If the restoration of normal business in this country, however, is to await the financial rehabilitation of Europe, then our return to prosperity promises to be a slow and difficult process. It is best that our efforts at business revival be diverted toward the home market, wherein lies the greater opportunity.

The Government can assist in this process mainly by the enactment of proper tariff and taxation measures. It is extremely difficult for the layman to see how the tariff is going to restrict imports and at the same time build up our export trade. We have hopes, however, that the new law will be so framed that the home market will be reserved for the domestic manufacturer, but that this will be accomplished without prohibiting fair competition from abroad. Europe must pay her obligations in goods, but obviously those goods must be such as to affect least seriously our own industries. Taxation enters into our calculations somewhat less directly, for taxes are seldom so oppressive as to have material effect on our purchasing power. It is generally admitted, on the other hand, that the present distribution of taxes has retarded rather than encouraged the investment of capital in necessary building and development.

Industry's chief contribution to the reviving process consists in the adjustment to lower prices by means of higher efficiency and hard work. This adjustment is inevitable and the American manufacturer must meet the situation with lower costs, which in turn mean increased efficiency.

Industry is affected in some degree by our exports and for that reason the export problem can not be dismissed completely from our consideration. In the case of many commodities, this trade, although of small volume, has an entirely disproportionate significance. A normal outflow will continue for those products for which our natural resources or our own ingenuity have placed us in a position of comparative advantage. Copper, iron and steel, cotton, meat and farm products are natural exports. We are also peculiarly adapted to export fabricated articles of large-scale production and standardized manufacture. Our foreign trade in dyes is an example of this natural development. The well-standardized articles of quantity output, such as indigo and sulphur black, are produced in excess of our requirements and are exported in large quantities. On the other hand there are many special products of secondary importance from a quantitative viewpoint which our industry is not yet producing in adequate amounts to supply even the domestic consumption.

A foreign outlet for some other products of our chemical industry is desirable and essential, but it is to be admitted that much of our war-time trade was

unnatural and its continuation can not be expected. Artificial stimulation by foreign financing and the exporting of goods on long-time credits have been proposed, but in our estimation they represent only a means of continuing our abnormal exports. Our foreign trade must be put on a safe and logical basis, but in the meantime we should not forget that our most direct path to business revival lies at our very door.

News Value or

Nuisance Value?

ON THE HOTTEST day yet there came to us a "news note" from a well-known corporation that shall be nameless because it ought to know better. Probably the Old Man does know better but is away on his vacation. The item reads as follows: "Blank Co. Distributes New Blotter. The Blank Co. are placing in the hands of their representatives for distribution a new and attractive blotter. The Blank Co. have always been strong advocates of the blotter for advertising purposes because of its usefulness, its attention value and its ability to drive home its sales message."

This is the kind of information for which our readers are supposed to hunger and thirst; to pay good money for subscriptions so that they may read it and still more good money to have their advertisement accompany it. It pains us to have anybody think so. We have a high opinion of our readers; a sense of brotherhood with them. We talk out of our hearts to them and feel that they understand, and in return they often talk straight from their hearts to us and we think we understand. We don't set up to be professional high-brows (who are those, according to Brander Matthews, whose instruction exceeds their mental capacity), but at the same time we do not worry over reducing the expression of our opinions to words of one syllable. We do not worry over the adenoids of our readers; we take it for granted that if they ever were congested they were duly removed; and we do not try to reach the feeble minded or those who are defective.

On the other hand we want news; all the news that is really news and that is worth reading and fit to print. Had the company in question developed a new product or process, different from any that is known and of such value that in our judgment our readers would be glad to know of it, we should have been glad to publish a technical article on the subject. We are not influenced by the advertising value such an article may have to the concern that produces the apparatus or product. If we think it worth while we print it, whereas if we do not think it worth while there isn't any money that can get it printed except at advertising rates and as an advertisement in the advertising section.

We do not print advertisements either as so-called "reading matter"—to fool our readers, or interspersed with it—to disturb them. Advertising is a legitimate art but it has been made the subject of serious malpractice. One of the most serious phases of this malpractice is to give it nuisance value. It consists in stealing the attention of busy men to tell them something they do not want to know. It has not a tithe of the value ascribed to it. Men with things to do and with obligations to perform are beginning to realize this. If we do not chew tobacco we do not want to be told which preparation of tobacco to chew. When we read our morning newspaper and are trying to learn what is being done with the tariff bill in Washington, we do not want to be interrupted by the information.

that the Maison de Paris is having a grand marked-down sale of lingerie. On the other hand, the women of the household may want to know about the sale but may not be interested in the tariff bill. This misplacement of news and advertising is a mistake, so far as we are concerned.

Worse than such a mix-up of understanding and underwear is the publication of news of such inane items as that a corporation has bought some blotting paper and had its name printed on it. That brings the corporation's name before our readers, but it offends them, and rightly so. It does not interest us and we don't see how it can interest anybody else.

The Steel Corporation's Quarterly Report

THE United States Steel Corporation reports \$21,892,016 as its "net earnings" in the second quarter of this year, against \$32,286,722 in the first quarter and averages of \$44,000,000 per quarter in 1920, \$83,000,000 per quarter in 1916, its best year, and \$18,000,000 per quarter in 1914, its poorest year.

Wall Street found the earnings reported for the quarter just ended higher than expected and considered them very favorable in the circumstances. Wall Street looks upon these matters from the viewpoint of returns and prospects of returns on the stock outstanding.

From the manufacturing viewpoint the angle is different. Such a thing as a direct loss from operation, or lack of operation, is conceivable. Wall Street regards "net earnings" as a positive quantity, the only question being how much they will be above zero. They could be below zero, however, the amount of money expended or the obligations incurred exceeding the amount of money received for goods or services furnished. If the Steel Corporation had not turned a wheel during the quarter the expenses would have amounted to something like \$15,000,000 or more—the "net earnings" would have been that amount below zero. This total would have been made up of taxes, rents, salaries, subsidiary company bond interest and a number of other items. Interest and sinking funds on bonds of the Steel Corporation itself, depreciation charges, etc., are met out of "net earnings."

The Steel Corporation plants were not wholly idle in the quarter, but they operated at an average of only between 35 and 40 per cent. Often a manufacturing business finds it impossible to pay expenses with a 50 per cent operation, and thus the Steel Corporation did well to have any "net earnings" at all.

The showing of the Steel Corporation is made more favorable still by another consideration, that there was a decidedly broad distribution of work among its various plants. A few small plants were closed, but by far the major portion of the productive capacity was kept in partial operation, instead of work being concentrated at a few plants. That is quite different from the policy contemplated in the great period of industrial consolidation 20 to 25 years ago. An argument of which the promoters of many consolidations were proud was that in times of stress some plants could be closed and others operated in full, while no particular secret was made of the thought that when it came time to resume work at idle plants they could be started with substantial wage reductions. This distribution of work, prompted by a desire to take care of employees as far as possible, and other influences, swelled the corporation's costs per ton in the quarter just ended far above

what they would have been with a reasonably full operation although with other conditions, such as wage rates, the same.

Conditions in the present quarter are more unfavorable than conditions in the June quarter. An average operating rate of between 35 and 40 per cent in the June quarter is followed by a rate of not over about 25 per cent at the beginning of the present quarter, and sufficient increase to strike the same quarterly average is improbable. Steel prices are already about \$6 per net ton below the average price at which shipments in the June quarter were invoiced, and the trend is still downward. At the middle of the June quarter, however, there was a wage reduction, and another, to the level now common among the independent steel producers, may occur before the end of the present quarter. A part of the Steel Corporation's earnings, of course, is derived from railroad operation and the production of cement and some other materials outside of steel.

Better Business Methods Needed

WHOLESONE advice and plain talk in palatable form characterized the address of President CHARLES H. MACDOWELL, at the recent convention of the National Fertilizer Association. Presumably his words have already reached to the uttermost parts of the fertilizer industry, but his speech could well be pondered by chemical industries other than the one to which he addressed himself. We surmise, for example, that fertilizer manufacturers are not the only ones who are ignorant of manufacturing costs or guilty of basing prices on incorrect estimates. The pitfalls left unguarded through inadequate cost-accounting are more numerous than obvious. Improvements in technology frequently find their mainspring in the cost sheet, while prudent business economy demands a thorough knowledge of those hidden and less obvious elements in cost which appear only at long intervals. Mr. MACDOWELL therefore properly took the fertilizer industry to task for ignorance of its actual costs and for the waste and inefficiency arising from lack of that knowledge.

Leadership along sound constructive lines, and not blind acquiescence to custom was another element of Mr. MACDOWELL's address. He deprecated the custom of supplying the farmer with "what he wants" in way of fertilizer instead of pointing the way to the most economical use of the most efficient fertilizers, educating the consumer to purchase on the basis of plant food units rather than cost per ton. The practice of manufacturing many brands and grades was also shown to be an important factor in increasing manufacturing costs. That it serves no useful purpose to either producer or consumer is indicated in the fact that Mr. MACDOWELL spoke of it as "all of this nonsense," and urged "a drastic elimination of brands and formulæ."

Methods of organization, relation of the parts of an organization to each other and the whole, co-ordination between sales and production managers, industrial statistics and freight rates all came in for a share of attention from Mr. MACDOWELL. In fact his speech was a wholesome industrial sermon applicable to a wider audience than he addressed in person. It has peculiar force for the entire chemical industry, however, because the production of fertilizers is a heavy chemical industry; and high grade technology, good business methods, and close chemical control are common factors in the success of all such processes.

Readers' Views and Comments

Setting a Recording Pyrometer for Cold Junction Temperature

To the Editor of Chemical & Metallurgical Engineering

SIR:—Relative to Kirtland Marsh's article in the June 29 issue of CHEM. & MET. entitled "Setting a Recording Pyrometer for Cold Junction Temperature," I wish to correct the impression that the method of "setting" a pyrometer as set forth is applicable to all pyrometers of the millivoltmeter type.

It is true that the great majority of pyrometers in use today are those calibrated for, and using, base metal thermocouples. In this type of thermocouple the e.m.f.-temperature relation is approximately linear and a unit of temperature at any point on the scale will correspond to a like unit at the instrument "zero" or calibrated cold end temperature. Undoubtedly Mr. Marsh refers to this type of pyrometer in his article.

However, there are not a few rare metal thermocouples in use at the present time, particularly in conjunction with high-speed furnaces, ceramic kilns and heat-treating work where a somewhat high degree of accuracy is desired. The emf.-temperature relation of the platinum-platinum rhodium couple of either the Heræus or Johnson, Matthey type is anything but linear. As a matter of fact, to obtain anything like consistent results, two separate formulas must be computed when calibrating this couple over its range, 32 to 3,000 deg. F.

The formula for the correction of cold junction temperatures varying from the calibrated cold junction temperature, of the Le Chatelier (Pt-Pt Rh) couple is expressed as follows:

$$E = (t_1 - t_0)x \text{ where}$$

E = actual error in deg. F.;

t_1 = cold end temperature;

t_0 = calibrated cold end temperature;

x = 0.7 for range 32 to 500 deg. F.;

0.6 for range 500 to 1,000 deg. F.;

0.5 for range 1,000 to 2,000 deg. F.

0.4 for range 2,000 to 3,000 deg. F.

It will be seen by this that any adjustment made at the instrument zero, using Mr. Marsh's method, would be a fraction of what it should be, provided the pointer is actually moved the number of degrees on the scale representing the difference between the actual cold junction temperature and the calibrated cold junction temperature.

For example, if a pyrometer is operating at 1,500 deg. F., calibrated for a cold end temperature of 32 deg. F. and having an actual cold end temperature of 75 deg. F., the error involved will be approximately 20 deg. F. at 1,500 deg. and 30 deg. F. at 32 deg. F. Naturally, as the instrument is being used at 1,500 deg. F., we are directly interested in errors that occur at that point. Therefore to adjust the instrument to read correctly we make a 30-deg. correction with the couple disconnected or a 20-deg. correction at 1,500 deg. F. The pointer actually travels the same distance in either case.

Ten degrees may not seem to be much to bother about in an industrial pyrometer installation, but there are so many other sources of error inherent in the millivoltmeter type of pyrometer that it does not seem advisable to overlook a simple adjustment of this kind.

Remington Arms Co., Inc.,
Bridgeport, Conn.

L. W. HOPKINS.

To the Editor of Chemical & Metallurgical Engineering

SIR:—Referring to the communication of L. W. Hopkins in which he criticizes the method of setting for cold junction temperature as outlined in the article entitled "Setting a Recording Pyrometer for Cold Junction Temperature" which appeared in the June 29 issue of CHEMICAL & METALLURGICAL ENGINEERING.

Mr. Hopkins' conclusions are quite erroneous and I am afraid that if he has followed out his theories in practice his temperature measurements with rare metal thermocouples have not been as accurate as he believes them to be.

Mr. Hopkins' formula for the correction of cold junction temperature gives the amount, to only a moderate degree of accuracy, which should be added to the reading of a pyrometer calibrated for a platinum — platinum + 10 per cent rhodium thermocouple when the zero setting of the instrument agrees with the calibration cold junction temperature while the actual cold junction temperature is higher or lower.

If the zero setting of the instrument is to be adjusted to correct for the cold junction temperature, the pointer should be set to the actual cold junction temperature instead of being advanced or set back an amount as determined by Mr. Hopkins' formula.

The following references discuss this subject and will substantiate this statement:

(1) The Measurement of High Temperatures, Burgess and Le Chatelier, third edition, 1912, p. 156, part 3.

(2) Supplement to Bulletin 153, September, 1919, American Institute of Mining and Metallurgical Engineers, article by Foote, Harrison and Fairchild, p. 2653, part 5.

(3) Scientific Paper 202, Bureau of Standards, p. 565, part 2.

It is evident therefore that the method of making this setting is applicable to pyrometers calibrated for rare metal couples as well as for base metal couples. I believe the only theoretical error in this method lies in the fact that since the temperature-emf. relation for rare metal couples is not linear the scale graduations on a pyrometer calibrated for these couples are not uniform. Therefore the amount of the deflection from the lowest scale division when the pointer is 20 deg. above that point will not be the same as when the pointer is 20 deg. below that point, but the difference will be so small the error involved in considering them equal, as is necessary in using the method of setting outlined in the above-mentioned article, is only a small fraction of the experimental error of making the setting.

KIRTLAND MARSH.

Aluminum Co. of America,
New Kensington, Pa.

Refining Chinese Bismuth Concentrates

To the Editor of Chemical & Metallurgical Engineering

SIR:—In "Refining Chinese Bismuth Concentrates," by Elton R. Darling (your issue of June 22) Mr. Darling explains that the hydrochloric solution containing the bismuth and antimony is treated with metallic iron and the metals precipitated; after thorough washing the precipitate is dried, and the bismuth obtained as a hydrate. This statement is open to question, as the addition of metallic iron liberates hydrogen, which in turn reduces metallic bismuth, and metallic bismuth is not converted to bismuth hydrate by simple drying, nor is it soluble in hydrochloric acid solution.

This would necessitate a different method of handling the bismuth and antimony metallics.

GEORGE DIEHLMAN.

New York City. Chief Chemist, Williams Harvey Corporation.

To the Editor of Chemical & Metallurgical Engineering

SIR:—May I say in reply to Mr. Diehlman that the process described is being used on a commercial scale with good results. As it works so well, it will not necessitate a different method of handling the bismuth and antimony metallics.

If my statement is wrong, perhaps he can account for the good results obtained in another way.

The James Milliken University,
Decatur, Ill.

ELTON R. DARLING.

Recovery of Volatile Solvents by Bregeat Process

To the Editor of Chemical & Metallurgical Engineering

SIR:—We are glad to see that our article entitled "Recovery of Volatile Solvents by the Bregeat Process" (published in CHEMICAL & METALLURGICAL ENGINEERING, vol. 24, p. 916, May 25, 1921) has been of sufficient interest to bring forth the comments by J. C. Lawrence of Blair, Campbell & McLean, Ltd., Glasgow, Scotland—the American offshoot of which Mr. Lawrence states is the American Chemical and Sugar Machinery Company—as published on p. 93 of your July 20, 1921 issue.

With regard to this history of solvent recovery in England as described by Mr. Lawrence, it is noted that he fails to give the names and fails to state the locations of the English solvent recovery plants to which he refers. Such being the case, we cannot reply or make specific statements in regard to these plants of which Mr. Lawrence claims knowledge. The writers believe that they are familiar with all plants—of any importance at least—where solvent recovery has been attempted either in England, on the Continent or in America. We believe that each and every statement in the article, and particularly those referred to by Mr. Lawrence, are correct. The writers regret that Mr. Lawrence has not been more specific.

Concerning our summary, which Mr. Lawrence states seems to him to "require considerable modification," we believe that up to the time Bregeat started his work no company put its whole energy into the one field of solvent recovery and that the statement made, which Mr. Lawrence misquoted, and which should read as follows, is correct. "Until the Bregeat Process had been developed solvent recovery was not an industry by itself. The Bregeat Process is responsible for bringing solvent recovery out of the class of an incidental and casual art into that of an independent and well-established business."

The writers believe, in turn, that Mr. Lawrence's statement in his last paragraph to the effect that "Both

British and American firms . . . have been building and installing solvent recovery equipment of the highest type for several years" needs decided modification. That the recovery systems attempted prior to Bregeat were not of the highest type is proved by the fact that they made little or no impression on the commercial world. In many instances they were replaced or are supplemented by Bregeat plants.

M. ROULLEUX.

ROBERT G. DORT.

The Slip Interference Theory of the Hardening of Metals

To the Editor of Chemical & Metallurgical Engineering

SIR:—The paper in your June 15 issue by Jeffries and Archer on "The Slip Interference Theory of the Hardening of Metals" will doubtless, as you suggest editorially, produce considerable discussion. My reaction on reading it the first time was one of amazement that a problem which has thus far baffled metallurgists could have such a reasonable and simple solution. Careful consideration by many minds may modify certain details, but I believe the main argument, based as it is on several generally accepted theories, will be widely accepted.

The theory, which seems to be well nigh flawless when applied to most metals and alloys, is more vulnerable when applied to steel. Perhaps carbon exists as such and cementite forms simultaneously with its separation, though I still doubt it. Perhaps the much discussed beta iron must be abandoned by its friends and supporters, though this is still an open question. Are either of the above points essential to a maintenance of the theory? They may at first thought seem to strengthen it, but it seems to me that the theory will still apply and much controversy be avoided if the points in question be made a side issue.

The internal strains set up in steel on quenching undoubtedly produce hardening in ways directly in line with the theory. These strains have often been referred to, but if a direct measurement of them has ever been made it has not come to my attention. An indirect illustration may be of some interest. A cylinder of 0.70 C steel 6 x 6 in. was quenched from 900 deg. C. in tap water. A thermocouple had been placed in a 3-in. hole at the center to study the rate of cooling. The quenching strains split the cylinder and it was found that the protection tube of the thermocouple was crushed and the diameter of the hole in the steel reduced to one-half its original size at the center of the specimen. A force to do this must be of very great magnitude, and it is not surprising if grain growth is prevented and slip produced, which will account for the hardening regardless of whether beta iron or carbon atoms are present.

CARLE R. HAYWARD.

Massachusetts Institute of Technology,
Cambridge, Mass.

Educational Motion Picture on Abrasive Industry

The completion of a new educational motion picture illustrative of the mineral industry is announced by the Bureau of Mines. The "Story of Abrasives" shows the generation of hydro-electric power at Niagara Falls, its utilization for the production of carborundum and aloxite, and finally the numerous interesting applications of abrasives.

The Use of Oil in Cleaning Coal

Coal, Pulverized by Wet Grinding, Is Agitated with About 30 per Cent of Oil, Causing the Formation of an Amalgam of Clean Coal and Oil and Separation of a Refuse Practically Free From Combustible Matter

BY G. ST. J. PERROTT* AND S. P. KINNEY†

Foreword

BY O. P. HOOD‡

DURING the war certain suggestions concerning power production were made by Walter E. Trent to the War Inventions Board, and at the request of the War Department facilities for experimental work were provided on the grounds of the Bureau of Standards.

The experiments were along the line of controlling the conditions of combustion in a closed space. In order to reduce slag troubles, experiments were carried out for removing ash from powdered coal. After the war, work along this line was continued, resulting in the Trent process, which agitates or beats together powdered coal, water and oil.

A new technology had previously been given to ore preparation by the use of small quantities of oil in water with froth flotation, and although the methods, results and mixtures of the Trent process were quite different, yet the same physical phenomenon of differential wetting was used, and the possibility of there being interesting results in fuel technology was evident. A co-operative agreement was entered into, whereby the Bureau of Mines was to investigate the underlying physical and chemical facts and make them public, and the Trent Corporation was to pay the cost of the investigation.

The several reports as made have been available to any one interested, and are now to be published. While the Bureau of Mines felt justified in investigating the physical phenomena so far as might be done in a laboratory, and so far as public interest might reach, no attempt was made to discover the commercial possibilities which development might bring. The question of commercial possibilities must be left for commercial enterprise to answer.

Briefly, the process consists in agitating together powdered coal, water and oil. This produces a partly de-ashed plastic fuel, called an amalgam, the oil selecting the coal particles and largely excluding the water and ash. The amalgam can be freed from water mechanically held by working much the same as butter is worked. The amalgam can be burned in several ways; for example, it may be shoveled, or forced through pipes by pressure; it can also be stored, under water if desired.

The laboratory results immediately suggest many interesting possible applications. For pulverizing fuel, wet grinding presents many advantages over dry grinding, provided the water can be eliminated afterwards.

To be able to reduce the ash in coal may make available great quantities of low grade coals and material now considered as waste at the mines.

If an oil is used which can be distilled at a temperature below the distilling temperature of the coal, powdered fuel is reclaimed from the amalgam and the oil may be re-used. If a heavy oil be used and distilled to dryness, a coke product may be recovered, although the coal used may have had no coking quality. If the distillation proceed only to a heavy pitch, a mass suitable for briquetting may be made.

In distilling oil mixed with a finely powdered material the distillates are similar to those obtained by distilling under pressure, so that the distillation of an amalgam of coal and oil gives quantities often more favorable than the sum of the separate distillations of the coal and the oil.

The amalgam can be used for a gas-making fuel, and gas-house tar emulsions can be dehydrated by mixing with powdered coal, the amalgam being retorted for further gas making.

Graphite ore can be separated from its gangue, and coke can be separated from flue dust by using the Trent process. Clean coal in anthracite sludge will make an amalgam if oil is added.

This brief sketch of possibilities revealed by small-scale laboratory work shows that the field for investigation and development is large. The general results show that real benefits are physically possible by treating coal in this manner. The Bureau has interested itself more particularly in the ash separation phenomena or the cleaning of coal, as outlined in the following paper, and in the distillation of the amalgam.

Laboratory Studies of the Trent Process

When a mixture of pulverized coal and water is agitated with oil in an amount equal to 30 per cent of the weight of the coal, a clean separation of a considerable part of the mineral matter is obtained. The carbonaceous material forms with the oil a pasty agglomerate which is heavier than water, while the mineral matter which was physically separated from the carbonaceous material by the fine pulverization remains suspended and can be drawn off with the water.

HISTORICAL

The history of coal washing has been similar to that of ore concentration. Hand picking has been supplanted by jigs, jigs have given way to tables in the treatment of the finer sizes of coal, and of late much attention has been given to the possibilities of froth flotation and other methods making use of the selective action of oils.

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‡Chief mechanical engineer, Bureau of Mines.

Bacon and Hamor¹ in discussing the problem of the utilization of fuels, describe experiments carried on at the Mellon Institute by Dr. C. B. Carter on froth flotation of coals. He found that the combustible matter contained in washer waste of all grades could be almost completely removed by suitable oil flotation, with a recovery of combustible matter between 70 and 90 per cent. Best results were obtained with washer waste crushed to pass a 48-mesh screen. The coal particles showed maximum floating properties when they were sharp, angular, and lustrous. Grinding in machines of the disk type was found to destroy these physical properties and to make the yield of recovered coal from refuse ground in this manner small and its ash content high. Estimates showed that a plant to handle 500 tons daily of ordinary bituminous coal washer waste would cost \$135,000. With such an installation it was estimated that coal could be obtained from refuse containing 65 to 70 per cent ash to the extent of 75 per cent of the total coal present, in the form of dry 25 per cent ash concentrate at a cost of \$1.84 per ton. Pyrite was found difficult to remove by froth flotation.

Ernest Bury² and co-workers describe an investigation of froth flotation of coal carried out at the works of the Skinningrove Iron Co., England. These workers were able to obtain concentrates analyzing 9 to 14 per cent ash from washery wastes containing 40 to 75 per cent ash. The tailings contained 76 to 89 per cent ash. The authors believe that a considerable amount of pyrite may be removed by the process, although no sulphur analyses are given. The washed product, which forms as a thick heavy stable scum on the water surface of the froth boxes, contains about 50 per cent of moisture. This concentrate is discharged into revolving filters of the Oliver type, drained under suction, and discharged as a filter cake containing 10 to 15 per cent of moisture. The cost of cleaning coal by froth flotation is estimated as not greater than the cost of jig washing. In regard to the scope of froth flotation in coal cleaning, the authors state as follows: "The flotation method does not, of course, compete with washers treating nut coal for sale on the open market for boiler firing, etc.; it can be employed only where the original coal is fine or where crushing is part of the normal treatment—that is, for coking, gas-making, briquetting, coal dust firing, colloidal fuel, etc."

NATURE OF MINERAL MATTER IN COAL

The mineral matter in coal is classified (1) according to its physical state of subdivision as intrinsic and extraneous and (2) according to its chemical composition as shale, clay, slate, sand, calcite, and pyrite. Intrinsic impurities are those which are present in a very fine state of dissemination throughout the coal substance and are not separated from the coal substance even by very fine pulverization. This intrinsic mineral matter is partly derived from the original material and partly deposited during the laying down of the coal bed from external sources by sedimentation and precipitation. Extraneous impurities occur in the form of partings, veins, and nodules or may be impurities mechanically mixed with the coal during the process of mining. Part of this extraneous mineral matter is

removed by the standard methods of washing coal, the amount removed depending on the fineness of crushing necessary to physically separate mineral matter from coal substance, and on the size of crushed coal which the washery can efficiently treat.

DIFFERENCES BETWEEN COAL AND ORE CONCENTRATION

There are certain obvious differences between concentrating coal and concentrating ore. In ore concentration the valuable material is heavier than the gangue and constitutes a small percentage of the total material treated. In coal concentration, the valuable material is lighter than the refuse and constitutes a large percentage of the total material treated. Furthermore, there is a larger difference in specific gravity between values and gangue in ore than in coal. Gangue in ore varies in specific gravity from 2.5 to 3.0 and values vary from 4 to 8, while the mineral matter in coal (with the exception of pyrite) varies in specific gravity from 2 to 2.7 and the clean coal concentrate from 1.2 to 1.7. Again, coal contains *extraneous* mineral matter easily separated by crushing and *intrinsic* mineral matter, none of which can be separated except by very fine pulverization. The crushed raw coal which is to be concentrated may contain particles of coal of varying gravities containing varying amounts of inseparable ash, making a clean separation impossible at the degree of fineness employed with ordinary washing methods.

One of the early processes of concentrating ores which made use of selective wetting was the Elmore bulk oil process. Elmore mixed the ore with several times its weight of water and an equal weight of oil in a revolving drum. After gentle agitation, the mixture was run into a spitzkasten, where the water and gangue settled to the bottom and were removed. The ore was separated from the oil by a centrifugal apparatus. Froth flotation, employing an amount of oil equal to about 1 lb. per ton of ore treated or less than the recovery losses in the bulk oil processes, has superseded the Elmore process in the treatment of ore.

Since the further history of the coal concentrate is to be different from that of the ore concentrate, it does not necessarily follow that methods using relatively large amounts of oil are impracticable for concentrating coal even though such methods have been practically abandoned in ore concentration practice. The ore concentrate is to be passed through a metallurgical operation for the recovery of the pure metal; the coal concentrate is to be used ultimately as a fuel and in many cases is to be subjected to distillation for the production of coke. The mixture of coal and oil may be burned without further treatment or it may be carbonized with the formation of coke and recovery of the oil and by-products from the coal. If the oil employed contains a considerable percentage of pitch, it may serve to make coherent coke from feebly coking coals.

SCOPE OF WORK OF THE BUREAU OF MINES

The work at the Bureau has been carried out rather on the fundamentals of the bulk oil method than on its economic aspects. Experiments on a laboratory scale have been made to determine for a variety of coals the ash and sulphur removal, combustible recovery, and oil losses with different oils, different methods of agitation, and various degrees of fineness of pulverized coal. The experimental procedure followed has aimed to obtain data giving a complete balance sheet of the process.

¹Bacon, Raymond F., and Hamor, William A. Problems in the Utilization of Fuels, *J. Soc. Chem. Ind.*, vol. 38, June 30, 1919, pp. 161-168.

²Bury, Ernest; Broadbridge, Walter, and Hutchinson, Alfred: Froth Flotation as Applied to the Washing of Industrial Coal. *Trans. Inst. Mining Eng.*, vol. 60, February, 1921, pp. 243-253.

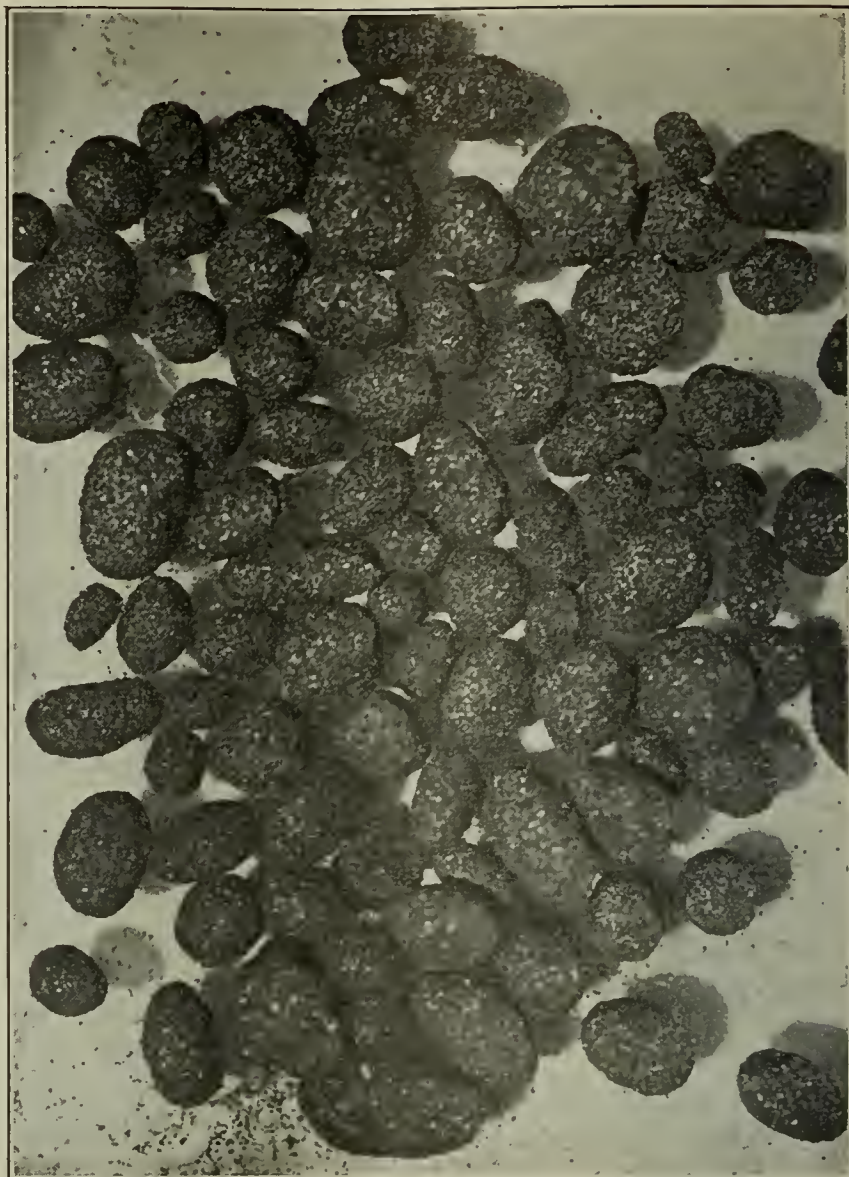
The bulk oil method of cleaning coal depends upon the same principles of selective wetting which have made possible froth flotation of ores and have been voluminously discussed in the literature of flotation. When oil is stirred into a suspension of coal in water, the first tendency is probably the formation of a suspension of droplets of oil in the mixture. The coal particles are, however, so readily wet by oil in preference to water that the globules rapidly become small agglomerates of coal and oil. These agglomerates tend to adhere to one another, entrapping water in the spaces between them and forming the pasty mass which precedes the breaking of the mixture. As a result of further agitation, the small agglomerates coalesce into larger granules and finally coalescence reaches a point where a large amount of water is released from between the particles and the separate granules are visible. With further agitation, the granules agglomerate into larger masses and if sufficient oil has been added, finally form a more or less homogeneous mass.

The best conditions for rapid formation of this amalgam³ are (1) low surface tension between coal and oil, (2) a high surface tension between coal and water, and (3) a high surface tension between oil and water. Or in other words, the reaction will take place most readily (1) with a coal which is very readily wet by oil, (2) with a coal which is not readily wet by water, and (3) with an oil which does not readily form emulsions with water. From (1) and (2) we should expect that the bituminous coals and graphite should respond to treatment most readily and the lignites least readily. From (3) we should expect gasoline and the higher paraffine oils to form an amalgam more readily than benzene and the higher aromatics and that the presence of substances in water or oil which tend to lower the surface tension between water and oil, would make the formation of the amalgam more difficult. Particles of refuse which have been physically separated from the clean coal particles by the preliminary pulverization, will be easily removed if they are readily wet by water in preference to oil and removed with difficulty if they have any tendency to be wet by oil. Hence we should expect that shale, clay and gypsum would be readily removed suspended in the water but that pyrite might tend to remain in the amalgam.

METHODS AND APPARATUS FOR LABORATORY SCALE WORK

Coal is pulverized to pass a 65-mesh screen in a laboratory disk crusher. For finer meshes the coal is then ground in a porcelain ball mill with an equal weight of water, for periods varying from 4 hr. to as long as 60 hr. when extremely fine grinding is desired (as fine as 800-mesh has been obtained in this manner). The coal is washed from the ball mill into a settling jar, from which after settling has taken place and some of the water has been decanted, it is transferred to a small electrically stirred glass churn—300-g. samples of coal have been employed in most of our work and have been agitated in the churn with about 900 cc. of water. A sufficient quantity of oil is added—about 25 per cent of the weight of the coal for a coal containing 25 per cent removable refuse—and agitation is carried on until the agglomerate of small egg-shaped granules known as the amalgam is formed.

³In ordinary technical usage, amalgam refers to an alloy of a metal with mercury, but the term is correctly used according to Webster's dictionary, to refer to any "mixture, compound, or union of different things."



AMALGAM GRANULES, NATURAL SIZE

The amalgam and water and suspended refuse are poured onto a 100-mesh screen and washed with water. The amalgam is then placed in the churn and washed with fresh water and the process repeated until no further mineral matter is removed.

After the amalgam has been separated from the refuse and the refuse filtered on a weighed paper, the products for analysis are:

- (1) Amalgam, consisting of purified coal, oil, and 10 to 30 per cent water.
- (2) Refuse, consisting of mineral matter, a small amount of combustible matter, oil, and water.
- (3) Refuse water, consisting of all the water used in the process with the exception of that retained in the amalgam and filtered refuse, a small amount of dissolved mineral matter, and under certain conditions possibly emulsified oil.

Before analysis can be made, both amalgam and refuse must be separated from oil and water. This separation must be done in a quantitative way so that oil losses, if any, may be determined. The obvious way of separating the oil is extraction of amalgam or refuse with a solvent which dissolves the oil but does not affect amalgam or refuse. If this solvent boils at a higher temperature than water, the water may be condensed and measured, thus determining amounts of oil and water in one operation. Due to the large amount of water in amalgam and refuse and the difficulty of accurately sampling the wet amalgam, it has been found more practicable to subject the whole amalgam and refuse to a separate distillation at 110 deg. C. in which water is caught and measured. The dry material is then extracted with benzene to determine the percentage

TABLE I. DESCRIPTION OF COALS TESTED

Classes of Coal	Seam	Source	Location
Anthracite culm.....	.....	Secured from Trent Process Corporation, Washington, D. C.	Anthracite culm I
Anthracite culm.....	.....	Feed to concentrating tables at washery of Hudson Coal Co., Scranton, Pa.	Anthracite culm II
Anthracite.....	.....	Rhode Island anthracite.....	Rhode Island
Bituminous.....	Pittsburgh.....	Pulverized coal from plant of Oliver Iron and Steel Co., Pittsburgh.....	Pittsburgh
Bituminous.....	Upper Freeport.....	Run-of-mine coal from Avenue Mine of Allegheny Steel Co., Brackenridge, Pa.	Upper Freeport I
Bituminous.....	Upper Freeport.....	Feed to washery at mine of Inland Collieries Co., Harmarville, Pa.	Upper Freeport II
Bituminous.....	Upper Freeport.....	Bone coal refuse from washery of Inland Collieries Co., Harmarville, Pa.	Bone coal
Bituminous.....	No. 6.....	Run-of-mine coal, No. 1 Mine, Superior Coal Co., Gillespie, Ill.	Illinois I
Bituminous.....	No. 6.....	Run-of-mine coal, No. 7 Mine, Big Muddy Coal and Iron Co., Herrin, Ill.	Illinois II
Bituminous.....	No. 6.....	Run-of-mine coal, No. 12 Mine, Vandalia Coal Co., Sullivan, Ind.	Indiana
Bituminous.....	Lehigh.....	Run-of-mine coal, No. 5 Mine, Folsom Morris Coal Mining Co., Lehigh, Okla.	Oklahoma
Bituminous.....	.....	Run-of-mine coal from cars at mouth of mine, Wilkeson Coal and Coke Co., Wilkeson, Wash.	Washington
Bituminous.....	.....	Coal from Brazil, secured from Trent Process Corporation.....	Brazil
Bituminous refuse.....	Blossburg.....	Waste from washery of Phelps Dodge Co., Dawson, N. M.	New Mexico
Bituminous refuse.....	Soddy.....	Washer refuse from washery of Durham Coal and Iron Co., Soddy, Tenn.	Tennessee
Bituminous refuse.....	Black Creek.....	Washer refuse from washery of Black Creek Coal Co., Nauvoo, Ala.	Alabama
Sub-bituminous.....	.....	Run-of-mine coal from bins at head of washery, plus the bone from the picking table Pacific Coast Coal Co., Isaquah, Wash.	Washington
Lignite.....	.....	Run-of-mine coal, No. 1 Mine, Bertetti Coal Co., Lytle, Texas	Texas lignite
Lignite.....	.....	Run-of-mine coal, Kassick Cattle Co., Lone, Cal.	California lignite

of oil. When a volatile liquid such as benzene is used in making the amalgam, distillation determines the amounts of both water and benzene and no extraction is necessary. Even when heavy petroleum oils are used in making the amalgam, it is best to dry in the still because a small portion of the oil always comes over with the water. Drying in an open dish would thus give rise to an unaccounted for loss of oil.

ASH REDUCTION AND COMBUSTIBLE RECOVERY

In calculating the efficiency of the process, several values are of interest; three of the most important being (1) per cent ash in the oil-and-water-free cleaned coal; (2) per cent ash reduction; (3) per cent combustible recovery. The first two values are qualitative measures of the efficiency. Per cent ash reduction equals the per cent ash in the raw coal minus the per cent ash in the cleaned coal, divided by the per cent ash in the raw coal. Per cent combustible recovery is a quantitative measure of the efficiency of separation of combustible matter from mineral matter. It is

equal to
$$\frac{C - rc}{C}$$

where *C* is the per cent combustible matter in the raw coal, *c* the per cent combustible matter in the refuse, and *r* is the per cent refuse by weight of the raw coal.

In calculating the amount of combustible matter in coal or refuse, it must be borne in mind that combustion of carbon is not the sole reason for loss in weight when coal is ignited in the analytical method for determina-

tion of ash. There is always a larger amount of mineral matter in coal or refuse than represented by the percentage ash as determined by the ordinary analytical method. For example, a refuse which shows 85 per cent ash remaining after ignition to constant weight at 750 deg. C. does not contain 15 per cent combustible matter. Several factors contribute to this loss in weight: Combustion of carbonaceous material; decomposition of carbonates; oxidation of pyrite to Fe₂O₃ and SO₃, and combination of part of the SO₃ with oxides formed from decomposed carbonates; loss of water of hydration from clay and shale.

Water of hydration varies from 2 to 12 per cent of shale, calcium carbonate is present in small amounts in the coals of the Appalachian fields, but may run as high as 50 per cent of the ash of some of the Illinois coals. Parr⁴ has proposed a formula for calculating the corrected ash which involves the per cent carbon occurring as carbonate in the unburned coal. In our work, time has not been available for the determination of carbonate in the refuse and the corrected ash has been determined as follows:

Ash corrected = 1.08 ash — $\frac{21}{40}$ S

Any correction factor must of necessity be an approximation, the correctness varying according as the composition of the ash varies from the assumptions made in deriving the formula. The water of hydration which

⁴Parr, S. W., Preliminary report of committee on coal analysis *J. Ind. Eng. Chem.*, vol. 5, June, 1913, p. 523.

TABLE II. SUMMARY OF TRENT PROCESS RESULTS

Kind of Coal	Lab. No.	Amount of Oil Used, Gal. per Ton	Raw Coal			Cleaned Coal			Refuse				Efficiency			Time of Agita- tion, Hours
			Ash	Corrected Ash	Sulphur	Weight	Ash	Sulphur	Weight	Ash	Corrected Ash	Sulphur	Ash Reduction	Combustible Recovery	Sulphur Reduc- tion	
Per Cent			Per Cent			Per Cent			Per Cent							
Anthracite culm I.....	34,647	65	27.7	30.4	1.00	74.0	7.0	0.70	26.0	87.0	95.0	1.99	74.7	97.8	30	0.5
Anthracite culm II.....	76,975	65	31.4	34.8	1.63	69.0	6.5	0.85	31.0	87.0	95.6	3.05	70.2	98.0	48	0.5
Anthracite, Rhode Island.....	78,127	75	21.7	23.8	0.85	82.0	6.7	0.83	18.0	90.7	98.3	0.95	69.2	99.5		2.0
Bituminous, Pittsburgh.....	34,768	80	12.5	14.2	1.27	92.0	6.0	1.34	8.0	88.0	95.2	0.40	52.0	99.5		0.1
Bituminous, Upper Freeport.....	76,974	80	9.3	11.2	2.28	96.5	6.7	2.34	3.5	87.6	94.8	0.60	28.0	99.7		2.0
Bituminous, bone coal refuse.....	34,645	80	21.7	23.9	0.93	88.0	12.5	0.80	12.0	88.7	96.9	2.08	42.3	99.4	14	1.0
Bituminous, Illinois.....	75,637	80	16.6	20.7	5.33	85.0	7.4	5.28	15.0	69.7	76.6	2.25	55.4	99.8	1	3.0
Bituminous, Indiana.....	76,027	80	9.9	13.0	4.38	96.4	6.3	4.27	3.6	86.2	93.5	0.80	36.4	99.8	3	0.5
Bituminous, Oklahoma.....	75,631	80	19.5	23.6	4.74	69.0	5.7	3.08	31.0	50.5	59.0	8.50	70.8	83.5	35	2.0
Bituminous, Washington.....	76,142	80	22.6	24.7	0.49	87.5	13.6	0.50	12.5	85.0	92.1	0.50	39.8	98.7		0.5
Bituminous, refuse, New Mexico.....	77,989	60	54.7	59.3	0.55	45.0	22.9	0.86	55.0	80.6	87.3	0.29	58.1	82.8		2.0
Bituminous, refuse, Tennessee.....	77,541	50	63.5	69.4	1.64	31.0	20.6	1.48	69.0	82.7	90.2	1.65	67.7	77.8	10	2.0
Bituminous, refuse, Alabama.....	77,864	80	23.5	26.2	1.60	80.5	6.6	1.76	19.5	92.8	100.7	0.90	72.0	100		1.0
Sub-bituminous, Washington.....	75,897	80	19.3	21.1	0.48	87.0	10.0	0.50	13.0	80.0	86.7	0.45	48.4	97.8		3.0
Lignite, California (a).....	76,026	80	35.1	39.3	1.77	81.5	25.7	1.56	18.5	75.9	83.2	2.30	26.8	95.0	12	2.0
Lignite, Texas (a).....	75,823	80	33.5	36.9	1.44	79.7	18.1	1.42	20.3	94.2	102.4	1.25	46.0	100	1	2.0
Bituminous, Brazil.....	78,226	60	35.6	39.7	2.47	66.0	9.4	2.32	34.0	86.0	94.4	2.71	73.6	97.0	6	4.0

(a) Carbonized at 500 deg. C.

(a) Carbonized at 500 deg. C.

is present in shales may vary from 2 to 12 per cent. Part of the sulphur is present as organic sulphur while the formula assumes the sulphur is all present as pyrite. Since little organic sulphur is removed with the refuse, the sulphur correction is fairly accurate.

Table I gives a description of the coals discussed in the present article. These coals are referred to in the remaining paragraphs as noted in the column under "designation."

Table II gives averages of results with a number of typical coals of the United States. The coals were pulverized to 65 mesh and ground for 6 hr. with an equal weight of water in a laboratory ball mill before treatment by the Trent process. The oil employed was in all cases a grade of Navy fuel oil running 125 seconds on the Saybolt viscosimeter at 25 deg. C. The specific gravity of the oil was 0.875 (30.0 deg. Bé.) at 20 deg. C.

The results as set down are for the most part self-explanatory. It will be seen that ash reduction with most of the coals tested is good, varying from 30 to 75 per cent. Sulphur reduction is fairly good in the case of anthracite coals but low in the case of bituminous coals. With these latter coals just sufficient sulphur is removed to keep the sulphur content of the recovered coal about the same as that of the raw coal. Combustible recovery is with a few exceptions better than 95 per cent.

SULPHUR REMOVAL

The removal of pyrite from coal by any process depending on the selective action of oils is considerably more difficult than the removal of other mineral matter such as shale or slate. Pyrite is readily wet by oil and particularly when in a fine state of sub-division tends to attach itself to the coal-oil agglomerates rather than remain suspended in the water. Separation is accomplished with greater ease from anthracites than from bituminous coals. This difference in behavior of anthracite and bituminous coals is shown in the following analyses giving the percentage of total sulphur, sulphate sulphur, pyritic sulphur, and organic sulphur in a bituminous and an anthracite coal before and after treatment by the Trent process. It will be seen that in the treatment of anthracite coal, the pyritic sulphur almost disappeared from the recovered coal, while in treating the bituminous coal there was still a considerable percentage of pyritic sulphur remaining in the recovered coal.

Coal	Condition	Ash	Analysis of Sulphur			
			Total	Pyritic	Sulphate	Organic
Oklahoma bituminous, No. 75631	Raw.....	19.5	4.74	3.01	0.36	1.37
	Recovered	7.9	3.75	2.10	0.15	1.50
	Refuse...	46.3	6.50	4.85	0.35	1.30
Pennsylvania anthracite culm, No. 76975	Raw.....	31.5	1.74	1.21	0.06	0.47
	Recovered	7.0	0.85	0.13	0.07	0.65
	Refuse...	66.1	2.73	2.41	0.01	0.31

A study of synthetic mixtures of coal and pyrite was made with a view to determining definitely the percentage of pyrite which might be removed from a mixture in which the pyrite was known to be separated from the coal particles. With mixtures of bituminous coal and pyrite ground to pass a 200-mesh sieve, separation of about 60 per cent of the pyrite was obtained by means of the Trent process, but practically no separation was obtained when this mixture was ground to 600-mesh or finer. Better separation was obtained with mixtures of anthracite coal and pyrite. The pyrite refuse separated

from the various mixtures always retained considerable amounts of oil, pointing to the fact that where separation of pyrites was obtained in the coarser mesh mixtures, this pyrite was mechanically separated from the amalgam by reason of its high density and still retained a film of oil. Coal pyrite containing about 46 per cent sulphur was used in the experiments. It was found possible to make an amalgam of the wet ground pyrite alone with very little of the pyrite remaining suspended in the water.

Results point to the desirability of preliminary water concentration of high sulphur coals for removal of pyrite before treatment by the Trent process.

OIL EMPLOYED IN PROCESS

Any oil or organic liquid not miscible with water may be employed in the Trent process provided its viscosity is not too great. The heavy topped crudes may be employed if the water used in the process is heated, thus reducing the viscosity of the oil. Certain commercial emulsions such as water-gas tar or B.S. petroleum emulsions have been successfully employed. Here again the viscosity must not be too great. B. S. refinery settlings of the consistency of cup grease were not found to be satisfactory at ordinary temperatures. An oil of viscosity equal to 135 sec. (at 25 deg. C.) on the Saybolt viscosimeter gives satisfactory results. When oils of viscosity equal to 400 sec. and upwards are employed, it is necessary to employ heated water to secure best results. Using an oil with a viscosity equivalent to 4,000 sec. Saybolt, at room temperature, it was found necessary to heat the water to 70 deg. C. to effect formation of the amalgam.

Apparently the efficiency of ash separation begins to diminish when an oil greater in viscosity than about 40 sec. Saybolt is employed. Combustible loss in the refuse is somewhat less with the more viscous oils. Considerably more of the liquids of low viscosity such as benzene and carbon tetrachloride must be used to obtain a coherent amalgam than of the oils of higher viscosity.

In the greater part of our work, oil has been used in an amount equal to 0.3 lb. per lb. of dry cleaned coal. If a coal contains 25 per cent of removable refuse, it will be necessary to use 450 lb. or about 62 gal. of a light fuel oil per ton of raw coal treated. With coal ground to pass a 200-mesh screen, this quantity of oil produces an amalgam in granules about $\frac{1}{8}$ -in. in diameter. If finer ground coal is employed, it may be necessary to use as much as 0.4 lb. of oil per lb. of dry cleaned coal. It is best to work with as small an amount of oil as possible because better washing of the amalgam is possible when the granules are fairly small, and the resultant cleaned coal contains less ash.

OIL LOSSES

Emulsification. Although at first sight it might be thought that considerable oil would be lost as a result of emulsification in the water, experiments have shown no appreciable loss due to this cause. Apparently the presence of finely pulverized coal in the water effectively prevents emulsification. As a matter of fact, certain commercial emulsions such as water-gas tar and B. S. emulsion are broken down by the addition of pulverized coal and may be used as oils for carrying out the Trent process. Even if a certain amount of oil were retained in the water, the use of this water over again after separation of the refuse, would eliminate loss from this source.

Absorption in the refuse. The oil retained by the refuse is seldom more than 1 per cent of the total oil used and frequently is practically zero. In certain cases where a large amount of refuse high in carbon and pyrite has been removed, the oil absorbed in this refuse has been as much as 10 or 15 per cent of the total oil used.

Volatilization. Volatilization losses are negligible with the heavier petroleum oils but of course quite appreciable in the case of gasoline or benzene. It is hardly likely, however, that such volatile oils will be used in any commercial application of the process.

Our results point to the conclusion that oil losses in the first stage of the process, i.e., agitation and separation of refuse, will be negligible. Recovery of oil from the amalgam by distillation is another matter and one outside the scope of the present article.

AMOUNT OF WATER RETAINED IN THE AMALGAM

An amalgam in granules $\frac{1}{8}$ -in. or larger usually retains 8 to 12 per cent moisture which will not drain out of the mixture, in addition to the hygroscopic moisture of the coal. It has been found possible to reduce this moisture to about 5 per cent by passing through a kneading machine of the meat chopper type. In an amalgam of very fine granules, the moisture content may be as high as 30 or 40 per cent. A large part of this moisture occurs as a coating of the small particles and is separated by further agitation or the addition of more oil to effect the formation of larger granules. The size of the granules depends upon the amount of oil used, the size of the coal particles, the method of agitation and time of agitation and to some extent on the character of the coal. Certain sub-bituminous coals require more oil to produce granules of a given size than do the bituminous coals or anthracite.

Brisk agitation of the kind given by rapidly revolving paddle blades is most efficient in separating mineral matter from coal and in securing rapid formation of the amalgam.

TIME REQUIRED FOR FORMATION OF THE AMALGAM

Coals differ very much in the rapidity with which they form the so-called amalgam. As a general rule, it may be stated that coals containing more than 3 or 4 per cent hygroscopic moisture as received will be difficult to work. When they contain 20 or 30 per cent moisture as do the lignites, separation is practically impossible even with prolonged agitation.

It has not been found possible to get good separation of carbonaceous material from mineral matter by treatment of the raw lignite. Lignites are very readily wetted by water, and once the lignite is well wetted with water, either by wet grinding or by soaking, the water is not readily displaced by oil. On agitation of a wet ground mixture of lignite with oil, there is some tendency for separation into layers of coal-oil and refuse-water, but no formation of the compact agglomerate of coal and oil which takes place with bituminous coals or anthracites. Microscopic examination of the mixture shows globules of oil suspended in the mixture of lignite and water indicating a high surface tension between the oil and the coal-water mixture.

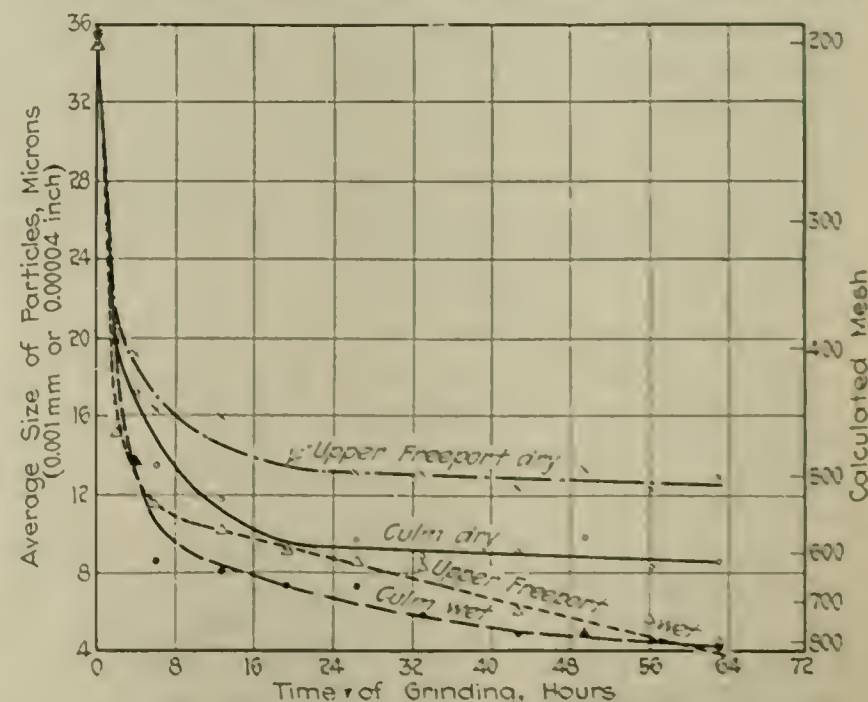
Inspection of Table I will show that the two samples of lignite were carbonized at 500 deg. C. before treatment. Mere drying of the coal at 110 deg. C. is not sufficient. The structure of the coal is not changed by such treatment and the water so driven off is re-absorbed

when the coal is soaked in water prior to treatment by the Trent process. It is necessary to carbonize the lignite at a sufficiently high temperature to so change its structure that it is no longer hygroscopic. When this is done and the carbonized material finely pulverized by grinding in the ball mill, the formation of the amalgam takes place readily although a large ash reduction is not obtained with the brown woody lignites. The mineral matter in these lignites is apparently very finely disseminated throughout the coal substances and complete separation is not attained even at the finest degree of pulverization possible by grinding in the ball mill or about 5 microns (0.005 mm.).

In considering the efficiency of the Trent process in cleaning a given coal, we must then consider a third factor—time of agitation—in addition to ash reduction and combustible recovery. This factor assumes importance with the sub-bituminous coals and lignites. Obviously, overhead expenses will become greater as the time of agitation increases and there will be a length of agitation beyond which it will not be profitable to go. In the following table are set down analyses of a number

Name of Coal	Time of Agitation		H ₂ O	Vol. Matter	Analysis Fixed Carbon	Ash	Sulphur
	First Separation Min.	Completion Min.					
Pittsburgh.....	1	10	1.53	33.42	52.72	12.33	1.25
Upper Freeport I.....	2	30	1.50	34.40	54.92	9.18	2.25
Illinois II.....	2	30	2.50	31.87	52.42	9.93	1.28
Illinois I.....	30	180	10.93	36.22	40.30	12.55	4.03
Oklahoma.....	5	120	5.10	35.80	41.40	17.70	4.46
Indiana.....	1	30	1.75	42.75	45.80	9.70	4.19
Texas lignite.....	60	∞	26.68	31.97	26.55	14.80	1.41
Texas lignite, carbonized.....	20	120	0.05	10.95	55.50	33.50	1.44
Calif. lignite.....	60	∞	15.20	48.31	21.29	15.20	1.60
Calif. lignite carbonized.....	30	120	0.05	19.05	45.80	35.10	1.77
Anthracite culm I.....	2	30	2.15	7.27	64.87	27.70	1.00

of coals together with the time for which it was found necessary to agitate these coals when treating them by the Trent process. Two figures for time of agitation are given, the first column being the time the mixture was agitated before a separation into small agglomerates of coal and oil were visible. At this time the granules of coal and oil are soft and cannot be separated from the refuse by screening. After a further period of agita-



COMPARISON OF WET AND DRY BALL MILL GRINDING OF ANTHRACITE CULM AND UPPER FREEPORT BITUMINOUS COAL

Original samples first ground dry to pass a 200-mesh screen. Right-hand ordinate represents calculated mesh of screen through which entire sample would pass at time of grinding indicated.

tion, the granules become larger and more coherent, and may be filtered from the refuse and water by screening. The figures in the second column show the total time taken for agitation and screening of the amalgam and for the several agitations in fresh water for removal of the last traces of refuse.

The Trent process is unique among coal cleaning methods in that it treats coal in a very finely pulverized condition. Any advantages which are obtained by treatment of finely pulverized coal are advantages peculiar to the process. In the course of the investigation, a considerable amount of work has been done to determine the relation between fineness of grinding, ash removal, and combustible recovery or in other words to show to what degree of fineness it is necessary to grind different coals in order to secure optimum separation of mineral matter from combustible matter.

It was found that grinding finer than 200-mesh does not give sufficiently greater ash reduction to pay for the increased cost of the finer pulverization. The percentage of combustible matter in the refuse decreases with finer pulverization but it may not be sufficient to warrant the added expense of grinding from 200-mesh to 600-mesh or finer. Sulphur reduction is in general at a maximum with the 200-mesh material.

A number of comparative determinations of the fusibility of ash in raw and cleaned coal were made. Where any considerable amount of ash has been removed, the ash from the cleaned coal shows either a slightly higher softening temperature or larger softening interval. This was not true in the case of the bituminous coal from Oklahoma.

SUMMARY

This paper has presented the results of laboratory-scale tests of the efficiency of the Trent process in cleaning coal. A noteworthy feature of the operation of the process is the cleanness of separation of mineral matter from combustible matter. Combustible recovery has averaged better than 95 per cent. High ash reduction has been obtained with the bituminous coals and anthracites. Sulphur reduction has been good in the case of anthracites but poor with the bituminous coals. It has not been found feasible to treat the lignites without preliminary carbonization, due to the difficulty of forming a coherent agglomerate of the raw lignite and oil. Finer pulverization than 200-mesh does not give a sufficient increase in ash reduction with most coals to warrant the added expense of the longer period of grinding. Any oil whose viscosity is not too great may be employed in the process. Oil losses in the refuse or water are apparently negligible.

Beet-Sugar Industry in Northern France

France before the World War had attained a high rank among the sugar-producing nations. From its beginning under the First Empire, attaining in 1830 a production of 3,000 tons, it reached 272,000 tons in 1884, with 148,000 hectares (365,714 acres) in cultivation. In 1901-2 France planted 312,000 hectares (770,965 acres) of beets and refined 1,051,000 tons of sugar. This was the largest annual production recorded and is attributed to favorable legislation then in force. The convention of Brussels, which suppressed the practice of subsidizing sugar exports, had thereafter an unfavorable effect upon the sugar industry, so that in 1913-14 only 216,200 hectares (534,230 acres) were planted and only 712,000 tons of sugar produced.

At the outbreak of the war the invasion of the northern department reduced by 54 per cent the acreage planted. The bad quality of the seed, the scarcity of labor, and the persistently increasing difficulty of procuring fertilizer diminished the yield by about 57 per cent, as the following table will show:

Season	Acreage Hectares	Sugar Refined Metric Tons	Season	Acreage Hectares	Sugar Refined Metric Tons
1914-15.....	98,250	302,000	1917-18.....	66,305	200,000
1915-16.....	63,209	135,000	1918-19.....	59,908	110,000
1916-17.....	60,000	185,000			

NOTE—One hectare equals 2.471 acres.

The difficulty of bringing in colonial or other sugar forced the government to restrict consumption, which fell from 710,000 in 1914 to 412,000 tons in 1919, of which last 300,000 tons were imported. At the end of 1919 the price of sugar was fixed by the government at 290 fr. per 100 kilos; a decree of June 28, 1920, raised it to 310 fr. Quotations on uncontrolled sugar rose rapidly to 400 francs during the month of August, and declined rapidly in October, and in November it was quoted at 170 fr. for 100 kilos.

Out of about 210 sugar factories that were running in France before the war 170 were located in the invaded departments: Nord, Pas-de-Calais, Somme, Aisne, Oise, Marne, and Ardennes. Of these 135 were damaged by the German invasion. These damaged factories had a total capacity of 490,000 tons of sugar each season of about 75 days per year.

The total damage is estimated at 250,000,000 fr. (value in 1914). Almost all these establishments will require total rebuilding. In 1919 a few plants in the Oise, which was only moderately damaged, and one in the Nord, recommenced work. In 1920 three damaged factories in the Nord, one in the Somme, and three in the Aisne resumed activity, with a total capacity of 3,000 tons of beets per day. The advanced state of reconstruction of factory building, and the manufacture of apparatus permit the estimate that during 1921 six plants in the Nord, one in the Pas-de-Calais, one in the Somme, and four in the Aisne will resume operations. As well as can be at present foreseen, about 20 plants will recommence work in 1922, and the whole program of reconstruction will be completed in 1925.

It is estimated that out of the 135 damaged plants, about 20 will be abandoned entirely, or for a number of years, or will be employed in other industries. Among those in process of rebuilding, a certain number will increase their former capacity, several plants being consolidated in one new one. The number of establishments will be reduced, but the total capacity will not follow the same diminution. The forecast of the future sugar production is given as follows:

1920-21.....	350,000	1923-24.....	550,000
1921-22.....	460,000	1924-25.....	580,000
1922-23.....	530,000	1925-26.....	600,000

The materials and machinery necessary to be replaced or repaired is large, and for the present, French foundries and machine shops are counted upon almost entirely. Fortunately the rapid reconstruction of the industrial plants of northern France have permitted them to take care of orders since the end of 1919. American and English constructors have been temporarily eliminated from the market on account of the exchange rate. German bids have not been much lower than the French for this work, and in view of the uncertainty of deliveries no orders have been given in that quarter. The reconstructed factories will in most cases be equipped with new and improved machinery.

The Colloid Chemistry of Petroleum

A Description of the Two-Phase Petroleum System Found in Oil Emulsions —Emulsifying Agents—Types of Emulsions—Breaking an Emulsion— Effect on Lubrication and Plant Practice—Products

By FRED W. PADGETT*

COLLOID chemistry has lately been defined¹ as the chemistry of bubbles, drops, grains, filaments and films. To anyone familiar with petroleum and its products this definition suggests an important relation to hydrocarbon technology. That petroleum and petroleum distillates are of a colloidal nature has been indicated by several investigators. Ostwald² entertains the belief that high-boiling petroleum fractions are to be regarded as iso-colloids in which the disperse phase and dispersion means possess the same or analogous chemical composition. Pyhäälä³ considers that crude petroleum is a sol, of which the disperse phases are solid gels, such as asphalt, together with liquid particles. Holde⁴ has made the following observations concerning petroleum oils and distillates: Mineral oils are to be regarded as colloids. A solution of precipitated lime soap in benzene and in benzene-alcohol also behaves as a colloid. The heavy, opaque mineral oils, which are regarded as solutions of asphalt and lighter mineral resins in mineral oil, behave as colloids when viewed in benzene solution. Reddish yellow machine⁵ oils and white paraffin oils displayed a bluish cone of light containing amicrons. Small quantities of crystallized paraffins dissolved in benzene gave no cone of light, but in larger quantities a cone of light and submicrons were to be seen which became more intense or numerous the more concentrated the solution. Submicrons were scarcely to be found in Russian petroleum free from paraffin, but were readily detected in paraffin-base petroleum from America. The fluorescence of petroleum has been attributed to the colloidal nature of the product, but Brooks and Bacon⁶ reported that the fluorescent material was not adsorbed by fullers earth, and that, when a highly fluorescent oil was diluted with kerosene, filtered and carefully dried, there was no reaction with the ultramicroscope.⁷ Brooks and Bacon's view is that fluorescence is caused by a small quantity of aromatics, such as chrysene, pyrene and fluorene.

OIL EMULSIONS

An emulsion consists of drops of one liquid suspended in another liquid. Dispersed systems of this type, particularly the oil-water emulsions, are of practical importance in the technology of petroleum production and refining. The problem before the technologist may be to resolve the emulsion which is already

formed, or, on the other hand, may be to prepare a product which will form a stable emulsion; therefore a knowledge of the theory of emulsification,⁸ especially if it is a good working theory, is of practical value.

Stable emulsions of any considerable concentration of dispersed phase must necessarily contain a third substance, an emulsifying agent, which is in colloidal solution in one of the phases, but is precipitated by the other.⁹ Sometimes the emulsifying agent is not colloidal, but gathers at the interface in finely divided form, provided the substance adsorbs both phases simultaneously.

EMULSIFYING AGENTS

What is the mechanism of a stable emulsion? Will the dispersed system be an oil-in-water emulsion, or the opposite, a water-in-oil emulsion; or both together? This may be illustrated by considering a hypothetical mixture of neutral oil and distilled water, the latter containing the emulsifying agent, potassium oleate, in colloidal solution. The addition of the soap to the water has lowered the surface tension on the water side of the interface more than on the oil side; consequently the interface will tend to curve so as to be convex on the water side, producing an oil-in-water emulsion when the mixture is shaken.¹⁰ But there is nothing to prevent the drops from coalescing unless they have acquired like electric charges, have become surrounded by an adsorbed film of emulsifying agent, or are exceedingly small. If the drops have become surrounded by an adsorbed film of emulsifying agent, then the permanency of the emulsion will depend upon the stability of the film. If the emulsifying agent goes into colloidal solution with one of the phases, but is precipitated by the other, then the latter phase is dispersed and it will be possible to disperse water in oil, or oil in water, depending upon whether or not the emulsifying agent is a "hydrophobe" or "hydrophile" colloid. Sodium and potassium soaps are soluble in both water and oil, but, according to Fischer,¹¹ the soap, when dissolved in water, exists as a hydrated colloid which is not soluble in oil.

Is it always necessary to agitate violently a mixture in order to produce an emulsion? This will depend upon the "aggressiveness" of the emulsifying agent, and oils can be prepared which display such a marked

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¹Bancroft's "Applied Colloid Chemistry."

²Ostwald's "A Handbook of Colloid Chemistry," p. 103.

³Z. Chem. Ind. Koll., vol. 9, p. 209 (1911).

⁴Z. angew. Chem., vol. 31, p. 2138 (1908).

⁵That optical heterogeneity of lubricating oils exists has been demonstrated by Dunstan and Thole (J. Inst. Pet. Tech., vol. 4, p. 191 (1918)), but they find that the degree of dispersion is high.

⁶J. Ind. Eng. Chem., vol. 6, p. 623 (1914).

⁷Unless oils are carefully dried and filtered they will show particles under the ultramicroscope and wrong conclusions as to the true dispersed nature of the product may be drawn.

⁸On modern conceptions of emulsions see Clayton, J. Soc. Chem. Ind., vol. 38, p. 113T (1919). Bancroft's classics on the subject appeared in J. Phys. Chem., vol. 16, pp. 177, 345, 739; vol. 17, p. 501; vol. 19, pp. 275, 513. See also Thomas, J. Ind. Eng. Chem., vol. 12, p. 177 (1920).

⁹Emulsifying agents giving colloidal solutions in water (hydrophiles) are sodium and potassium soaps of oleic acid, and gums such as gum tragacanth. Those giving colloidal solutions in oil (hydrophobes) are soaps of calcium, aluminum, magnesium, etc.; also lamp black.

¹⁰If both emulsions (water in oil and oil in water) are produced, it is reasonable to expect that one will be only temporary.

¹¹Science, vol. 43, p. 468 (1916).

tendency to emulsify that, when they are poured upon water and permitted to stand, an emulsion results.¹²

TYPES OF EMULSIONS

Crude petroleum often comes to the surface emulsified with water; upon standing, a product known as "bottom settlings" collects in the storage tanks. These emulsions may be temporary, semi-permanent or permanent, and it is therefore evident that a method which has proved successful in breaking up one type of emulsion may be wholly unsuited for another. In the case of crude oil the stabilizing or emulsifying agent may be asphaltenes, finely divided clay or dirt, or possibly soaps formed by the interaction of the salts in the water with traces of organic acids in the oil; then, too, the acquirement of electric charges of like sign by the drops of water may produce the effect of an emulsifying agent.¹³ Combinations of the above-mentioned emulsifying or stabilizing agents may be of significance in regard to the stability of oil-field emulsions.¹⁴ Generally, the more viscous an oil the more readily will it hold dispersed material, such as water and earthy matter.

As an example of the variability in character of crude oil emulsions, there may be mentioned a laboratory experience in the case of two crudes, one of 21 deg. Bé., very asphaltic and quite viscous, the other of 27 deg. Bé., less asphaltic and viscous than the first. Both oils were from the same lease, but from different sands, and both contained water in form of emulsion. Upon attempting to distill the first-mentioned oil it was found that the distillation could be carried out without the necessity of adding a solvent to bring over the water, although there was some bumping at the lower temperature where this occurred. In the case of the second oil, however, even after the addition of gasoline, or benzene and toluene, the distillation could not be completed without the oil foaming violently into the condenser when a certain point was reached. Only after diluting the crude with 15 per cent of light gasoline, permitting the mixture to settle, and drawing off the oil above the bottom settlings, was it found that a distillation could be made successfully even though some water was still present. The difference in behavior between the two oils is thought to be due to the presence, in the latter case, of finely divided clay or dirt.

BREAKING AN EMULSION

Many methods of resolving crude oil emulsions have been proposed and the most important may be enumerated as follows: Heating in various ways in open and closed systems; alternating- and direct-current electricity; centrifugal action; filtration, and chemical agents. Filtration through a filter composed of excelsior is advocated by one company which has a patented filter on the market. The writer has not had the opportunity of testing this method with emulsions of various types. The oil proceeds upward through the filter and, according to the claims, there is a considerable break in the emulsion with consequent separation

of B. S. As a chemical method there may be mentioned water-soluble soap, which has a tendency to produce the opposite kind of emulsion from that existing, the effect being to break up the emulsion already formed. Sherrick¹⁵ has been able to discharge a crude oil emulsion by the use of ferric nitrate,¹⁶ having previously made the observation that the drops of water in this particular emulsion were negatively charged. In actual practice it may be found advantageous to utilize combinations of the methods mentioned above. Thus, one company has developed a process which is a combination of closed heating, settling, direct-current electricity and centrifugal action. The writer is of the opinion that most crude oil emulsions may be successfully and economically resolved¹⁷ by means of a closed heating system, properly designed to prevent the loss of volatile constituents; and that the more refractory emulsions will be treated ultimately by a method which is one of mild heating and contact with a substance which is slightly, if at all, consumed. There are also prospects of new electrical processes.¹⁸

The field is not the only place where troublesome emulsions are encountered in the petroleum industry. During the refining of lubricating oils with sulphuric acid, refractory dispersed systems of oil and water are likely to develop in the later stages of the process. In the laboratory it has been found that the formation of emulsions under these circumstances may be minimized if the alkali solution used is concentrated and the agitation is carried out with a hot solution.

EMULSIONS AND LUBRICATION

For general lubrication some engineers prefer an oil which will emulsify with water; but for use in continuous circulating systems, oils which possess sufficiently high resistance to emulsification are essential, since permanent emulsions would cause difficulties in the filtering and settling chambers where the process of purification usually consists only of screening, heating, settling and filtration. The recovery of used lubricating oils, such as those from crankcases, involves the removal of dirt which has accumulated from extraneous sources, colloidal decomposition products due to the more severe heat-treatment of the oil, water in form of rather permanent emulsion, and high ends from the gasoline used as fuel. Therefore the recovery of this type of used oil presents rather more difficulties than in the case of ordinary lubricants used in continuous circulating systems.¹⁹ The production, during refining, of lubricating oils possessing high resistance to emulsification depends to some extent upon the character of the original crude oil, but more particularly upon the proper method of refining.

In plant and laboratory practice, wherever oil and water come into contact, emulsions are likely to be formed which may result in problems of major impor-

¹²In this connection consult the work of Roon and Oesper, *J. Ind. Eng. Chem.*, vol. 9, p. 156 (1917).

¹³See Sherrick, *J. Ind. Eng. Chem.*, vol. 12, p. 133 (1920).

¹⁴Richardson's definition of Trinidad asphalt from a colloidal standpoint will illustrate this: A suspension of relatively large-sized mineral particles in an extremely viscous medium, together with highly dispersed mineral matter in colloidal form intimately mixed with an emulsion of thermal water with the bitumen present. The colloidal mineral matter present has a high adsorption capacity for the bitumen of the asphalt, *J. Phys. Chem.*, vol. 19, p. 245, (1915).

¹⁵Sherrick, *J. Ind. Eng. Chem.*, vol. 12, p. 133 (1920).

¹⁶Ferric chloride solution discharged the emulsion, but also produced jellies which were discharged by sodium nitrate.

¹⁷It may also be practical to study conditions in the well and to devise ways of preventing or minimizing the formation of emulsions as the oil comes from the sand to the storage tank. See McCoy, Shidel and Trager, *Bull., A. I. M. E.*, August, 1919, p. 1513.

¹⁸Other methods proposed for breaking up emulsions in general involve the use of sodium salts of sulphonates; heating under pressure; freezing; filtration through amorphous calcium and magnesium carbonates; various electrolytes, such as acids, aluminum chloride, cupric chloride, barium chloride, etc. The concentration of the electrolyte is of importance.

¹⁹One method is to blow the oil with steam, then to agitate with sodium carbonate solution, or a mixture of sodium carbonate and sodium soap. Final percolation of the dried oil through fuller's earth ought to be advantageous.

tance, but often are but passing incidents of the day. An interesting phenomenon may be mentioned in connection with the operation of absorption gasoline plants. An investigation of slight discrepancies in determining the gravity of the charged absorbing oil disclosed the fact that the rapidity with which the sample was collected from the high-pressure oil-line effected the apparent gravity of the sample, due to the formation of an emulsion between the oil and a small quantity of water generally present. The rapidly drawn sample possessed the lowest apparent Baumé gravity, and this was also lower than that of the oil on its way from the vent tank to the still, for the reason that a large proportion of the water in the vented oil had been relinquished at the vent tank.

Another incident, reported by J. D. Underwood, may be noted in passing. An undesirable emulsified product was being produced from the water-trap attached to the expansion box of a steam-still, and was collecting in the separatory basins. Experiments with the product developed the fact that a small quantity of silt was present, probably acting as an emulsifying agent. The temperature in the expansion box was controlled by a direct spray of water in the auxiliary tower and the silt in the emulsified product no doubt originated from this source. Cleaner water used as a spray probably would have obviated the difficulty.

EMULSION PRODUCTS

In the preparation of certain petroleum products it is necessary to compound mixtures which will produce with water emulsions of a high degree of permanency. Examples are emulsifiable cutting oil (sometimes containing emulsifying agents in the form of phenolates, sulphonated castor oil or soaps), used for the lubrication of the cutting edges of tools; and spraying mixtures for trees, which have been prepared by the use of emulsifying agents in the form of water-soluble soaps, also finely divided basic copper and iron sulphates.¹⁹ Detergent soaps²⁰ with a petroleum base may be compounded by dispersing mineral oil in a mixture of water and soap, stabilized by means of a suitable fourth substance. The resulting product, which is of a semi-solid consistency, when properly used, produces a lather which carries away the main portion of the oil. Products of this character combine the detergent action of ordinary soap with the solvent action of the oil. Cup grease, which is one type of lubricating grease, is manufactured by dispersing a calcium or other soap in mineral oil, and adding a small quantity of water which becomes emulsified in the oil. The addition of the water increases the consistency of the product and assists in preventing the separation of the soap in time.

EFFECT OF DISTILLATION ON AMORPHOUS WAX

The crystallization of paraffin in petroleum distillates is a subject which has always been of practical importance in petroleum refining. In the manufacture of lubricating oils from distillates containing paraffin wax, it is often customary to redistill the fraction rapidly, utilizing little or no steam, in order to produce a distillate which, when cooled, will precipitate paraffin crystals of sufficient size to permit rapid and efficient pressing, and yielding a "slack wax" which will "sweat" to the best advantage. In the parlance of the industry

this is known as "cracking the wax distillate." One explanation of why "cracking" gives a better wax is that the paraffin hydrocarbons exist as "amorphous wax" and are changed in molecular structure by cracking to "crystalline" wax. The other explanation is that upon "cracking" the viscous liquid components of the oil are altered sufficiently to permit the formation of larger crystals when the distillate is cooled. Experiments by one investigator may be cited in this connection.²¹ Natural petrolatum was partly distilled in steam and the distillate and residue examined microscopically. The crystals in the distillate were much more pronounced than in the residue; and when the distillate was melted with the residue it was found that the mixture possessed the same physical properties, and that the appearance of the mass under the microscope was identical with the original product before distillation.²² The conclusion is drawn that the crystal size is influenced materially by the viscous, non-crystalline components of the oil, and that distilling off part of the oil is equivalent to removal of heavy lubricating oil. If this always is entirely true in regard to the crystallization of paraffin in mineral oil residues and distillates, then the subject is mainly colloidal. Bergel²³ and also Fuchs²⁴ have carried out investigations which seem to be fair checks of the work of Gurwitsch, although there is still work to be done on this subject. What, for example, will be the comparative crystal sizes of paraffins of different molecular weight in the same heavy oil?

Petrolatum, which is a refined residual from paraffinaceous petroleum, may be defined from the colloidal point of view as being composed of paraffins in dispersed form in a viscous hydrocarbon medium, the latter inhibiting the deposition of paraffin. Artificial petrolatum, manufactured by adding paraffin to heavy oil, often develops a tendency to deposit the paraffin upon standing. Colloidal fuel consists of powdered coal more or less permanently suspended in fuel oil by means of suitable stabilizing agents or "fixateurs," such as soaps or creosote. These products may be prepared of such a consistency that they may be pumped through pipes and burners and may be stored under water. The "germ theory" of lubrication was suggested by Wells and Southcombe²⁵ to account for the fact that increased efficiency in the lubrication of heavy-duty bearings was attained by adding a small proportion of fatty acid to the oil. One action of the fatty acid was to lower the interfacial tension between the oil and metal, resulting in what might be termed increased oiliness. Since some of the fatty acids are colloidal in mineral oil, the idea suggests itself that other colloidal substances added to the oil may have the same effect. In fact, the relation of colloid chemistry to lubrication offers a field of study in which a solution of many of the abstruse problems may result.²⁶

An important application of colloid chemistry to the refining of petroleum distillates is in the use of fullers earth, bauxite, Japanese acid clay and other minerals,

¹⁹See Gurwitsch's "Wissenschaftliche Grundlagen der Erdölbearbeitung," p. 140.

²⁰The addition of a lighter oil, such as kerosene or naphtha, has somewhat the same effect as cracking. Cooling the distillate slowly also promotes the formation of larger crystals.

²¹Petroleum, vol. 14, p. 173 (1918).

²²Petroleum, vol. 14, p. 1281 (1919).

²³J. Soc. Chem. Ind., vol. 39, pp. 51, 60T (1920). The small percentage of fatty acid was more efficient than a much larger proportion of fatty oil.

²⁴In this connection see Dunstan and Thole, J. Inst. Pet. Tech., vol. 4, p. 191 (1918), and Alexander, J. Ind. Eng. Chem., vol. 12, p. 435 (1920).

¹⁹See Pickering, J. Chem. Soc., vol. 91, p. 2001 (1907). An important and interesting paper.

²⁰Reference is had here to that type of oil soap which contains a large proportion (40 per cent or more) of oil.

bone black, and synthetic products of a siliceous nature, as refining agents by percolation. The principal action is adsorption combined with polymerization²⁷. This method of refining offers one of the most promising fields of research at the present time in the direction of search for new and efficient substances, both mineral and synthetic, and their preliminary treatment for the best efficiency in refining. Florida earth has been used more extensively in the past than other fullers earths, but recently new products have been discovered. Death Valley clay, after a special treatment with sulphuric acid, has been found very efficient as a bleaching agent for mineral oils. Some enthusiasts predict that this type of refining agent will eventually replace the use of sulphuric acid.²⁸

The examples given above by no means exhaust the possible list of applications of colloid chemistry to petroleum. Other phenomena—in connection with sulphuric acid treatment, plumbite treatment and several phases of large-scale distillation—might be discussed at some length, but the examples already given are sufficient to indicate the importance of the comparatively new science of colloid chemistry to petroleum and its products.

Edible Oils and Bean Cake in Japan

The Department of Agriculture and Commerce lists 21,304 vegetable oil mills in Japan, employing 28,663 persons. These figures include the vast number of small hand-power mills using primitive crushing methods and scattered through the country districts. Accurate statistics from these mills are practically impossible to obtain. There are about 40 oil mills in Japan of commercial importance. Of these 20 are located in the Kobe consular district. Data concerning the total capacity of the oil mills of Japan are difficult to obtain, owing to their large number and diversity of methods and material, and the further fact that for the smaller mills there are no reliable statistics. The 34 largest mills have a capacity of about 3,570,200 gal. of oil per month. The production of oil for 1918 (the latest figures the Government departments have on the industry), which was a banner year in the industry and the mills were practically working at full capacity, was 547,671 koku (1 koku = 47.6 gal.). The hand mills are operated mainly as side lines during a part of the year by farmers or persons having other occupations. These hand mills consume by far the greater part of the oil-making materials grown in Japan.

The following seeds and nuts are utilized: Rapeseed, perilla, sesame, cotton seed, camellia seed, sasanqua seed, tea seed, wood nuts, kaya nuts, mustard and sumac seeds.

There has been no great increase in the capacity of the plants since that time. The production in 1918 was

Oil	Koku	Oil	Koku
Rape seed.....	150,455	Peanut.....	12,883
Sesame seed.....	18,358	Coconut.....	181,121
Perilla.....	21,514		
Cottonseed.....	16,152	Total.....	547,671
Bean.....	147,188		

It may be noted that the mills as a general thing do not confine their operations to any particular kind of oil, but vary their materials with the demand and the supply of raw materials.

²⁷Thiele (*Petroleum Age*, vol. 7, No. 9, p. 45 (1920) proposes the use of fullers earth as a cracking agent for petroleum oils.

²⁸Recent patents propose that gasoline, especially pyrolytic gasoline, be refined by passing the vapors over fullers earth or other substances of like nature.

Care and Use of the Hygrometer*

The correct use of the hygrometer is of vital importance in the interpretation and consequent regulation of drier conditions. Altered regulation because of a false conception of the conditions present often results in damage to materials in the chambers or kilns. Several basic practices may be suggested for the proper handling of hygrometers.

CONDITIONS UNDER WHICH A HYGROMETER SHOULD BE CALIBRATED

Hygrometers should never be assumed as registering the correct reading until their accuracy has been established.

It is not at all unusual for a thermometer to register a few degrees higher or lower than the true temperature. Each thermometer of a hygrometer should be checked against a standard thermometer of known accuracy over the range of temperature anticipated in its use. Corrections for the several temperatures may thus be determined if inaccuracy exists. Checking should be done with the bulbs of the standard and the tested thermometers close together and in the same medium and temperature of medium. The correction factor for a thermometer at a certain reading being known, it is simple enough to determine the true temperature.

FILLING AND CARE

Hygrometer reservoirs should be filled with pure water only. The open-top type of reservoir is easily filled but the inverted-tube type often presents difficulties. The latter type may be filled if submerged horizontally in a pail of water with the water level slightly above the well opening. Other methods of filling such a tube are by means of a wash bottle or small bent-stem funnel. In any case the body should be dropped below the mouth level.

It is important that the silk or muslin covering of the wet bulb be kept in good condition at all times. At least a small amount of solid material is always left in the meshes after evaporation, and sooner or later such a deposit impedes the transference of moisture. It is because of this that pure or distilled water should always be used in the reservoir and that the wick should frequently be changed.

PLACING THE HYGROMETER

The hygrometer should be placed at the exact points where information as to conditions is desired. Do not place it near a door or a wall, or where it will be subjected to direct radiation from the heating coils, as conditions at these points are probably not representative. To obtain representative conditions take an average of several readings in different parts of the chamber.

TAKING THE READINGS

In reading the wet-bulb thermometer care should be taken that there is sufficient air circulation to give the maximum evaporation rate from the bulb covering. At low temperatures, *i.e.*, up to 120 deg. F., there should be an air velocity of at least fifteen feet per second. At the higher temperatures this rate is not quite so essential. A thorough fanning of the air about the wet bulb is usually required. The lowest wet bulb reading for any air condition is the one desired.

*From U. S. Forest Product Laboratory Technical Notes.

Electric Reduction of Iron Ores

A Discussion of the Comparative Costs for the Commercial Production of Electric Pig Iron in the Shaft and Pit Types of Electric Furnaces and of the Respective Adaptabilities of These Furnaces to Local Conditions

BY H. A. DE FRIES

ELECTRIC pig iron today is produced commercially in two different ways and in two distinct types of furnaces—i.e., in so-called electric pit furnaces and in electric shaft furnaces of the Electro-Metals type. The latter being the best known, it will be discussed first.

REDUCTION OF IRON ORES IN ELECTRIC SHAFT FURNACES

The shaft type of electric furnace resembles in construction the ordinary blast furnace. It is generally designed for three-phase operation with six electrodes, or two-phase Scott connection with eight electrodes. The size mostly in use is three-phase, 3,000 to 4,000 kva., capable of producing from 25 to 30 tons of pig iron per twenty-four hours. The furnace itself and its accessories were fully described by Herlenius in *CHEMICAL & METALLURGICAL ENGINEERING*.¹

This furnace demands for a charge lump ore, and only a limited amount of fine concentrate may be added in crude form, the maximum being 30 per cent. To use a larger percentage of concentrate it is necessary first to agglomerate it.

The reducing agent most commonly employed is charcoal, which is aided by a constant volume of furnace gas circulated through the furnace. It is therefore obvious that the charge be porous. Coke has been used with varying results.

If we assume that the charge contains 60 per cent Fe, approximately 2,600 kw.-hr. is required for producing one ton of pig. About 500 lb. of lime is added for fluxing and as a reducing agent about 1,000 lb. of charcoal is required. The electrode consumption averages 16 lb.

A complete plant capable of producing 7,500 tons of pig per year will cost about \$150,000. Comparative conversion figures for the production of one ton of pig in this type of furnace are given later.

REDUCTION OF IRON ORES IN ELECTRIC PIT FURNACES

As far as the writer is aware, only single-phase and two-phase furnaces of the pit type have produced pig iron commercially. The furnaces have all been constructed on about similar lines and generally consist of a rectangular iron box with open top. This box is lined inside and the hearth is formed by a rammed-in mixture of graphite and tar, which in some instances extends clear to the top. In others the upper part of the furnace is lined with brick. One central electrode of suitable square section serves for the top electrode, whereas the bottom electrode is a graphite block imbedded in the hearth.

These furnaces are generally equipped with one single-phase transformer of from 600 to 1,000 kva. For

larger capacities the two-phase system is used. The low-tension voltage is 50-65-80 volts with full capacity at the lower voltage.

The charge can be either lump ore or all concentrate, or a mixture of the two. Lime is added for fluxing, and charcoal, coke or charcoal mixed with anthracite can be used as reducing agent. The charge is prepared on a platform level with the top of the furnace and is shoveled in continuously. Iron and slag is tapped about every three hours through a common tap hole at the bottom of the hearth. The electrode feed is mechanically regulated by push-button control and as consumed is lowered until its holder is about level with the charge, when a new electrode is inserted. The loss on electrode stumps therefore is low. The furnace itself is cooled on the outside by a waterspray.

The cost of a plant with one 600-kva. unit is about \$25,000, and for each additional unit \$12,000.

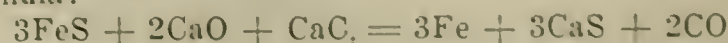
A plant at Porjus, Sweden, is equipped with two single-phase furnaces of this type with 600 kva. each, also one two-phase furnace of 1,800 kva. Here lump ore or concentrate, together with scrap, is used and the average composition of the charge for producing one ton of pig has been as follows:

3,150 lb. of 68 per cent iron ore
555 lb. of scrap
145 lb. of lime
245 lb. of silica
950 lb. of charcoal
300 lb. of coke breeze

The 600-kva. furnace produces from this charge an average of six tons of pig iron per twenty-four hours. This pig will average 3½ to 4 per cent C and 2 per cent Si. The kw.-hr. consumption averages 2,800 and the electrode consumption averages 30 lb.

Another interesting example of the application of electric reduction in pit furnaces are the runs made by Guédras & Duina.² In this instance pig iron was produced from pyrite cinders. They analyzed about 3 per cent SiO₂, 94.3 per cent Fe₂O₃, 2.8 to 3.5 per cent S and contained about 20 to 22 per cent moisture. The cinders are therefore passed through a rotary drier, which at the same time eliminates most of the sulphur and nodulizes the fine particles. The temperature in this roaster is kept at about 1,000 deg. C. The resulting product contains about 0.1 to 0.2 per cent S. This material is charged into a single-phase furnace of 1,000 kva. with 50-volt, 20,000-amp. low tension.

The furnace is constructed as an open-top furnace, with one carbon upper electrode and a graphitized bottom electrode. Lime is added to the charge and the desulphurizing takes place according to the following formula:



¹"Swedish Electric Pig-Iron Furnace," *CHEM. & MET. ENG.*, vol. 24, No. 3, Jan. 19, 1921, pp. 108-112. See also Baron Gerard de Geer, "Electric Smelting of Pig Iron at Domnarfvet, Sweden," *CHEM. & MET. ENG.*, vol. 24, No. 10, March 9, 1921, pp. 429-433.

²*La Technique Moderne*, July, 1920. See also *CHEM. & MET. ENG.*, Oct. 20, 1920, p. 795.

The carbon necessary for reduction was 450 lb. and can be added in form of coke, charcoal or as a mixture of charcoal and anthracite.

The heat balance sheet as given by Guédras & Duina is interesting:

	Cal.
Reduction of 930 kg. Fe = 930×1887	1,754,910
Reduction of 10 kg. Si = $10 \times 7,830$	78,300
Reduction of 5 kg. Mn = 5×1730	8,650
Evaporation of 165 kg. H ₂ O = 165×1549	255,585
Sensible heat in 1,000 kg. iron = 1000×300	300,000
Sensible heat in 400 kg. slag = 400×500	200,000
Losses through radiation, gases, conductors.....	259,744
Total.....	2,857,189
Against	
Heat of 212 kg. C = 212×8133	1,724,916
Heat supplied by electricity.....	1,132,273
Total.....	2,857,189

By analyzing this balance sheet it is seen that the heat of evaporation (1,549 calories) is figured for about 2,000 deg. C.³ The heat of carbon is calculated, it being entirely burned to CO₂.

We may roughly reconstruct this heat balance sheet, using Richards' figures, and then would have the following:

Heat distribution:	Cal.
Reduction Fe, 930×1746	1,623,780
Reduction Si, 10×7000	70,000
Reduction Mn, 5×1653	8,265
Evaporation H ₂ O, 165×606.5	99,073
Sensible heat in iron, 1000×400	400,000
Sensible heat in slag, 400×600	240,000
Losses.....	259,744
Total.....	2,700,862
Heat available:	
Assume charge will give up about 410 kg.	Cal.
Oxidation of C to CO = 212×2430	515,516
Oxidation of CO to CO ₂ = 223×2430	541,890
Heat of slag formation and Fe ₃ C, etc.....	60,000
Heat supplied by electricity.....	1,583,456
Total.....	2,700,862

The first balance sheet shows a requirement of $1,132,273 \div 846$, or 1,340 kw.-hr. per 1,000 kg. of pig iron; the second $1,583,456 \div 846$, or 1,870 kw.-hr. With single-phase furnaces $\cos \phi$ is generally 0.7. The actual requirement would, therefore, be 1,900 and 2,670 kw.-hr. respectively. In actual practice an average of 2,200 kw.-hr. per ton was consumed.⁴ The resulting pig iron contained from 0.01 to 0.3 per cent S. Electrode consumption was about 30 lb.

In operating electric pit furnaces slag should be based on SiO₂.2CaO, and if it is necessary to reduce its melting point some Al₂O₃ is added, the degree then being based on SiO₂.Al₂O₃.2CaO.

COMPARISON OF PRODUCTION COST PER TON OF PIG IRON IN SHAFT AND PIT FURNACES

In order to compare the two methods of producing pig iron electrically we will base our estimate on the results obtained abroad, but will modify these to suit American conditions. A comparative conversion table for shaft furnaces as well as pit furnaces will then appear about as shown in Table I.

It will thus be seen that the price of power is the principal item entering into the manufacture of electric pig iron. At today's prices for charcoal iron, about \$25 per hp.-yr. would be the limit for the eastern and central parts of the country. Conditions in the western part, and especially in the Pacific States, however, are much more favorable. From the table it will be seen that the cost of production varies only slightly whether

TABLE I. COMPARISON OF PRODUCTION COST PER TON OF PIG

Assumed: Cost of power, \$25 per hp.-yr. Lump ore or sintered concentrates, \$5 per ton. Crude concentrates, \$4 per ton. Carbon electrodes, \$8 per 100 lb. Lime, \$1.50 per ton. Charcoal, \$12 per ton. Labor, 75c. per hour. 60 per cent Fe in charge. Amortization and interest spread over ten years.

Electric Shaft Furnace, 3,000 kva.		Pit Furnace, Single Phase, 600 kva.	
Power, 2,600 kw.-hr.	\$9 10	2,800 kw.-hr.	\$9.80
Ore, 3,300 lb. @ \$5.	7.40	3,300 lb. @ \$4.	5.90
Charcoal, 1,000 lb.	6.00	1,200 lb.	7.20
Electrodes, 15 lb.	1 20	30 lb.	2.40
Lime, 500 lb.	37	200 lb.	.15
Labor, operation.	2 65	Operation.	6.00
Repair gang.	40		
Furnace repair.	10		.80
Miscellaneous power for auxiliaries, etc.	2 20		
Amortization and interest..	3.00		1.75
Total, per ton of pig.	*\$32 42		\$34.00
Yearly production per furnace	7,500 tons		2,000 tons
Plant investment.....	\$150,000.00		\$25,000.00
Plant investment per year ton of pig..	\$20.00		\$12.50

*3,000-kva. furnaces supply enough gas to fire one 10 to 15-ton open hearth; value of this gas is, therefore, about \$1 per ton of pig produced, so that the above net cost is \$31 42.

the iron is produced in a shaft furnace or a pit furnace. The difference in plant investment, however, is considerable, even if it takes three single-phase furnaces to equal the output of one shaft furnace. The cost of the shaft-furnace plant was given at \$150,000, whereas a plant with three pit furnaces would cost only \$50,000, or one-third. The labor cost may seem high for a one-unit pit furnace plant, but with three of these furnaces installed under the same roof it will approach the labor cost given for the shaft furnace. From a central station point of view, the shaft furnace will be more acceptable than the single-phase furnace and most power companies may object to a large single-phase load. This objectionable feature could be somewhat remedied by installing two or three furnaces on the same line.

However, the main advantage the pit furnace has over the shaft type is its adaptability to all kinds of ores, whether lump or concentrates, or both mixed.

This feature may be of utmost importance for working magnetite and other concentrates direct without previous sintering, and a possibility may exist even of reducing in them the concentrates from the black sands which are found so abundantly on the shores of the Pacific States. These sands as a rule carry considerable TiO₂. How far this can be removed by concentration or what influence it has during reduction the writer is unable to state. I believe, however, that 2 per cent TiO₂ in the concentrates would have little influence in the operation. It would be worth while to experiment with them in a small unit of, say, 150 kva. If such experiments should prove successful, they not only would make available a considerable new supply of iron, but there may also exist the possibility of retaining some of the Ti in the pig, which may make it more valuable for certain purposes.

ADAPTABILITY OF SHAFT AND PIT TYPES OF ELECTRIC FURNACES

In the production of electric pig iron, we have to consider two alternates:

First, if lumpy ore and sintered concentrates are available, a large unit plant is desired, the demands of the central station are strict and capital expenditure is of secondary nature, the electric shaft furnace should be employed.

On the other hand, if only crude concentrates are available, or the plant depends on a varying ore supply, no objections being raised against single-phase loads, and capital expenditure has to be limited, then the pit furnaces apparently possess considerable advantages over the shaft type.

³Heat content of H₂O vapor at 2,000 deg. C.

⁴As Richards has stated: "In properly designed furnaces the gases passing out may contain nearly equal volumes of CO and CO₂, instead of as shown. Any greater utilization of the heat-producing power of the carbon will naturally decrease the electrical energy required." This evidently is the fact with the pit furnace.

Hardwood-Distillation Industry—II

Influence of Temperature and Speed of Distillation on the Amount and Nature of the Distillates. With a Brief Review of the Crude Products Obtained by the Destructive Distillation of Wood*

BY L. F. HAWLEY†

ONE of the first questions to be asked in connection with wood-distillation is naturally in regard to the temperature at which wood begins to distill. This, unfortunately, is a subject on which much misinformation is still in circulation, owing largely to the fact that certain figures published nearly seventy years ago have been copied and recopied from one book to another until the original article has been lost track of and the methods used in obtaining the figures have been forgotten. Most articles on wood-distillation include tables showing the loss in weight of wood when heated to different temperatures. These tables are usually ascribed to Violette, but the original article is never cited and the method by which Violette obtained his figures is never described. Violette's table shows that there is a gradual increase in the loss in weight of wood with increase in temperature to which it is subjected. The point at which the drying of the wood ceases and the destructive distillation begins being arbitrarily taken as 150 deg. C., there is no break in the curve except a very slight one at about 260 deg. C. Although information has been available for some time to show that these figures are wrong, yet each new book or article on wood-distillation includes Violette's original table as showing the effect of temperature on wood.

RELATION BETWEEN TEMPERATURE AND DECOMPOSITION OF WOOD SUBSTANCE

Probably the first correct figures published on the relation between temperature and decomposition of wood substance were by Chorley and Ramsay.¹ These results indicated that there was very slight decomposition of wood below a temperature of about 270 deg. C., but that at this point the decomposition was very rapid and in fact the reaction became exothermic. These figures remained unnoticed for some time; but in 1907 Klason² and his co-workers repeated the experiments more accurately and in more detail, showing definitely the exothermic reaction and computing the amount of heat given off by this reaction.

In the case of an exothermic reaction such as this, it would not be possible to obtain a gradual decomposition with increase in temperature, as shown by Violette, since the decomposition would become very rapid at about 270 deg. C. In an endeavor to explain this discrepancy the original article³ was consulted and a satisfactory explanation obtained. The figures re-

ported by him were obtained with wood in very small cylindrical blocks about $\frac{1}{2}$ x $1\frac{1}{2}$ in. heated by a rapid current of superheated steam in direct contact with the wood, and the temperatures measured at the outlet from the retort. Experiments in distilling wood in a vacuum have shown that no exothermic heat is noticed under these conditions, and as the rapid passage of a current of superheated steam has exactly the same effect as a vacuum distillation, in so far as the rapid removal of the products from the retort is concerned, no exothermic reaction should be expected under conditions such as were present during Violette's distillations. It is hoped that Violette's figures will not be quoted again as representing the effect of temperature on wood as ordinarily heated, but that the correct and recent figures of Klason may be used instead.

There is, of course, a certain amount of decomposition of wood below 270 deg. C., but this is very slow



RETORT HOUSE, COOLERS AND CHARCOAL SHEDS
AT PLANT OF THE CLIFFS CHEMICAL CO.,
GOODMAN, WIS.

and the products given off are mostly carbon dioxide and water. At about 270 the exothermic reaction begins and the decomposition of wood into its ordinary distillation products is completed without further addition of heat. If the residual charcoal is heated to still higher temperatures it comes nearer and nearer to being pure carbon; but the volatile products given off are mostly tar and gas, and only traces of methanol and acetic acid are obtained.

Klason, who made the first measurements of the heat of the exothermic reaction, has also offered the first partial explanation of the heat given off at this

*For Part I see CHEM. & MET. ENG., vol. 25, No. 4, July 27, 1921, pp. 137 to 140.

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¹J. Soc. Chem. Ind., vol. 11, p. 395 (1892).

²"Arkiv för Kemi, Mineralogi och Geologi, 1907," Z. angew. Chemie, vol. 25, p. 1205 (1909), and vol. 27, p. 1252 (1910).

³Ann. chim. phys. 3me serie, vol. 32, p. 304 (1853), and vol. 39, p. 291 (1855).

period.⁷ By distilling wood under very low pressure and at a carefully regulated temperature, it was found possible to complete the distillation without obtaining an exothermic reaction. The products of this slow decomposition were, however, different from the original products, in that over 40 per cent of the weight consisted of a transparent red oil and much less gas and charcoal than usual were formed. This red oil when heated to about 275 deg. C. decomposed exothermically, forming considerable quantities of gas, water, a black tar similar to ordinary hardwood tar, and coke. This indicates that the first decomposition of wood by heat is not exothermic, but that some of the primary products of the distillation decompose exothermically. In any kind of practical process, however, this distinction between primary and secondary reactions is not applicable, and it may be correctly considered that wood-distillation is an exothermic reaction.

TEMPERATURE CONTROL

Temperature control, as a means of increasing the yields of methanol and acid, has always been a subject of great interest in the wood-distillation industry. Many



STANDARD CHARCOAL COOLERS

years ago Senfft⁸ published some figures which showed the effect of charging the wood into a red-hot retort as compared with starting from a cold retort. In nearly all cases the distillation in the red-hot retort resulted in a higher yield of gas and a lower yield of charcoal, tar and acid. Unfortunately the methanol determinations were not made in this study. It has been a general opinion among the distillation-plant operators that considerably higher yields could be obtained by a long, slow distillation of thirty-six hours than by the ordinary twenty-four-hour period.

Palmer's work on temperature control⁹ showed that it was possible to increase the yields of both acid and methanol by a careful regulation of the firing of the retorts, which was accomplished by watching the temperature of the vapors coming from the retort and the composition of the distillate as noticed at the mouth of the condenser. By heating rapidly at the beginning of the distillation and then checking the fire at just the right time, so as not to have the temperature carried too high by the exothermic reaction, he found it possible to complete the distillation in the usual period and still obtain an increase in yields. This seemed to check the prevailing opinion that slow distillations gave high yields and fast distillation low yields.

This opinion is undoubtedly correct under the conditions of large-scale distillations and considerable

super-heating of the walls of the retort. It has been shown, however, by Klason in the article previously mentioned, that this opinion is not correct in connection with small-scale distillations. Klason distilled wood in small glass apparatus under conditions varying from a 3-hour distillation under the highest possible vacuum to a 14-day distillation at ordinary pressures. From the results of this series of distillations it was possible to decide with considerable accuracy which products were primary products of the first decomposition of the wood by heat and which were secondary products obtained by decomposition or interaction of the primary products. It was found that methanol and acetic acid were both primary products and that their yields did not vary appreciably when varying the conditions of distillation. The speed of distillation, therefore, has no effect on the yields of methanol and acetic acid.

DISTINCTION BETWEEN EXPERIMENTAL AND COMMERCIAL DISTILLATION PRACTICE

At first glance it may seem difficult to harmonize Klason's results with the opinion commonly held in commercial operations, that high speed of distillation gives low yields of methanol and acid. We believe, however, that these apparently opposite views can be reconciled. The experimental work of Klason was carried out in very small-scale apparatus, only about 9 g. of wood being used in some of the experiments. In a case like this, rapid distillation, such as a complete distillation in three to four hours, can be obtained without any very great superheating of the walls of the containing vessels—that is, the walls of the vessel may have been only 5 to 10 deg. higher than the reaction temperature, a difference which is not sufficient to produce secondary reactions. In commercial practice, on the other hand, the cross-section of the distillation vessel is very large, and in order to finish a distillation even in twenty-four hours it is necessary that the walls of the retort during much of the distillation be heated 100 or 200 deg. higher than the reaction temperature. This means that, in commercial apparatus, high speed of distillation is obtained only by greatly increased temperature of the walls of the retort and the super-heating of the walls of the retort is sufficient to produce secondary reactions.

INFLUENCE OF THE SPEED OF DISTILLATION

Klason found that slow distillation produced more secondary reactions, since the vapors remained in the retort for a greater length of time than they do in rapid distillation. In this case the slight increase in temperature of the containing vessel in order to obtain rapid distillation does not have so much effect on the secondary reactions as the length of time which the vapors remain in the retort. He also showed that within certain limits and certain conditions of distillation it is impossible to vary the yields of methanol and acid appreciably by variation of the speed of the reaction or the pressure at which it is carried on. This does not mean, however, that there is not still a chance to obtain increased yields in commercial practice by temperature control, since present commercial plants obtain only about two-thirds of the acetic acid which can be obtained in medium-sized apparatus. Many carefully managed commercial plants obtain the apparent full yields of methanol, so that temperature control does not offer much in connection with this product.

⁷J. Prakt. Chem. (2), vol. 90, p. 413 (1914).

⁸Ber., vol. 18, p. 60.

⁹J. Ind. Eng. Chem., vol. 7, p. 633 (1915).

It has been frequently noticed that wood continuously subjected to medium-high temperatures, such as the temperatures of steam pipes containing steam under low pressure, will slowly darken and finally become a true charcoal. A commercial process was at one time developed for obtaining acetic acid from wood at temperatures below the exothermic reaction; but this was a very slow process requiring careful temperature control, and besides it gave different proportions of methanol and tar. It is apparently possible, therefore, to obtain the effects of high temperature on wood by long subjecting to lower temperatures; but this is of no importance in connection with commercial wood-distillation, which must be completed within a practical time limit.

CRUDE PRODUCTS OF THE DESTRUCTIVE DISTILLATION OF WOOD

From what has been said previously in regard to the complexity of the composition of wood and the character of the decomposition which takes place with heat, it might be expected that the chemical reaction of the decomposition would be very complex and that the products would be numerous. This supposition is correct as regards the various chemical constituents of the products, but the crude products as described in the terms used in the industry are not numerous and the general conception of the chemical composition of these crude products is not very complex. The crude products are: charcoal, vapors (pyroligneous acid and tar) and gas.

CHARCOAL

The charcoal which is left behind in the retort is usually thought of as carbon, and since this charcoal is a finished commercial product, its chemical composition is not considered important. It may be considered as being a very complex hydrocarbon, varying in composition between the extremes of wood on one hand and pure carbon on the other, depending on the temperature to which it has been heated. The commercial product usually still contains as high as 25 per cent of volatile matter. A new conception of ordinary charcoal is given by Klason, who considers it as consisting of a primary charcoal plus a secondary deposit of tar coke.

The charcoal as drawn from the retorts needs only to be cooled in order to render it safe for shipment or storage as a marketable product. In ordinary commercial practice it is cooled for forty-eight hours in coolers and then left for twenty-four hours in the open air.

Even with this cooling and air-seasoning, spontaneous combustion will sometimes take place in the charcoal. It is quite certain that this combustion is not caused by incomplete cooling or by sparks or brands which remain in the coal but by incomplete saturation of the charcoal with the gases of the air, so that with further absorption of these gases comes a slight increase in temperature, which in large amounts of charcoal may be sufficient to start combustion. The detailed mechanism of this spontaneous combustion has not been worked out and no clear theory has been developed.

CRUDE VAPORS (PYROLIGNEOUS ACID AND TAR)

The chemically valuable products of wood-distillation are contained in the crude vapors which after condensation separate into two layers: tar underneath and crude pyroligneous acid on top. Gravity and solubility are not sufficient for the complete separation of these two products, and some of the constituents of the tar are found in the pyroligneous acid and *vice versa*. Their

complete separation can be realized by fractional distillations.

The pyroligneous acid consists largely of water, but methanol, acetic acid and dissolved tar are also among the main constituents. The presence of acetic acid and methanol seems to make certain constituents of tar soluble in pyroligneous acid which are not soluble in pure water. The tar which is soluble in pyroligneous acid has a very different composition from the insoluble tar and consists largely of a non-volatile pitch containing only a small amount of oil. Many of the tar constituents, especially the acids and esters, are also present in the pyroligneous acid.

There are many other products occurring in the pyroligneous acid in small amounts which have not been identified and which are recognized only by their effect on the refining process. For instance, when the pyroligneous acid is distilled in order to separate it from the dissolved tar, it is obtained as a light-colored liquid which, having just been distilled, must contain only volatile products. Yet when the distilled pyroligneous acid is neutralized with lime and the solution evaporated, considerable amounts of non-volatile tarry material are left behind with the acetate of lime. This tarry impurity in the acetate of lime must come from



CHARCOAL GOING FROM FIRST TO SECOND COOLER

volatile constituents of the pyroligneous acid which have been decomposed or polymerized by the addition of lime. Small quantities of oils also remain dissolved in the pyroligneous acid until it has been neutralized and distilled. These oils have been separated out from the distillate and at some plants are known as primary oils or lime-lee oils. They are the most valuable raw material for making beechwood creosote.

The tar obtained in the distillation of hardwood was used as fuel without further treatment until a few years ago; but now it is common practice to distill it with steam in order to remove the acid and methanol contained in it. This process has been fully discussed in a recent publication.¹⁰

The separation of the chemically valuable products from pyroligneous acid and tar will be discussed in a subsequent issue.

WOOD GAS

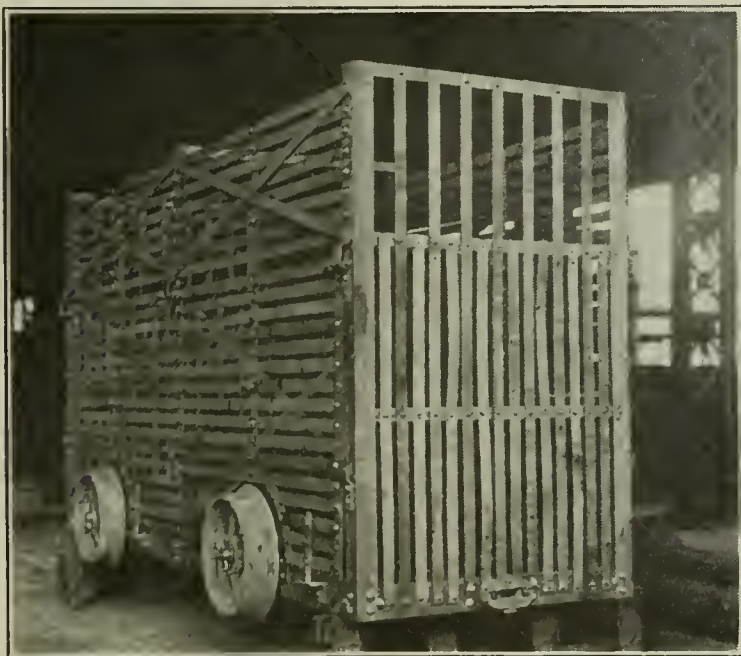
The gas which is formed during the distillation of the wood has a low heating power and is ordinarily used for

¹⁰J. Ind. Eng. Chem., vol. 12, p. 684 (1920).

fuel at the plant. It contains large quantities of carbon dioxide, which accounts largely for its low heating power. Carbon monoxide and methane are the main combustible constituents, and it seems very likely that other gases which have been found in small quantities, such as hydrogen and ethylene, are obtained only as secondary products when the temperature of distillation is very high.

It has long been recognized that certain valuable products are lost in the wood gas which passes from the condensers, but there seems to be some general misunderstanding in regard to what these products may be, in what form they are lost, and by what process they may be recovered.

The first source of loss at this point is the mechanical carrying over of drops of liquid in the form of a fog or mist. This is not caused by incomplete cooling, since the fog will persist even when the condensers are working properly and the gas is well cooled. Apparently the loss in the form of fog cannot be avoided where considerable quantities of non-condensable gas pass through the condensers. The other source of loss in the gas is the vaporizing of the low-boiling constituents, which



24-CORD CHARCOAL BUGGY

will be carried off in the gas to some extent, however low the temperature of the condenser may be. The amount of the various liquid constituents therein will depend on their volatility and on the relation between the amounts of gas and volatile liquid. That is, as might be expected, the most volatile constituents are the ones which are lost in greatest proportions, and since they are among the most valuable constituents in wood-distillation, the loss from this source may be of serious consequence. Methanol, methyl acetate and acetone will be the main products lost in this way, since they not only have low boiling points but also form constant boiling mixtures with lower boiling points than the pure products themselves.

USE OF THE COTTRELL PRECIPITATOR FOR THE SEPARATION OF THE FOG IN WOOD GAS

The loss due to mechanically carried over drops of liquid in the form of a fog or mist can be partly stopped by the use of gas scrubbers in which the gas is subjected to the action of a liquid such as water. Washing a gas with water may still leave a part of this fog unprecipitated, and the best method for stopping such losses is by means of the Cottrell precipitator.

An unpublished report by the Research Corporation shows that a Cottrell precipitator on the gas line beyond the condenser will completely stop this fog, with the recovery of the products otherwise lost in this form. The amount of the material precipitated by the Cottrell process amounts to only about 1.7 per cent of the total distillate obtained at the condenser, and the proportion of valuable products in the recovered fog is slightly different from that in the condensate. The proportion of tar to pyroligneous acid is about the same, but there is a little less methanol in the pyroligneous acid from the precipitator than in that from the condenser.

During the period of high prices of acetate and methanol a few years ago it would have apparently been a profitable investment to install a Cottrell precipitator for the recovery of this material, but at present price it would not be a favorable investment.

USE OF SCRUBBERS FOR THE RECOVERY OF THE LOW BOILING CONSTITUENTS CARRIED OFF BY THE WOOD GAS

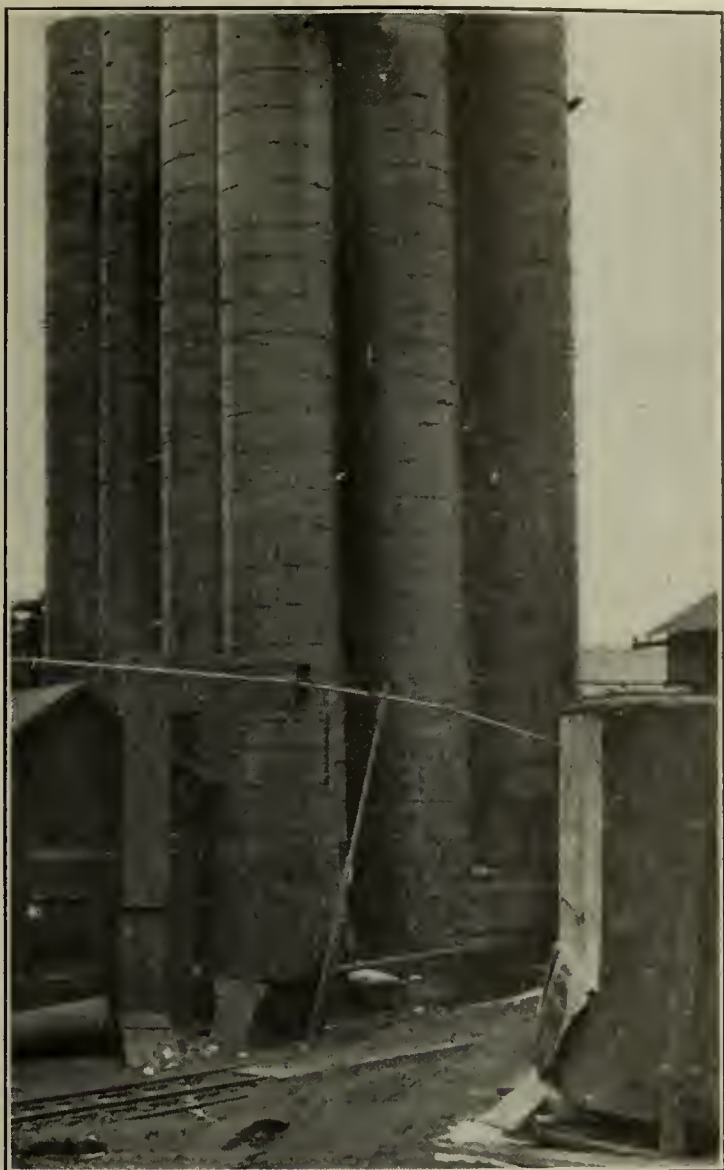
The loss of the vapors of low-boiling constituents carried off by the wood gas can be controlled to a certain extent by a lower temperature of the condenser water, but there is a limit to the recovery by this method. The only other method is a treatment of the gas with some liquid in which the volatile products are soluble and which will reduce their vapor pressure. Water would naturally be the scrubbing liquid to be used, since it is convenient and the volatile products are soluble in it.

The amount of the products which can be recovered by scrubbing with water depends upon the amount of water and the efficiency with which it is used. With large amounts of water, with complete contact between the water and the gas, and with the water and gas moving in opposite directions, it is possible to make a practically complete recovery of the vaporized products in the gas. There is a limit, however, below which the complete recovery would be impractical, since too large amounts of water would be required and the recovery from the water would be too expensive.

The kiln plants at one time in common use in northern Michigan and Wisconsin had a much larger proportion of gas than the retort plants, since large amounts of air were admitted to the kiln during the burning process. The residual nitrogen of the air and the products of combustion are, therefore, added to the normal amount of gas obtained from the distillation of the wood. Most of these kiln plants had some sort of gas-scrubbing apparatus, but it was usually small in size, and frequently pyroligneous acid was used for the scrubbing material instead of pure water. This was wrong in theory, since the gas was being washed by some of the liquid with which it was already in equilibrium, and it could not be expected that any more of the vapors in the gas could be removed by means of the liquid with which the gas had just been in contact. In some cases the first fraction from the central condensing system was used for the scrubber, and this naturally held somewhat less of the low-boiling constituents than the last fractions. This was a step in the right direction, but pure water would have been much better.

We do not know of any place where scrubbers are now used in retort or oven plants, but some interesting applications of this principle have recently been made at some of the old kiln plants. Special scrubbing towers with fresh water as scrubbing material have been

installed, and liberal amounts of water have been used to wash the gas. It is claimed that increased yields of methanol amounting to as much as 3 gal. per cord have been obtained by the use of these tower scrubbers. This is not all pure gain, since the liquor from the scrubbers contains only a small percentage of methanol, and large amounts of liquor must be handled in order to secure this increased yield. By means of a special still it is possible to recover that liquor in partly concen-



GAS-SCRUBBING TOWERS BUILT OF WOOD STAVE-PIPE, FILLED WITH BRUSH PACKING

trated form without actually distilling a very large portion of the scrubber liquors, and at small cost.

In view of these increased yields obtained with a gas scrubber at a kiln plant, it seems as if similar results might be obtained by applying this principle to the modern oven plants. Although there is a higher proportion of gas from the kiln plant, yet the concentration of the more volatile products is greater in the liquor from the oven plant, and the proportion of the total product lost in the gas might be as great in the latter as in the former. The application of this principle is, however, much simpler in the kiln plant, since here a central condenser system is used and all the gases are naturally collected at one place.

It has been reported that gas scrubbers have been used at oven plants, but that explosions occurred in them, and they were finally given up. There is, of course, danger of explosion with gas scrubbers when air is allowed to mix with the gas in proper proportions to form an explosive mixture, but ordinary care in the design and operation of the apparatus should obviate this danger.

Part III will be published in a subsequent issue.

Antimony in 1920

Except for the antimony in hard lead, no antimony has been produced in the United States from domestic ores since 1918, according to Frank C. Schrader, United States Geological Survey. This situation, however, is not considered altogether unfortunate, as our meager supply of ore may thus be kept for a time when we will need it, perhaps as urgently as we did during the World War.

Hard lead carrying about 14 per cent of antimony is a byproduct of the smelting of the precious metals, and the quantity of hard lead produced in 1920, which was 12,535 short tons, carried 2,033 tons of antimony and was obtained from both domestic and foreign ores. A small quantity of metallic antimony was produced by one smelter from both foreign and domestic ores, and about 5,000 tons of secondary antimony was recovered from old alloys, scrap, and dross.

The average price of antimony in 1920 was 8.49c. a pound. The highest price, which was reached in February and March, was 11½c., but owing to large imports and heavy offerings of war scrap and shrapnel by several governments, the price fell in December to 5½c., the lowest in more than six years.

The imports for consumption, calculated in terms of metallic antimony, were 11,768 short tons, as compared with 7,867 tons in 1919. Their value was \$1,435,823. They consisted of 1,709 tons of 40 per cent ore, 1,375 tons of 75 per cent matte, 9,817 tons of metallic antimony, and 298 tons of 80 per cent antimony oxides and other compounds.

The general imports were 12,474 tons of antimony and 1,709 tons of ore containing 682 tons of antimony. They showed an increase of about 76 per cent as compared with those of 1919. The metal came mostly from China and Japan and the ore from China, France and Bolivia. The imports of metal from China increased 175 per cent over those of 1919.

The imports of type metal were 14,944 short tons, or more than twice those of 1919. Their antimony content was assumed to be 2,063 tons, or about 14 per cent.

The exports of foreign antimony from the United States in 1920, mainly to Canada, amounted to 448 tons, more than double those of 1919.

About 1,877 short tons of antimony was in bond in December, 1920, as compared with 1,200 tons for December, 1919.

The world's production of antimony in 1920 was about 14,000 metric tons, as compared with 11,900 tons in 1919. Nearly all of it was produced in China, Mexico, and France. For several years China has produced more than 60 per cent of the world's supply.

The world's average annual peace-time consumption of antimony, not including that in antimonial lead, is about 22,000 metric tons, of which the United States consumes 7,000 tons. The United States also uses annually about 2,100 tons of virgin antimony contained in domestic antimonial lead and 3,500 tons of secondary antimony recovered from old alloys, scrap, and dross, a total of 12,600 tons.

Metallic antimony is used chiefly in alloys, such as type metal, Babbitt or bearing metal, Britannia or white metal, and antimonial or hard lead. Antimony oxides are used for making white enamel, and both oxides and sulphides are used as coloring agents and pigments.

A copy of the report may be obtained from the Director of the U. S. Geological Survey, Washington, D. C.

Heat Balance of a Blast-Furnace Stove

Careful Tests by Improved Methods of a Two-Pass Side Combustion Stove at the Lackawanna Steel Co.
—Net Efficiency Found to Be 62 Per Cent—Volume of Blast Computed From Carbon
Balance, and Volume of Gas From Its Analysis, Fresh and Diluted

By D. W. WILSON*

IN THE first full year, 1920, of its operation, the School of Chemical Engineering Practice of the Massachusetts Institute of Technology has located one of its industrial stations in Buffalo at the plants of the Larkin Co. and the Lackawanna Steel Co. The experimental work forming the basis for this article was performed at the latter plant by the students enrolled in this course during 1920. Three separate tests, the last of which is given in detail here, were carried out by as many groups of students on the same blast-furnace stove, but under slightly varying conditions. The interest and enthusiasm of all the students in this work was very inspiring, and it is desired to acknowledge here the able assistance rendered by A. J. Hartsook, L. Weinberg and H. R. Couch, leaders respectively of the first, second and third groups of students performing this test.

PURPOSE OF THE TESTS

Necessarily, in this work the purpose was twofold: (1) From the students' point of view to illustrate the practical use of thermocouples and other temperature-measuring devices, as well as methods for measuring gas volumes under somewhat unusual conditions, and, further, to show the method of calculating the data obtained in this way to indicate the heat efficiency of a large gas-fired furnace: (2) from the technical standpoint—that is, the value of the results of the experimental work in and of themselves—the endeavor was made to carry out a complete and careful heat balance on a modern, well-designed blast-furnace stove, and inasmuch as tests had not previously been carried out on this installation, figures showing the utilization of heat are of considerable interest, since by comparison with other stoves of the same type it is possible to determine the relative efficiency of design, construction and operation.

TYPE OF STOVE AND ACCESSORIES

The stove itself consists of a vertical cylindrical steel shell lined with firebrick, 22 ft. in diameter by 110 ft. in height. Inside the firebrick lining it is divided into two vertical parts, one elliptical in cross-section and extending the entire height of the stove, through which space the gas is burned for heating, and the other, also running the entire height and occupying the remainder of the space, filled with firebrick laid so as to give a large number of parallel flues through which the gas must pass. This is the so-called two-pass side-combustion stove. It is equipped with two chimney valves, only one of which was in use. Gas passes through a suitable burner into the elliptical space, burns up

through it, and the burned gas passes down through the parallel flues and out to the stack, while in heating the air blast the flow of air is counter-current. The operation is necessarily an intermittent one in which the time ratio of heating and cooling a given stove is three to one, since four stoves are in use.

The gas used in this installation was cooled and cleaned before burning by a system of dry dust catchers followed by scrubbing with water. Natural draft only was used in the combustion of the gas and in taking care of the burned gases. The stove was in excellent condition, it having been in constant operation on clean gas about three years.

DESIGN OF TESTS

The tests, consisting as they did of balancing heat input against heat output, involved primarily a knowledge of the quantity of gas supplied per unit time to the stove; the analysis, calorific value and temperature of this gas; amount, temperature and moisture content of the air used for combustion; temperature and analysis of stack gas; and quantity, moisture content and temperature of air in the blast heated by passage through the stove. Details of this and other needed information may be obtained from the tables.

A suitable method of measuring the volume of blast-furnace gas passing to the stove was necessary, and was not at once apparent, since the amount of moisture and dirt in the gas was sufficient to make the use of the Pitot tube very difficult. The scheme finally adopted consisted in diluting the gas some distance back from the point of its entrance to the stove with a measured volume of air and analyzing the gas before adding the air and again after the gas and air were thoroughly mixed. Air for this purpose was measured by an orifice and delivered into the gas main by a small pressure blower. To obtain results of the needed accuracy required careful gas analyses, which, with care, however, was entirely within the range of practical possibilities. Table I contains the experimental data obtained in this way.

Another problem consisted in the estimation of the volume of air delivered to the blast furnace. This is extremely important, since the heat efficiency of the stove is based upon an exact knowledge of it. A method often depended upon and which was used in this work as a check only consists in estimating the volume from the size of cylinder, length of stroke, speed and slip-page of the blowing engines.

In this test the air volume delivered by the stove was determined by analyzing all carbon-bearing materials entering and leaving the blast furnace. This information, coupled with a knowledge of the quantities of these various materials entering or leaving the

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furnace over a given period of time, is sufficient to render possible the calculation of the air volume per unit time.

In Table I are included all the experimental measurements taken, upon which were calculated the data shown in Table II and III.

TABLE I. EXPERIMENTAL DATA

Date of test, Dec. 2-3, 1920.	
Size of stove, 22 x 110 ft.	
Size of combustion chamber (cross-section) 4 ft. 11 in. x 11 ft. 9 in.	
Length of time in service, 3 years.	
Checker opening, 5 $\frac{1}{8}$ in.	
Duration of cycle (returning to initial temperature).	
Starting temperature, 770 deg. C.	
Cycle 1—From 3:34 p.m. Dec. 2 to 1:14 a.m. Dec. 3. On gas 3:40 p.m. to 10:40 p.m. (Blast off 3.5 min.) On air 10:45 p.m. to 1:07 a.m. (Blast off 7 $\frac{1}{2}$ min.) Time extended 7 min. beyond 1:07 a.m. to allow time for stove to reach temp. of 770 deg. C.	
Cycle 2—From 1:14 a.m. Dec. 3 to 10:29 a.m. Dec. 3. On gas 1:12 a.m. to 7:55 a.m. (Blast off 23.5 min.) On air 8:00 a.m. to 10:25 a.m. (Blast off 17.5 min.) Time extended 4 min. beyond 10:25 to allow time for stove to cool to 770 deg. C.	
Net time on gas (No. 1 cycle), 416.5 min.	
Net time on air (No. 1 cycle), 141.75 min.	
Net time on gas (No. 2 cycle), 379.5 min.	
Net time on air (No. 2 cycle), 131.5 min.	
Pressures: (In inches of water unless otherwise stated):	
Blast-furnace gas in main (No. 1 cycle).....	8
Blast-furnace gas in main (No. 2 cycle).....	8
Air for dilution (in line to orifice).....	27
Orifice differential.....	12
Air blast, lb. per sq.in., avg. (No. 1 cycle).....	17.8
(No. 2 cycle).....	21.4
Barometer, lb. per sq.in.	14.8
Size of orifice for air.....	3.1 in.
Temperatures, Deg. F.:	
Blast-furnace gas in main, avg. (No. 1 cycle).....	58
(No. 2 cycle).....	54.6
Air through orifice (avg. for two cycles).....	37.0
Cold air blast (No. 1 cycle), avg.	150
(No. 2 cycle), avg.	162
Hot air blast (No. 1 cycle), avg.	1,645
Leaving stove (No. 2 cycle), avg.	1,543
Flue gas to stack (No. 1 cycle), avg.	426
(No. 2 cycle), avg.	406
Hot air blast (bustle pipe), avg.	1,196
Atmospheric Conditions, Deg. F.:	
Wet bulb.....	34.6
Dry bulb.....	37.2
Wet bulb at blowing engines, during pumping (avg.)...	36.0
Dry bulb at blowing engines, during pumping (avg.)...	39.5
Gas Analyses:	
Blast-furnace gas, 12-in. orifice differential before adding air (avg.):	
CO ₂	Per Cent 14.5
O ₂	0.1
H ₂	3.5
CO.....	24.1
CO + H ₂	27.6
After adding air (avg.):	
H ₂	2.6
CO.....	22.8
CO + H ₂	25.4
Flue gas (avg.):	
CO ₂	19.3
O ₂	1.9
N ₂	78.8
Carbon Balance:	
Carbon input, 9:17 a.m. to 9 p.m. Dec. 2 (703 mln.):	
Coke:	
Total weight charged, lb. 581,000.	
Per cent carbon, 83.8.	
Scrap:	
Total weight charged, lb. 56,000.	
Per cent carbon, 4.0.	
Limestone:	
Total weight charged, lb. 264,000.	
Per cent carbon (95 per cent CaCO ₃) 11.4.	
Carbon Output:	
Flue Dust:	
Weight per day (estimated), lb. 70,000.	
Per cent carbon, 7.14.	
Pig Iron (duration of test):	
Weight, lb. 1,047,000.	
Per cent carbon (estimated) 3.75.	
Blowing Engines:	
R.p.m., 61.2. Number of compressions per revolution, 2.	
Diameter of piston, 84 in.	
Diameter of piston rod, 16 in.	
Length of stroke, 60 in.	
Slippage (measured), 5 per cent.	
Radiation Data:	
Average skin temperature, combustion side of stove, 161 deg. F.	
Average skin temperature, flue side of stove, 108 deg. F.	
Temperature of surrounding air, 37 deg. F.	
Area of combustion side of stove, 1,990 sq.ft.	
Area of flue side of stove, 5,660 sq.ft.	
Average skin temperature of hot blast main, 90 deg. F.	
Area of exposed surface of hot blast main, 1,980 sq.ft.	

This test extended over two complete cycles—that is, two periods during which gas was burned in the stove

to heat it up, and subsequently air passed through it to be heated before its entrance to the blast furnace. An arbitrary point of 770 deg. C. was chosen as the starting point, and therefore the length of cycle is corrected to allow for the return of the stove to the initial temperature. A constant differential pressure of 12 in. was maintained at the orifice measuring the air used to dilute the blast-furnace gas. This was kept constant by proper regulation of a valve controlling the volume of air. The orifice used was sharp-edged and had a diameter of 3.1 in.

The hot-blast temperature measurements were taken by means of thermocouples both as it left the stove and at the bustle pipe. In calculating the efficiency, the bustle pipe temperature was used, allowing for radiation along the hot-blast main, and in determining the starting and ending points of the test, the temperature of the blast leaving the stove was relied upon. The cold-blast temperatures were sufficiently low so that they were obtained by the use of a thermometer.

In analyzing the blast-furnace gas the usual methods were employed for carbon dioxide and oxygen. However, hydrogen and carbon monoxide were determined very carefully by a slow combustion method, since the volume of blast-furnace gas passing to the stove was calculated on the basis of the change in the sum of these two caused by the air dilution.

In getting data for the carbon balance care was taken to extend it over a sufficient length of time to equalize any slight irregularities in operation. The possible error involved did not warrant the analysis of the scrap and limestone for carbon, and consequently figures for this given in Table I are estimates. The necessary gas analyses for the calculation of the carbon balance were obtained from the values given in Table I for the blast-furnace gas before diluting with air.

Moisture and dust determinations were made on the gas two or three times during the test.

Measurements made to determine the loss of heat due to cooling the hot-blast valve stem are not included in Table I, inasmuch as they consist merely in the measurement of the volume of water passing to and from the valve per unit time together with the change in temperature of this water.

In the determination of the so-called "skin"—i.e., surface—temperatures of the stove, use was made of an ordinary mercury thermometer immersed in mercury and insulated from the surrounding air by a small block of wood. This was so arranged as to be constantly movable over the surface of the stove.

In Table II the various computed results of importance are given.

DISCUSSION OF COMPUTED RESULTS

The air volume passing through the orifice per minute was obtained by the usual methods of calculation using 0.605 as a coefficient of discharge. The dilution of the gas by air was calculated from the change in sum of carbon monoxide and hydrogen, due to the addition of the air. The heating value of the gas was not determined calorimetrically, but was figured from the analysis of the gas.

From a knowledge of the carbon content of the stack gas and blast-furnace gas the volume of stack gas per volume of blast furnace gas was obtained.

In estimating all heat quantities involving changes in temperature of gases, the usual method was employed necessitating a knowledge of initial and final tempera-

TABLE II. COMPUTED RESULTS

Average air volume per min. through orifice at 37 deg. F. and 8 in. H ₂ O, 433 cu.ft.
Per cent dilution of gas by air, 8.7.
Average gas volume per min. to stove at 32 deg. F. and 1 atm., 5,030 cu.ft.
Calorific value per cu.ft. of dry gas at 32 deg. F. and 1 atm., 94.3 B.t.u.
Total net time on gas, 809.5 min.
(Allowance made for small amount of gas from other furnaces.)
Volumes of stack gas per volume of blast-furnace gas (dry basis), 2.0.
Stack loss per min. above 62 deg. F. (average, dry basis), 73,200 B.t.u.
Pounds H ₂ O per min. in blast-furnace gas (gas saturated), 4.0.
Pounds H ₂ O per min. in air supplied for combustion, 1.25.
Heat loss per min. above 62 deg. F. due to moisture in air and gas, 860 B.t.u.
Heat required per min. to raise air for combustion from 37 to 62 deg. F., 3,110 B.t.u.
Per cent excess air used, 28.
Pounds H ₂ O vapor formed per min. from combustion of hydrogen, 8.8.
Heat loss per min. above 62 deg. F. due to above H ₂ O, 10,700 B.t.u.
Volume of air blast per min. from blowing engine displacement (dry basis 32 deg. F. and 1 atm.), 42,200 cu.ft.
Volume of air blast per min. from carbon balance (dry basis 32 deg. F. and 1 atm.), 41,500 cu.ft.
Time on air, 273.3 min.
Heat absorbed by blast per min. (dry basis), 863,000 B.t.u.
Pounds H ₂ O in blast per min., 12.
Heat absorbed by H ₂ O in blast per min., 5,970 B.t.u.
Radiation per min. along hot blast main from stove to bustle pipe, 5,250 B.t.u.
Heat required for cooling hot blast valve and valve stem per min. (stove on gas), 5,230 B.t.u.
Heat required for cooling hot blast, valve and valve stem per min. (stove on air), 19,400 B.t.u.
Convection coefficient for loss of heat from stove surface, 2.0. (B.t.u. per hr. per sq.ft. surface per deg. F. temperature difference).
Radiation coefficient for loss of heat from stove surface:
Combustion side, 1.3.
Flue side, 1.1.
Total radiation loss from stove surface per min., 34,400 B.t.u.

tures, analyses of gas and specific heats of the various gases over the temperature ranges involved.

An interesting comparison is shown between the volume of air delivered to the furnace as obtained from displacement figures on blowing engines and by the carbon balance method. It will be seen from the values given in Table II that the agreement was very close, the two figures checking within about 2.0 per cent. In estimating the slippage on the blowing engines, use was made of the results of a careful overall efficiency test of these engines.

The values used for heat loss by radiation were obtained by estimating the total coefficient of heat transfer from stove surface to air in terms of B.t.u. per hour per sq.ft. of surface exposed per deg. F. temperature difference. This total coefficient is the sum of two independent ones, that of radiation and that of convection. The latter was estimated, allowing as well as possible for wind velocity and other modifying influences. The radiation coefficient for black bodies was figured from a knowledge of the temperature difference between the exposed surface and surrounding air, and the total radiation loss then was calculated from a knowledge of the surface exposed, temperature difference between the surface and surrounding air, the time of the test, and total coefficient of heat transfer.

SUMMARY AND CONCLUSION

The efficiency figure of 62 per cent obtained in this test indicates a well-designed and well-operated stove, as this value compares very favorably with figures given in previously published reports¹ of tests made at other plants on stoves of the same type. It is realized that the comparatively short length of this test may tend to give a higher efficiency than would be shown by

¹A. E. Maccoun, "Blast-Furnace Advancement," 1915 Yearbook American Iron and Steel Institute. A. N. Diehl, "Burning Blast-Furnace Gas," 1915 Yearbook American Iron and Steel Institute.

TABLE III. SUMMARY OF HEAT QUANTITIES

Efficiency and Heat Distribution:	B.t.u.	Per Cent
Heat Input:		
Heating value in gas	384,000,000	100.0
Heat Output:		
Heating value in flue gas	59,900,000	15.6
Heating air for combustion	2,600,000	0.7
Uncondensed water from hydrogen combustion ..	8,700,000	2.3
Heat removed by air blast	238,000,000	62.0
Cooling water for valve	10,100,000	2.6
Radiation loss	39,000,000	10.1
Unaccounted for	25,700,000	6.7

tests run over a considerably longer time. In this work no attempt was made to determine the distribution of air or gas through the checkers, since it was not practicable to do this at this time. It is felt, however, that the stack loss of approximately 16 per cent indicates fairly uniform distribution through the checkers. Considerable information might be obtained from a comparison of figures obtained here with those resulting from previous tests² on other types of stoves such as center combustion and the three-pass or four-pass, but it is not within the scope of this report to attempt such a comparison.

While the figures for radiation loss included here are necessarily more liable to error than the others of Table III, since all factors influencing it cannot be definitely determined, yet even so it is felt that it is reliable to within about 2 per cent of the total heat input. Future work should be done on blast-furnace stoves along the line of the calculation of figures giving the transmission of heat from gas to brick work and brick to air. Figures such as these, if arranged in terms of fundamental units, have the possibility of ultimately being extremely helpful in the future design of hot-blast stoves. Especially useful would be a study of the relationships between such heat-transmission figures and varying velocities of gas or air through the stove.

The author desires to express his sincere appreciation of the hearty co-operation and extremely helpful advice given by various members of the operating, metallurgical and engineering departments of the Lackawanna Steel Co., as well as by his colleagues in the School of Chemical Engineering Practice.

²See J. E. Johnson, Jr., "Blast-Furnace Construction in America."

British Standard Leather-Measuring Regulations

On July 1, 1921, certain regulations promulgated by the British Government Board of Trade came into force, requiring every leather-measuring instrument to conform to an approved pattern verified and stamped by an inspector of weights and measures. This action has been taken in view of the increasing use of measuring instruments in the leather trade and must be complied with within a period of 12 months. Before the instrument can be passed by the inspector the templates—which are required to be provided—must be stamped at the National Physical Laboratory, and they must be subjected to a second stamping at the laboratory after the lapse of 12 months. This requirement is necessary because of the shrinkage to which templates are liable and until this has ceased the permanent area can not be ascertained.

The regulations provide for local standard templates to be kept by the local authorities, and based thereon all instruments will be verified by the inspectors at intervals of not less than six months. The full regulations have been issued under the title of "Weights and Measures (Leather Measurement) Regulations, 1921."

The Engineer's Part in Industrial Safety*

A Plea for Industrial Safety Work in Which It Is Clearly Brought Out That Properly Conducted Accident Prevention Work Pays a Larger Return on Investment and Operating Cost Than Any Other Department of an Ordinary Industrial Plant

By C. P. TOLMAN†

IN THE APPLICATION of engineering principles to safety the engineer is answering the same call of humanity to which engineers of all times have responded. There is probably no field of scientific industrial work which in any one plant calls for and can advantageously use a broader range of professional training and experience.

What is the magnitude of the problems with which we have to deal? I have before me some statistics prepared by Sidney J. Williams, secretary of the National Safety Council. We can read our answer in the following annual statement rendered and paid in full by the industries of our country in 1919:

Human lives.....	23,000	
Accidents, each causing four weeks' disability or more.....	575,000	
Accidents involving one day's disability.....	3,000,000	
Total equivalent working days lost.....	296,000,000	
At average wage of \$4 a day.....	\$1,184,000,000	
Incidental expense—medical, surgical, hospital, insurance, etc.....	\$161,000,000	
Total.....	\$1,345,000,000	
Credit—for the subsistence of 23,000 men who no longer need clothes, food, nor housing.....		\$331,000,000
Balance due.....	\$1,014,000,000	

You say perhaps it was an unusual year. Yes. In the previous year, 1918, more men were employed and the bill was 13 per cent larger.

Without further analysis we may safely agree that this waste of a billion dollars a year is great enough to demand attention. And our next question naturally is, "Can this waste be substantially reduced without prohibitive expense?" The answer is, "Yes; it has been done."

I have here totals from carefully recorded data in the files of the National Safety Council from eight widely known companies, members of the Council; in each case the accident record of one year is compared with the record of a previous year. The total number of men employed by these eight companies is 36,200. The reduction in accidents, measured by the difference in days lost per thousand hours worked, averages over 70 per cent. This is a most conservative figure, for in several cases effective accident prevention work was going on before the first of the two years compared. So we have part of our answer—it can be done.

COST OF INDUSTRIAL SAFETY WORK

Now as to the rest: Is the cost prohibitive?

On the contrary, properly conducted accident prevention work pays a larger return on investment and operating cost than any other department of the ordinary industrial plant.

This is an astounding statement, but it is borne out by fact.

A certain small company operating a coal mine with 100 men reduced its accident cost per ton 68 per cent. A large corporation tells us of a profit from its safety work of \$1,000,000 per year. These illustrations will serve as a general proof of the statement; they recite only what is to be found in the bookkeeper's balance. They tell us nothing of the incidental profits from better relations between men and management, and give no credit for the saving of human life and suffering. In the specific illustrations we shall consider only the cash profits. For with the assurance of definite profit the industrial manager need have no hesitation about undertaking organized safety work. He need fear no criticism from the owners; on the contrary, he is neglecting the owners' interest if he fails to establish the safety principle in his plant and give it that support, supervision and interest necessary for successful functioning.

Our immediate subject does not include that phase of safety work which has to do with the personal equation. Volumes have been written—available from the National Safety Council headquarters in Chicago—on the instruction of foremen and workmen, on methods of organizing shop safety committees, on medical supervision and first aid training, on the use of bulletin service, and on safe operating practices, both in general and applied to specific industries. All of this is essential to a successful safety program.

PROBLEMS CONFRONTING THE ENGINEER IN HIS INDUSTRIAL SAFETY WORK

We are here considering the relation of the engineer as such to the material rather than the human side of industrial safety.

Usually the engineer finds for his problem a plant equipped and operating. He is required to make it as safe as possible with the following stipulations:

- (a) He must not interrupt operations.
- (b) He must do nothing which would decrease output or increase cost.
- (c) He must not make changes of a character or in a manner to cause labor trouble.
- (d) He must not make changes which will affect the character of the product.

Otherwise he has a free rein.

This seems to leave little chance for accomplishment. But hundreds of engineers are doing effective safety work under just such restrictions. The work is limited, of course, to the more common measures, such as guarding machines and transmissions, general betterment of ventilation, lighting and floor conditions, etc. It is well worth while, profitable to the industry, and calls for real ability.

The design of a gear guard is not beneath professional dignity. A gear guard which answers all require-

*An address delivered before the joint meeting of the Cleveland Engineering Society and the Engineering Section of the National Safety Council, May 31, 1921.

†Chief Engineer and Chairman Manufacturing Committee, National Lead Co., and President National Safety Council.

ments satisfactorily calls for skillful design. Among other requirements we have, for example, the following:

- (a) It must be securely attached.
- (b) It must be readily opened or removed.
- (c) It should be easier to close it than to leave it open.
- (d) It must not interfere with oiling or adjustment of the machine.
- (e) It should not drip oil or grease on the floor to make a slipping hazard.
- (f) It should be designed for economical manufacture.
- (g) The means for attaching and opening should be of a kind familiar or obvious to the average workman.
- (h) In so far as possible, it should permit inspection of gears without opening or removing.

Properly designed guards may save considerable in first cost, will save much in maintenance, and will remain in use. Improperly designed guards may not afford proper protection and, if awkward to replace, are usually left off, once they have been removed.

INDUSTRIAL SAFETY PLUS WASTE SAVING

Leaving the more obvious measures incidental to safeguarding machinery, let us consider the less obvious measures for safeguarding the immediate work of the operator. At once we are in a much more profitable field of work. Most of the profit in the earlier class comes through saving in cost through the prevention of accidents, whereas in the latter class, by bettering operation from the safety standpoint, we not only reduce accident cost, but if our work is properly done we invariably increase production or save waste. As an example of the latter, in the white lead industry portable dust collectors were developed and used for sanitary reasons. Purely out of curiosity the lead dust saved was weighed. The average of all factories showed a saving of lead amounting to a return of over 30 per cent on the investment.

INDUSTRIAL SAFETY PLUS INCREASE IN PRODUCTION

As an example of increased production, in the manufacture of steel drums, using toggle drawing presses, a factory was started about ten years ago with presses operating ten strokes a minute. At this rate the loss of fingers was alarming. The presses were therefore slowed down to seven strokes per minute. The accidents were reduced, but still were serious. The superintendent then devised and installed a method of operating the clutch by a solenoid magnet. The electric circuit led through two switches connected in series. These switches were arranged to open by springs and be closed by hand. One switch was located on each side of the press frame. To operate the press the workman had to use one hand on each switch. He could not get his hand or fingers in the press while it was operating. The presses were then speeded up to twelve strokes per minute, making an increase in production of 70 per cent with safe operation.

This is not an unusual case. Semi-automatic press feeds will, while making the operation safe, increase output from 10 to 100 per cent. Full automatic feeds will better this. Ejectors or kick-outs give similar results.

Lest we get the impression that results of this sort are confined to punch presses, suppose we consider another class of machinery infamous for mutilation of hands, the circular saw.

At the National Safety Council's congress in Mil-

waukee last year during a session of the Engineering Section it developed that 70 per cent of saw accidents originate in bad condition of the saw—dull, not properly set or not properly gummed. There were men present ranging from youth to rugged age, men who had lived with woodworking machinery. And they were unanimous on this point. They were then asked if saws and other woodworking machinery were kept in proper condition as compared with the average conditions, what increase in production would result. Again they agreed—at least 20 per cent. In other words, by keeping the saws in reasonable order, the average woodworking plant would eliminate the source of 70 per cent of saw accidents and make a net gain of 20 per cent in production with the same equipment, the same labor and less power.

SAFETY WORK IN MACHINE SHOPS

Once again that we may remember we are dealing with a broad general principle and not with any one class of machinery, let us consider the machine shop. Here we have the usual groups of accidents:

- (a) The kind which may befall any workman.
- (b) Selective accidents: (1) that select the careless, indifferent, or ignorant workman; (2) that select the best of the mechanics.

Aside from the labor turnover this last is a pretty serious proposition. The statement that there is a type of accident which selects your best men requires some proof. The best known example of this type happens when your machinist uses his hand as a brake on the rim of the face plate of his lathe. The man who does this is the man who wants to see his work progress. He is not content to stand idle while his lathe comes slowly to rest. He wants to get his micrometer on the work and see the result of the cut—to get the piece out when finished, and get in the next one. So he disobeys orders—he does just what you or I would do, he is interested in his job and he takes the chance.

This hazard can be wiped out. The corrective measure involves an important fundamental principle in safety work:

Make it easiest and most effective to do it the safe way.

In this case the thing to be done is to stop the lathe. The power must first be shut off. The remedy is obvious. Equip the lathe with a brake; if it is a belt-driven lathe, use a foot pedal which when pressed first shuts off the power and then applies the brake. The almost instantaneous effect of the powerful foot brake leaves no incentive to use the hand on the face plate. If the lathe is direct-motor-driven, use a controller designed for dynamic braking.

The International Harvester Co., at its Milwaukee shops, equipped the spinning lathes with foot brakes as just described. The accident hazard was eliminated and the increased production is paying an enormous return compared to the cost of this home-made attachment.

SAFETY WORK IN DESIGNING INDUSTRIAL PLANTS

Gratifying as are the results from careful analysis and treatment of hazards where found in a going plant, there is another broader fundamental method of treatment which is occasionally open to the engineer where a new plant is being built. Shall we digress a moment to make the principle clear by an illustration? The personal experience I am going to relate is one you

have all had. Recently I visited a plant for which an expensive addition was being planned. Upon going through the plant I found an unusual equipment of machinery specially designed for the work. The machines, although performing what would be considered difficult operations, were simple in that way which bespeaks the genius of the designer. But the arrangement of the machines was haphazard. Additions had been made from time to time and the original "flow sheet" was lost to view. Had the designer of the machines viewed his whole plant as one great machine, he would have done with it as he had done with the individual machines, and the additional building, machinery and labor would not be needed. This is the general principle of engineering revision as applied to safety: Regard the whole plant as a machine. Make the whole as well as each part function for safety. The production returns incidental to safe methods for the individual machine are multiplied again when the whole plant is co-ordinated on a safety basis.

SPECIFIC CASES FOR SAFETY DEVICES

Provision for clear aisles is a safety measure. It also facilitates transfer of materials and lowers production costs. Racks and bins properly placed reduce accidents from falling objects; they also save material from injury and facilitate production.

Correct lighting equipment and correct location of machines with respect to natural light prevents eye strain; waste from faulty manufacture is also saved, and production increased.

Grouping equipment involving special hazards or bad working conditions makes it possible to treat these conditions effectively and avoid exposure of other employees than those engaged in the particular work. For example, furnaces so grouped can be hooded to carry off heat and fumes; special cool air supply can be provided. The advantages of grouping apply also when chemicals are used or dusty operations are involved.

While some of these measures can be applied to a degree regardless of general plant arrangement, all of them can be applied much more effectively if it is feasible to treat the plant as a whole.

With the growth of an industry in volume it is usual to add more and more of the small capacity units which, although suitable as to capacity in the earlier days, have been outgrown, and too many units are needed to produce the output. It is engineering revision in respect to the custom of such an industry to redesign such equipment, increasing the capacity of the unit. The reduction of hazard is twofold when this is done—first, there are fewer men exposed; second, in redesigning, the equipment can always be made inherently safer. The reduction in manufacturing cost is obviously large. In the steel industry we have a striking example of just such revision.

HUMAN EQUATION IN SAFETY WORK

It is sometimes possible to make radical changes in the general process of manufacture, avoiding hazardous features and effecting large economies in operating cost. This is all work for the engineer, some phases of it calling for broader training and experience than others. To do any of it thoroughly and well we must include that factor which we have thus far omitted, the human equation. The engineer preparing for this work must become familiar with organized safety work and the practical data which have been patiently accumulated in

the course of such work. He must respond to the spirit of the safety movement, for words and data alone will not serve him.

SUMMARY

I have tried to establish two basic principles—first, properly conducted accident prevention work pays a larger return on investment and operating cost than any department of the ordinary industrial plant and, second, make it easiest and most effective to do it the safe way.

I have shown the opportunity for the engineer in this field of work. I do not mean that he is forthwith to christen himself safety engineer. On the contrary, he is not true to the ethics of his profession or to the interest of his client if, knowing the effectiveness of the safety viewpoint, he fails to make safety a part of his professional attitude toward all his work.

The safety movement needs the hearty co-operation of the engineer.

Antiseptic Treatment of Wood Pulp Prevents Mold and Decay*

Tests show that by the addition of certain antiseptics to wood pulp it is possible to prevent to a large extent the decay and molding which now cause such serious losses in the pulp during storage. Several preservatives were found which kept groundwood pulp clean for a year under the most severe conditions which could be devised. The procedure adopted in the tests was, briefly, to inoculate the treated pulp with active mold spores and wood-destroying fungi and then to store it in warm, moist air in piles between laps of very rotten pulp.

In determining the relative suitability of the preservatives, account was taken of their effectiveness as antiseptics, poisonous properties, tendency to discolor the pulp, odor, solubility in cold water, and cheapness.

All things considered, sodium fluoride appeared to give the best results. A 5 per cent solution sprayed on the pulp at the rate of 80 lb. of dry salt to a ton of air-dry pulp, kept it practically clean for a year. A 3 per cent solution (48 lb. per ton) permitted only slight molding. This chemical is safe to handle, and produces no discoloration in the pulp.

Borax followed a close second to sodium fluoride. A 5 per cent solution (80 lb. per ton) held the pulp in good condition for 6 to 8 months. Borax is safe for workmen to handle and does not darken the pulp to an objectionable degree. Boracic acid was equal or superior to borax in effectiveness, but the greater cost throws it out of competition. Sodium dinitrophenolate in a 1 per cent concentration (2 lb. per ton) had an antiseptic efficiency equal to anything tried, but yellowed the pulp somewhat. Sodium dichromate gave less consistent results than the four chemicals mentioned, and the tendency toward browning was marked in concentrations of 2 or more per cent (32 lb. per ton). Sodium carbonate and bicarbonate, although they kept the pulp nearly free from infection for a year or more, browned and softened it too seriously for commercial use.

In the laboratory experiments, the antiseptics were sprayed with an ordinary garden sprayer on the pulp as it came from the wet machine. These experiments were followed by a mill trial in which the preservatives were applied at the press roll of the wet machine, with promising results. Improved methods of applications should make it possible to lower the concentrations and, consequently, the cost of treatment.

*From U. S. Forest Products Laboratory.

Electric Vitreous Enamel Furnace

A TWO-COMPARTMENT electric furnace for baking vitreous enamel on resistance tubes has recently been installed at the Schenectady works of the General Electric Co.

The furnace is divided by a door which can be raised or lowered when a batch of tubes is to be transferred from one compartment to the other. These tubes consist of a grooved porcelain body, wound with resistance wire; the enamel is placed over this winding. The front compartment of the furnace is used as a pre-heater where the tubes are held at a temperature of 570 deg. F. for six minutes. This is necessary, because if the body of the tube is subjected to too high an initial temperature, it will crack. The connected load on this compartment is 9 kw. and the temperature is automatically controlled by means of a thermostat. When preheating is accomplished, the work is moved into the second or baking compartment by raising the door between the two compartments. In this compartment it is subjected to a temperature of 1,650 deg. F. for six minutes, emerging from it in a finished state. The connected load in the compartment is 24 kw. and the temperature is also automatically controlled by means of a thermostat.

The heating units on both chambers are arranged so as to give a very even heat distribution and, by using thermostats, an absolutely uniform temperature is obtained during the preheating and baking periods. This furnace also possesses the further advantage in that both operations—viz., preheating and baking—can be carried on at the same time on two different batches of work.

Each compartment will hold a tray containing thirty-six tubes which weigh about 27 lb.; the tray weighs 30 lb., so that there is a total load of 57 lb. in each compartment. The dimensions of the compartments are 48 in. long, 18 in. wide and 24 in. high and the overall dimensions of the furnace are 13 x 5 x 7 ft. The heating

equipments can be made for 230 volts direct current or 220 volts single phase alternating current.

This furnace has not only saved time and floor space but has improved the quality of the finished product and has reduced the percentage of defective tubes from 20 per cent to less than 1 per cent.

Some interesting comparisons have been obtained with this furnace and an oil-fired furnace which it replaced. Working on two different classes of material—viz., push buttons and resistance tubes—it was found that the kw.-hr. per lb. of push buttons was 1.87 and the cost per lb. was \$0.023. For resistance tubes, the kw.-hr. per lb. was 0.541 and the cost per lb. \$0.006. The cost per hour of operating the oil furnace was 72c., since it consumed 6 gal. of oil costing 12c. per gal. The cost over the same period with electric heat was 41c., or a saving of 31c. per hour in favor of the electric. It is estimated that production has also been increased approximately 50 per cent.

A Convenient Formula for Diluting Solutions

BY E. J. McMILLAN*

Where large volumes of standard solutions are prepared, much inconvenience is experienced in diluting such solutions to the desired strength on account of the inconvenience of directly measuring such large volumes.

A convenient and accurate determination of the amount of diluting required to bring any solution of unknown volume to desired strength is made as follows: Titrate the original solution against the standard. Add a known but insufficient amount of the diluent and titrate against the same amount of the standard.

Let C_1 = number c.c. used in first titration.

C_2 = number c.c. used in second titration.

C_3 = number c.c. required when the solution is diluted to the desired strength.

X = the original volume before diluting.

N = the amount of diluent added.

V = volume after diluting and making second titration.

D = number c.c. required to be added to V to bring the solution to the desired strength.

$$\frac{X}{C_1} = \frac{X + N - C_1}{C_2} + \frac{C_1}{C_2}$$

$$X = \frac{NC_1 - C_1^2 + C_1C_2}{C_2 - C_1}$$

$$V = X + N - C_1 - C_2$$

$$V = \frac{NC_2}{C_2 - C_1} - C_2$$

$$D = \frac{VC_3}{C_2} - V$$

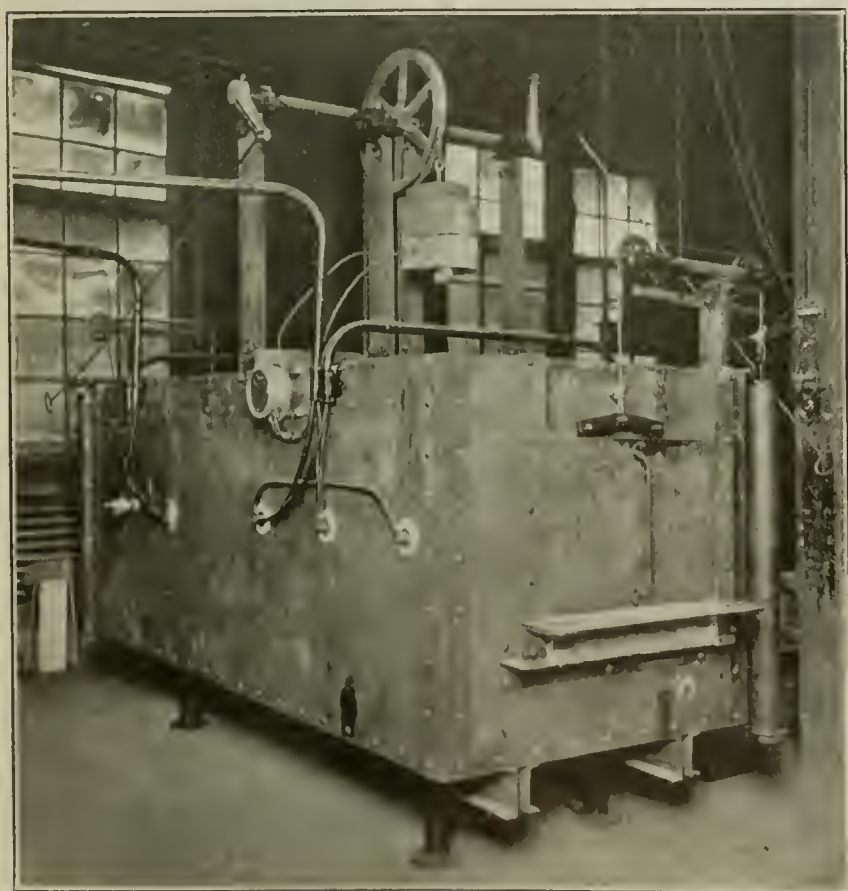
$$D = \frac{N(C_3 - C_2)}{C_2 - C_1} - (C_3 - C_2)$$

— $(C_3 - C_2)$ can be omitted without appreciable loss of accuracy.

$$D \text{ then becomes } \frac{N(C_3 - C_2)}{C_2 - C_1}$$

This calculation can conveniently be carried out on a slide rule with sufficient accuracy.

*Chemist, Cleveland Hardware Co., Cleveland, Ohio.



ELECTRIC VITREOUS ENAMELING FURNACE WITH PRE-HEATING AND HIGH-TEMPERATURE COMPARTMENTS

New Synthetic Bearing Metal

A NEW bearing material called Genelite, recently developed in the research laboratory of the General Electric Co., has given remarkable results in a series of tests made to determine its performance, both when lubricated and self-lubricating.

It consists of a mechanical mixture of a high-grade "synthetic" bronze, and graphite, the latter amounting to about 40 per cent by volume of the whole mass. Since the material cannot be melted and poured into molds like ordinary metals, its formation into bearings is accomplished by a special process. It is made from the oxides of tin, lead and copper (mixed in the proportions to form a high-grade bronze) plus graphite, all the ingredients being in a finely divided state. Graphite is added in sufficient excess quantity to reduce the oxides to the metals and still leave the required content in the finished material. The oxides are partly reduced by heating the mixture, after which it is still in powdered form, but is then pressed as nearly as possible to the required shape in massive metal molds.

In the pressed form it is still too brittle to stand handling, so it is given a final heat-treatment which reduces and sinters the metals together into a homogeneous bronze, holding the graphite uniformly distributed throughout the mass. The evenness of this distribution is shown in Fig. 1, at 100 diameters. The white spots are the bronze, and the black ones the

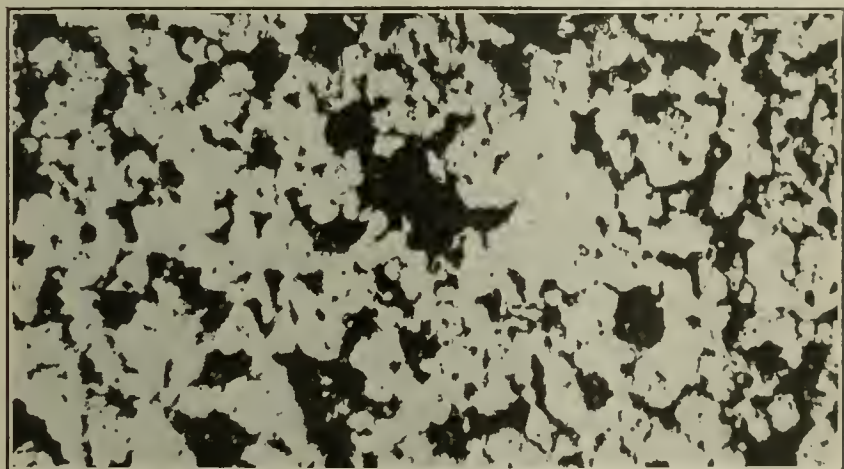


FIG. 1. MICROSTRUCTURE OF GENELITE. $\times 100$

graphite. The baking fixes the graphite so securely within the mass that it cannot be separated or washed out, even if the metal is lubricated. Some of the various stages of manufacture are shown in Fig. 2, in which substance number 5 is the mixture after the preliminary bake, ready for pressing, 6 a bushing

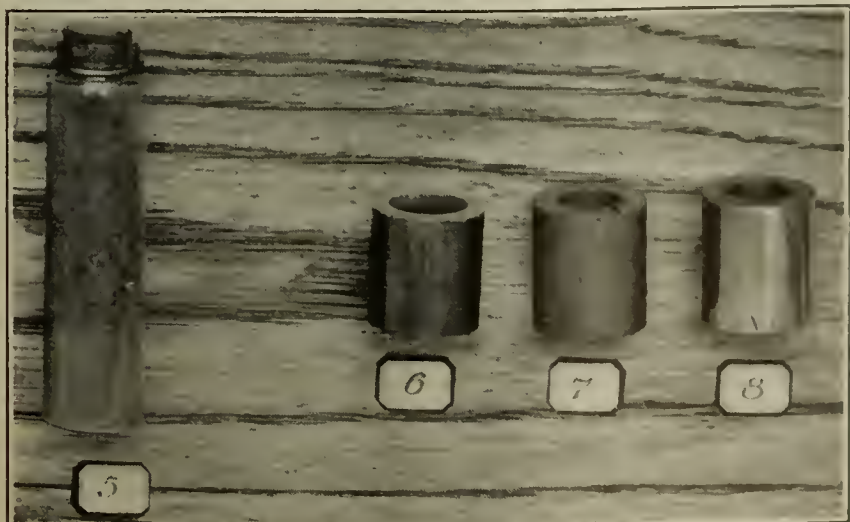


FIG. 2. VARIOUS STAGES IN THE MANUFACTURE OF GENELITE



FIG. 3. OIL SIPHONED FROM UPPER BEAKER BY CAPILLARITY THROUGH GENELITE AND WICKING

pressed from the powder, 7 a bushing after the final bake (or Genelite in the raw stock form) and 8 a finished piece. The material has the general appearance and body of bronze, but the characteristics are different. It does not machine readily by ordinary methods, but can easily be ground, which has been found to be the best method of handling it in production. Neither has it the physical characteristics of bronze, having very low tensile strength,

but being capable to withstand high compressive strains.

Another marked difference is its porosity, it being able to absorb as much as $2\frac{1}{2}$ per cent by weight of oil. This feature is made use of in some of the high-speed applications where oil is applied to the outside of the bushing and carried to the bearing surface by capillary attraction. Fig. 3 is a piece of apparatus set up to show this feature of the material. Oil from the upper beaker is siphoned to the lower one through the rod of Genelite and the woolen wick by capillary attraction.

The tests have brought out another valuable characteristic, from the user's standpoint, in that a bearing made from this material never seizes or "freezes" as these expressions are commonly understood. The metal of the shaft and bearing never flow and weld together as a result of bearing friction. If the Genelite bearing sticks, owing to having been fitted too close, examination will show that no damage has been done, either to the bearing or the shaft, and they can be reassembled after the bearing has been ground down to proper size.

One of the principal uses of Genelite is on various parts of automobile engines where lubrication is either poor or neglected altogether owing to the inaccessibility of the bearing. Places where its self-lubricating properties render it valuable are on fan bushings, clutch centering bushings, throttle control bushings, etc. Places where lubrication is apt to be poor owing to dilution of the oil by uncombusted fuel products or other cause are also helped by the installation of Genelite bearings.

Infringement of Permutit Patent

The broad patent of the Permutit Co. on zeolite water softeners was the subject of an infringement suit against the Hawley Foundry Co. and the Refinite Co., which was recently decided by Judge Hazel of the U. S. District Court at Buffalo, N. Y. The court recognized the priority of Gans' discovery of Permutit in 1906 and found that the apparatus used and manufactured by the defendant was an infringement on the Permutit Co.'s patented apparatus. An injunction was ordered against the defendants.

Recent Chemical & Metallurgical Patents

American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Electrolytic Cell.—A horizontal diaphragm of asbestos superimposed upon a perforated iron cathode, which in turn forms the bottom of the cell, is the principal feature of an electrolytic cell patented by John M. Williams of Guthrie, Okla. In addition to its normal function, the diaphragm serves as a gasket to make a liquid-tight joint between the bottom and sides of the cell. The diaphragm is made preferably of sheet asbestos and is covered by a protecting layer of sand or finely ground glass. (1,376,495; May 3, 1921.)

Bromine Extraction and Apparatus.—When brine is treated electrolytically to liberate bromine, there are also produced considerable quantities of hydrogen and chlorine. If the succeeding steps in the extraction—viz., removing the bromine from the brine by blowing air through it, and finally absorbing the bromine from this air—are carried out in a closed circuit, there is danger of forming an explosive mixture. If the air, after removing the bromine, is allowed to escape and fresh air is drawn into the system, there may be a loss of heat. These objections are met by Herbert H. Dow in the following manner: The gas produced incidental to the electrolysis and not absorbed by the brine is withdrawn through a separate system containing a standard absorption tower to take up the bromine and chlorine. The brine is then conveyed to another system where the dissolved gases are removed by blowing out with air. This air after passing through the absorption towers necessary to relieve it of the bromine and chlorine is returned to the first blowing-out tower, thus maintaining a closed circuit throughout the system. (1,376,610; assigned to Dow Chemical Co., Midland, Mich., May 3, 1921.)

Tempering Cam Shafts.—An ingenious adaptation of electrical heating for hardening or tempering cam-shafts is described in a patent by John F. Wandersee of Highland Park, Mich. It is necessary in order to produce satisfactory cam-shafts that the cams be very hard to withstand constant wear, while the shafts must be relatively soft and tough. The hardening, which has formerly been accomplished by a long and laborious process of carbonizing and cyaniding, is brought about by placing the shafts into an ordinary electric welding machine in a manner such that only the cam itself is held between the two electrodes. Current is applied until the desired temperature is reached and the shaft is removed and quenched. (1,376,984; assigned to Ford Motor Co., of Detroit, Mich., May 3, 1921.)

Clarifying and Decolorizing Oils.—R. W. Mumford, of New York, has been granted a patent for a process of treating oils with a particular type of vegetable carbon, described as "an open-textured granular material having a porous structure representing approximately the original cellular structure of the material carbonized." This carbon is claimed to be more effective than fullers earth and the other decolorizing and clarifying agents commonly used for both vegetable and mineral oils. The patent covers different processes of applying the decolorant, one of which consists in utilizing electrically charged fields in order to facilitate the action of the decolorant. (1,377,021; assigned, by mesne assignment, to Darco Corp., of Wilmington, Del.; May 3, 1921.)

Method for Producing Zinc Chloride.—Paul Danckwardt has patented a process of preparing zinc chloride by utilizing as a source of his chlorine the residue obtained from the aluminum chloride method of oil distillation. The

residue, either as sludge or cake, is leached with water, the solution filtered and then treated with zinc ore in the proper proportion to precipitate all of the zinc. The aluminum separates out as the oxide and, if the ore used has been sufficiently pure, can be recovered as pure Al_2O_3 —a valuable byproduct. The zinc chloride solution is evaporated and then heated to a high temperature for the production of the anhydrous salt. (1,378,219; assigned to the DANCKWARDT PROCESS Co., of Denver, Col.; May 17, 1921.)

Granulating Converter Slag.—In certain smelting operations, such as the production of copper matte, converter slag is sometimes poured into the ore-smelting furnace to aid in fluxing the charge. This method is not generally satisfactory, because the stream of molten slag does not mix properly with the ore charge. If, however, as the slag is fed into the furnace, a stream of steam under relatively high pressure is projected at right angles against the stream of falling slag, the latter is disintegrated and, in a granulated form, is spread over a large portion of the surface of the charge in the furnace. (1,378,223, SAMUEL RICHARD GARR, assignor to AMERICAN SMELTING & REFINING Co., of New York; May 17, 1921.)

Recovery of Ammonia and Production of Barium Chloride.—James H. MacMahon has devised a process for recovering both the ammonia and the chlorine present in the so-called feeder liquor of the ammonia-soda process. Former practice has been to free the volatile ammonia from the ammonium chloride and to pass this liquor into the lime still, where it is decomposed to form ammonia and calcium chloride. The calcium chloride represents a waste and moreover any free ammonia present in the waste liquor is lost. If, however, the black ash of crude barium sulphide is used instead of the lime, the barium chloride obtained is itself a valuable product or can be used for producing other barium salts. The ammonium sulphide formed, if decomposed with caustic soda, will yield marketable sodium sulphide. Modifications of the methods of carrying out these processes are described by which the different products can be obtained in various degrees of purity. (1,378,593 and 1,378,594; assigned to the MATHIESON ALKALI WORKS, INC., of Saltville, Va.; May 17, 1921.)

Process of Making Calcium Bisulphite.—A calcium bisulphite solution, which is rich in free sulphurous acid, is produced in a novel manner. Instead of causing a direct reaction between the sulphur dioxide and the milk of lime or of passing the free gas through a lime tower where it meets a counter-stream of water, George A. Richter, of Berlin, N. H., first acidulates water with sulphur dioxide in an absorbing tower, and then causes the acidulated water to react with lime in a separate reacting chamber. The product of this reaction may then be further acidulated to obtain the desired sulphur-dioxide content. (1,378,616; assigned to the BROWN Co., of Berlin, N. H.; May 17, 1921.) A second patent (1,378,617) provides for the preparation of a calcium-bisulphite cooking liquor by the use of a suspension of finely pulverized limestone instead of the milk of lime described in the previous patent.

Process of Making Methanol From Methane.—Methyl chloride is produced from methane by any suitable process and then in anhydrous alcoholic solution is converted into dimethyl ether by a process of heating with caustic soda under pressure. The dimethyl ether is subsequently hydrolyzed to methanol under high pressure. The latter reaction is accelerated by the presence of free mineral acid. The conversion of the methyl chloride is carried out in an iron receptacle containing ethyl alcohol and an excess of caustic soda under a pressure of about 20 atmospheres. The final hydrolysis usually proceeds very slowly unless fairly high temperatures are used. However, by the employment of certain accelerating agents, such for example as a 20 per cent solution of sulphuric acid, the reaction can be made to produce methanol on a commercial scale using a temperature of only 80 deg. C. The final reaction is carried out in tall, narrow iron cylinders tested for a pressure of 200 atmospheres. (1,379,362; E. H. RIESENFELD, of Freiburg, Germany, assignor, by mesne assignments, to the CHEMICAL FOUNDATION of New York; May 24, 1921.)

Current Events

in the Chemical and Metallurgical Industries

Object to Volstead Act Amendment

Determined objection is meeting even the modified amendment to the Volstead prohibition act. Senator Broussard, of Louisiana, in opposing the amendment, declared on the floor of the Senate that the bill should be known as the anti-prescription bill, rather than the anti-beer bill. His contention is that the Volstead act is intended to prohibit the beverage use of alcohol, and that no administrative officer of the Government should be vested with power which enables him to interfere with the valuable formulas of legitimate proprietary compounds in which alcohol is used and which gives federal officials a control over industrial alcohol which tends to discourage its manufacture.

"The proponents of this bill," declared Senator Broussard, "forget that alcohol is the universal solvent—one of the basic chemicals. They forget that if the manufacture of alcohol is impeded, many industries suffer. One result would be that this country would have to rely largely on imports of articles for whose manufacture alcohol is necessary. They do not conceive that alcohol is as essential to many industries in this country as pig iron is to the manufacture of steel." Senator Broussard also attacked the clause in the bill having to do with the refund of taxes when alcohol is stolen or lost before entering manufacture.

Senator Stanley, of Kentucky, expressed the opinion that the committee is without realization of the far-reaching effect of the alcohol-shipment clause of the bill, and he is not inclined to believe that any Senator is so ignorant of the legitimate use of alcohol for industrial purposes as not to want to encourage its manufacture, or that any Senator should want "to mulct in ruin the manufacture of industrial alcohol, when it could serve no legitimate purpose."

Senator Brandegee, of Connecticut, called the attention of the Senate to a communication he had from a large manufacturer of flavoring extracts and fruit syrups. "As a manufacturer of flavoring extracts and fruit syrups for soda fountains," said the telegram, "it is absolutely necessary to use non-beverage alcohol in flavoring extracts and less than half of one per cent in fruit syrups to cut the natural oil in the fruit. I have no objection to national prohibition, but this amendment, if passed, will disastrously affect business."

On the other hand, H. B. Thompson, the general counsel for the proprietary association, telegraphed Senator Willis that the Senate committee amendment is satisfactory to the members of his association.

Muscle Shoals on the Tapis Again

Announcement by the Secretary of Commerce that various chemical and power companies are considering the acquisition of the Muscle Shoals project has revived interest in this matter among members of Congress. Senator Underwood contends that the only way the public can secure the maximum benefit from the water power at Muscle Shoals will be by its operation by the Government. He continues to believe that the Government likewise should operate the nitrate plant. It is very evident, however, that a majority in the Senate favors the execution of any reasonable contract with a responsible private interest.

Just at this time, there is much opposition to further appropriations. Difficulties are anticipated in securing congressional approval for the \$28,000,000 which are required for the completion of the Wilson dam, even in view of the fact that the finished project could be leased. It is apparent that the majority in Congress prefers an arrangement whereby all additional expenditures should come from private sources.

The detailed proposal of Henry Ford is now being analyzed by the Chief of Engineers.

American Ceramic Society Meeting at St. Louis in 1922

The twenty-fourth annual meeting of the American Ceramic Society will be held in St. Louis, February 27 to March 2, 1922.

St. Louis is growing to greater importance as an industrial city every year. It is one of the largest centers for refractories and heavy clay products, while enameled ware, glass, and terra cotta are abundantly represented. A week of trips for the inspection of plants would be none too long.

The Hotel Statler will be the headquarters of the society and its facilities for the comfort of the meetings are unexcelled. Large rooms for divisional meetings, with a choice of ballrooms and banquet halls for the general sessions, will be available; while the luxury of the private rooms is too well-known to need description.

It will be noticed that the date is later than is customary. The reason for this is that the month of February is buyers' month in St. Louis, and the city is overcrowded without the additional influx of a national convention. The local men therefore urged that the date be put at the very end of the month, and the decision was made in accordance with this advice.

Dye Vote Surprises Congress

The opponents as well as the friends of the limited embargo prescribed for dyes in the Fordney tariff bill were surprised greatly at the action of the House in eliminating the dye schedule from the bill. At the time the matter first went to vote in the committee of the whole, there was some doubt as to the result, but with the apparently safe margin in favor of the embargo, indicated by the vote in the committee of the whole, there was little thought that the vote would be reversed in the House proper.

As a result of this unexpected action, communications reaching the finance committee of the Senate indicate that the entire chemical industry is aroused as never before, and that a determined effort is under way to secure the reinstatement in the Senate of the limited embargo.

It is very apparent that the important relationship between the dye industry and the national defense will play an important part in the contests certain to be waged in the Senate. General Amos A. Fries, head of the Chemical Warfare Service, will be one of the witnesses called by the Senate committee. He will reiterate his declaration to the House committee that he regards the plan of the Ways and Means committee for the handling of dye imports as absolutely necessary to the upbuilding of a type of dye industry essential to the national defense. He will point out to the Senate committee the close relationship between the dye industry and the manufacture of explosives and poisonous gases.

Now that it is absolutely apparent that the permanent tariff bill will not become a law prior to August 28, when the limited dye embargo expires, an effort will be made in the very near future to put through a bill extending the temporary embargo for another six months. If that embargo were allowed to lapse, it is declared that there are enough German dyes in American bonded warehouses to supply the American demand for two years.

New Ceramic School in Canada

The University of Saskatchewan, Saskatoon, Can., is perfecting plans for the establishment of a new ceramic department, to be the first such institution in Canada. W. G. Worcester, a graduate of the Ohio State University ceramic department, has been appointed professor at the new school.

Manufacturing Chemists Make Plea for Protection

Scores of chemical products are being imported even now at prices which make American competition impossible. This is only the inception of this import movement of chemicals. Conditions abroad, particularly in Germany, have retarded that country's struggle for chemical supremacy, but from this time forward a systematic attack upon the American market is anticipated. This is one of the arguments used by Henry Howard, chairman of the executive committee of the Manufacturing Chemists' Association, at his appearance before the finance committee of the Senate. The general arguments presented by Mr. Howard were embodied in a brief which was filed with the committee, and later a number of members of the association called attention to specific commodities for which increased rates were needed.

T.A.P.P.I. Notes—Plans for Fall Meeting

Among acquisitions to the membership list of the Technical Association of the Pulp and Paper Industry not previously reported are the following whose applications have been approved by the executive committee:

A. M. E. Johnstone, technical representative, Wallace & Tiernan Co., Newark, N. J.; L. J. List, engineer and sales manager, Samuel M. Langston Co., Camden, N. J.; Harold A. Morrison, sales engineer, Oliver Continuous Filter Co., 33 West Forty-second St., New York City; William J. Orchard, engineer and sales manager, Wallace & Tiernan Co., Newark, N. J.

VOCATIONAL EDUCATION TEXTBOOKS

An appeal made by the committee on vocational education of the pulp and paper industry at the annual meeting of the association in April has met with generous response in some quarters. Following the receipt of letters from the committee stating the present situation with regard to funds for the continuance of the work, \$50 contributions have been received from each of the following: McDowell Paper Mills, Manayunk, Pa.; Hummel & Downing Co., Milwaukee, Wis.; Pittston Paper Corporation, Pittston, Pa.; Kalamazoo Vegetable Parchment Co., Kalamazoo, Mich.; Bardeen Paper Co., Otsego, Mich.; Tidewater Paper Mills Co., Brooklyn, N. Y.

At the annual meeting of the Technical Association, a contribution of \$500 was made by the Champion Fibre Co., Canton, N. C., and the New York & Pennsylvania Co. donated another \$500, which, with the contributions listed, make a total of \$1,300. The amount which it is hoped to raise in the United States to defray expenses of producing the complete set of vocational education textbooks on the manufacture of pulp and paper is \$7,500. It will be recalled that \$5,000 was subscribed by the Canadian Pulp and Paper Association as a body, the pro rata assessment on United States manufacturers being \$7,500. There is yet to be raised by contribution or otherwise the sum of \$6,200. The importance of continuing the work of the vocational education committee does not require to be emphasized in any way and it is hoped that firms who have delayed in responding to the appeal of the committee for funds will at once communicate with R. S. Kellogg, secretary of the committee, 342 Madison Ave., New York.

TECHNICAL ASSOCIATION PAPERS

Series IV of *Technical Association Papers* has been issued and mailed to members. This makes a volume of 174 pages and covers. The volume contains verbatim reports of the various group meetings held during the annual convention of T.A.P.P.I., and all of the papers and their discussions are presented in full. The account of the banquet proceedings is especially interesting and entertaining. The after-dinner speeches are given in full and it is seldom that a more admirable mingling of grave and gay has been presented. Chemical warfare and the sources of the deadly gases used are described in a speech of great rhetorical ability by Prof. Bogert of Columbia University, while Ellwood Hendrick, president of the Chemists' Club, is represented with a whimsical discourse on odors which he announced as a "Homily on Olfactics." In his inimitable

fashion Dr. Hendrick spoke of odors in literature, the mnemonic associations of smell, and the function of smell in insects and animals. The relations of paper and electricity are touched upon by Calvert Townley, assistant to the president of the Westinghouse Electric & Manufacturing Co., who, however, did not stick closely to his text and told many stories. Paper's place in our daily life and the appalling situation which would develop if newspapers were abolished were the subject of an address by Arthur L. Dawe, secretary of the Canadian Pulp and Paper Association.

Technical education in general was the theme of a speech by Philip T. Dodge, president of the International Paper Co., whose talk is reported in full. Mr. Dodge made a plea for the interchange of technical knowledge and drew a picture of a project he had in mind for the establishment of a great central college or school for teaching the art of papermaking. It is a thoughtful speech well worth pondering. Series IV of *Technical Association Papers* sells for \$3 a copy.

PLANS FOR JOINT FALL MEETING

Preliminary arrangements for the joint fall meeting of the Technical Association and the Superintendents Association are nearly completed. The heads of the local committees have been in conference with the secretary of the association at Washington and sub-committees appointed. The committee appointed by the Superintendents Association to co-operate with T.A.P.P.I. consists of the following members: Robert B. Wolf, 42 Broadway, New York City; Thomas F. Heberly, Schmidt & Ault Paper Co., York, Pa.; Nelson R. Davis, S. D. Warren Co., Cumberland Mills, Me.; James A. Ramsay, Dill & Collins Paper Co., Manayunk, Pa.; Leon K. Detwiller, Diamond State Fibre Co., Bridgeport, Pa.

Fred A. Curtis, chief of the Paper Section, U. S. Bureau of Standards, Washington, D. C., is chairman of the committee of arrangements for the fall meeting of T.A.P.P.I. and the Superintendents Association, assisted by Daniel A. Smith of the District of Columbia Paper Manufacturing Co. and Grellet N. Collins of Dill & Collins Paper Co., Philadelphia.

Asks Hearing on Metric System Bill

An early hearing on his bill providing for the compulsory adoption of the metric system, after a period of ten years, has been asked by Senator Ladd of North Dakota. Senator LaFollette, the chairman of the committee on manufactures, states that he is disposed to grant the hearing but that he is dubious of securing the consent of any three members of his committee to act as a sub-committee to conduct the hearings. Senator LaFollette states that there is so much legislation at this time which appeals to him as being of greater importance that he cannot undertake the conduct of the hearings personally. He expresses the opinion that it will be difficult to find three members of the committee willing to take the time for metric system hearings during the consideration of the tariff and other matters of first importance.

Senator Ladd's plan is to conduct a short hearing at the earliest possible time in order that the outstanding arguments may be presented by each side, thus giving the public an opportunity to study the relative merits of these contentions. After the convening of the regular session in December, it is his desire to re-open the hearings and go into the question in a comprehensive way.

Byproduct Coke Statistics

A monthly summary of byproduct coke production will be issued by the U. S. Geological Survey according to the new plan recently adopted. Reports are requested from every coke-oven operator as soon as possible after the first of each calendar month for the output of byproduct coke during the previous month. Summaries of these reports will be prepared and issued as a portion of the weekly coal report of the Survey appearing in the number next following the 15th of the month succeeding that to which the data apply.

Federal Trade Commission Issues Order Against Royal Baking Powder Co.

Following inquiry, trial and final argument, the Federal Trade Commission on July 15, issued an order against the Royal Baking Powder Company to cease and desist from the sale or advertising for sale a phosphate baking powder under a label which simulates so closely as to be deceptive, a label long identified with a cream of tartar powder and from advertising price of the new powder as a reduction in price of the former product.

A competing concern complained against the Royal Baking Powder Company some months ago, charging unfair methods of competition. Testimony at trial of the case showed that the Royal Baking Powder Company in 1899 absorbed the company which manufactured and sold the well-known Dr. Price's cream baking powder, which had for its acid ingredient cream of tartar. At the trial it was shown that for a period of over sixty years prior to September, 1919, "Dr. Price's Cream Baking Powder" was marketed and advertised exclusively as cream of tartar baking powder, and that for at least thirty-five years the respondent and the Price Baking Powder Company carried on an extensive advertising campaign throughout the country to establish to consumers the superiority, especially from the point of view of healthfulness, of cream of tartar baking powder, and the inferiority of baking powders manufactured and sold by competitors which contained phosphate or alum or both as their acid ingredients. The latter competing powders were represented by the Royal Baking Powder Company in its advertising campaign to be unwholesome and deleterious.

It was further brought out in the testimony that in September, 1919, at a time when the price of cream of tartar was increasing the Royal Baking Powder Company after making certain alterations in its factory began the output of Dr. Price's baking powder substituting phosphate for cream of tartar as the acid ingredient of the commodity. It was shown also that coincidental with this change in the basic ingredients of the powder the Royal Baking Powder Company started a nation-wide campaign, advertising that the well-known Dr. Price's baking powder could now be bought by housewives for one half the price formerly charged.

This advertising campaign, it was shown by the testimony, misled the public into the belief that when it bought Dr. Price's baking powder it was buying the well-known cream of tartar brand for one half of what it formerly cost, when as a matter of fact it was buying a phosphate powder.

Standardization of Petroleum Specifications

A number of changes in the specifications used by the Federal Government for the purchase of gasoline, kerosene, fuel and lubricating oils were proposed at an open meeting of the Technical Committee on Standardization of Petroleum Specifications held at the Interior Department Building, Washington, D. C., on July 12. N. A. C. Smith, of the Bureau of Mines and chairman of the committee, presided. Representatives of the different government departments and members of the technical staffs of the various refining companies were present. The several engineering societies constituting the Advisory Board were represented by the chairman of the board, Dr. T. G. Delbridge, of the American Society for Testing Materials and the American Petroleum Institute.

The new methods of testing various petroleum products, which have recently been approved by the American Society for Testing Materials, were discussed, and although the general sentiment of the meeting favored their adoption, it was decided that careful study should first be given to each method. The methods discussed included the following tests: corrosion; flash; distillation; sulphur; cloud and pour; saponification in place of fatty oil; water and sediment, precipitation; viscosity, and melting point.

Considerable discussion arose over the distillation range of motor gasoline. It was suggested that the present 90 per cent point should be raised slightly. On the other hand,

it was argued that the specification should be retained unchanged until such time as an entirely new grade of gasoline can be used. It was said that experimental work now in progress would probably afford more information as to the correct range for motor gasoline.

In view of the fact that the specification for fuel oil for Diesel engines, which had been intended to cover a very high grade of oil for submarines, has been criticised as being too stringent, a revision of the fuel oil specifications was proposed to show how several of the present grades can be used for Diesel and other oil engines. The raising of the permissible water and sediment from 1 to 2 per cent was advocated with the penalty attached for all water and sediment above one per cent. It was shown that testing the viscosity of fuel oils at 77 instead of 70 deg. F. would be in harmony with the work of the American Society for Testing Materials.

Other subjects discussed included the proper application of the saponification number of fatty oils, more definite color standards and a corrosion test for gasoline, and the need for further definiteness in the test for the emulsifying properties of lubricants.

At the close of the meeting Chairman Smith announced that he would tabulate the various suggestions made and would, within a short time, call a meeting of the Technical Committee to vote on the final form of the revisions, which would then be submitted to the Interdepartmental Committee for approval and publication.

The Committee on Standardization of Petroleum Specifications, frequently known as the Presidential Committee, was a war-time committee originally under the direction of the Fuel Administrator but later transferred to the Bureau of Mines. Bulletin 5 was its last official publication, and contained all of the committee's testing methods and specifications in their latest revised form. This war-time committee went out of existence on January 18 of this year, when the President authorized the Secretary of the Interior to form a new Interdepartmental Committee on Standardization of Petroleum Specifications.

The new committee met and organized on February 19 and adopted Bulletin 5 pending its revision. Each member of the committee appointed a technical representative, and these representatives were directed to form a Technical Committee to consider the revision of Bulletin 5 and to make recommendations in the matter to the Interdepartmental Committee. This plan was used successfully by the previous committee. The Technical Committee has met twice and has compiled a list of suggested changes and additions to Bulletin 5. Neither committee has yet voted on these proposals, but it is now planned to compile them in final shape and the Technical Committee will then decide what recommendations it will make to the Interdepartmental Committee.

The original committee tried to maintain as close contact as possible with the various industries involved in the manufacture and use of petroleum products. To make this contact even more effective the Interdepartmental Committee authorized the formation of an Advisory Board composed of representatives of the several engineering societies interested. This board met with the Technical Committee on May 4, and appointed Dr. T. G. Delbridge, representing the American Society for Testing Materials, as chairman. It is hoped that the Advisory Board will serve to bring to the attention of the committee such changes in the specifications as may become necessary from time to time, and that it will also be able to aid the committee by making available the technical knowledge of the refiners and of the consumers of petroleum products.

Canadian Chicago Bridge & Iron Co. Changes Name

The Canadian Chicago Bridge & Iron Co., Ltd., of Bridgeburg, Ontario and Montreal, Quebec, has changed its corporate name to the Horton Steel Works, Ltd., in honor of the late Horace E. Horton, who founded the organization in the United States in 1865. The Canadian organization was first incorporated in 1913, the plant at Bridgeburg being constructed in that year.

Chemical Exposition Notes

DRIERS AND EVAPORATORS

The services of expert drying engineers from experimental drying laboratories will be at the disposal of any interested visitor at the Seventh National Exposition of Chemical Industries to be held in the Eighth Coast Artillery Armory, New York, Sept. 12 to 17. The discussion of all problems in connection with satisfaction and economy in drying products is urged by all exhibitors.

Exhibits on this subject will include a one-man machine that dries any material capable of being sprayed in three seconds, and to pass practically any mesh desired without scorching or burning, a vacuum chamber drier which dries sensitive materials which are subject to reaction, oxidation, discoloration, etc., at a high temperature, without any of these changes taking place, vacuum drum driers so constructed that every part is readily accessible, enabling the drier to be kept sanitary at all times, in fact every phase and condition of drying systems will be covered designed to eliminate all excess of consumption of steam, grinding costs, time, labor, and floor space.

Something new will be displayed in the nature of an evaporator, which will be featured by one exhibitor. This evaporator has been developed by long experience in the evaporator field. The heating tubes are neither horizontal nor vertical. They are installed in an angle position and are staggered. Steam enters the top chamber on left hand and descends through the tube toward the right. Any condensation formed falls to the bottom and goes out the pipe provided for this purpose. The steam which is not condensed rises and again descends through the tubes toward the left. This inclination of the tubes very materially increases the flow of the steam through the unit and consequently gives a very large capacity per sq.ft. of heating surface. Well directed and very violent circulation of the liquid being evaporated is one of the features of the machine, while a large expanding chamber above the heating surface has been provided.

How to turn waste liquors from a variety of chemical industries and convert noxious waste elements into a dry, compact, odorless and frequently valuable byproduct is one of the interesting subjects which will be discussed. In fact the exposition offers the technical and engineering service of the most experienced chemical engineers to visitors seeking a solution to such problems.

Petrolia Helium Plant Shut Down

Orders have been issued to reduce the staff at the Government Helium Plant No. 3 at Petrolia, Texas, and to place the heavy machinery in standby condition for the present. These orders, issued by H. Foster Bain, director of the U. S. Bureau of Mines, have been concurred in by the U. S. Helium Board, composed of representatives of the Army, Navy and Bureau of Mines.

The extreme lack of funds necessary for the continuance of the plant and the desire to reduce to an absolute minimum the present expenditures of the Government have caused officials of the Bureau of Mines, which is immediately in charge for the Army and Navy, to feel that a stage has been reached where it will be better to work with a smaller unit while accumulating the data necessary for conversion into an economical operating plant, rather than to attempt steady operations with machinery planned primarily for experimental work. This plant was built in war time to test out the Jefferies-Norton process for separation of helium from natural gas and has since been operated intermittently on an experimental basis.

It is felt by the officials of the bureau that it is possible to place the Petrolia plant in a standby condition, since the large production plant at Forth Worth, operated by the Navy, is in operation. Both plants have been drawing on the same supply for gas and it will simplify the operations of the Lone Star Gas Company, which produces it, to have Plant 3 held in reserve while the Forth Worth plant is being brought up to full scale steady operation, since success is contingent upon a steady flow of gas of fairly uniform composition.

Plant No. 3, while undergoing trials, has produced helium

of 60 per cent purity and has made repeated runs of considerable duration, yielding gas of lower purity. While by re-processing, it is possible to bring up such gas to the standard for balloon use, this would increase the cost and it has been the expectation of the Bureau of Mines that first run gas of satisfactory purity could be obtained. As a war measure, it was considered wise to build on a sufficient scale so that the experimental plant could be transformed directly into an operating unit, but with the close of the war and the completion at Forth Worth of a production plant which, to a certain extent, meets present needs, it is more economical to conduct the experimental work on a smaller scale.

The purpose of continuing it is to provide ultimately a plant which shall furnish helium at a much lower cost than is possible by any known operative system. The importance of having a supply of non-combustible balloon gas in war time, and its utility in times of peace is so great that it is necessary that every means of reducing the cost be fully studied.

American Foundrymen's Association Postpones Convention

From the date of organization to 1911 the conventions of the American Foundrymen's Association were held in May or June of each year. In 1912 it was found necessary to postpone the convention scheduled for June at Buffalo until late in September, due to delay in completing the building in which the exhibits were to be placed, and since that time the annual meetings have been held in the fall.

When the committee met this year to consider the place of the next meeting it was found that in none of the eight cities considered was it possible to find, during September or October, adequate hotel accommodations and exhibit facilities to properly care for such meetings as were held in 1919 and 1920.

Confronted with this situation and taking into consideration general industrial conditions, the committee adopted a resolution recommending to the board of directors that the convention be held in New York City, in October or November of this year, without exhibits. After due consideration it was decided to hold the next convention and exhibit in April or May, 1922, at a place to be selected by the convention and exhibits committee.

With the hotels disposed to reserve a larger percentage of their rooms for a convention in the spring than in the fall, and with the probability that better exhibition facilities can be secured in the spring of 1922, it is hoped that no difficulty will be experienced in making satisfactory arrangements for the next convention and exhibit, the place and date of which will be announced later.

New Chemical and Oil Companies

During the month of June a total of 18 new chemical concerns were organized, with an authorized capital of \$50,000 or over, and aggregate capitalization of \$3,325,000. In a same month a year ago, the combined capitalization of companies formed in that month was \$41,476,000. This month has produced the lowest point yet recorded for 1921. For the first six months of the year, the total capital represented by new companies in the chemical field is \$65,625,000. Of this aggregate, January was the largest month, with an amount of \$22,295,000; the other months totaled: February, \$6,450,000; March, \$11,765,000; April, \$9,390,000; May, \$12,400,000, and June, as noted, \$3,325,000.

During the same month, a total of 65 oil companies was formed, with aggregate capitalization of \$52,620,000, each company being capitalized for \$50,000 or more. This is the lowest month of the present year and compares with June, 1920, with a total of 132 companies, and combined capitalization of \$161,275,000. During the first six months of the present year, a total of 545 companies in this line has been organized, with aggregate capitalization involving \$812,280,000. The largest month was April, representing \$227,470,000 in combined capitals of new companies. The other months were: January, \$163,480,000; February, \$136,935,000; March, \$148,850,000; May, \$112,925,000; and June, as noted, \$52,620,000.

The Paper Industry in the Kalamazoo Valley District

There are 18 paper manufacturing companies in the Kalamazoo Valley district of Michigan, with stockholders in the different concerns totaling close to 2,000, the large majority of whom reside in this same section. Following unusually prosperous times, when large stock and cash dividends were declared, the industry is now passing through a period of curtailment. During the past 3 months the wages of employees have been reduced from 46 per cent to about 30 per cent at the different mills, and in this same period stockholders have sustained dividend losses ranging from 25 per cent upward.

C.W.S. Needs \$4,000,000 Next Year

To carry on the work of the Chemical Warfare Service during the next fiscal year on a scale necessary to insure the proper development of that arm of the military service, Congress should appropriate not less than \$4,000,000 in the opinion of chemists who are familiar with the work of the service. This is exclusive of the expense which would be required for the production of masks or other equipment. It is declared that the work on war gases is at a stage of development which requires intensive application on a variety of chemical and mechanical problems, if practical use is to be made of the more recent developments in this work.

Book Reviews

IRON AND STEEL IN SWEDEN. A compilation by *Alf Grabe*. Edited and Published under the control of and in co-operation with Jernkontoret. 183 pp., 7½ x 9½ in. New York: The Swedish Chamber of Commerce of the United States.

This well made book is frankly a piece of propaganda aimed at giving correct information regarding irons, steels and their major manufactures available for export. A list of producing firms is given under each class of material, together with post office and telegraph address, code, and export harbor. A good map is also included.

About one quarter of the hundred Swedish iron and steel firms are described in detail, and herein lies the main interest of the book to metallurgists. The equipment and plant of such well known companies as Udderholm, Bofors, Sandriken, Osterberg, Avesta, and Hellefors are described. Particularly fascinating are the historical notes, nearly every one of the operations having its beginnings centuries back.

* * *

THE CHEMISTRY OF PLANT LIFE. By *Rosecoe W. Thatcher*. 268 pages. New York: McGraw-Hill Book Co., Inc. Price, \$3.

The author states in the preface that he had in mind a two-fold purpose in the preparation of the book which bears the above title.

First, it is hoped that it may serve as a reference book for collegiate students of plant science who are seeking a proper foundation on which to build a scientific knowledge of how plants grow.

Second, the purpose of the writer will not have been fully accomplished unless the book shall serve as a stimulus to further study in a fascinating field.

The chapter headings which follow give an idea of the scope of the work:

Introduction; Plant Nutrients; Organic Components of Plants; Photosynthesis; Carbohydrates; Gums, Pectins and Celluloses; Glucosides; Tannins; Pigments; Organic Acids; Acid Salts and Esters; Fats and Oils, Waxes and Lipoids; Essential Oils and Resins; The Vegetable Bases; Proteins; Enzymes; The Colloidal Conditions; The Physical Chemistry of Protoplasm; Hormones, Auximones, Vitamines, and Toxins; Adaptations; Index.

The book seems, to the reviewer, to be a chemistry of substances which occur in plants rather than a chemistry

of plant life. It contains in its various chapters excellent discussions of the chemical properties of various important plant substances such as sugars, glucosides, fats, proteins, pigments, etc. There is, however, relatively little on the living chemistry of these compounds. Each chapter closes with a discussion of the physiological uses of and the biological significance of the compounds discussed in that chapter. This discussion is necessarily limited in most cases by the meagreness of our knowledge of the chemistry of living processes. These chapter discussions in many cases suggest various avenues of investigation for the research student. In this Dean Thatcher has accomplished his second purpose admirably. The book should also go far toward accomplishing the first purpose since a knowledge of the laboratory chemistry of those compounds which occur in plants is important for an understanding of plant problems.

Dean Thatcher's book supplies a long-felt want since it is the first book of this kind from the pen of an American scientist who is a recognized authority in this field. "The Chemistry of Plant Life" should prove useful to a large number of students, either as a text or reference work. The book is well gotten up and is interestingly written. A few errors such as usually creep into a first edition were noted. For example, the formulas of some of the sugars and glucosides are incorrectly printed.

FRED W. UPSON.

Personal

Dr. CARL L. ALSBERG, formerly chief of the Bureau of Chemistry, has left Washington, D. C., for Stanford University, where he will have the directorship of the food research institute of Leland Stanford University. Dr. Alsberg's successor has not yet been appointed.

W. H. BASSETT, technical superintendent of the American Iron Company, has been elected chairman, and G. C. Stone, metallurgist of the New Jersey Zinc Co., secretary, of a committee on zinc and zinc ores, recently organized by the American Society for Testing Materials, to work in co-operation with the American Zinc Institute.

ARTHUR M. COMEY, director of the Eastern Laboratory, E. I. duPont de Nemours Powder Co., has resigned and will reside in Cambridge, Mass. He expects to devote his time to writing.

C. D. DAVIES has been appointed managing editor of *Mechanical Engineering*, which is published by the American Society of Mechanical Engineers, succeeding the late L. G. French.

M. V. DISHER has become president of the Bertie Natural Gas Co., Ltd., Ridgway, Ont., succeeding John Young.

Dr. FEDERICO GIOLITTI is planning a brief business trip to America in a few months.

R. C. PURDY, consulting ceramic engineer, at Columbus, has been appointed chairman of the committee C-S of the American Society for Testing Materials for the study of refractories.

OTTO W. SIEBERT, Gardner, Mass., for the past twenty-three years secretary and treasurer of the Bay State Metal Wheel Co., and the Children's Vehicle Corporation, both of East Templeton, Mass., has disposed of his interest in these companies to devote his entire time to the American Fiber Co., of which he is an officer and large stockholder.

E. C. WELBORN, 29 South La Salle St., Chicago, has opened offices as business and engineering counsel in the solution of financial, business and engineering problems. He was formerly identified with the Illinois Steel Co., the Allis-Chalmers Mfg. Co., the Standard Separator Co. and for the past two years has been vice-president of the Hanna Engineering Works, Chicago, in charge of engineering development, manufacturing and sales.

C. D. YOUNG was elected president of the American Society for Testing Materials at the recent annual meeting held at Asbury Park, N. J.

Obituary

Major LOUIS A. FISCHER, chief of the Division of Weights and Measures of the Bureau of Standards, died at his home in Washington July 25, at the age of 57. Major Fischer had been in charge of that division of the Bureau's work since its foundation in 1910. Prior to that time, he served for many years in the old Weights and Measures office of the Coast and Geodetic Survey. Major Fischer obtained his title during the war, when he was commissioned to carry forward important work for the Ordnance Department. He was in immediate charge of the section of gage design.

EDWARD HARTNESS KIDDER, 82 years old, one of the founders of The Barrett Co., N. Y., died July 22.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, July 29, 1921.

There was a slight improvement noted in the volume of chemical transactions during the past week, but no apparent snap to trading was visible. Quiet intervals are to be expected during this time of the year. Interests close to the pulse of business are convinced that the market is diverging from the course it seemed headed for and that it is gradually rounding itself into good shape. That the peak of depression has passed is the general belief of some of the largest manufacturers as well as dealers. The trend of chemical values has been downward since the beginning of the year, but prices in the more important commodities are showing more resistance at present. This condition is to be expected because there are no flagrant signs of forced selling while indications favor stability after a period of liquidation experienced for so many months. No one is looking for a sharp recovery in the general list although some items with more speculative value than others will eventually follow the road of least resistance. It has been the desire of producers to stabilize the values all around and it looks as though their efforts will be successful. Price changes for the week have not been noticeable. *Bichromate of soda* has held well around former levels and the market is being watched on account of advices regarding the tanneries. *Caustic soda* has been somewhat lower in the resale market while light *soda ash* has met with support at recently quoted prices. Contract prices on both of these latter items have not been altered in the open market. *Bleaching powder* has found buyers in the paper-making industry. *Prussiate of soda* eased off slightly under the competitive attitude of sellers. *Nitrite of soda* was also a shade easier. Domestic *oxalic acid* has been well sustained while small lots of imported material have moved at concessions. Some interests believe that *mariate of potash* is due for a rise while others do not anticipate any nearby change. *Sulphuric acid* is moving quietly at old figures. Leading producers of *copper sulphate* say that June sales to the agricultural trade exceeded all previous records. *Camphor* has ruled steady and a little firmer feeling was reported.

EXPORT OUTLOOK IMPROVING

According to those well posted in foreign affairs, the export outlook is gradually improving. Throughout the European continent, except Russia, conditions are steadily progressing, although the disordered state of public finances continues to be a heavy handicap to industry. German competition in the world market is favored by the position of the mark, but, on the other hand, continued inflation of the German currency, after inflation has practically ceased in

other countries, is serving to maintain German production costs, including labor, while they are declining in other important centers. Though the Russian situation imposes a severe detriment on European recovery, it is also to be remembered that Russia has been practically cut off from Europe for several years and business has become accustomed to do without Russia. In the European situation there are also indications of a steadying of political conditions and of a better attitude of the respective nations toward each other, which are of especial significance. A restoration of political stability must in a large measure precede Europe's economic rehabilitation. From the Far East we learn that conditions in India and China are clearly, even though only slightly, better, despite the position of silver and uncertain political factors in both countries. Improvement in Japan is plainly indicated by the improvement in the bank situation. The less developed countries, those chiefly dependent on an export market for raw materials, are at this time in the least satisfactory condition. Reviewing the world situation as a whole, for the first time since the armistice there is a sound basis for a hopeful outlook.

CHEMICALS

Bichromate of potash is finding a quiet outlook at 11½@11¾c. per lb., depending upon the quantity. Small resale lots have changed hands at 11¾@12c. Odd lot sales of calcined *carbonate of potash*, 80-85 per cent, are reported at 5½c. per lb. It is very possible that this price could be shaded on a firm offer for a round lot. The 90-95 per cent is obtainable at 6c. per lb. The inquiry is not very active and the movement is confined chiefly to small quantities. Imported *caustic potash*, 88-92 per cent, is moving quietly at 4¾c. per lb. and upward, according to the size of order. Some business in this material has been booked lately while soapmakers and dealers report the market quite steady at recently quoted figures. *Standard bichromate of soda* on spot is reported firm at 8c. per lb., with light trading reported at 8@8¼c. As previously stated, offerings are not heavy and it is doubtful if much material could be purchased without advancing quotations. Producers of *bicarbonate of soda* quote the market on a basis of 2¼c. per lb. in bbls. and 2½c. per lb. in kegs f.o.b. works. Sales of spot material have been reported by dealers at \$2.40@\$2.50 per 100 lb. in bbls. ex store. Resales of solid *caustic soda* have been reported at slightly lower prices although there is no sign of real weakness in the market. Producers quote the market firm at 3¼c. per lb., basis 60 per cent f.o.b. works and 5c. per 100 lb. higher for single carload lots. Dealers quote the market at \$3.85@\$3.90 per 100 lb. for standard goods either ex store or f.a.s. N. Y. Moderate miscellaneous inquiries are reaching the market but business in most quarters appears rather quiet.

Producers of *fluoride of soda* are reporting sales of this material at 12c. per lb. ex store. Prices in the open market range from 11½@13c. per lb. While rumors of odd lots of *nitrite of soda* have been heard at slight concessions, sellers were not inclined to quote under 7c. per lb. for spot material in the resale market. The general quotation was 7@7¼c. per lb., depending on quantity and seller. Imported *prussiate of soda* is quoted at 11½c. per lb. for shipment and spot quotations were heard at 11½@11¾c. per lb. The competitive attitude of sellers is responsible for the recent decline of values. Imported *sulphide of soda*, 60-62 per cent, fused, was offered at prices ranging from 4¾@5c. per lb. The broken variety is held at 5½@6c. per lb., depending on seller and quantity. Spot offerings did not appear to be unusually free, but it was stated that goods are expected within the next few days.

Prices on spot *citric acid* range from 44@45c. per lb., with most sellers not eager to shade 44½c. Small lots are attracting some attention and the movement is mostly of a jobbing character. Manufacturers of *hydrofluoric acid* are offering the 30 per cent test at 7c. per lb. in bbls. and report some business at this figure. The 48 per cent test is quoted nominally at 10c. per lb. and the 52 per cent at 11½c. per lb. Sales of *formaldehyde* are reported at prices ranging from 12½@13c. per lb., depending upon the seller. The demand is quiet and aside from the exchange of a few

moderate quantities the movement has been devoid of any special features. Dealers of *epsom salt* report sales of the technical variety at \$1.20@1.50 per 100 lb., according to the quantity. The U.S.P. variety is held at \$2.40@2.60 per 100 lb. in carload lots and up to 3c. per lb. in smaller quantities. American *oxalic acid* is quoted at 17½c. per lb. f.o.b. works and at various figures up to 19c. per lb. on spot, depending upon seller and quantity. Small lots of imported material are quoted at 17½@17¾c. per lb., with occasional odd lot sales down to 17¼c. per lb. The inquiry for *sulphate of aluminum* was reported more active in some quarters and it was stated that the consuming trade was showing more interest. Sellers quoted the iron-free variety at 3@3½c. per lb. and the commercial at 2@2½c. per lb. Producers of *acetic acid* have slightly strengthened their views on the different grades. While it is possible that 2½c. might be done in a large way in the 28 per cent, commercial, first hands are not inclined to quote below 2¼@3c. per lb. The 56 per cent test is quoted at 5@6c. and the glacial 99 per cent is moving quietly at prices from 10@10½c. per lb., according to seller.

The inquiry for *copper sulphate* for agricultural requirements still continues active and considerable business is being placed by leading producers. In one prominent selling quarter it was stated that June sales to farming sections were the best ever recorded. Textile mills are showing more interest and some business is being recorded. The increase in sales is quite large compared with a few months ago. Export inquiries are reaching the market but little actual business is being placed. Leading producers quote 5¾c. per lb. for standard 99 per cent large crystals and up to 6c. per lb. for less than carload lots. Small crystals, 98-99 per cent, is quoted at 5½c. per lb. in carlots and ¼c. per lb. higher for smaller quantities.

COAL-TAR PRODUCTS

Leading producers of coal-tar products are firmly maintaining prices on their stocks. Some weak producers on the other hand are shading prices and holders of high priced resale goods are cutting prices. Surface conditions in the trade are rather spotty, but the undertone is surprisingly strong. One of the leading figures in the market states that in his opinion good business can be looked for at the beginning of the fall season and that in the meantime a steady improvement will be made in the volume of sales. Some producers report very favorable business over the past month, with consumers showing an increased tendency to buy ahead. On some products there undoubtedly will be further price reductions and liquidation of weak holdings may cause price flurries, but on the whole, consumers, by their recent steady buying are testifying to their faith in the stability of prices on many items. The export demand for *benzene*, particularly from England, continues strong, but supplies are limited and most of the orders remain unfilled. Domestic consumers have to be satisfied with future deliveries. Producers are firm at 27@33c. per gal. for the pure grade. *Naphthalene flakes* are easy with the demand rather light. Prime white flakes are quoted at 6¾c. per lb. and off-colored can be had down to 4c. per lb. Balls are around 8@8½c. per lb. in the resale market. Producers of *toluene* quote lower prices than resellers, but it would be difficult to obtain a round lot from other than first hands. The demand is fairly strong, but the light supply keeps the price pegged at 28c. per gal. and up, depending on quantity. Some fair sized lots of *aniline oil* sold at 18c. per lb. Other sellers ask up to 21c. The demand is light, but some routine business is passing. Surplus stocks of *beta-naphthol* are making prices saggy and the low figure of 33c. per lb. could easily be shaded on real business. Inquiries were heard at prices below the above figure. Some sellers asked up to 36c. per lb., but buyers are uninterested at the high level. Lower prices on *paranitraniline* have stimulated buying to a fair extent. Quotations range from 75@85c. per lb. Light business passed in *para-phenylenediamine* at \$1.70 with quotations ranging up to \$1.80. More interest was displayed at the close of the week. Small lot business in *benzidine sulphate* passed at 75c. per lb. The base variety held at 85c., with some sellers asking up to 90c. per lb.

The Chicago Market

CHICAGO, Ill., July 29, 1921.

Developments of importance were lacking in the industrial chemical market during the past week. Dealers report a good volume of small orders but nothing in the way of large business was noted. As a rule prices were quite firm with little or no shading. Stocks are getting smaller and practically all distressed material has been absorbed.

Caustic soda is firm and quiet with supplies light. The solid 76 per cent is quoted at \$4@4.10 per 100 lb. and the ground or flake at \$4.65. *Soda ash* is moving in a very fair way and in some quarters stocks are getting low. The prevailing quotation was \$2.60 per 100 lb. in bbls., although it was possible to shade this price slightly in some directions for quantities. *Ammonium chloride* is quiet and unchanged as to price, supplies being readily available at 7½c. per lb. for the white granular. Spot stocks of *barium chloride* are offered freely at \$75@385 per ton according to the quantity. *Copper sulphate* is moving in a small way at 6¼c. per lb. for less than car lots. The demand for *carbon tetrachloride* has dropped off somewhat but the price is firm at 11c. per lb. *Carbon bisulphide* is in better request and supplies are available at 6¾@7c. per lb. *Formaldehyde* is dull and plentiful at 14c. per lb. in single bbl. lots. There is a fair movement of methanol 95 per cent at 75c. per gal. in drums. *Glycerine* is very quiet with plentiful supplies of the C.P. available at 14¾c. per lb. There is a fair demand for *iron sulphate*, holders asking \$1.90 per 100 lb. for bbls.

A quiet market continues to be noted for *potassium bichromate* and the situation lacks new features of any kind. Buyers are interested only in small quantities and the price is unchanged at 14½@14¾c. per lb. *Sodium bichromate* is in the same position and supplies are available at 9@9½c. *Caustic potash* is quiet, dealers asking 6½@6¾c. per lb. for the 88-92 per cent material. A fair movement of *bicarbonate of soda* was noted at \$2.65 per 100 lb. *Hyposulphite of soda* continues to move in a small way to the photographic trade and dealers are asking \$4.05 per 100 lb. for the pea cryst. in bbls. *Zinc chloride* is moving in a small way and holders are asking 11@11½c. for spot goods.

There were no new developments in the acid markets during the past week, the prevailing tone being firm. The 28 per cent *acetic acid* continues to move fairly well and the price is unchanged at \$2.60 per 100 lb. for bbls. Glacial *acetic* is extremely quiet, some quarters reporting no sales. A wide range of prices are obtainable running from 8 to 11c. per lb. A brisk demand for *oxalic acid* was noted and the price is very firm at 18c. per lb. for bbls. The heavy acids are all quiet and unchanged in price. *Hydrochloric* is offered at 1¾@2c. per lb. in carboys.

VEGETABLE OILS

Linseed oil is the item demanding the most attention in this branch of the trade. This material is quoted higher at 81c. per gal. for the raw and 83c. for the boiled. Dealers report a good movement to the paint trade and appear to be well satisfied.

NAVAL STORES

Business in the naval stores market continues good and all quarters report a satisfactory volume. *Turpentine* is moving in a very fair way at 66½c. per gal. Business on the *rosins* is better and the G grade is quoted today at \$5.50 per 280 lb. in car lots. *Rosin oils* are not moving so well and the spot price is unchanged at 45c. per gal. for material in cooperage.

The Iron and Steel Market

PITTSBURGH, July 29, 1921.

The turn in the tide as to the volume of demand upon the steel mills, only barely perceptible at the time of last report, has now become more clearly marked. Beginning in sheets the improvement has spread over bars, tubular goods and probably some other products. In no case is there any sweeping change, there being merely a gradual increase in the total volume of tonnage. Buying or specifying in large lots is conspicuously absent, engagements for moderate sized lots are few, and single carload orders and specifications are impressively numerous.

The totally wrong inference is drawn in some quarters that buying is being encouraged, business is being developed, by declining prices. Scrutiny of the business placed shows plainly that this is not the case. Steel prices are declining, but reduced prices are not made on the principle of encouraging buyers to buy. It might even be said that a mill does not reduce a price to bring the order to it, but rather to forestall its going elsewhere. That is, nearly every order or specification results from a determination of the buyer to buy, and buy at once. If there is negotiation, it is merely to determine where the order is to be placed, and at what particular price.

Practically all the increase in buying and specifying is attributable to further depletion of stocks, in the hands of jobbers and manufacturing consumers. Thus, instead of there being indicated any material increase in actual ultimate consumption of goods made from steel there is indicated rather a trend in demand upon the mills toward a rate in keeping with the present level of general industrial or commercial activity. For some time past the demand upon the mills has been subnormal in this relation.

PRICES DECLINING

While no formula can be devised to represent the rate at which steel prices have been or are declining, it may be said, very roughly speaking, that the average of all steel mill products has been going down in the past few weeks at the rate of something like a dollar per net ton per week. If precisely such a rate were maintained for a weighted average of the various commodities the average would be down to zero in about a year. The illustration may be fanciful, but it furnishes an idea of what has been occurring. Steel prices now, by a weighted average, are about \$15 per net ton above the ten-year pre-war average and about \$23 above the extreme low point, touched at the end of 1914. Considering the great increases in production costs there is no room left for an actual "break" in steel prices, but apart from that consideration, the market is too soft to break. The analogy between the market and a material is inexact only in that softness is a greater preventive of breakage in a market than in a material.

In last report reference was made to a recent trend in prices toward wider spreads between large lots and small lots. In the past week the trend has rather been the other way, of prices showing less variation according to the tonnage involved. What was the large lot price of two or three weeks ago may be the carload price now, but the large lot price has not declined as much as the carload price.

The independent market on bars, shapes and plates has tended to crystallize on prices of 1.75c. for bars and 1.85c. for shapes and plates, for carloads and moderate sized lots, with possibly slight concessions in some cases for large lots. As to Pittsburgh territory the Steel Corporation retains 1.90c. on bars and 2c. on shapes and plates as its regular prices, although it is possible concessions might be made. In territory removed from Pittsburgh the "Pittsburgh plus" system has disappeared very largely in substance, though the form may remain, by the necessity of meeting independent competition, particularly in Chicago territory.

The common market on sheets is 3.25c. for black and 4.25c. on galvanized, or \$5 a ton below the prices announced July 5, but the lower prices here named might be shaded in some cases.

OPERATIONS

There has been an increase in mill operations, on the whole, in the past fortnight, but the average rate of operation of the industry cannot be estimated closely enough to show the change. Steel production is probably at about 20 per cent of capacity. Rates are quite different in different lines. Sheets are being produced at perhaps 30 per cent of capacity, tubular goods coming next. Rail production is almost zero. The most conspicuous case of improvement is that of sheet mill operations by the Steel Corporation, which were a shade under 30 per cent week before last and about 36 per cent last week, while an average of about 40 per cent is likely to mark the present week.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots		Less Carlots	
Acetic anhydride.....lb.	\$0.12	\$0.12	\$0.40	\$0.45
Acetone.....lb.	2.75	3.00	3.25	3.50
Acid, acetic, 28 per cent.....100 lbs.	5.00	5.25	5.50	6.00
Acetic, 56 per cent.....100 lbs.	10.00	10.25	10.50	10.75
Acetic, glacial, 99½ per cent, carboys, 100 lbs.	13½	14	14½	15
Boric, crystals.....lb.	15	15½	16	16½
Boric, powder.....lb.	125	150	160	175
Citric.....lb.	11½	11½	12	12½
Hydrochloric.....100 lb.	10	11	11½	12
Hydrofluoric, 52 per cent.....lb.	10½	10½	106	107
Lactic, 44 per cent tech.....lb.	4.00	4.50	4.50	5.00
Lactic, 22 per cent tech.....lb.	.....	.....	.....	.....
Molybdic, C. P.....lb.	.....	.....	.....	.....
Muriatic, 20 deg. (see hydrochloric).....lb.	.....	.....	.....	.....
Nitric, 40 deg.....lb.	.....	.....	.....	.....
Nitric, 42 deg.....lb.	.....	.....	.....	.....
Oxalic, crystals.....lb.	.....	.....	.....	.....
Phosphoric, 50 per cent solution.....lb.	.....	.....	.....	.....
Picric.....lb.	.....	.....	.....	.....
Pyrogallol, resublimed.....lb.	.....	.....	.....	.....
Sulphuric, 60 deg., tank cars.....ton	.....	.....	.....	.....
Sulphuric, 60 deg., drums.....ton	.....	.....	.....	.....
Sulphuric, 66 deg., tank cars.....ton	18.00	20.00	.....	.....
Sulphuric, 66 deg., drums.....ton	21.00	22.00	22.50	23.00
Sulphuric, 66 deg., carboys.....ton	.....	.....	.....	.....
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	21.00	22.00	.....	.....
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	23.00	23.50	24.00	24.50
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	31.00	32.50	33.00	34.00
Tannic, U. S. P.....lb.	.....	.....	.....	.....
Tannic (tech.).....lb.	45	48	50	55
Tartaric, crystals.....lb.	.....	.....	.....	.....
Tungstic, per lb. of WO.....lb.	.....	.....	.....	.....
Alcohol, Ethyl.....gal.	.....	.....	.....	.....
Alcohol, Methyl (see methanol).....gal.	.....	.....	.....	.....
Alcohol, denatured, 188 proof.....gal.	.....	.....	.....	.....
Alcohol, denatured, 190 proof.....gal.	.....	.....	.....	.....
Alum, ammonia lump.....lb.	03½	03½	04	04½
Alum, potash lump.....lb.	03½	04	04	04½
Alum, chrome lump.....lb.	10	11	11½	12½
Aluminum sulphate, commercial.....lb.	02	02½	02½	02½
Aluminum sulphate, iron free.....lb.	03	03½	03½	04
Aqua ammonia, 26 deg., drums (750 lb.).....lb.	07	07½	07½	08
Ammonia, anhydrous, cyl. (100-150 lb.).....lb.	30	32	33	35
Ammonium carbonate, powder.....lb.	08	08½	09	10
Ammonium chloride, granular (white sal ammoniac).....lb.	06½	06½	07	08
Ammonium chloride, granular (gray sal ammoniac).....lb.	06½	06½	07	07½
Ammonium nitrate.....lb.	07	07½	07½	08½
Ammonium sulphate.....100 lb.	2 20	2 25	2 30	2 40
Amylacetate.....gal.	.....	.....	.....	.....
Amylacetate tech.....gal.	.....	.....	.....	.....
Arsenic oxide, (white arsenic) powdered lb.	06½	07	07½	08
Arsenic, sulphide, powdered (red arsenic) lb.	11	11½	12	13
Barium chloride.....ton	59.00	59.50	60.00	62.00
Barium dioxide (peroxide).....lb.	20	21	22	23
Barium nitrate.....lb.	07½	07½	08	08½
Barium sulphate (precip.) (blanc fixe).....lb.	04	04½	04½	05½
Bleaching powder (see calc. hypochlorite).....lb.	.....	.....	.....	.....
Blue vitriol (see copper sulphate).....lb.	.....	.....	.....	.....
Borax (see sodium borate).....lb.	.....	.....	.....	.....
Brimstone (see sulphur, roll).....lb.	.....	.....	.....	.....
Bromine.....lb.	41	42	43	45
Calcium acetate.....100 lbs.	2.00	2.05	.....	.....
Calcium carbide.....lb.	04½	04½	05	05½
Calcium chloride, fused, lump.....ton	23.50	24.00	24.50	25.50
Calcium chloride, granulated.....lb.	01½	02	02½	02½
Calcium hypochlorite (bleach'g powder) 100 lb.	2.15	2.25	2.35	2.50
Calcium peroxide.....lb.	.....	.....	1.40	1.50
Calcium phosphate, tribasic.....lb.	.....	.....	15	16
Camphor.....lb.	.....	.....	75	78
Carbon bisulphide.....lb.	06½	07	07½	08
Carbon tetrachloride, drums.....lb.	10½	10	11	12
Carbonyl chloride (phosgene).....lb.	.....	.....	60	75
Caustic potash (see potassium hydroxide).....lb.	.....	.....	.....	.....
Caustic soda (see sodium hydroxide).....lb.	.....	.....	.....	.....
Chlorine, gas, liquid-cylinders (100 lb.).....lb.	08	09	09½	10
Chloroform.....lb.	.....	.....	38	43
Cobalt oxide.....lb.	.....	.....	3.00	3.10
Copperas (see iron sulphate).....lb.	.....	.....	.....	.....
Copper carbonate, green precipitate.....lb.	19	19½	20	21
Copper cyanide.....lb.	.....	.....	50	62
Copper sulphate, crystals.....lb.	05½	06	06½	06½
Cream of tartar (see potassium bitartrate).....lb.	.....	.....	.....	.....
Epsom salt (see magnesium sulphate).....lb.	.....	.....	.....	.....
Ethyl Acetate Com. 85%.....gal.	.....	.....	1.00	1.10
Ethyl Acetate pure (acetic ether 98% to 100%).....lb.	.....	.....	50	52
Formaldehyde, 40 per cent.....lb.	12½	13	13½	13½
Fusel oil, ref.....gal.	.....	.....	3.25	3.75
Fusel oil, crude.....gal.	.....	.....	1.75	2.00
Glauber's salt (see sodium sulphate).....lb.	.....	.....	.....	.....
Glycerine, C. P. drums extra.....lb.	.....	.....	14½	15
Iodine, resublimed.....lb.	.....	.....	3.65	3.75
Iron oxide, red.....lb.	.....	.....	10	20
Iron sulphate (copperas).....ton	19.60	20.00	21.00	22.00
Lead acetate.....lb.	.....	.....	11½	13½
Lead arsenate, paste.....lb.	09	09½	10	11
Lead nitrate.....lb.	.....	.....	15	20
Litharge.....lb.	08½	08½	08½	09
Lithium carbonate.....lb.	.....	.....	1.30	1.40
Magnesium carbonate, technical.....lb.	09	09½	10	11
Magnesium sulphate, U. S. P.....100 lb.	2.40	2.75	.....	.....
Magnesium sulphate, technical.....100 lb.	.....	.....	1.20	1.60
Methanol, 95%.....gal.	.....	.....	83	85
Methanol, 97%.....gal.	.....	.....	86	88
Nickel salt, double.....lb.	.....	.....	12	12½
Nickel salt, single.....lb.	.....	.....	14	14½
Phosgene (see carbonyl chloride).....lb.	.....	.....	.....	.....
Phosphorus, red.....lb.	45	46	47	50
Phosphorus, yellow.....lb.	.....	.....	35	37
Potassium bichromate.....lb.	11½	11½	12	12½

	Carlots	Less Carlot
Potassium bitartrate (cream of tartar)..... lb.	\$ 35 - 40	\$0 29 - \$0 30
Potassium bromide, granular..... lb.	.....	16 - 25
Potassium carbonate, U. S. P..... lb.	35 - 40	45 - 50
Potassium carbonate, 80-85%..... lb.	.05 - .05	06 - 07
Potassium chlorate, crystals..... lb.	.07 - .07	08 - 12
Potassium cyanide..... lb.	.....	26 - 28
Potassium hydroxide (caustic potash)..... lb.	.04 - .05	.05 - .05
Potassium muriate, 80% K.C.L..... ton	45.00 - 50.00	.....
Potassium iodide..... lb.	.....	2 75 - 3 00
Potassium nitrate..... lb.	.09 - .09	10 - 12
Potassium permanganate..... lb.	.29 - .30	31 - 32
Potassium prussiate, red..... lb.	.28 - .29	29 - 30
Potassium prussiate, yellow..... lb.	.22 - .22	23 - 23
Potassium sulphate (powdered)..... per unit	.....	1 35 - 1 35
Rochelle salts (see sodium potas tartrate).....	.....	.....
Salammoniac (see ammonium chloride).....	.....	.....
Salt soda (see sodium carbonate).....	.....	.....
Salt cake..... ton	.....	20 00 - 25 00
Silver cyanide..... oz.	.....	1 35 - 1 38
Silver nitrate..... oz.	.....	40 - 41
Soda ash light..... 100 lb.	2.10 - 2.15	2 20 - 2 50
Soda ash, dense..... 100 lb.	2.35 - 2 40	2 45 - 2 70
Sodium acetate..... lb.	.04 - .04	.04 - .05
Sodium bicarbonate..... 100 lb.	2.25 - 2 40	2 50 - 2 75
Sodium bichromate..... lb.	.08 - .08	.08 - .09
Sodium bisulphate (nitre cake)..... ton	5.00 - 5 25	5 50 - 6 50
Sodium bisulphate powdered, U.S.P..... lb.	.05 - .05	.05 - .06
Sodium borate (borax)..... lb.	.06 - .06	.06 - .07
Sodium carbonate (salt soda)..... 100 lb.	1.90 - 2.00	2 10 - 2 40
Sodium chloride..... lb.	.07 - .07	.08 - .08
Sodium cyanide..... lb.	.19 - .21	.22 - .30
Sodium fluoride..... lb.	.11 - .12	.12 - .13
Sodium hydroxide (caustic soda)..... 100 lb.	3.85 - 3.90	4 00 - 4 50
Sodium hyposulphite..... lb.	.....	.03 - .03
Sodium nitrate..... 100 lb.	2.30 - 2 50	2 50 - 2 50
Sodium nitrite..... lb.	.07 - .07	.07 - .08
Sodium peroxide, powdered..... lb.	.25 - .26	.27 - .30
Sodium phosphate, dibasic..... lb.	.04 - .04	.05 - .05
Sodium potassium tartrate (Rochelle salts)..... lb.	.....	.26 - .27
Sodium prussiate, yellow..... lb.	.11 - .12	.12 - .12
Sodium silicate, solution (40 deg.)..... 100 lb.	1.00 - 1 15	1 25 - 1 40
Sodium silicate, solution (60 deg.)..... lb.	.02 - .03	.03 - .03
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	1.50 - 1 75	2 00 - 2 25
Sodium sulphide, fused, 60-62 per cent (conc.) lb.	.04 - .05	.05 - .06
Sodium sulphite, crystals..... lb.	.03 - .04	.04 - .04
Strontium nitrate, powdered..... lb.	.15 - .15	.16 - .17
Sulphur chloride, red..... lb.	.07 - .07	.07 - .08
Sulphur, crude..... ton	20.00 - 22 00	.....
Sulphur dioxide, liquid, cylinders exu..... lb.	.08 - .08	.09 - .10
Sulphur (sublimed), flour..... 100 lb.	.....	2 25 - 3 10
Sulphur, roll (brim tone)..... 100 lb.	.....	2 00 - 2 75
Tin bichloride, 50 per cent..... lb.	.18 - .19	.....
Tin oxide..... lb.	.....	.40 - .42
Zinc carbonate, precipitate..... lb.	.15 - .16	.16 - .17
Zinc chloride, gran..... lb.	.11 - .11	.11 - .12
Zinc cyanide..... lb.	.45 - .49	.50 - .60
Zinc dust..... lb.	.11 - .11	.11 - .12
Zinc oxide, XX..... lb.	.07 - .07	.08 - .09
Zinc sulphate..... 100 lb.	3 00 - 3 25	3 30 - 3 50

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude..... lb.	\$1 10 - \$1 15
Alpha-naphthol, refined..... lb.	1 25 - 1 30
Alpha-naphthylamine..... lb.	.35 - .40
Aniline oil, drums extra..... lb.	.18 - .21
Aniline salts..... lb.	.25 - .28
Anthracene, 80% in drums (100 lb.)..... lb.	.75 - 1 00
Benzaldehyde U.S.P..... lb.	1.00 - 1 25
Benzidine, base..... lb.	.85 - 1 00
Benzidine sulphate..... lb.	.75 - .85
Benzoic acid, U.S.P..... lb.	.60 - .65
Benzoate of soda, U.S.P..... lb.	.55 - .60
Benzene, pure, water-white, in drums (100 gal.)..... gal.	.27 - .32
Benzene, 90%, in drums (100 gal.)..... gal.	.25 - .28
Benzyl chloride, 95-97%, refined..... lb.	.25 - .27
Benzyl chloride, tech..... lb.	.20 - .23
Beta-naphthol benzoate..... lb.	3 50 - 4 00
Beta-naphthol, sublimed..... lb.	.70 - .75
Beta-naphthol, tech..... lb.	.32 - .37
Beta-naphthylamine, sublimed..... lb.	1.75 - 1 80
Cresol, U. S. P., in drums (100 lb.)..... lb.	.16 - .18
Ortho-cresol, in drums (100 lb.)..... lb.	.25 - .27
Cresylic acid, 97-99%, straw color, in drums..... gal.	.68 - .75
Cresylic acid, 75-97%, dark, in drums..... gal.	.65 - .70
Cresylic acid, 50%, first quality, drums..... gal.	.45 - .50
Dichlorobenzene..... lb.	.06 - .09
Diethylaniline..... lb.	1.20 - 1 25
Dimethylaniline..... lb.	.38 - .48
Dinitrobenzene..... lb.	.26 - .28
Dinitrochlorobenzene..... lb.	.20 - .30
Dinitronaphthalene..... lb.	.30 - .40
Dinitrophenol..... lb.	.35 - .40
Dinitrotoluene..... lb.	.27 - .30
Dip oil, 25%, car lots, in drums..... gal.	.40 - .45
Diphenylamine..... lb.	.60 - .65
H-acid..... lb.	1 15 - 1 25
Meta-phenylenediamine..... lb.	1 15 - 1 20
Monochlorobenzene..... lb.	.12 - .14
Monoethylaniline..... lb.	1 75 - 1 85
Naphthalene crushed, in bbls..... lb.	.05 - .08
Naphthalene, flake..... lb.	.06 - .08
Naphthalene, balls..... lb.	.08 - .09
Naphthionic acid, crude..... lb.	.70 - .75
Nitrobenzene..... lb.	.12 - .15
Nitro-naphthalene..... lb.	.30 - .35
Nitro-toluene..... lb.	.16 - .18
Ortho-amidophenol..... lb.	3 10 - 3 20
Ortho-dichlor-benzene..... lb.	.15 - .20
Ortho-nitro-phenol..... lb.	.80 - .85
Ortho-nitro-toluene..... lb.	.15 - .20
Ortho-toluidine..... lb.	.20 - .25
Para-amidophenol, base..... lb.	1 40 - 1 45
Para-amidophenol, HCl..... lb.	1 60 - 1 75

Para-dichlorobenzene..... lb.	15 - 20
Paramethaniline..... lb.	75 - 80
Para-nitrotoluene..... lb.	45 - 50
Para-phenylenediamine..... lb.	70 - 75
Para-toluene..... lb.	25 - 30
Phthalic anhydride..... lb.	30 - 35
Phenol, U. S. P., drums..... lb.	20 - 25
Pyridine..... gal.	2 00 - 3 50
Resorcinol, technical..... lb.	1 40 - 1 45
Resorcinol, pure..... lb.	2 25 - 2 30
Salicylic acid, tech., in bbls..... lb.	20 - 22
Salicylic acid, U. S. P..... lb.	23 - 25
Salol..... lb.	41 - 45
Solvent naphtha, water-white, in drums, 100 gal..... gal.	25 - 28
Solvent naphtha, crude, heavy, in drums, 100 gal..... gal.	24 - 26
Sulphanilic acid, crude..... lb.	30 - 35
Tolidine..... lb.	25 - 35
Toluidine, mixed..... lb.	40 - 45
Toluene, in tank cars..... gal.	25 - 28
Toluene, in drums..... gal.	28 - 31
Xylidines, drums, 100 gal..... lb.	40 - 45
Xylene, pure, in drums..... gal.	40 - 45
Xylene, pure, in tank cars..... gal.	45 - 48
Xylene, commercial, in drums, 100 gal..... gal.	33 - 35
Xylene, commercial, in tank cars..... gal.	30 - 32

Waxes

Prices based on original packages in large quantities

Beeswax, refined, dark..... lb.	\$0 24 - \$0 25
Beeswax, refined, light..... lb.	27 - 28
Beeswax, white pure..... lb.	40 - 45
Carnauba, Florida..... lb.	58 - 60
Carnauba, No. 2, North Country..... lb.	25 - 26
Carnauba, No. 3, North Country..... lb.	13 - 14
Japan..... lb.	15 - 16
Montan, crude..... lb.	00 - 00
Paraffine waxes, crude match wax (white) 105-110 m.p..... lb.	03 - 03
Paraffine waxes, crude, scale 124-126 m.p..... lb.	02 - 02
Paraffine waxes, refined, 118-120 m.p..... lb.	03 - 03
Paraffine waxes, refined, 125 m.p..... lb.	03 - 03
Paraffine waxes, refined, 128-130 m.p..... lb.	04 - 04
Paraffine waxes, refined, 133-135 m.p..... lb.	04 - 05
Paraffine waxes, refined, 135-137 m.p..... lb.	05 - 06
Stearic acid, single pressed..... lb.	09 - 09
Stearic acid, double pressed..... lb.	09 - 09
Stearic acid, triple pressed..... lb.	10 - 10

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl..... 280 lb.	\$5 10 - 5 15
Rosin E-L..... 280 lb.	5 20 - 5 45
Rosin K-N..... 280 lb.	5 70 - 6 75
Rosin W. G.-W. W..... 280 lb.	7 35 - 7 40
Wool rosin, bbl..... 280 lb.	6 25 - 6 30
Spirit of turpentine..... gal.	59 - 59
Wood turpentine, steam dist..... gal.	57 - 57
Wood turpentine, dest. dist..... gal.	55 - 55
Pine tar pitch, bbl..... 200 lb.	.....
Tar, kiln burned, bbl. (500 lb.)..... bbl.	.....
Retort tar, bbl..... 500 lb.	.....
Rosin oil, first run..... gal.	35 - 35
Rosin oil, second run..... gal.	37 - 37
Rosin oil, third run..... gal.	41 - 41
Pine oil, steam dist., sp.gr. 0.930-0.940..... gal.	\$1 80 - 1 80
Pine oil, pure, dest. dist..... gal.	1 50 - 1 50
Pine tar oil, ref., sp.gr. 1.025-1.035..... gal.	46 - 46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla..... gal.	35 - 35
Pine tar oil, double ref., sp.gr. 0.965-0.990..... gal.	75 - 75
Pine tar, ref., thin, sp.gr. 1.080-1.060..... gal.	35 - 35
Turpentine, crude, sp.gr. 0.900-0.970..... gal.	1 20 - 1 20
Hardwood oil, f.o.b. Mich., sp.gr. 0.960-0.990..... gal.	35 - 35
Pinewood creosote, ref..... gal.	52 - 52

Solvents

73-76 deg., steel bbls. (85 lb.)..... gal.	\$0 41 - 0 41
70-72 deg., steel bbls. (85 lb.)..... gal.	30 - 30
68-70 deg., steel bbls. (85 lb.)..... gal.	38 - 38
V. M. and P. naphtha, steel bbls. (85 lb.)..... gal.	30 - 30

Crude Rubber

Para-Upriver fine..... lb.	\$0 16 - 0 17
Upriver coarse..... lb.	09 - 09
Upriver caucho ball..... lb.	11 - 12
Plantation—First latex crepe..... lb.	14 - 14
Ribbed smoked sheets..... lb.	12 - 12
Brown crepe, thin, clean..... lb.	15 - 15
Amber crepe No. 1..... lb.	17 - 17

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls..... lb.	\$0 09 - \$0 09
Castor oil, AA, in bbls..... lb.	10 - 10
China wood oil, in bbls. (f.o.b. Pac. coast)..... lb.	12 - 12
Cocanut oil, Ceylon grade, in bbls..... lb.	09 - 10
Cocanut oil, Cochon grade, in bbls..... lb.	10 - 11
Corn oil, crude, in bbls..... lb.	08 - 08
Cottonseed oil, crude (f.o.b. mill)..... lb.	08 - 08
Cottonseed oil, summer yellow..... lb.	09 - 09
Cottonseed oil, winter yellow..... lb.	09 - 09
Linseed oil, raw, car lots (domestic)..... gal.	78 - 79
Linseed oil, raw, tank cars (domestic)..... gal.	72 - 73
Linseed oil, in 5-bbl lots (domestic)..... gal.	80 - 81

Olive oil, Denatured.....	gal.	\$1.30	—	\$1.40
Palm, Lagos.....	lb.	.06½	—	.06¾
Palm, Niger.....	lb.	.05½	—	.05¾
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.07½	—	.07¾
Peanut oil, refined, in bbls.....	lb.	.10½	—	.10¾
Rapeseed oil, refined in bbls.....	gal.	.90	—	.92
Rapeseed oil, blown, in bbls.....	gal.	.94	—	.95
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.07½	—	.....
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.06½	—	.....

FISH

Light pressed menhaden.....	gal.	\$0.42	—	.....
Yellow bleached menhaden.....	gal.	.44	—	.....
White bleached menhaden.....	gal.	.46	—	.....
Blown menhaden.....	gal.	.50	—	.....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$24.00	—	30.00
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	22.00	—	26.00
Barytes, crude, 88% @ 94% ba., Kings Creek.....	net ton	10.00	—	12.00
Barytes, floated, f.o.b. St. Louis.....	net ton	26.50	—	28.00
Barytes, crude, first grade, Missouri.....	net ton	7.00	—	.....
Blanc fixe, dry.....	lb.	.04½	—	.04¾
Blanc fixe, pulp.....	net ton	45.00	—	55.00
Casein.....	lb.	.03½	—	.07½
Chalk, domestic, extra light.....	lb.	.04½	—	.05
Chalk, domestic, light.....	lb.	.04	—	.04½
Chalk, domestic, heavy.....	lb.	.03¾	—	.04
Chalk, English, extra light.....	lb.	.04½	—	.05
Chalk, English, light.....	lb.	.04½	—	.05
Chalk, English, dense.....	lb.	.04	—	.04½
China clay (kaolin) crude, f.o.b. mines, Georgia.....	net ton	8.00	—	10.00
China clay (kaolin) washed, f.o.b. Georgia.....	net ton	12.00	—	15.00
China clay (kaolin) powdered, f.o.b. Georgia.....	net ton	18.00	—	22.00
China clay (kaolin) crude f.o.b. Virginia points.....	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points.....	net ton	15.00	—	25.00
China clay (kaolin), imported, lump.....	net ton	12.00	—	20.00
China clay (kaolin), imported, powdered.....	net ton	20.00	—	25.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	net ton	5.00	—	7.50
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27.00	—	30.00
Fullers earth, f.o.b. Mines.....	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Pa.....	net ton	15.00	—	18.00
Fullers earth, powdered, f.o.b. Fla.....	net ton	18.00	—	.....
Fullers earth, imported, powdered.....	net ton	24.00	—	27.00
Graphite, Ceylon lump, first quality.....	lb.	.07	—	.07½
Graphite, Ceylon chip.....	lb.	.05½	—	.05¾
Graphite, high grade amorphous crude.....	lb.	.02½	—	.03
Pumice stone, imported, lump.....	lb.	.04	—	.50
Pumice stone, domestic lump.....	lb.	.05	—	.05½
Pumice stone, ground.....	lb.	.06	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore.....	net ton	.....	—	10.00
Quartz (acid tower) 1½ @ 2 in., f.o.b. Baltimore.....	net ton	.....	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	.....	—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange fine.....	lb.	.68	—	.69
Shellac, orange superfine.....	lb.	.53	—	.54
Shellac, A. C. garnet.....	lb.	.46	—	.47
Shellac, T. N.....	lb.	.47	—	.48
Soapstone.....	ton	12.00	—	15.00
Sodium chloride.....	long ton	12.50	—	13.00
Talc, paper-making grades, f.o.b. Vermont.....	ton	11.00	—	20.00
Talc, roofing grades, f.o.b. Vermont.....	ton	8.50	—	13.00
Talc, rubber grades, f.o.b. Vermont.....	ton	11.00	—	18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	10.00	—	14.00
Talc, imported.....	ton	30.00	—	40.00
Talc, California talcum powder grade.....	ton	18.00	—	40.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	per ton	\$37.50—40.00
Carborundum refractory brick, 9-in.	1,000	1250.00
Chrome brick, f.o.b. Eastern shipping points.....	1,000	1100.00
Chrome cement, 40-45% Cr ₂ O ₃	net ton	60
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in car lots, f.o.b. Eastern shipping points.....	net ton	30—32
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	33—35
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	36—40
Magnesite brick, 9-in. straight.....	net ton	30—35
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	70
Magnesite brick, soaps and splits.....	net ton	77
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	98
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	42—45
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	46—50
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	35—38

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00 — \$225.00
Ferrochrome per lb. of Cr. contained, 6-8% carbon, carlots.....	lb.	.14 —
Ferrochrome, per lb. of Cr. contained, 4-6% carbon, carlots.....	lb.	.15 —
Ferromanganese, 76-80% Mn, domestic.....	net ton	70.00 —
Ferromanganese, 76-80% Mn, English.....	net ton	70.00 —
Spiegelisen, 18-22% Mn.....	net ton	26.00 — 27.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.50 —
Ferrosilicon, 10-15%.....	net ton	40.00 — 42.00
Ferrosilicon, 50%.....	net ton	65.00 — 68.00
Ferrosilicon, 75%.....	net ton	135.00 — 138.00
Ferrotungsten, 70-80%, per lb. of contained W.....	lb.	.45 — .50
Ferroumium, 35-50% of U, per lb. of U content.....	lb.	6.00 —
Ferrovannadium, 30-40% per lb. of contained V.....	lb.	4.25 — 4.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content.....	net ton	\$8.00 — \$10.00
Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃	unit	.30 — .33
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard.....	unit	.30 — .33
Coke, foundry, f.o.b. ovens.....	net ton	4.00 — 4.50
Coke, furnace, f.o.b. ovens.....	net ton	2.75 — 3.00
Coke, petroleum, refinery, Atlantic seaboard.....	net ton	14.00 — 15.00
Fluorspar, lump, f.o.b. mines, New Mexico.....	net ton	12.50 —
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	20.00 —
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01½ — .01¾
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	.22 —
Manganese ore, chemical (MnO ₂).....	net ton	50.00 — 55.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.55 — .60
Monazite, per unit of ThO ₂ , c.i.f., Atlantic seaport.....	unit	30.00 —
Pyrites, Spanish, fines, c.i.f., Atlantic seaport.....	unit	.12 — .12
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.12 — .12
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.11 — .12
Rutile, 95% TiO ₂ per lb. ore.....	lb.	.15 —
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	2.75 — 3.00
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	3.00 — 3.25
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	1.50 — 2.50
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.25 — 2.50
Vanadium pentoxide, 99%.....	lb.	12.00 — 14.00
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1.00 —
Zircon, washed, iron free.....	lb.	.03 —

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic.....	12.00
Aluminum, 98 to 99 per cent.....	24.50 @ 25
Antimony, wholesale lots, Chinese and Japanese.....	4½
Nickel, ordinary (ingot).....	41.00
Nickel, electrolytic.....	44.00
Monel metal, spot and blocks.....	35.00
Monel metal, ingots.....	38.00
Monel metal, sheet bars.....	40.00
Tin, 5-ton lots, S. rails.....	26.375
Lead, New York, spot.....	4.35—4.40
Lead, E. St. Louis, spot.....	4.20—4.25
Zinc, spot, New York.....	4.55
Zinc, spot, E. St. Louis.....	4.20

OTHER METALS

Silver (commercial).....	oz.	\$0.61½
Cadmium.....	lb.	1.00—1.25
Bismuth (500 lb. lots).....	lb.	1.50 @ 1.55
Cobalt.....	lb.	3.00 @ 3.25
Magnesium (f.o.b. Philadelphia).....	lb.	1.25
Platinum.....	oz.	72.00 @ 75.00
Iridium.....	oz.	160.00 @ 180.00
Palladium.....	oz.	60.00—65.00
Mercury.....	.75 lb.	43.50—45.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled.....	20.50—20.75
Copper bottoms.....	28.00—28.25
Copper rods.....	19.25—20.00
High brass wire.....	16.75
High brass rods.....	13.75
Low brass wire.....	18.25
Low brass rods.....	18.25
Brazed brass tubing.....	27.00
Brazed bronze tubing.....	31.75
Seamless copper tubing.....	21.00
Seamless high brass tubing.....	18.50

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current	Cleveland	Chicago
Copper, heavy and crucible.....	9.00 @ 9.25	9.25	9.50
Copper, heavy and wire.....	8.25 @ 8.50	8.50	8.50
Copper, light and bottoms.....	7.00 @ 7.25	7.50	7.25
Lead, heavy.....	3.00 @ 3.25	3.25	3.25
Lead, tea.....	2.25 @ 2.35	2.25	2.25
Brass, heavy.....	4.00 @ 4.25	4.50	5.00
Brass, light.....	3.00 @ 3.25	3.25	3.50
No. 1 yellow brass turnings.....	3.75 @ 4.00	4.25	4.50
Zinc.....	2.00 @ 2.25	2.00	2.25

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ½ in. and larger, and plates ½ in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes.....	\$2.23	\$3.00	\$3.00
S ft steel bars.....	2.18	2.80	2.80
Soft steel bar shapes.....	2.18	2.90	2.90
Soft steel bands.....	2.50	3.20	3.20
Plates, ½ to 1 in. thick.....	2.18	3.00	3.00

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Arkansas

LITTLE ROCK—The Grandfield Refining Co., Kansas City, Mo., Garland Biffle, head of the company in charge, has plans under way for the establishment of a new branch oil refining plant at Little Rock, with initial capacity of about 5,000 bbl. Departments will be installed for the production of gasoline and naphtha. The new plant is estimated to cost about \$200,000 with equipment.

California

OXNARD—The Sierra Oil & Refining Co. has plans under way for the erection of a new local refinery to handle crude petroleum from the Camarillo-Conejo fields, in which the company is operating.

Delaware

WILMINGTON—The Atlas Powder Co., du Pont Bldg., has awarded a contract to the Austin Co., Bulletin Building, Philadelphia, Pa., for the erection of its proposed new 1-story experimental laboratory at Gray Street and Lancaster Avenue, to be 60x80-ft. The company has arranged for a bond issue of \$4,000,000 for general operations, financing, etc. W. J. Webster is president.

WILMINGTON—The Wilmington Sugar Refinery Co. has pile-driving and foundation work under way for the erection of its proposed new local sugar refining plant, to be 9-story, brick and steel, and estimated to cost in excess of \$2,500,000 with machinery. W. J. Wayte, Inc., Grand Central Terminal, New York, N. Y., is architect and engineer.

Florida

APOPKA—The Florida Insecticide Co. is perfecting plans for the construction of a new local plant, 46x50 ft., for the manufacture of insecticides and chemical specialties. J. C. Grossenbacher is manager.

Illinois

CHICAGO—The Waterway Paper Co., Kedzie Ave. and 32d St., has completed plans for the erection of a new 1-story plant on Kedzie Ave., 80x180 ft., estimated to cost about \$175,000, including power plant, 33x60 ft. Frank D. Chase, Inc., 645 North Michigan Ave., is architect and engineer.

RAYVILLE—The Hercules Powder Co., du Pont, Bldg., Wilmington, Del., is arranging for a number of improvements in its local dynamite plant, now inactive. It is proposed to resume operations at the works early in the fall.

Indiana

ALEXANDRIA—The Lippincott Glass Co. will make a number of improvements in its plant, including machinery repairs and betterments, during the remainder of the summer. The plant recently was closed down and will re-open early in the fall.

EVANSVILLE—The Graham Glass Co. is planning for the resumption of operations at its local plant at capacity early in September, concentrating on the production of bottles for beverages. Manufacture recently was curtailed with about 50 per cent of the regular working force.

Louisiana

SHREVEPORT—The Gulf States Chemical Co., has acquired the plant and adjoining property of the National Glass Co. The new owner will enlarge the works and make a number of improvements in present buildings for the manufacture of chemical specialties. Equipment will be installed at an early date. W. H. Raplee is vice-president.

NEW IBERIA—Fire, July 20, destroyed the refining plant of the Morshahn Sugar Co., with loss estimated at about \$250,000, including machinery and stock. It is reported that the plant will be rebuilt.

SHREVEPORT—The United States Window Glass Co., Morgantown, W. Va., is tak-

ing bids for the erection of its proposed new plant at Shreveport, to consist of a number of buildings, estimated to cost close to \$3,500,000 with machinery. The main glass works will be 1-story, 400x850 ft., with 3-story clay department, 80x140 ft. Other structures will include a power plant and box factory, the latter, 1-story, 100x200 ft. The DeVore Co., 908 Nicholas Bldg., Toledo, Ohio, is architect and engineer. Walter A. Jones is president. It is proposed to commence erection at an early date.

Maryland

CUMBERLAND—A number of former employees of the Wellington Glass Co. are in negotiation with Franklin H. Ankeney, secretary of the local Chamber of Commerce, for the rebuilding of the Wellington plant, destroyed by fire more than a year ago. It is proposed to re-establish the works, giving employment to close to 300 operatives.

Michigan

DETROIT—The Peninsular Paper Can Co., Detroit, is said to be planning for the establishment of a new plant at Monroe, Mich., for the manufacture of paper cans and other containers. It is proposed to inaugurate work at an early date, having the plant ready for service early in the fall. The company is arranging for a state charter with capital of \$500,000. R. P. Adams, sales manager of the Detroit Heating & Lighting Co., is president.

Missouri

OZARK—The Bain Mining Co. is perfecting plans for the construction of a new concentrating plant, electrically operated, with capacity of about 250 tons, at its local ore properties; the company has a tract of about 600 acres of land for development. John Denton, Ozark, is vice-president and construction engineer. Eastern offices of the company are at 925 Market Street, Wilmington, Del.

Nebraska

ANTIOCH—The Nebraska Potash Works has plans under way for the erection of new plant units to replace the portion of its plant recently destroyed by fire. The new buildings with equipment are estimated to cost about \$250,000.

Nevada

RENO—The Candelaria Mines Co. has approved plans for the erection of a new reduction plant at its silver properties in the Lucky Hill district. The initial cyanide unit will have a capacity of close to 200 tons of ore daily, while the crushing plant will be equipped for a production of about 400 tons per day. Eastern offices of the company are at 43 Exchange Place, New York, N. Y.

New Jersey

TRENTON—Milton Mirkens has acquired the former mill of the Ewing Rubber Co., Hilton Ave., for the establishment of a new plant for the manufacture of rubber goods. The structure will be remodeled at once and necessary machinery installed. The plant site totals 205x235 ft., providing space for future buildings.

NEWARK—Eric Steiner has leased the building in the rear of 52-54 Lafayette St., fronting on Maple Place, for the establishment of a new plant for the manufacture of colors, chemicals, etc., for the coloring of leather. Immediate possession will be taken and necessary equipment installed.

LINDEN—As soon as insurance has been adjusted, the Warner-Quinlan Asphalt Co., 79 Wall St., New York, N. Y., will commence the rebuilding of its plant at Linden, destroyed by fire July 18, with loss estimated at \$3,500,000, including equipment. In addition to the main manufacturing works, the loss included oil stills, oil tanks, asphalt tanks, gasoline tanks, machine shop and mechanical buildings, laboratory and power plant. Charles Almquist is superintendent.

GLASSBORO—The Owens Bottle Co. has started up one of the furnaces at its plant

at South Glassboro, following a curtailment of several weeks. Improvements and repairs are being made to the other furnaces at the plant, with plans to start up other units at an early date.

New York

ALBANY—A new 1-story foundry for the production of bronze and brass castings will be erected at the plant of the Thatcher Propeller & Machine Co., Learned St. The structure, with new machine shop to be built, is estimated to cost about \$150,000. George Thatcher is president.

BUFFALO—The Iroquois Natural Gas Co., Iroquois Building, has increased its capital from \$10,000,000 to \$11,000,000, the proceeds to be used for plant extensions and improvements. Bert C. Oliphant is president.

BROOKLYN—The Doshier Die-Casting Co., Court and Huntington Sts., has commenced the construction of a new gas manufacturing plant at its works to cost about \$40,000. The plant will be for exclusive plant service and is being constructed owing to the prevailing high rate for gas. Operation is estimated at 40c. per 1,000 cu.ft.

BUFFALO—The Archer-Daniels Linseed Co., Buffalo River, near Hamburg Turnpike, is said to be planning for the rebuilding of the portion of its plant destroyed by fire July 10, with loss estimated at about \$50,000, including equipment.

Ohio

YOUNGSTOWN—The Republic Rubber Corp. has resumed operations at its plant, following a suspension of several weeks, giving employment to about 700 operatives. Work will be conducted under the direction of H. C. Booth, receiver.

CLEVELAND—The Noble Refining Co., 706 Canal Road, has awarded a contract to the Camp Construction, Altamont Bldg., for the erection of its proposed new oil plant at East 99th St. and Elk Ave., estimated to cost about \$80,000. A power house will also be constructed.

Oklahoma

TULSA—The Constantin Refining Co., operating local oil refineries, has arranged for a bond issue of \$4,000,000 for improvements, extensions, general operations, etc. E. Constantin, Sr., is president.

Tennessee

MOUNT PLEASANT—The Phosphates Products Co., recently organized, is perfecting plans for the early erection of its proposed new local plant for the manufacture of fertilizer products. A number of plant departments will be installed, each for the purpose of manufacturing particular kinds of fertilizers.

Texas

HOUSTON—The Southern Brass & Plating Co. is planning for the rebuilding of the portion of its plant recently destroyed by fire.

West Virginia

MORGANTOWN—The South Penn Oil Co. is planning for extensions in its tankage department at a cost of about \$300,000. A number of new tanks, each with capacity of 74,000 bbl., will be installed.

HUNTINGTON—A new 1-story foundry, 50x120 ft., will be erected by the West Virginia Foundry & Stove Co., to be equipped for the manufacture of iron castings. It is proposed to double, approximately, the present plant output. Frank C. Boggess is manager.

Wisconsin

TOMAHAWK—The Tomahawk Steel & Iron Co. will take bids early in August for the construction of a new 2- and 3-story plant, 100x180 ft., to replace its works recently destroyed by fire. The new plant is estimated to cost about \$75,000. William Bauman is manager.

MILWAUKEE—The Filler & Stowell Co., 219-45 Beecher St., manufacturer of machinery, will make improvements and extensions in its 1-story foundry to cost about \$16,000. Walter Read is president.

Mexico

DURANGO—The Monterey Iron & Steel Co. is planning for the operation of its new iron ore properties at Iron Mountain, recently acquired, for raw material supply for its plant at Monterey, to be placed in active production at an early date.

Capital Increases, etc.

THE VITREOUS ENAMELING & STAMPING Co., 306 Depot Place, New York, N. Y., has filed notice of increase in capital from \$300,000 to \$400,000.

THE SUMMIT VARNISH Co., Summit, Ill., has filed notice of increase in capital from \$50,000 to \$100,000.

THE SOUTHERN OIL CORP., Tulsa, Okla., manufacturer of petroleum products, has filed notice of increase in capital to \$3,000,000.

THE MONROE BINDER BOARD Co., Monroe, Mich., manufacturer of paper board products, has filed notice of dissolution under state laws.

THE AMERICAN STEEL PRODUCTS Co., Macomb, Ill., has filed notice of increase in capital from \$100,000 to \$210,000.

THE CHAMPLAIN BRICK Co., Mechanicsville, N. Y., manufacturer of brick and other burned clay products, has increased its capital from \$40,000 to \$100,000.

THE CUMBERLAND HYDRAULIC CEMENT Co., Cumberland, Md., has filed notice of increase in capital from \$200,000 to \$450,000.

THE UNITED STATES MICA MFG. Co., Chicago, Ill., has filed notice of increase in capital from \$10,000 to \$50,000.

THE SUNBEAM CHEMICAL Co., 2436 West Fifteenth Street, Chicago, Ill., manufacturer of soaps, etc., has filed a voluntary petition in bankruptcy.

THE INDUSTRIAL POTASH CORP., Salt Lake City, Utah, has filed notice of decrease in capital from \$30,000,000 to \$16,000,000.

THE SUNSET PAINT Co., Los Angeles, Cal., has filed notice of increase in capital from \$100,000 to \$150,000. H. A. Hendriksen is secretary.

New Companies

THE SOUTH SANTA PAULA PETROLEUM Co., Los Angeles, Cal., has been incorporated with a capital of \$250,000 to manufacture petroleum products. The incorporators are Charles L. Horsey, Pioche, Nev.; W. H. Rand and Minor Moore, Washington Building, Los Angeles.

THE TIER CHEMICAL Co., 3920 Lake Park Ave., Chicago, Ill., has been chartered under state laws to manufacture chemicals and chemical byproducts. The incorporators are C. O. and P. H. Patier, and M. J. Farnbaker.

THE EASTERN METAL STAMPING CORP., Newark, N. J., has been incorporated with a capital of \$250,000 to manufacture metal stampings, etc. The incorporators are William G. Viall, Thomas W. Paterson and Frederick A. Slater. The company is represented by Karl Z. Kiefer, 810 Broad St.

THE E. R. NASH LEATHER Co., Boston, Mass., has been incorporated with a capital of \$25,000 to manufacture leather products. Edward P. Nash, Brookline, Mass., is president and treasurer.

THE POCOT OIL Co., Tonawanda, N. Y., has been incorporated with a capital of \$10,000 to manufacture refined oil products. The incorporators are F. G. Demaroe, F. J. Wallenberg and LeR. J. Tiehor. The company is represented by J. A. W. Simpson, Tonawanda.

THE NATIONAL ALLOYS Co., Detroit, Mich., has been incorporated with a capital of \$200,000 to manufacture aluminum, brass, bronze and other metal castings. The incorporators are Horace H. Lane, W. J. Reardon and John G. Collins, 2320 Dime Bank Bldg.

THE MARYLAND VEGETABLE OIL Co., Seventh Ave. and Sixteenth St., Baltimore, Md., has been incorporated with a capital of \$1,000,000 to manufacture vegetable oil products and byproducts. The incorporators are Enos S. Stockbridge, Roland H. Brady and J. A. Knoerr.

THE POSTAL PETROLEUM Co., Los Angeles, Cal., has been incorporated with a capital of \$750,000 to manufacture petroleum products. The incorporators are F. A. Andrew, E. G. Hurst and R. W. Street. Robert M. Fulton, Trust & Savings Bldg., represents the company.

THE SOUTHERN BOTTLE MFG. Co., Tampa, Fla., has been incorporated under state laws to manufacture bottles and other glass products. J. F. Jones, Tampa, is president; A. B. Jones, vice-president and treasurer; and R. L. Rundell, secretary.

THE OXFORD STEEL PRODUCTS Co., Boston, Mass., has been incorporated with a capital of \$300,000 to manufacture steel specialties. Clarence E. Dodge is president; and Maurice T. Viall, 155 Armington St., Cranston, R. I., treasurer.

THE PEABODY LEATHER Co., Camden, N. J., has been incorporated with a capital of \$100,000 to manufacture leather products. The incorporators are Eugene O. Peabody, D. Paul Brown and G. Lewis Mayor. The company is represented by the Corporations Co., 104 Market St.

THE C. F. BATTENFELD OIL Co., Detroit, Mich., has been incorporated with a capital of \$15,000 to manufacture greases, soaps, oil compounds, etc. The incorporators are J. R. Battenfeld, Jack Mourse and L. E. Thomason, Kansas City, Mo.

THE HUDSON GLASS Co., New York, N. Y., has been incorporated with a capital of \$9,000, to manufacture and deal in glass products. The incorporators are F. H. Sparks, R. W. Weed and L. Finkelstein. The company is represented by M. M. Fox, 201 Havemeyer St., Brooklyn, N. Y.

THE BELL CHEMICAL Co., 12 East 58th St., Chicago, Ill., has been incorporated with a capital of \$25,000, to manufacture chemicals and chemical byproducts. The incorporators are Isadore Bell, Henry J. Tenhoope, and Elias Freudenheim.

THE EU-RE-KA SOAP Co., INC., Providence, R. I., has been incorporated with a capital of 480 shares of stock, no par value, to manufacture soaps and kindred products. The incorporators are Benjamin C. Emmons, Thomas M. Webb, and Oscar H. Seavey, 276 Wickenden St.

THE GRANITE DISCOVERY OIL Co., Los Angeles, Cal., has been incorporated with a capital of \$750,000, to manufacture petroleum products. The incorporators are George Dennison, S. J. Bowman, and L. L. Woods. The company is represented by Carnahan & Clark, 756 South Broadway.

THE BEL FAST ADHESIVE Co., Lyndonville, (Orleans Co.), N. Y., has been incorporated with a capital of \$25,000, to manufacture glue, paste and other adhesives. The incorporators are M. P. Barry, G. E. Lyman, and E. E. Belding, Lyndonville. The company is represented by W. S. Garber, attorney, Rochester, N. Y.

THE FAHEY LEATHER STAIN Co., Lynn, Mass., has been incorporated with a capital of \$25,000, to manufacture leather chemical products and affiliated specialties. Daniel J. Fahey is president; and John J. Fahey, 10 Blaisdell Terrace, treasurer.

THE BARRINGTON OIL Co., 1404 Harris Trust Bldg., Chicago, Ill., has been incorporated with a capital of \$1,000,000 to manufacture refined oil products. The incorporators are H. M. Cassidy, E. F. Brubaker, and R. O. Farrell.

THE TERRELL OIL & REFINING Co., Terrell, Tex., has been incorporated with a capital of \$250,000, to manufacture refined oil products. The incorporators are Robert L. Warren and W. P. Allen, Terrell.

THE APEX TIRE & RUBBER Co., Providence, R. I., has been incorporated with a capital of 250 shares of stock, no par value, to manufacture rubber products. The incorporators are John M. Franklin, Charles H. Sprague, and David W. Smith, 104 Franklin St.

THE BITUMINOUS COATINGS CORP., New York, N. Y., has been incorporated with a capital of \$5,000, to manufacture paints, varnishes, etc. The incorporators are W. B. Betzig, R. D. Kenmore and T. O'Callaghan, 115 Broadway.

THE ATLANTIC CARBONIC & CHEMICAL CORP., Chelsea, Mass., has been incorporated with a capital of \$125,000 to manufacture chemicals, chemical byproducts, etc. Phillips Rogers, 195 Winthrop Road, Brookline, Mass., is president and treasurer.

THE GENERAL REPRODUCTION Co., Philadelphia, Pa., has been incorporated with a capital of \$30,000 to manufacture sensitized paper and kindred products. C. R. Ringard, 801 Vernon Road, is treasurer.

THE PETERSON SPRING Co., Detroit, Mich., has been incorporated with a capital of \$20,000 to manufacture steel springs, wire goods, etc. August Peterson, 4762 Townsend Avenue, is president.

THE CO-OPERATIVE OIL CORP., Long Beach, Cal., has been incorporated with a capital of \$350,000 to manufacture petroleum products. The incorporators are J. D. Hawk, J. S. Bradley and L. J. Keck, Long Beach. The company is represented by L. H. Wealton, 206 Marine Bank Bldg., Long Beach.

THE STERLING EXTRACT Co., INC., Wilkes-Barre, Pa., has been incorporated with a capital of \$10,000 to manufacture extracts, chemical compounds, etc. David Walkman, Wilkes-Barre, is treasurer.

THE MONROE OIL & REFINING Co., Fort Worth, Tex., has been incorporated with a capital of \$1,000,000 to manufacture refined oil products. The incorporators are V. S. Monroe, Fort Worth; and R. W. Perry, Polytechnic, Tex.

THE OHIO-KENTUCKY FLUORSAPAR & LEAD CORP., White Castle, La., has been incorporated under Delaware laws with capital of \$1,000,000 to operate production plants for fluorspar, lead and kindred products. The incorporators are Thomas J. Clay, White Castle; C. P. Shaver, Thibodeaux, La.; and F. B. Moody, Smithland, Ky. The company is represented by the Colonial Charter Co., Ford Bldg., Wilmington, Del.

New Publications

BOOKS

A DICTIONARY OF APPLIED CHEMISTRY. Vol. I, revised and enlarged edition. By Sir Edward Thorpe, assisted by eminent contributors. Pp. 752, illustrated. London and New York: Longmans, Green & Co., 1921. Price, \$20.

Volumes of this revised and enlarged edition of Thorpe's Dictionary will be issued at intervals during the next two years. Volume I is now ready and Volume II will probably appear during this summer.

An approximate idea of the amount of new material added can be gained from the fact that the new Volume I devotes 752 pages to subjects from Aal through Calcium, whereas this same range was covered in 614 pages in the previous edition. Six volumes will certainly be needed to complete the work and it is possible that a seventh will be required.

The work of revision has been carefully and thoroughly done and new articles have been prepared to cover recent developments, so that this work will maintain its position as the greatest contribution in English to the literature of applied chemistry.

TABLES OF REFRACTIVE INDICES, VOL. II—OILS, FATS AND WAXES. Compiled by R. Kanthack. Edited by J. N. Goldsmith, Ph.D., M.Sc., F.D.C. Pp. 295. London: Adam Hilger, Ltd., 1921. Price, £1, 5s.

This critical compilation of refractive indices of oils, fats and waxes is Volume II of a series from the research department of Adam Hilger, Ltd., Volume I on the refractive indices of essential oils having been published in 1918.

The present volume contains over 2,500 measurements on over 500 oils, fats and waxes, together with references to the original sources of information, so that it should prove invaluable to workers in this field.

Coming Meetings and Events

AMERICAN CERAMIC SOCIETY will hold its twenty-first annual meeting at St. Louis, Feb. 27 to March 2, 1922.

AMERICAN CHEMICAL SOCIETY, THE SOCIETY OF CHEMICAL INDUSTRY and the American Section of the latter society will hold a joint meeting in New York, Sept. 6 to 10.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in Lake Placid, N. Y., Sept. 29 and 30, and Oct. 1.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its fall meeting at Wilkes-Barre, Pa., Sept. 12 to 17.

AMERICAN MINING CONGRESS AND NATIONAL EXPOSITION OF MINES AND MINING EQUIPMENT will hold its twenty-fourth annual convention in the Coliseum, Chicago, Oct. 17 to 22.

AMERICAN SOCIETY FOR STEEL TREATING will hold its third annual convention and exhibition Sept. 19 to 24 at Indianapolis.

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SEVENTH) will be held during the week of Sept. 12 in the Eighth Coast Artillery armory, New York City.

NEW JERSEY CHEMICAL SOCIETY has discontinued meetings for the summer and will resume them in October.

SOCIETY OF CHEMICAL INDUSTRY (BRITISH) at the invitation of the Montreal section will hold its annual meeting in Montreal and other Canadian cities during the week of Aug. 29, 1921. Details will be printed in this magazine from time to time.

SOCIETY OF INDUSTRIAL ENGINEERS will hold its fall meeting at Springfield, Mass., Oct. 5 to 7.

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY will hold its fall convention with the American Pulp and Paper Mill Superintendents' Association, at Washington, Philadelphia, Spring Grove, York, York Haven, Pa., and Wilmington, Del., Oct. 18 to 20.

CHEMICAL & METALLURGICAL ENGINEERING

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R. S. MARRICK
CHARLES N. HULBERT
Assistant Editors
CHESTER H. JONES
Industrial Editor
J. S. NEGRO
Managing Editor

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Fair Dealing With Washington

IMPORTANT negotiations are now under way in Washington and much depends upon the forthcoming legislation. The chemical industry occupies a prominent position in these considerations, and Congress is naturally relying on the representatives of that industry for assistance in solving many of its problems. The industry in turn is relying on its representatives to present its case fairly and frankly, and it is therefore deeply concerned with the recent reports that this has not always been the case.

The hearings before the Congressional committee in charge of tariff legislation are occasions where willing co-operation and patient service are sorely needed. The committee is in search of certain definite information, and oddly enough it is not satisfied with broad generalities and sweeping statements of impending floods of cheaply made foreign goods. In attempting to fix a tariff rate in terms of production costs and foreign market values, the legislator must have specific facts and figures. The Senator who in recent hearings demanded data on costs, profits and dividends was well within his rights, although it must be realized, of course, that information of a confidential nature cannot always be given in the public hearings. There are ways and means, however, by which such data can be presented to Congressional committees, and our chemical manufacturers must at least show their complete willingness to meet these requirements.

The efforts of the Department of Commerce to be of real assistance to industry are also in certain instances being met in a half-hearted way, and here again the chemical industry is among the offenders. Many industrialists are betraying a manifestly selfish attitude toward this worthy enterprise. Apparently there is the fear that more information must be given than will be received, and that therefore the Government's activities are to be regarded with suspicion. Even the well-considered program for a useful statistical service is not receiving the genuine and frank support it deserves from our industries. Secretary HOOVER'S broad plans for a comprehensive study of the facts and figures for all business demanded relatively little of the chemical manufacturer. Only a half-dozen important chemicals were on the list for production statistics, but still there are some of our producers who are objecting because they fear that the Government is encroaching on their business and they resent "government in business."

In many cases these same manufacturers are the ones who are seeking special favors from Congress. The very controversial measure of protection demanded by the dye industry, badly needed as it is, is still regarded in many localities as a special dispen-

sation for a particular industrial group. The approaching expiration of the import control on dyes and organic chemicals also creates a serious emergency, and a special effort must be made to bridge the gap between August 27 and the final enactment of the permanent tariff. In the face of these special demands for vitally important legislation, can we afford to withhold any information from Congress? Obviously, we cannot. If mistakes have been made in the past, it is time they be rectified, for the chemical industry must adopt a frank and open policy in its dealings with the Government.

Alcohol Dyes and Industrial Supremacy

A COMMITTEE was appointed recently by the British Government to report on the dye industry, and its findings are being published serially in the *Chemical Age* of London. The industry began in Manchester in 1856 with PERKIN'S discovery of mauve. That much seems settled. Its decline and fall in England coincident with its rise and prosperity in Germany is a phenomenon for which the committee has tried to discover the reason. And after long research it gives as one of the two leading causes "the lack of duty-free industrial alcohol throughout a long and critical period during which the Germans, having the advantage of duty-free alcohol, were able to produce dyes at a correspondingly lower cost than British manufacturers."

Other attributed causes we shall consider later. We have already noted this finding, but it will do us no harm to ponder over the alcohol problem again. We can produce alcohol as cheaply as the Germans, and probably more cheaply than they, because we have the facilities, the technique and more abundant materials. The dye industry is also here. It needs the alcohol to make dyes, but not to drink. The Congressional mind, however, as exemplified in Mr. VOLSTEAD and his followers seems to hold that if alcohol goes into the apparatus in which dyes or the materials to make dyes are made, it must also come out with the product; that the product must be "booze," because the makers put alcohol into it.

It may seem easy to disprove such a postulate, and indeed it would be were it not for the fact that there's none so blind as he who will not see. The trouble is that in this country the problem of industrial alcohol has entered politics, and politics in its modern sense has almost ceased to be a host to reason or logic, or even the consideration of anything else than scare-heads. Its principal business is to swing the crowd before it can think, and when a crowd is once well swung, it does precious little thinking. This is not a pleasant thought, but unfortunately it is true.

For instance, last fall in Minnesota there was wit-

nessed the amazing phenomenon of the defeat of state-owned grain elevators on an issue of free love. We have no interest in either proposal; we give it merely as an illustration of swinging the crowd. The farmers either rightly or wrongly wanted state-owned grain elevators. An enthusiastic supporter of the somewhat radical idea recommended that voters read a number of radical books and in the list was included a work by ELLEN KEY. In one of her works were found some caustic criticisms of present conventions relating to the institution of marriage. This was construed to favor its total abolition, whereupon the opinion that free love and not elevators was the real issue was framed up and published broadcast by the ladies whose husbands were interested in privately-owned elevators. The farmers, including thousands of seasoned old Swedes and Norwegians with large families and all the traditional Scandinavian piety, protested in vain that they didn't want free love, that they wanted elevators and proposed to cling to their good wives—but the scarehead was well framed up, the crowd had been started at shouting and the protest against free love carried the day.

Now we have the dye, pharmaceutical, varnish and general chemical industries all mixed up in Congress, not with prohibition but with what THEODORE ROOSEVELT called "the lunatic fringe" of prohibition. Truly we are in a parlous state in regard to industrial alcohol.

Soft-Pedaling the Curtailement of Research

OF RECENT years it has been fashionable to make widespread public announcement of the research facilities maintained by manufacturing establishments. The public has been taught and can well believe that a company maintaining such agencies for investigation and development is apt to have the latest and the best product, continually improving it to utilize every advance in the art.

However, a new phase in research activities has been noticed with great regret during the times of depression which have come like an industrial blight upon the country during the past year. In this period many of the research and development laboratories of big corporations have been discontinued and still more frequently these departments have been reduced to a bare skeleton of their former glory. It is noticeable that when this has been done the corporations have been very modest in their announcement of the change or have altogether suppressed the news where suppression was possible. In this there is both encouragement and warning.

The encouragement comes from the fact that industry apparently recognizes that cutting off research and development work is really poor policy. It recognizes that it would be much better to continue these departments, for they are essential to efficiency and at no time is efficiency more important than in time of stringency. The fact that little mention is made of discontinuance of laboratories shows that the management of corporations knows that the public will look with suspicion upon tendencies in this direction. And the public may well ask whether the interruption of research does not mean that the corporation will no longer progress and that its product may fall behind in the race under the keen competitive conditions of the coming few years. The signs are so plain that "he who runs may read."

Simultaneous

Discoveries in Science

PHILOSOPHERS have argued that discoveries are made when the world is ready for them; that a man arises when he is needed, and his name is a matter of no moment. If, they say, CROMWELL had not been at Naseby, some other Puritan would have been Lord Protector. NEWTON was but an incident, apples were falling everywhere and gravitation could not long have remained undiscovered. The studies of any one of a dozen scientists would ultimately have led him to the discovery of radium, but the CURIES happened to arrive there first.

About the only foundation for this theory is the undoubted historical fact that many of our most important truths were discovered independently and practically simultaneously. In not a few cases important conclusions were reached years before the world was ready for them, and then lay forgotten, only to be rediscovered when the time was ripe. Who can count the many controversies as to priority, both in and out of the patent courts? LIPPERSHEY in Holland and GALLILEO in Italy both discovered the telescope. KELLY in America and BESSEMER in England both invented the pneumatic process of making steel. The same day that NICHOLSON announced the presence of a new gas in the great nebula of Orion, a German, WOLFF, read a paper in Heidelberg in which he showed that two of the spectral lines which NICHOLSON could not explain were due to the fact that the nebula consisted of two parts.

The recent paper by JEFFRIES and ARCHER, published in these columns, on "The Slip Interference Theory of the Hardening of Metals," furnishes more striking evidences of simultaneous arrival at the same point by two widely separated investigators. At about the time their manuscript was completed another was read before the British Iron and Steel Institute by the Swedish investigator Dr. ARNE WESTGREN. Both papers contained the new experimental result, proved by X-ray analysis, that ferrite and martensite both contain body-centered cubic crystals of iron, whereas austenite contains iron atoms in face-centered crystals. The peculiar thing is not that austenite is austenite whether in Cleveland or in Gothenburg, but that its crystallographic nature should have been announced in two papers at the same time. A further fact, more than a coincidence, is this: An issue of the *Proceedings* of the Royal Society was on the way from England containing a paper (reprinted in this issue) by Dr. ROSENHAIN of the National Physical Laboratory setting forth views on the hardness of solid solutions substantially identical with those proposed by JEFFRIES and ARCHER.

A rather striking parallel can be drawn. JEFFRIES and ARCHER in their paper which was mentioned above say:

The resistance to permanent deformation, which is a general measure of hardness and strength, represents resistance to the beginning and propagation of slip Our knowledge of the structure of solid solutions is quite limited, but from the results so far obtained it seems that the atoms of the solute replace those of the solvent without substantial change in the space lattice of the latter. . . . The increased hardness and strength are traceable directly to increased interatomic forces, the attraction between unlike atoms being in general greater than between like atoms. We may conceive an additional mechanical factor in the form of a roughening of the slip planes due to the

presence of atoms of unlike size, or, as Bridgman puts it, a staggered arrangement of the atoms.

We now quote ROSENHAIN:

The forces acting on any atom of A, for instance, when one of its neighbors in the lattice is an atom of B, cannot possibly be the same as those acting on an atom of A entirely surrounded by atoms of A; there must be some want of symmetry in the forces acting on an atom so placed, with a result which is perhaps best expressed by saying that such an atom will be pulled slightly out of its proper place. . . . It is evident that such distortion must affect the internal energy of the whole system. Anything which tends to hinder the free occurrence of slip on the principal planes of a crystal will increase the hardness. . . . Any, even slight, distortion of the space-lattice of the crystals of a metal by the presence of "dissolved" atoms of another metal . . . must serve as a hindrance to slip on the crystal planes. Strictly speaking, in fact, the crystal "planes" have ceased to exist in such a slightly-distorted crystal. . . .

Quality Pays

In the Long Run

NO OTHER factor can be as potent in causing disaster for an industry as the failure of its customers to continue to buy the industry's product. At the present time the zinc producers find this as one of the factors in their industrial distress. If they were simply suffering from inability of their purchasers to use their product because of reduced scale of operations there would be no point in discussing their situation. But there is another factor in this case which makes the matter of particular significance.

Dr. H. FOSTER BAIN, director of the Bureau of Mines, in a discussion of this industry states: "The increasing use of black sheets (instead of galvanized) can be blamed in part on the increasing tendency, particularly during the war, of certain manufacturers of galvanized wire and galvanized sheets to use too thin a coating of zinc." In Dr. BAIN'S opinion this has resulted in a loss of confidence in galvanized materials especially among the smaller users who have not had facilities for judging just why it is that they have suffered losses through failure of galvanized materials.

Undoubtedly most of the larger producers of galvanized materials did not follow any such short-sighted policy as to willingly furnish inferior products even when zinc was high or hard to get. It is the shyster of the industry who always indulges in such practices. And yet not only the shyster but also the reputable operator suffers.

In metal products as in every other line of business, honest quality in the long run is the most satisfactory product from the manufacturers' point of view as well as from the standpoint of the user. No industry can afford to permit any member of the business to have his product unnecessarily fall into disrepute as to quality. More than high-grade technology is needed. Broad co-operation in maintenance of industrial standards is also essential. At times it may seem that this co-operation gives the smaller producer an unfair advantage compared with the larger concern with which it is in competition and yet in the long run it is often found that the large operator gains fully as much as the small by this mutual support in the application of the best technology and maintenance of appropriate industrial standards. The next time a case of inferior quality among smaller producers arises, let everyone involved think of the present situation among the zinc producers.

An Era of

Construction in Prospect

THAT the people of the United States are going to be busy as soon as they can get on the right basis for being busy may be accepted practically as a foregone conclusion. The real question is what they will be busy about. Some have argued that we have such a large productive capacity that we can do much more than supply our own needs, and must have a large export trade. That raises the question what we should get for our exports. If we have a surplus of goods we scarcely want to be paid in goods, for the goods we cannot produce and still can use would hardly measure up well in quantity or value against the goods we could export. We do not want gold. If we accepted securities, we should probably be getting part ownership in construction works outside the country. Why not have construction work in this country?

That we can take care of our current requirements without working hard was shown by the experience of 1920. Men did not work hard then by any means, yet in many lines surpluses were created.

In construction work there is an unlimited field for our surplus energy, and it is obviously in that direction that the energy should be directed. We need more dwelling houses if we wish to be comfortable and if we can get them at the right price, while if the price is low enough we ought to abandon a great many of the dwelling houses we have.

The distribution of power presents an excellent field. Our system of power and heat generation has grown top-heavy. The last two doublings in coal production were less than fifteen years apart and the preceding doubling had required only ten years. From 1880 to 1918, thirty-eight years, instead of the production of coal doubling three times the production was multiplied by 9.5. Nothing like such a pace can be continued, as the old-fashioned methods of production and shipment cannot be improved sufficiently in detail. The solution is to adopt new methods entirely, converting coal at the pit mouth into high-tension current and making byproduct coke for such fuel as must be provided. It is easier and better to construct along that line than to construct more railroads. There is nothing the matter with byproduct coking except possibly the high level of construction cost as it has been lately. Of the coke produced in the United States last June about 86 per cent was byproduct and 14 per cent beehive, although as to capacity there is not far from a 50-50 division. That is only a beginning, however. The proportion of all coke that is byproduct may be fairly high, but the proportion of all coal mined that is coked at all is very low. Where there is water power it is of course far more economical to develop it than to mine coal.

In construction work there is no limit. Of food and clothing we can conveniently use only so much. With construction work the field is unlimited, the only problem being to make it pay. And in order to make it pay the cost must be sufficiently low. A great deal of progress in that direction has been made in the past few months. The condition is the same as that of a commodity market when there is a latent demand, but the commodity is not low enough priced. It is compelled to make its market by developing a suitable price.

Readers' Views and Comments

Oxygen Research of the Institut de Beauté

To the Editor of Chemical & Metallurgical Engineering

SIR:—A colleague with a high thoughtful brow sent me lately a circular of the Institut de Beauté de Paris which contains so much new chemistry that I venture to add a few excerpts from it to my former contributions on the unfamiliar aspects of science. The Institute, according to its circular, addresses itself to the culture of the human hair and its growth. It does not appear to extend its activities to include harvesting, or barberology.

The thesis is presented that "there is no such thing as a dead hair root" and it is claimed that no matter how bald we may be, the "roots" are all there, in the scalp, but in an atrophied condition. The proof offered in support is that if the roots were to die, Nature would expel them like so many splinters and that we should therefore have dreadful eruptions of the pate during the process of growing bald; and the irritation, according to the circular, would be beyond endurance. The same authority declares that "the roots of the hair and the roots of the grains and grasses of the field need one and the same nourishment" and that this is oxygen. "Introduce oxygen into the roots of the hair," it continues, "and . . . the most shiny bald pate responds to the nourishment just as a plant does to the air." "What would happen to a plant," is asked in the circular, "if you put it in a dark place and excluded all the oxygen from it?" From this we gather our first note that there isn't any oxygen in the dark.

In the preparation of an "oxygen product" to induce the atrophied roots of the hair to "breathe" and thus to grow, "we have done," affirms the publication of the Institute, "what science insists is absolutely impossible. *We have liquefied oxygen.*"

It may seem that this has been done before; indeed I recall your frequent references to the Linde, Claude and Norton processes, but it would appear from the revelations of the Institute that its savants have developed a remarkable allotropy of oxygen. For instance, if liquid oxygen, as prepared under the Linde, Claude or other patents, were applied to a bald spot, it might well cause the remaining hair to curl, but it would hardly make new hair to grow over the vacant spots. Dr. Metzger of the Air Reduction Company refuses absolutely to recommend applications to the scalp of liquid oxygen prepared by the Claude process for any purpose whatever, and even in the hottest weather, Dr. Metzger is very firm in this advice.

As evidence of the originality of the contribution of the Institute the circular declares that "Just what a step in scientific research this achievement is, only the medical profession can appreciate." This statement is, in itself, a credential of the Institute, because while I do not profess to know the mind of the medical profession I think I am in a position to say that the chemical profession does not appreciate it. We must remember, however, that there is a great deal of original chemistry in medicine. An eminent practitioner told

me once that the object sought in the aging of wines or liquors is "to get rid of all the ethyl bodies."

Another point brought out in the circular of the Institute which chemists do not understand is this: "The oxygen is an ether that evaporates as soon as the air touches it." It "disappears as soon as the vial is opened." But "by a long and tedious process in electricity" the members of the Institute have "imprisoned oxygen" and this is their "very own invention." "We have succeeded," they claim, "in capturing the ozone needed for the health of the hair roots and in bottling it in a fashion that will preserve the strongest quality of oxygen indefinitely." Then "even though the bottle be uncorked, the oxygen will not evaporate from this air-giving lotion, and only when it is rubbed into the scalp and the temperature of the body sets free the imprisoned oxygen can this genuine ozone be absorbed into the deep-down roots of the hair." After this is accomplished it is affirmed that "the hair will curl and wave naturally and vibrate with your own human magnetism."

Revelations come so fast in the foregoing that we can hardly catch them as they fly. But besides the note that oxygen will not keep in the dark we learn that oxygen is an ether.

The hunt for and capture of ozone is still a secret process, but I suggest that probably the Institute has its own preserves and shoots ozone with electric guns. Ozone is absorbed by the "deep-down" roots of the hair. This leads to a quest for a proper name for this product with new qualities.

How would "Osmotic Ozone" do? Or "Cute-oze" (cute from "cutaneous," not from "nifty")?

The synchronous vibration of hair of the scalp with human magnetism is also new. I once knew an old deacon whose tuft of chin whiskers used to vibrate with his own human magnetism after the absorption of one or two milk punches into the face above the beard, but this was not a scalp phenomenon. The Institute is entitled to all credit for the scalp shakes.

MARTIN SEYT.

Inventors Are Active

Despite the industrial depression, applications for patents during the first six months of 1921 broke all records. Applications for patents during that period numbered 45,005. This is nearly 300 more applications than the best previous half-year period. Although the demands on the Patent Office are increasing, its capacity is limited to the volume of business of twenty years ago. There is pending in Congress a bill providing for some additions to the force and for some increases in salaries. This bill probably will pass in the near future, but even it will not meet the exigencies of the situation. It seems probable that applications will continue to accumulate until the pressure becomes sufficiently great to induce legislative relief. The failure to provide adequate machinery to handle promptly all applications for patents is particularly difficult to understand, since the office is more than self-sustaining.

American Ceramic Society Summer Meeting

Announcement of Appointment and Scope of Activity of Full-Time Secretary for the Society—Important Effect of This Step on Development of Research and Industrial Advancement in the Clay-Working Business—Social Features and Plant Trips

PERHAPS the most successful summer meeting of the American Ceramic Society was convened in the pottery district of southeastern Ohio, with headquarters at the Hotel Courtland, Canton, Ohio, lasting for three days, July 25-27. These meetings are usually called for the sole purpose of visiting industrial plants in each particular district, with social features to bring closer personal relations between members. On this occasion the program was carried out by the local committee under the direction of Ira E. Sproat with such excellent results as to win the approbation of every member attending.

At the banquet Monday evening President Pence announced the action of the board of trustees in retaining the services of Ross C. Purdy to act as full-time secretary. In response to the requirements of the times and expressed desire of the society, the board has employed Mr. Purdy to serve the remainder of 1921 as organizing and next year as general secretary. The object of this action is none other than the object for which the society was founded, and for which it has for twenty-two years been maintained—"to advance the ceramic arts and sciences."

Mr. Purdy was called upon to give further details and responded in part as follows:

Abstracts of Mr. Purdy's Address

The organizing work of this secretary can be generalized in the words of the special committee in its report to the board of trustees, which report was accepted and approved, and the section under the caption "Duties of the Proposed Permanent Secretary" was made a part of the contract of employment.

The scope of the organizing secretary's authority is limited to "assisting," "supplementing," "supporting" and "aiding." He is to encourage, promote and execute only by the authority of, in the name of, and through the board, the committees, the local sections or the divisions, as each case will require. In other words, he is merely to assist, support, aid and supplement the existing agencies already provided for by the constitution and bylaws.

By the appointment of an organizing secretary to serve in the capacity of an assisting and supporting supervisor of the work of the committees, sections and divisions, the board of trustees for the first time has a means of co-ordinating and unifying the work of the entire organization on the one general program of advancing ceramic arts and sciences. Emphasis should be placed on the fact that the organizing secretary cannot and will not relieve the committeemen nor the officers of the local sections and divisions of their responsibilities.

Research financing by associated corporations is the vogue today, whereas in former years the industries supported general ceramic research without regard to special applications. As the industries progressed in

things technical, they learned the value of joining by groups in financial support of researches in which they were particularly interested. Thus their support of and interest in scientific and technical research gradually shifted from the general to specialized investigations. The advantages of group specialization, emphasized as they were by war conditions, was recognized by the American Ceramic Society by providing industrial divisions. These divisions have succeeded or failed according to the quality and the continuity of executive attention given by the division officers and also according to the extent to which they have enlisted their particular group of manufacturers in the support of scientific and technical research. It is to correct these shortcomings that the organizing secretary was appointed, for the success or failure of the division is the success or failure of the society as a whole in serving the different groups of ceramic industries.

The American Ceramic Society has been and will continue to be the principal agency for the advancement of ceramic arts and sciences. In the early days, when there was but one collegiate department of ceramics, no federal bureaus, and when the manufacturers were jealous of their trade secrets, Prof. Edward Orton, Jr., did a great service to the ceramic industries when he persuaded a few ceramic workers to join in the founding of the American Ceramic Society. Since 1899 this society has continued steadfast to its original purpose, and was and is deserving and is enjoying the support of the ceramic industries, with the result that today our industries are second to none and equal to any in the world in technical attainments.

It is intended that this society shall continue as the leading agent for the advancement of ceramic technology, and it is assured that each division will enjoy in this purpose the full co-operation and backing of its respective group of manufacturers with the same zeal and for the same purposes with which, in previous years, the society as a whole was supported.

That all this may be realized and thus carry to full fruition the purposes and hopes of Prof. Orton and his collaborators, the board of trustees has appointed a full-time secretary and given emphasis to the organizing duties as distinct from the routine, and it is to the carrying through of this program that I, the appointed secretary, pledge my ability, zeal and singleness of purpose, and it is to this that the full co-operation of each and every member of the society is asked.

The Board of Trustees' Meeting

Tuesday night the board of trustees met for dinner and a business meeting. The more important business taken up concerned the activities of the new organizing secretary. Part of his program as submitted to the board was read before the members at the Elks Club luncheon in East Liverpool, Ohio, Wednesday noon. Abstracts follow.

A general program, to which all can work, is essential to definiteness in policy, cohesiveness in organization and maximum success; the prime requisites to obtaining the largest returns in things accomplished with the expenditure of the least time and money. To this end there are two suggestions, (1) that a conference be called of members of the board, officers of divisions and local sections and chairmen of standing committees, and (2) that a program be prepared for such a conference, which program can be issued and freely discussed prior to the conference.

One of the fundamental requisites to the most perfect attainment in the organized activities of a society like ours is close contact with the individual members of the society by finding some way for each to be actively

where for the very service for which our society is maintained have not known that we would thus serve them, and (3) some of our standing committees have not known what or how to do and where to obtain information. Neither the board nor the *Journal* has met the situation just described and could not have done so in any other than some way as is here proposed.

DIVISIONS

The plan of organization and general purpose of the divisions are defined in the constitution and bylaws, but the constitution very properly leaves to the decision of the division members the manner in which these purposes shall be served. Although a detailed arbitrary plan or program cannot be made alike for all divisions, there are some things that could be practiced in common by all: The divisions should have semi-annual or quarterly meetings for consideration of research problems and plant visitations. One or more of these meetings, when possible, should be held in conjunction with meetings of trade associations.

Each division could plan these mid-year meetings in part as institute meetings for the benefit of superintendents, foremen, etc.

Opportunity could be solicited for reciprocal participation in progress and contributions to literature with associations of users of the ceramic materials.

There should be a close affiliation of the standards committee of each division with the committees in the American Society for Testing Materials having like interest, such affiliation being by one or more members of the divisional committee having membership on the A.S.T.M. committee. A way for our society having official representation as a society on all A.S.T.M. committees dealing with ceramic products is now being devised.

Each division should have a definite program of research with assignments to federal, school and industrial laboratories, involving, when feasible, plant-scale trials. There need be no curtailment of reports of private and individual researches, but co-operatively planned and executed researches among the division members would make much for teamwork.

Co-operative research finances by persons or organizations outside of the division should have such supervision by the secretary as shall be decided by the board of trustees in general and the division in detail, but understanding should be had with the laboratories and all other parties concerned that the results must appear first in the bulletins of the society or the supporting associations rather than as announcements by the laboratories to trade journals.

Reports of plans for co-operative researches and progress reports should be made to the society as a whole as news propaganda that creates appreciation for the society. This would in no way hinder or detract, but would render a service beyond and aside from the actual result obtained.

A definite schedule of meetings of the divisions should be agreed upon so as to prevent conflicts of dates and also to permit of time and place distribution as would best promote the society as a whole without loss to the purposes had by any of the divisions.

LOCAL SECTIONS

With the exception of the New Jersey Section, which has had a definite goal, the local sections have been without definiteness in purpose and program of pro-



ROSS C. PURDY

engaged in or constantly informed of what is being done or planning to be done in the section and division to which he belongs, and to be kept informed of the plans and doings of the committees. Such may be thought accomplished as far as it can be by the reports now appearing in the *Journal*, but this is not quite correct, for those reports are lacking in the personal appeal to co-operate in the planning and execution of the work. This means, in the last analysis, that there is a need of and a virtue in an inter-member and inter-group of members correspondence that will instill a desire to serve, a feeling of welcome for his service and opinions, and a co-operative obligation and interest.

It is no mere phrasing of general thoughts or theories, but a bald statement of facts, that, because our society has been without a definite and known general program on which each and all groups within the organization could be working, (1) our members are not as well satisfied as they should be, (2) the associations which would naturally look to us rather than else-

cedure, which lack has resulted in much misspent and early spent enthusiasm. They have found no way of interesting the local manufacturers in the society through the local section.

It is true that the problem of each section is different in many respects, but unless these sections are prompted to do for their district that which the activities of the society as a whole will prompt the manufacturers to want, other agencies will usurp our "rights and benefits."

To be definite with a concrete example, the local sections covering Zanesville and East Liverpool could with profit to all concerned organize institutes in these cities, holding classes, operating a laboratory and providing for lectures, etc. The local manufacturers would support such institutes and it would be of advantage to them that the institute was being managed jointly with them, they carrying the financial responsibility and our society through the local sections the instructional responsibilities. Unless our society promotes such enterprises in different sections, the local interests will do this and the society thus lose opportunities.

Local sections should have regularly scheduled meetings and much attention should be given that the programs are attractive.

Co-operation in joint meetings with local sections of other societies should be encouraged, but in these the American Ceramic Society section should do its share.

The local sections should make a list of the ceramic concerns and important users of ceramic products in their district and assist in compilation of data whenever any agency within the society should issue a questionnaire.

There is a need of redistricting of local sections and a need of keeping the section officers notified of members leaving or moving into their districts.

CHANGE IN CHARACTER OF JOURNAL

In the past the *Journal* has been the society's main point of contact between the members and will continue to be such until the local sections, divisions and committees begin to function under the stimulus of the board through the secretary. The *Journal*, however, has not served as successfully in this respect as it would if changed to include "industrial journal" features.

We have lost considerable of the personal or human element in our publications through loss of the discussions, but even a trade journal with the discussion added to the technical papers would not actuate the members to research, either individually or in groups, as would more direct stimulating methods. In every organization it seems to be necessary to have frequent personal contact and a subject of common interest other than the *Journal*.

It is wise for the society to consider adding the news feature and shop discussions to the two divisions the *Journal* now has and in addition to this make more use of bulletins than we have in the past.

ACTIVITIES OF THE STANDING COMMITTEE

In the correspondence relative to full-time secretary, there were suggestions of how the committee on research could co-ordinate its work with the work of the divisions. There are overlapping interests in this instance which cannot be removed and which, if properly directed, would really be of benefit. Similarly, there

are overlapping interests and duties among the different committees.

The programming of the activities of the committees would depend largely on the general program adopted for and by the local sections and divisions; hence the importance of the conference.

CENTRALIZATION OF BUSINESS AND ACTIVITIES

This is a question for decision by the board, but there are interests involved aside from those of the board. It is true that the selection of an editor and determination of official relations between the general secretary and editor are to be made by the publication committee and the board. It would seem to be worth while, however, for such a conference of executives as is here proposed to discuss this and perhaps formulate recommendations.

AFFILIATION WITH THE NATIONAL ASSOCIATION

We accepted affiliation with the National Research Council without members of our board (and apparently the appointees on the Research Council committee) knowing just what the affiliation meant in obligation, liability or benefit to either party. For four years we have kept ourselves blind to the possibilities and limitations in our affiliation with the National Research Council, with the result that our committees have served the council wholly, our society being concerned and credited only in a very incidental way.

It is a duty to ourselves in particular and to the ceramic fraternity in general that the Research Council committee inform us on this question of our affiliation with the Research Council.

There are three items in this connection worthy of discussion in this suggested conference: (1) Should not the personnel of the Research Council be representative of the different divisions and of both the laboratory and the plant, and (2) should our society join the Engineering Division of the council as well as that of the Division of Chemistry, and (3) should ceramists be styled as a group of ceramic chemists, whereas a large part of ceramic work is engineering and the largest part of graduates of ceramic courses are called engineers?

The American Society for Testing Materials offers an opportunity for our society to co-operate officially with manufacturers and users of ceramic products in the work of standards and methods of testing, etc., that would bring into prominence before the technical and scientific world the service that we are rendering. This is important, and as it would touch upon the particular interest of each group in our organization, it should be thoroughly investigated and presented to the suggested conference.

SOURCES OF REVENUE

Final decisions on finances are left with the board, but to know in what way our resources can be increased requires acquaintance with the men of affairs in the several industries which only representatives from that group can have. Then, too, there are related interests which would ally with us in the support and prosecution of co-operative researches. The possibilities and extent of such alliance are properly a subject for general discussion.

There are other topics which properly would come before such a conference for discussion and recom-

mendations, but it is thought that the foregoing suggestions are sufficient to be a basis for decision as to whether such a conference should be called.

Plant Visits and Social Features

On the morning of Monday, July 25, visits were made to the Dueber Watch Case Co. and the Hamden Watch Co., in Canton, Ohio. Among details of production were the recovery of waste gold products to be used in plating cases involving pulverizers, briquet machines, blast furnaces, melting reverberatories with sliding hearths and electroplating apparatus; heat-treating processes for the watch case parts and plant for enameling watch dials.

In the afternoon a trip to the Bonnot Co. enlightened the visitors on methods for the manufacture of modern clay-working machinery. The Canton Stamping & Enameling Co. plant occupied a considerable part of the afternoon. This company produces a mottled gray kitchenware by burning the enamel in one firing. The steel is shaped to proper dimensions in a machine shop equipped with large stamping tools, electric spot welding outfits for attaching handles and annealing ovens. The next step involves pickling in large vats in sulphuric acid solution. From the pickling room the ware is transported in small industrial cars to the dipping hoods and washed in slightly acid solution. To this

wash solution is added a small quantity of sulphate salts. After the ware is hand-dipped in the enamel slip it is placed on rack cars to dry slowly. During drying the rust spots from the sulphate solution appear in irregular formation throughout the white enamel. When the ware is burned these spots fire to a dark gray, giving a mottling of dark and light gray spots over the surface of the finished piece.

Delightful banquet and evening entertainment were provided at the Congress Lake Country Club. This was the outstanding social event of the meeting and was well concluded by informal dancing.

On Tuesday the Richardson compartment kiln equipment at the Alliance Brick Co. held the interest of the visitors all morning. After a pleasant luncheon at the Alliance Country Club the party was carried by automobiles to the Sebring potteries and the Strong Enamel Co. at Sebring, Ohio. Returning to Canton in the evening, some of the members attended an informal smoker, while others with their ladies danced till a late hour at Myers Lake.

Wednesday was spent at East Liverpool plants. Luncheon was at the Elks Club, where refreshment and food added zest to speeches and applause alike.

Later issues of CHEMICAL & METALLURGICAL ENGINEERING will describe the Ohio ceramic plants in detail.

Low-Temperature Carbonization*

BY SIR GEORGE BEILBY

I HAVE for many years taken a deep interest in the production of a solid smokeless fuel for domestic purposes by the carbonization of selected coals at 550 deg. to 600 deg. C. The resulting coke is entirely free from smoke-producing hydro-carbons, while still containing 10 to 12 per cent of volatile combustible matter, which burns with a very slightly luminous, perfectly smokeless flame. When the coke is kindled, it becomes enveloped by these flames, which quickly raise the surface to incandescence. Undoubtedly, if this smokeless solid fuel could be produced at a cost permitting of its being sold at little more than the price of the coal which it would replace, it would lead to a complete revolution in domestic heating, and, among other good things, to the abolition of black smoke from house fires. This attractive prospect has been spread before our eyes for many years by enthusiastic inventors and company promoters, yet its realization seems always to move a little further into the future!

From the experience of the past two years at the Fuel Research Station with a considerable variety of coals, we know with certainty the yields and quality of the gas, oils and coke produced under definite conditions, but this knowledge is only the first step in the inquiry. For, until we know with equal certainty the cost of producing these, and the markets in which they are to be disposed of, no economic balance sheet of any real value can be arrived at.

Let me illustrate the market uncertainty by a few comparative figures. Assume that 15 gallons of fuel oil suitable for naval use can be obtained from a ton of coal. Six months ago the value of this oil could safely be taken at 1s. per gallon, and the 15 gallons

would have realized 15s. Today the price of this oil is only 4d. per gallon, and the product would therefore only realize 5s.—a drop of 10s. per ton on the coal carbonized. It is obvious that a method of carbonizing which would have paid its way handsomely six months ago would today result in a loss. My own belief is that low-temperature carbonization can only be established on a sound commercial basis with low operating-costs and a very moderate margin of profit.

Prior to 1914 the shale oil industry in Scotland was distilling 3,000,000 tons of shale per annum. The entire cost of the carbonizing operation, for labor, maintenance and fuel, was 1s. 6d. (36.5c.) per ton, and the margin of profit on which fair dividends were paid was 2s. 6d. (61c.) per ton. Unless the costs and profit margins of low-temperature carbonization can be reduced to the modern equivalents of these figures, the prospects of its development on a large scale would not seem to be particularly hopeful, from the national point of view.

If low-temperature carbonization is proved to be a feasible operation commercially, it would find its first and most natural application to the 35,000,000 tons of coal used for domestic purposes. Were this coal all carbonized, it would produce about 2,000,000 tons of fuel oil. The motor spirit produced would amount to about 100,000,000 gallons.

The capital expenditure required for the installation of carbonizing plant for 35,000,000 tons of coal per annum would be of the order of 30 to 40 millions sterling (\$175,000,000). A gross profit of 5s. (\$1.20) per ton of coal carbonized would provide 10 per cent for interest and 10 per cent for depreciation on this expenditure.

When coal is used for steam-raising under the best known conditions, it is obvious that there is little to be gained in thermal efficiency by any preliminary sorting out of the thermal units of the coal into fuels of higher availability.

*Extract from the James Forest Lecture on "Fuel Problems of the Future," delivered June 28 before the British Institution of Civil Engineers.

The Economy of Modern Grinding Methods

Preliminary Statement Regarding the High Cost of the Obsolete Grinding Plant and an Appeal to the Operator to Study Fundamental Principles of Reduction—
—Classification of Grinding Operations

By HARLOWE HARDINGE

GRINDING is a subject so broad and so involved that an attempt to cover the entire field in a short article would be a waste of effort. On the other hand, it is a process thought by many to be of little importance, as compared with others, in their plant. The general attitude taken toward grinding is that it is a necessary evil and that the operator might as well make up his mind that he is going to have trouble, and let the matter rest at that.

In the last few years there have been such strides made in simplifying and standardizing methods of grinding that the manager of the modern plant no longer considers grinding to be "the fly in the ointment" of an otherwise smoothly running plant. It is the aim of this article to point out why there has been so much trouble in the past and how it is possible to eliminate, to a great extent at least, the waste that is occurring in so many plants where materials of all kinds are ground.

The old hand-to-mouth method of operating that has been in existence in industrial plants throughout the country is gradually dying out and those in charge are realizing that modern equipment, although it may be more expensive than the old style in the initial cost, is far cheaper in the long run, and when once installed causes no trouble. In the old days the first cost was the chief consideration and the machinery soon ground itself to pieces and the operator found he was paying more each year for repairs than the original purchase price of the machine.

Business will soon be procured on a highly competitive basis. The manager whose main thought in equipping his plant is first cost rather than ultimate cost of operation will find that he is out of the running; he will not be able to compete with the man who figured on staying in business and operating at a minimum cost, not only for one year but for many years, with the same equipment. It is very gratifying to see that so many companies have forsaken the old ideas and have rebuilt or are redesigning their plants so as to be able to stand the close competition which is bound to come.

ACCUMULATION OF GRINDING MILLS

It was common practice several years ago for the millman to try first one style of equipment and then when a salesman came along who recommended another style, with its supposed marked advantages, he would either throw out the old equipment or install a new mill alongside the old, with the chances that the new mill would have little or no advantage over the old. After this was done several times and the plant was filled with all sorts of grinding devices, the operator would give up in disgust and absolutely refuse to entertain a new proposition. He would worry along with the equipment he had, continually buying repair parts and becoming thoroughly convinced that what he had was as

good as anything for handling his problem, even though he would admit he was shut down for repairs more than he would like to be. He would also excuse the situation by saying that no grinding equipment could run more than 75 or 80 per cent of the time on his particular material.

Based upon his experience with grinding equipment he had operated, he possessed strong ideas on the principle of grinding, and tried to make every problem substantiate his claims. This condition, while fast dying out, still exists in many fields, and it is in these fields that grinding in general is about fifteen years behind the times. It is just within this period that other methods have been worked out, so that now, unless these old-time operators and managers make a study of modern methods, they will soon find themselves out of the running. They must know something about grinding other than the ideas that have been forced upon them by the operation of the particular equipment they have used, in the particular way that they desired to grind.

GRINDING PRINCIPLES AND EXPERIENCE

A person may get his nose so close to the grindstone that he cannot see an obvious solution coming right to him, and cannot see how the operation, under other conditions, is at all analogous to his.

As a striking example of what a broader knowledge of grinding will do to help solve difficult problems, there was a case brought up recently by a wide-awake manager handling diamond-bearing clay, which had to be disintegrated in order to free the diamonds. This manager spoke of the trouble that was encountered due to the diamonds remaining in the mill longer than necessary, which resulted in a tendency to cause breakage. As this problem had never confronted the manufacturer of this particular grinding device before, there was no direct method, except by guesswork, of how to correct this trouble. By referring to the solution of a problem of grinding barytes containing a small amount of silica—which had a tendency to remain in the mill and be ground up, but which later by a simple adjustment was discharged without being ground—the problem of getting rid of the diamonds without breaking them was solved, and the operation made highly satisfactory. It is this application of one method to another problem which is directly responsible for the enormous strides which have been made in grinding methods within the last few years.

The matter boils itself down to just this: In order to keep abreast of the times the operator must study the fundamental principles of grinding in addition to those which he has evolved from his own experience. The operator must also know what he is buying and how it compares with other devices to do the same

work from all standpoints, particularly that of operating cost. When this study has been made, he will no longer be in the position that he was a few years ago when he installed equipment in a more or less haphazard manner, and trusted too much to the salesmen's theories, which are often warped, to apply to the particular device then being advocated.

EXCUSES FOR THE OBSOLETE PLANT

The following are some of the reasons why many operators have failed to standardize on grinding equipment and why so many plants are now out of date:

Pulverizing Usually a Side Issue. In many plants, grinding is not the main item of expense, or even if it is, it may not receive sufficient attention.

Principle of Grinding Not Comprehended. The operator usually evolves principles of grinding which are biased, and while correct to some degree, are not broad enough to allow him to get the most out of the equipment he has, to say nothing of getting the right sort of equipment to handle his particular problem.

First Cost Too Often Considered as Most Important. A very grave mistake is made when pulverizing equipment is bought mainly on first-cost basis, for the chances are it not only operates on the wrong principle but is inferior in design and construction and will be much more expensive to operate as compared with more costly machines offered at the same time.

Lack of Knowledge of Operations in the Same Field. While in some fields operators take full advantage of the information of the grinding done by their neighbor, operators in other fields show no interest in what their neighbor is doing and do not believe the information obtainable from their neighbor could possibly be of any use to them.

Lack of Interest in Other Fields of Grinding. The operator seldom takes much interest in other methods of handling grinding problems than his own, while if he were alive to the situation he might be able to apply the other man's method of handling his problem to his own and be much better off.

Methods He Is Now Using Made Money for Years. The operator often goes on the basis that equipment he is now using has made money for him for years. Why is it not just as good now? The question will of course be answered within the next year or two, if he is one of those who insists on using equipment purchased ten or twenty years ago.

Limited Experience. Very often the operator has grown up with his plant and has not had an opportunity of seeing how others handle the same or similar problems. As a consequence he goes along year after year, using the empirical methods he has evolved, which could almost certainly be improved with broader vision.

Making All Cases Apply to His Limited Understanding. If a problem comes up which is new to him, he will apply the principles he has evolved from his experience to this particular problem, and if his experience is limited, the chances are he will not be able to solve the problem as satisfactorily as the man who has made a broader study.

Unbiased Principles of Grinding Hard to Obtain. The user of pulverizing machinery is to be excused in a great measure for a lack of knowledge of grinding, as there is very little published on the subject. What information is published is either written from the

standpoint of one man's knowledge of a particular problem, which is limited in scope, or the information is obtained through salesmen, who unintentionally distort fundamental principles to suit their purpose.

Information obtained from other operators is valuable, as it is concrete evidence of what has been done under specified conditions. On the other hand it is often bad, first because it gives a biased viewpoint, especially when the use of the equipment for a special case has been subject to question by others, and second, because the operator using this equipment will try to prove his point and thereby substantiate his actions.

In some cases, especially where the field for the particular product being manufactured is limited, deliberate attempt is made to belittle the grinding equipment, even though it is operating with a high degree of satisfaction and efficiency, the object of this being to steer the competitor clear of equipment that is keeping production costs below the average.

TYPES OF GRINDING OPERATIONS

In order to give a slight idea of the enormous field of grinding, the table on p. 231 mentions some of its applications. Further details as to just how these problems are solved will be taken up in a later article. The object of this paper is to give a slight idea of the large scope of the modern grinding methods and why no two problems are alike.

Grinding, in general, may be classified under two main headings—wet and dry. Each of these may be subdivided into: Granular grinding, medium fine grinding, fine grinding, extremely fine grinding (with special applications), as shown in Table I.

In the case of granular grinding a product is desired with as small an amount of "fines" as possible, the average requirements calling for a product which passes a $\frac{1}{4}$ -in. opening and as much as possible remains on 10-, 20- or 30-mesh, as the case may be.

For medium fine grinding, most cases call for a product which passes a 20-mesh screen, the amount of "fines" produced being of little importance.

In the case of fine grinding, it is desired that as much fine material be produced as possible, commensurate with economical operation. Usually the specifications will run anywhere from 90 per cent through 100-mesh to 95 per cent through 200-mesh.

For extremely fine grinding, the specifications are very rigid and often call for a product so fine that it will all pass any screen manufactured. Therefore other physical tests must be resorted to, such as by microscope, feeling of grit between the teeth, by a spatula on glass or by a predetermined settling rate in water or air.

GUIDE FOR THE OPERATOR IN PURCHASING GRINDING EQUIPMENT

As no two grinding problems are alike, it is necessary to treat each separately and cover all the points which will affect the ultimate cost of operation.

First cost is important, but is secondary when compared to the cost of operation. Unless both are carefully considered, the operator is storing up trouble for himself in the months and years to come.

In considering grinding equipment of several makes, it is well to tabulate answers to the questions in each case, covering the main factors that are liable to determine the outcome of the purchase. These questions may be summarized as follows:

Is it the type of equipment to perform your work properly?

What is the total first cost of equipment and auxiliary apparatus f.o.b. factory?

What is the total cost of freight for equipment and auxiliary apparatus to go with this equipment, if any?

What is the cost of erection, including buildings, foundations, etc.?

What floor space is required?

What head-room is required?

Is the equipment self-contained?

Is it easy to inspect when located in the building as you have planned?

What power is required to start and what power to operate?

Is the equipment and lay-out designed so that it is dustless, if grinding dry or water-tight and clean if grinding wet?

What repair parts will have to be kept on hand?

What will be cost of repairs per ton of material ground?

What labor will be required to operate the grinding equipment? Will it have to be skilled and how much time must be allotted?

What percentage of operating time is assured after the equipment has been in operation one year?

Is the equipment simple in design and does it require constant attention to keep oiled or parts tight?

What facilities are there for feeding or discharging automatically?

Is the unit as a whole flexible—i.e., will it wear itself out if underloaded or overloaded?

What troubles are liable to follow, either in loss of production or otherwise, due to choking or jamming of working parts?

Has estimate of capacity been based upon actual conditions that you will maintain, such as maximum size of feed, fineness of product, moisture content and hardness of material?

In the old days (and in some cases today) an operator had no idea of what it was costing him to grind. All he knew was the total amount he spent each month for his entire plant, but he did not segregate the cost of labor, power, repairs and miscellaneous expenses to each operation. The old hand-to-mouth method is rapidly dying out. It is possible to estimate very closely what the total grinding cost will be.

Grinding costs are usually segregated as follows:

Power	Delays
Labor	Interest on investment
Supplies	Depreciation
Repairs	Miscellaneous

Some operators are not familiar with the method of figuring these costs, and the examples given in Tables II and III will be useful.

The first case shows typical itemized costs of a modern grinding device, pulverizing medium hard limestone at the rate of 15 tons per hour, grinding dry, the feed going to the mill all passing a 2-in. ring and the product all passing 20-mesh, with 50 per cent through 100-mesh. It must not be forgotten that this cost is based upon a given operating condition and that larger tonnages under the same condition will reduce the cost, and conversely, the cost will increase as the capacity and size of equipment are reduced.

The second case is a striking example of the cost of dry grinding by the older methods, many of which are being employed even today. The figures given are averages and do not cover any particular type of mill, but cover the same items based upon the same unit cost.

Under item "Interest on Investment" the same total amounts were used in each case. The cost of the mill itself for the new installation was assumed higher than for the old, but when accessory equipment, freight and all erection charges were figured in, the total cost was approximately the same.

The reader may not agree with the method of calculation throughout, but as comparison is being drawn, it

TABLE I. CLASSIFICATION OF GRINDING

DRY GRINDING

Granular Grinding

Carborundum, emery, silica and ganister rock.	For abrasives
Salt	For table use
Iron and metals	For recovery from gangue or waste.
Chemicals	For aid in chemical processes.
Grog.	For manufacture of tiles, porcelain ware, etc.
Mica and slate	For roofing.
Asbestos	For obtaining fiber

Medium Fine Grinding

Limestone	For asphalt filler and agricultural purposes.
Barytes and coal mixture.	For manufacture of paint / base.
Phosphate rock	For fertilizer.
Sulphur	For chemical compounds.
Iron and minerals	For concentration or separation by special processes.
Hard rubber	For manufacture of rubber composition.
Sawdust	For chemical purposes.
Cast-iron borings	For chemical purposes.

Fine Grinding

Limestone	For the manufacture of cement.
Clinker	For the manufacture of cement.
Coal — bituminous and anthracite	For burning under boilers, in kilns, driers, furnaces, etc.
Grain—various kinds.	For food purposes.
Feldspar	For pottery manufacture.
Mica	For use in tire trades.

Extremely Fine Grinding

Barytes	For use as a paint base
Filter cake	To prevent formation of lumps in further processes.
Grain	For best grades of flour for food.
Pigments	For the manufacture of paints.
Pumice stone and emery	For dental purposes.
Graphite	For pencils.
Talc	For paper filler, talcum powder, etc.

WET GRINDING

Granular Grinding

Ores	For extraction of minerals by jigging and table concentration.
Clay	For recovery of diamonds.
Graphite schist	For recovery of flake graphite from waste rock.

Medium Fine Grinding

Ores	For extraction of minerals by amalgamation and flotation processes.
Foundry waste	For reclamation of metal contained therein.
Iron pyrites	For manufacture of sulphur.

Fine Grinding

Ores	For extraction of metal by cyanidation.
Mica	For wallpaper trade.
Feldspar	For use in pottery manufacture.

Extremely Fine Grinding

Barytes	For paint base.
Carborundum and emery	For glass polishing.
Limestone	For manufacture of whiting.
Pigments in water	For manufacture of colors.
Pigments in oil	For manufacture of oil paints.
Ink	Incorporation of carbon and other materials in oil.

stands to reason that figures made up on the same basis for both methods will give comparative results.

Most engineers in figuring costs do not include all the items mentioned, especially that of "delays." This item is of considerable importance and one of the most difficult to figure. Some operators object to this from the

TABLE II. ESTIMATED COST OF GRINDING

Modern Type of Equipment	Old Type of Equipment
Power: 90-hp. at 2c. per kw.-hr. Hp. × cost per hp.-hr. = Cost per ton. Tons per Hour $90 \times 2 \times 0.746$ 15 = 8.95c.	Power: 150-hp. at 2c. per kw.-hr. $150 \times 2 \times 0.746$ 15 = 14.90c.
Labor: One man at 50% total time employed at 40c. per hr. Labor cost per hour = Cost per ton. Tons per hour $0.5 \times 40c.$ 15 = 1.33c.	Labor: One man at 100% of total time employed at 40c. per hour. 40 15 = 2.66c.
Supplies: Wear of grinding media 1/5-lb. per ton. Cost laid down at plant 6c. per lb. Cost per ton equals $6 \div 5 = 1.2c.$ per ton. Wear of lining 1/15-lb. per ton. Cost laid down at plant, 12c. per lb. Cost per ton equals $12 \div 15 = 0.8c.$ per ton. Total, per ton. 2.00c.	Supplies and Repairs: Assuming either old type of ball mill or high-speed pulverizer, average results show at least Per ton. 10.00c.
Repairs: Miscellaneous repairs, gears, bearings, etc., at \$800 per year. Assume 300 working days per year and 24 working hours per day. Cost per year in cents Tons per year = Cost of misc. repairs per ton. 800×100 $24 \times 300 \times 15$ = 0.74c.	Refer to above.
Delays: Time lost in breakage and delays, chargeable to mill at 6 days per year of 300 days. Cost of unground limestone \$1.50 per ton. Selling price of ground limestone \$3 per ton. All charges, except power and supplies, continue regardless of delays. Hours of time lost Total possible hrs. per yr. = Per cent of time lost. Selling price of product less operating costs (exclusive of delays), less cost of unground limestone = Profit per ton. Difference between profit per ton and power and supply costs per ton, multiplied by % of time lost % of time operated = Cost of delays per ton. $6 \times 24 \times 100$ 300×24 = 2% time lost. Profit = $300 - 16.11 - 150 = 133.89c.$ per ton. Cost = $(133.89 - 10.95) \times 2$ 98 = 2.54c.	Delays: Time lost due to breakage and delays chargeable to mill, 20% of total possible operating time per year of 300 days. Worth of unground limestone \$1.50 per ton. Worth of ground limestone \$3 per ton. All charges, except power at 14.90c. per ton, continue regardless of shutdown. Per cent of time lost, 20%. $300 - 32.52 - 150 =$ profit 117.48c. per ton. $(117.48 - 24.9) \times 20$ 80 = 23.10c.
Interest on Investment: Cost of mill erected complete with all accessories, including freight, foundations, labor, etc. (but not building cost), \$20,000. Cost × interest rate per year Tons ground per year = Cost per ton. $20,000 \times 0.06 \times 100$ $15 \times 24 \times 300$ = 1.11c.	Interest on Investment: Cost of mill erected complete with all accessories (including freight, foundations, labor, etc.), but not building cost, \$20,000. Cost × interest rate per year Tons ground per year = Cost per ton. $20,000 \times 0.06 \times 100$ $15 \times 24 \times 300$ = 1.11c.
Depreciation: Cost as above \$20,000 at 8% per year. $20,000 \times 0.08 \times 100$ $15 \times 24 \times 300$ = 1.48c.	Depreciation: Cost as above \$20,000 at 10% per year. $20,000 \times 0.1 \times 100$ $15 \times 24 \times 300$ = 1.85c.
Miscellaneous: Oil, grease, etc. 0.5c.	Miscellaneous: Oil, grease, etc. 2.00c.

standpoint that they run their plant only twenty hours out of a 24-hour day, or if running on a 10-hour day basis, figure on getting their required capacity in eight hours and therefore this item would not enter into their calculations. Why do they figure on running only twenty hours out of twenty-four, or eight out of ten? Why not figure on running closer to the limit, thus increasing the capacity and enabling the plant to make more money, assuming, of course, that the other equipment in the plant, if any, is able to handle this increased

TABLE III. SUMMARY OF COMPARATIVE COSTS

	Modern Type of Equipment	Old Type
Power.....	8.95c.	14.90c.
Labor.....	1.33c.	2.66c.
Supplies.....	2.00c.	10.00c.
Repairs.....	0.74c.	23.10c.
Delays.....	2.54c.	1.11c.
Interest on investment.....	1.11c.	1.85c.
Depreciation.....	1.48c.	2.00c.
Miscellaneous.....	0.5c.	
Total cost per ton.....	18.65c.	55.62c.

capacity? Those who realize the value of continuity of operation have made provision for obtaining a definite capacity by installing spare equipment. This is certainly cheaper than running the old style of grinding equipment up to capacity, and the moment any mill is shut down the whole plant is retarded by the amount of loss in production in the grinding department. With modern equipment, there is no use in figuring on a large "factor of safety." Instead of running 80 per cent of the time, a unit will run 90 to 98 per cent of the time. Operators have been so accustomed for years to figure on a large percentage of lost time that they take this loss for granted. This condition was true in the mining industry a number of years ago, but of recent years the equipment has been so developed and standardized that 97 to 98 per cent running time for the grinding equipment is not unusual.

The value of the new method is readily appreciated when it is seen how long it would take to pay for the entire new installation out of the savings in the cost of grinding.

This is shown in Table IV.

TABLE IV. SAVINGS IN COST OF GRINDING

Total cost of installing new equipment.....	\$20,000.00
Scrap value of discarded old equipment.....	2,500.00
Net cost of new equipment.....	\$17,500.00
Grinding cost per ton of old system.....	0.5562
Grinding cost per ton of new system.....	0.1865
Saving in cost per ton over old system.....	0.3697
Saving per day = $0.3697 \times 15 \times 24$ or.....	\$133.20
Saving per year = 133.2×300 , or approximately.....	\$40,000.00
Time required to pay for new installation out of savings, due to decreased operating expense, $17,500 \div 40,000 \times 12 =$ 5.25 months.	

In other words, in one year's time the entire new installation is paid for with an additional net saving of approximately \$22,500. It is difficult to believe that such a saving is possible, but the figures are based upon concrete evidence, submitted by several managers and operators who have replaced old equipment with new.

There is absolutely no doubt that the time has come when the operator must be a specialist in his line and make a comprehensive study of conditions in his plant, just as the modern executive has evolved a simple method of keeping track of what is going on about him and has made a special study of the specific points of vital interest, in order to handle his business efficiently. New York City.

Plastic Calcined Magnesite and Oxychloride Cements*

Physical Tests Showing and Factors Influencing the Properties of Oxychloride Cements — Suggested Specifications Include Reduction of Magnesia 97 per Cent Passing 100 Mesh and 75 Through 200 —Chloride Solution 22 Deg. Bé.—Initial Set From One to Eight Hours

By M. Y. SEATON

THE magnesium oxychloride industry dates from the discovery by Sorel, in 1867, of the cementing action of a mixture of magnesium oxide and a solution of magnesium chloride. Sorel found that the cement produced was enormously strong and had very high binding power—that is, that it would allow of dilution with a very large quantity of aggregate and still produce a product of high strength. It was particularly noted that it would bind sawdust in satisfactory fashion to a hard, tough mass. This could not be accomplished by any of the usual cementing mediums known at that time.

The exact chemical constitution of Sorel's cement is still an open question. It seems probable that it is only partly a definite oxychloride, probably $3 \text{ MgO} \cdot \text{MgCl}_2 \cdot 10\text{H}_2\text{O}$, and that this is mixed with solid solutions of indefinite composition. Efforts to regulate the composition of a mix in such fashion as to keep the oxide-chloride ratio constant at that which holds for some particular oxychloride have not been reflected by any striking results from a strength or soundness standpoint.

The commercial possibilities of Sorel's cement were very soon recognized and within a comparatively few years after his invention the construction of floors composed of sawdust, wood flour and sometimes siliceous aggregate, cemented with magnesium oxychloride, became quite common in Germany and in France. Various difficulties in the preparation of satisfactory mixes were experienced, but the industry developed normally and later spread to this country. It is found possible to secure properties in a flooring using an oxychloride cement binder which cannot be obtained by the use of any other flooring material. The product accordingly has taken its place as a more or less standard building material. Oxychloride, or, as they are commonly called, "composition" floorings require highly skilled workmanship in their application, but numerous organizations are now in a position to lay such floors. The development of exterior stuccos in which magnesium oxychloride is the binding medium is more recent. Sorel's original statements as to the water-proofness of his cement have not been entirely confirmed and there was for a long time a real doubt as to the permanence of such stuccos. Experience has shown, however, that, provided the raw materials are of proper quality and are properly mixed, a sound and permanent stucco will result.

In the preparation of any oxychloride cement, three classes of raw materials are required: aggregates, magnesium chloride, and magnesium oxide. The aggregates employed include sand, ground sand or silex, marble or limestone dust, talc, china clay, sawdust and

wood flours of various grades, asbestos fiber, and pulverized cork. The fineness and the percentage of voids in sand, the fineness of the various fine fillers, the type of wood and the particle size of wood flours and sawdust, the fiber length of asbestos, and the fineness of granulated cork give indications as to their value. The magnesium chloride employed is recovered from natural brines or salts in the Stassfurt district, or from Michigan, Utah or California in this country. The usual product is either a solid or granular material containing in the neighborhood of 98 per cent $\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$ and less than 2 per cent of calcium chloride, of magnesium sulphate, or of sodium chloride. Chemical analysis clearly indicates its quality. The magnesium oxide required is essentially all prepared from natural magnesite, large deposits of which occur in Greece, Austria, Venezuela and in the states of Nevada, Washington and California. The term "plastic calcined magnesite" is in a sense a misnomer. Magnesite after being calcined is obviously no longer magnesite, but is magnesium oxide or magnesia. Inasmuch as the magnesium oxide used by the oxychloride industry is generally prepared by the heating of natural magnesite rock, the term has gained such standing with consumers that it will be used unchanged throughout this paper. "Plastic magnesia" or "caustic magnesia" are occasionally employed in the same sense. The testing of this product has proved one of the most troublesome points encountered by producers of oxychloride cements.

PHYSICAL TESTS OF OXYCHLORIDE CEMENTS

It is obvious, of course, that the value of any plastic calcined magnesite lies in its ability to form sound, strong and permanent oxychloride cements when used in proper mixtures and that only tests which are indicative of its ability to fulfil this function will throw light on its quality. We must consider first, then, the question of physical tests of oxychloride cements.

Selection of a standard testing mix for oxychloride cement investigations is rather troublesome. Entirely unsatisfactory results have been obtained by attempting to test mortars containing only sand as an aggregate, that is, by following the general practice used in testing portland cement. The reason for the trouble is not far to seek. The mortars and the concretes used in portland cement tests approximate in composition mixes used in the field. It is quite rare for a commercial oxychloride cement to contain only sand as an aggregate, or at least only sand of the character of the sands usually used in cement testing. The usual oxychloride stucco is either prepared from an excessively fine sand or contains a considerable amount of fine aggregate, most commonly ground silica or silex. It is found, in fact, that best results can be obtained only

*Read before the American Society for Testing Materials, Asbury Park, N. J., June 22, 1921.

when such a fine aggregate is used in an oxychloride mix. An elaborate series of investigations has indicated that most concordant test results are obtained in a mix which contains as high as two parts of silex to five of sand. Such a mix requires the use of only a comparatively small amount of calcined magnesite, 12½ per cent of the total mix being sufficient. The standard testing mix referred to throughout the remainder of the paper will be one containing one part calcined magnesite, two of silex—the material known commercially as 120-mesh silex being used—and five of standard Ottawa sand. When the question of adoption of a standard floor mix is considered, even more difficulty is encountered. So many different types of floors are laid, varying from soft and resilient to hard and stonelike, that any one mix will represent but a comparatively small proportion of the total actual installations. There are definite relations between the results obtained on flooring and on stucco mixes when used with various magnesites, so we will consider at length only tests on the standard stucco mix.

The data necessary for determination of quality of an oxychloride cement can be obtained from tests for strength, volume change, setting time and permanence of the product.

STRENGTH TESTS

Four types of strength tests have been studied—namely, tensile, compressive and cross-bending strengths, and resistance to abrasion. No particular comment is needed on tests for tensile or for compressive strengths. The ordinary standard size briquet for tensile tests and the usual cubes or cylinders employed for mortar compression tests can be used to good advantage. Such tests, although throwing much light on the properties of oxychloride cements, sometimes do not check field results. It should be recognized that oxychloride products are used at present only as comparatively thin surface coatings, never being employed in mass work of any type. Neither briquets nor compression cubes or cylinders can be aged under conditions comparable with the aging of such thin coats of flooring or stucco. Especially during the early life of the cement, contact with air exerts a considerable influence on its rate of gain of strength.

It has been considered important, accordingly, to work mainly with test specimens approximating in shape a section from the coatings as applied in practice. Excellent results have been secured from flat bars ½ in. thick, 2 in. wide and 24 in. long. These bars can readily be prepared in suitable steel molds and, after proper aging, can be tested in a simple cross-bending machine in which the load is applied by running shot into a cup supported on the bar. An ordinary plasterers' trowel is used in preparing the test specimens and the influence of various methods of troweling can be readily studied. Flat bars of this type, besides more closely approximating field aging conditions for stucco or flooring mixes, allow also of determination of modulus of elasticity and of the making of water resistance tests, which latter cannot be conveniently made on other forms of specimen.

For flooring mixes, there is no inherent reason to suppose that a direct relation between tensile strength and resistance to abrasion need exist. Some interesting data on the abrasion resistance of various composition floors have been obtained by rotating a set of steel cubes weighing about 5,000 g. over the

surface of the floor while a slow stream of fine silex is fed onto the surface to serve as abrasive material. The depth of the impression in the floor is readily obtained from a small measuring bridge supported on points outside the abraded area by which a map of the floor surface can be drawn.

VOLUME CHANGE

The volume change, or more exactly, the linear expansion or contraction of a test specimen, is of decided importance in a study of oxychloride cement quality. Two methods for the measurement of this property have been considered. One consists in the preparation of bars 1 in. square and 10 in. long, which have metal plates imbedded in their ends. These bars can be removed from the molds at about the period of final set and measured by a large micrometer. Such bars, however, do not allow of determination of change in length during the early ages of the material—that is, during the period before final set—as they are too weak to be handled at such a time. Inasmuch as a certain amount of difficulty with cracking of stucco and of flooring mixtures has been encountered during this early period, somewhat more satisfactory results have been obtained by measurement with the Berry strain gage of the movement of reference points inserted in a ½-in. bar of stucco or flooring mix which is formed on a sheet of waxed paper and need not be disturbed during testing. Such measurements can be begun at the period of initial set.

SETTING TIME

Setting time of oxychloride mixes can be determined by the usual Vicat or Gillmore needles. Certain complications are introduced by the fact that mixes containing aggregate must be tested. The results on neat mixes of calcined magnesite and magnesium chloride solution are not found to be comparable with results obtained from the use of the same magnesite in the usual flooring or stucco composition. Some difficulty in determining definitely the end point of setting time may be encountered on account of the presence of sand in the mixes being tested, but determinations are still fairly accurate. Where a large number of determinations are to be made, the Hill setting-time machine, which automatically raises and lowers a set of Gillmore needles onto an extremely slowly moving pat of the oxychloride mix, has been found to give good results. With a known rate of movement of the pat, setting time can be determined by measuring the length of the series of impressions from each needle.

PERMANENCE

Inasmuch as all oxychloride products are submitted to periodic wetting either from the weather, in case of a stucco, or from scrubbing, in case of a flooring, some data on water resistance of oxychloride mixes are of value. The flat bars mentioned above allow of making a water test comparatively easily. They can be placed behind a perforated grid which protects their backs from direct contact with water and sprayed with a gentle mist of water directed against their faces. Strength can be determined after various periods of wetting and of subsequent drying. A satisfactory water test has been found to consist of spraying 14-day-old bars for three successive 24-hr. periods with 24-hr. drying periods intervening, finally testing the bars wet and after two days' additional drying in comparison with the usual test on an unsprayed bar.

Various factors will influence the value of the test results obtained by any of the methods noted above.

Consistency of the mortar will influence strength in the same direction in which consistency variation influences strength of portland cement mortars. The effect is very much less marked, however. With portland cement mortars, an increase in consistency from normal to 125 per cent of normal gives a lowering in strength to about 65 per cent of normal. A similar increase in consistency of an oxychloride cement mortar gives a decrease in strength of 93 per cent of normal. There is not as great danger, accordingly, of poor results being obtained from excessive addition of chloride solution with oxychloride cements as there is from the use of too much water with portland cement. On this account, too, the usual schemes of definition of aggregate quality which depend directly or indirectly on the amount of water required to make a plastic mix with the aggregate in question entirely fail when applied to oxychloride cement mixes.

The strength of the magnesium chloride solution has great influence on the properties of oxychloride cement. Fig. 1 gives the results obtained from an average oxychloride stucco mix by increasing the strength of magnesium chloride solution progressively. It is seen that satisfactory results cannot be expected from dilute chloride solutions. The curves might indicate that better cements would be obtained as the specific gravity of the chloride solution was increased to a very high point. Other factors, however, must be studied before such a step can be considered. With chloride solution strengths above 24 deg. Bé., undue expansion effects develop. The optimum concentration of the magnesium chloride solution appears to lie at 22 deg. Bé. A certain amount of field work is done with chloride solutions of from 18 to 20 deg. Bé., but the slight saving in magnesium chloride effected by this practice cannot be justified in view of the decided advantage to be gained by the use of somewhat stronger chloride. The reason for the use of weak chloride is frequently said to be the fact that such chloride solutions will make an oxychloride cement which sets slower. This is entirely opposed to the results found from determination of setting time of a series of mixes in which

chloride strength is varied. From the practical man's standpoint setting time of an oxychloride stucco is of interest inasmuch as it influences the behavior of the stucco when dry pebble dash is applied to it. A material which sets too fast resists the penetration of the pebbles. Careful tests have shown that although there is a slight difference in favor of a stucco prepared with weak chloride when the question of dash penetration is considered, this difference is only in the neighborhood of 10 per cent, an amount which is not observable in actual practice.

INFLUENCE OF THE CHARACTER OF THE AGGREGATE

The character of the aggregate influences the various properties of an oxychloride cement in a rather complex way, and the question can no more be covered in a short space than can that of the study of aggregates for use in portland cement concretes. In general it may be said that the use of fine aggregate is essential for the attainment of high strengths and good water resistance. The mechanism of the setting reaction with oxychloride cement is quite different than with portland cement. When portland cement sets, the small particles surround themselves with a shell of reaction product, but the center of each cement particle remains unchanged. In a sense, then, portland cement furnishes its own fine aggregate. With oxychloride cements, provided the calcined magnesite is reasonably finely ground, each particle of magnesium oxide completely enters into reaction. If the reaction product is called on to fill the comparatively large voids between sand grains, a mass of inferior strength will result.

However, if a fine aggregate is introduced which will itself enter the voids between sand grains, the oxychloride cement will need only to coat these particles of fine aggregate and to fill the much smaller voids which would result and much higher strengths and permanence will be secured. Here, as in the case of portland cement mortars or concretes, the cementing material is the weakest portion of the set mass and if it can be reduced to a minimum, the physical properties resulting will be more desirable. When very fine magnesites are employed, the amount required for production of strong cements can be reduced to a surprisingly low figure, 4 or 5 per cent only being required in a mixture in which the coarsest aggregate is a comparatively fine sand. If an oxychloride concrete were to be formed, the amount needed would be still smaller.

Curves giving strength of mixtures of various composition, in all of which the same magnesite and same strength of chloride solution were used, are given in Fig. 2. They indicate strikingly the advisability of the addition of fine aggregate. It should be noted that the influence of fine aggregate on wet strength is even greater than on dry strength. Mixes without fine aggregate often disintegrate completely on wetting.

Storage conditions during the aging of oxychloride test specimens of any type must be carefully regulated. Storage in air is always employed. The temperature must not vary more than 10 deg. F. from a standard of 70 deg. F. and humidity not over 15 per cent from a standard of 50 per cent relative humidity if concordant results are expected. High temperature or low humidity increases rate of gain of strength and greatly accelerates setting; low temperature and high humidity have the reverse effect.

The quality of commercial calcined magnesite exerts

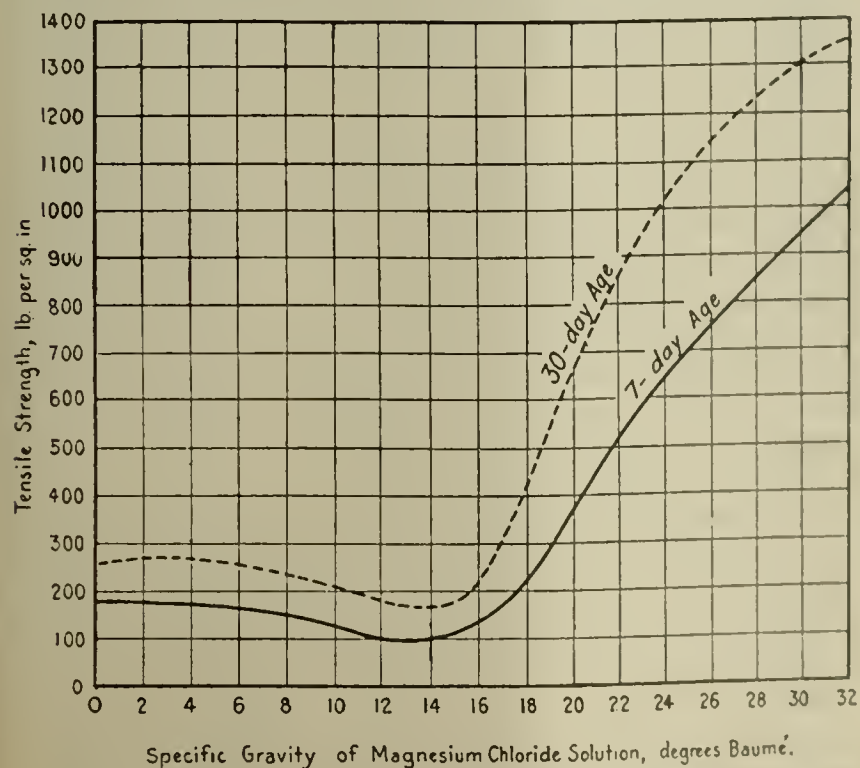


FIG. 1. RELATION BETWEEN SPECIFIC GRAVITY OF CHLORIDE SOLUTION AND TENSILE STRENGTH OF 1:2:5 OXYCHLORIDE MIX

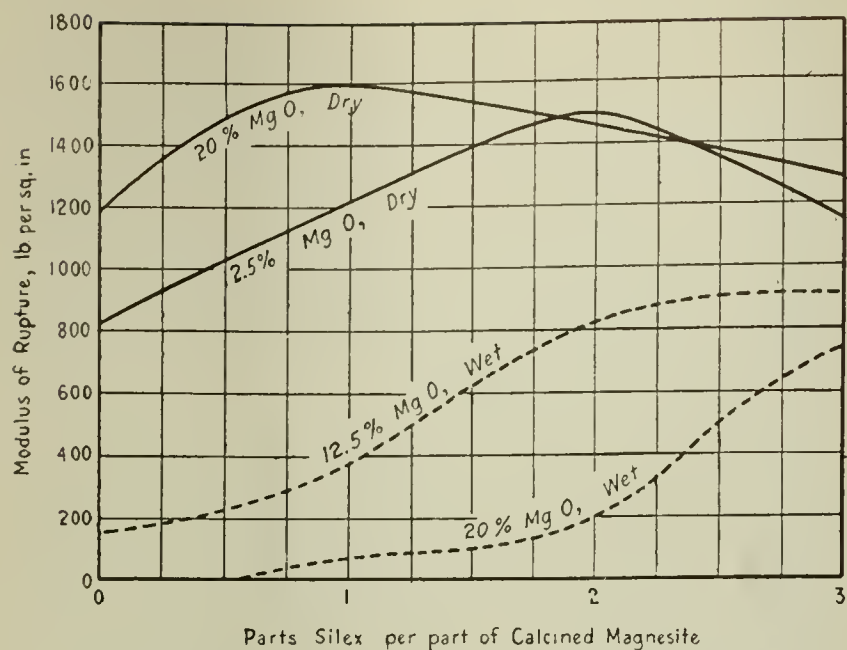


FIG. 2. STRENGTH AT 14 DAYS OF OXYCHLORIDE MIXES CONTAINING CALCINED MAGNESITE, SILEX, AND SAND

Ratio of silex to sand varied, but MgO content of each mix held constant.

a tremendous influence on the properties of oxychloride cements. Certain magnesites appear on the market which will not give a satisfactory product no matter what attention be paid to other details of mix composition. The usual tests of magnesite quality which have been applied in the past have consisted of a chemical analysis of the calcined product. In general, limits for ignition loss, calcium oxide, silica and magnesium oxide have been written into specifications. Users of this product have come to realize during the past few years, however, that their chemical analysis specifications were not insuring them a magnesite of high quality. Some results which bear out this point are shown in Table I.

Study of several hundred commercial magnesites has indicated that there is only one factor determinable by chemical test which exerts a definite influence on the character of the cement. This is the percentage of the active lime. The amount of this constituent present bears no relation to the content of total lime in the magnesium oxide. Active lime can be determined by agitation with dilute magnesium chloride solution and determination of the amount of calcium chloride introduced into the solution. Unfortunately, it is found that the relation between strength, permanency and active lime content is traceable only when average figures covering many magnesites are examined. Other factors play so important a part in regulating oxychloride cement strength that the relation does not appear when test results on individual samples are examined.

The explanation of the wide discrepancy between chemical analysis and physical test results is found in the fact that the time-temperature history of the calcining procedure is of vital influence on the reaction between magnesium oxide and magnesium chloride, although it is not reflected in any major change in analysis. Widely varying results can be secured from samples of calcined magnesite from the same rock.

SUGGESTED SPECIFICATIONS

Fairly satisfactory results can be obtained in study of magnesite quality if reliance be placed on purely physical tests. A determination of fineness is unquestionably of value. At least 97 per cent of the material should pass a 100-mesh screen and at least 75 per cent

TABLE I. COMPARISON OF CHEMICAL ANALYSIS OF CALCINED MAGNESITES AND PHYSICAL PROPERTIES OF OXYCHLORIDE CEMENTS

Mag- nesite Loss No.	1 : 2 : 5 Mix. 22 Deg. Baumé Chloride Chemical Analysis, per Cent						Setting Time Hr. and Min.		Modulus of Rupture, Lb. per Sq.In.		Re- cov- ered
	Ignition	CO ₂	SiO ₂	R ₂ O ₃	CaO	MgO	Initial	Final	Dry	Wet	
1...	9.20	4.05	9.58	0.95	7.50	73.7	2:15	3:00	1,500	828	1,218
2...	6.05	4.20	17.7	4.50	11.10	60.6	2:00	6:00	1,362	654	1,374
3...	8.35	3.25	5.07	0.80	3.58	82.0	2:30	4:30	1,232	642	977
4...	6.98	1.68	7.01	0.42	3.64	82.8	3:45	4:30	1,010	618	854
5...	10.65	4.07	8.09	1.32	4.34	75.6	2:15	4:00	1,277	594	1,188
6...	7.91	2.08	1.41	0.59	2.44	87.6	2:15	4:00	1,580	525	967
7...	9.09	1.54	2.09	1.20	3.40	85.0	3:45	6:00	1,486	273	605
8...	8.69	3.44	13.34	2.03	4.28	71.6	2:30	3:30	1,011	252	810
9...	2.95	2.80	3.45	0.88	4.48	88.2	2:30	3:30	1,604	132	198
10...	6.95	2.54	7.65	1.21	3.75	80.5	2:00	4:00	1,378	97	300

a 200-mesh screen. Calcined magnesite is a comparatively easy material to grind and it is very probable that this fineness can be greatly increased and quality accordingly improved without introducing serious manufacturing difficulties. Coarse magnesite results in abnormal expansion of the cements prepared from it. The magnesite, if of satisfactory fineness, should be used in a standard oxychloride mix, preferably the one magnesite, two silex, five sand composition previously mentioned, and further tests carried out on this material. The specific gravity of the chloride solution used should be 22 deg. Bé.

The plastic oxychloride mortar should not show initial set within an hour. It should attain final set within eight hours. A 2-hr. minimum for initial set is preferred by some workers while some will consider the 8-hr. maximum for final set unduly long. The first limits, however, are about those met by average commercial calcined magnesite. Modulus of rupture on the flat bars previously described should be at least 550 lb. per sq.in. at one day and at least 1,000 lb. per sq.in. at seven days.¹ Oxychloride cements from average magnesites will give figures much higher than these. Limits on expansion and contraction are exceedingly difficult to set but it is probable that a magnesite which shows over 0.3 per cent contraction or expansion within twenty-four hours after initial set in the mix specified should be considered as of questionable quality. Limits for water resistance are also hard to set. Unless the oxychloride cement made from a particular magnesite shows a wet strength after the standard spraying procedure of at least 30 per cent of its dry strength, however, some doubt as to magnesite quality should be felt.

A calcined magnesite which meets the requirements suggested will certainly be of at least average quality. Much better material than that indicated can be secured when greater attention to the preparation of the calcined product is given by the various producers. Co-operative work is now under way which should lead to the establishment of more definite limits for the various factors discussed, probably resulting in the issuance of definite specifications for plastic calcined magnesite within a year or so.

The oxychloride industry is one of remarkable latent possibilities. It has suffered seriously from lack of attention to the quality of the raw materials used and from lack of knowledge of the basic principles of mix preparation. As more data on both of these points become available, there is little question that oxychloride cement products will take their place as standard construction materials for certain definite uses.

¹On 3x2-in. bars, broken on 20-in. centers, the modulus of rupture will average 2.2 times the tensile strength.

Hardwood-Distillation Industry—III

Discussion of the Problems Encountered in the Separation of Commercial Products From the Mixtures of Wood Distillates and of the Difficulties Encountered in the Distillation of Sawdust*

By L. F. HAWLEY†

THE problem of obtaining commercial products from the mixtures of wood distillates is usually taken up from the standpoint of producing especially acetate of lime and methanol from the pyroligneous acid and of separating the different oils contained in the tar.

It has been stated previously (p. 197) that the wood distillates when condensed give two crude products—namely, pyroligneous acid and tar—that gravity and solubility are not sufficient for their complete separation, that some constituents of the tar are found in the pyroligneous acid and *vice versa* and that their complete separation can be realized only by fractional distillation. The first operations, therefore, are the separation of the tarry material from the pyroligneous acid and the freeing of the methanol and acetic acid from the settled tar. If the tar is to be distilled in a fire still, the removal of the acid and methanol is made a part of that process, otherwise a steam distillation only is used.

The first apparatus used in refining the mixtures of wood distillates were fire stills heated by the direct heat from a firebox underneath. These stills required very careful control, and only workmen with considerable experience were able to obtain good results with them or even to operate them with safety. All of the stills used in the refining process, except the fire stills for tar, are now heated by steam coils, which are much easier to regulate and which give better results due to less superheating of the product.

PRODUCTS OBTAINED BY WOOD TAR DISTILLATION

On distillation the wood tar may be separated into products of considerable difference in their chemical and physical properties.

The first parts of the distillate, the light oils with boiling points up to 200 deg. C., have specific gravities less than unity and contain practically no phenols. These light oils are very complex and have been studied chemically by G. S. Fraps,¹¹ who investigated a commercial "wood oil" to determine its prominent chemical constituents. Fraps found that this oil contained a series of aldehydes, ketones and acids of the formaldehyde, acetone and acetic acid series respectively, the acids occurring mostly in the form of methyl esters. These constituents, however, are only the more active ones, and the less active compounds, apparently complex hydrocarbons, were not studied. No exact quantitative determinations were made, and the compounds identified probably constituted only a small proportion of the total oil.

The heavy oils from wood tar have also been studied in some detail, but only the phenolic bodies soluble in alkali have been identified. About sixteen phenolic bodies with boiling points between 178 and 285 deg. C. have been detected, but no figures have been given in regard to the percentage composition. It is noticeable that all these compounds are either straight phenols or methyl ethers of phenols. Although phenol itself and the cresols have been detected in wood tar, these occur only in very small quantities, the high-gravity and high-boiling methyl ethers being the main constituents. This is one respect in which hardwood tar differs from coal tar—namely, that phenol and the cresols are not present in considerable quantities.

Benzene and xylene have been reported as occurring in hardwood tar or tar oils; but although they may be present in small quantities, they are not of commercial importance.

That part of the heavy oils which is insoluble in alkali has never been studied, and there is no information available in regard to its probable composition. It does not, however, contain naphthalene or anthracene in appreciable quantities like the coal tars.

The residual pitch has never been studied from the chemical standpoint, but from its general properties it must be very complex chemically. A hard or soft pitch can be obtained, depending on the amount of heavy oils left undistilled in the pitch.

When distilling with steam a product known in the market as "wood oil" is obtained. This oil naturally varies with the amount of steam used in the distillation, but practically always contains all of the light oils previously mentioned, and in many cases considerable quantities of the heavy oils with boiling points above 200 are also included.

USES FOR WOOD TAR DISTILLATION PRODUCTS

From the discussion of the composition of the tar it can be seen that numerous different products could be made by variations in the method of separating, redistilling and drying the fractions of tar oils.

The light oils are a very good solvent for some purposes; the heavy oils are valuable for stains, disinfectants and preservatives, or as a raw material for the manufacture of beech-wood creosote; and the pitch has been used as a waterproofing and insulating material. Various combinations of light and heavy oils and pitch have been used for flotation oils, and this is the one general use to which hardwood tar and tar products seem to be especially adapted.

The distillation of hardwood tar in fire stills is a comparatively new process, but it has been very successful and there is a chance here for an increase in the value and number of hardwood-distillation products.

*For Parts I and II see CHEM. & MET. ENG., vol. 25, Nos. 1 and 5, July 27 and Aug. 3, 1921, pp. 137 and 195.

†In charge Section of Derived Products, Forest Products Laboratory, U. S. Forest Service, Madison, Wis.

¹¹Am. Chem. J., vol. 25, p. 26 (1901).



ACETATE DRYING FLOOR OVER THE OVENS

The pyroligneous acid freed of the tar it contained is neutralized with lime in order to form a non-volatile acetic acid compound from which the volatile methanol can be separated completely by distillation. After this neutralization the pyroligneous acid turns very dark, and non-volatile impurities are formed which contaminate the acetate of lime. The methanol is removed by distillation and the impure solution of acetate of lime remains behind. This impure solution is evaporated and dried to the commercial product called "gray acetate of lime."

Until within a few years some crude pyroligneous acid was used directly, when, after neutralization with lime, evaporation and drying, a product containing tarry impurities was obtained known as "brown acetate of lime."

As calcium acetate is more soluble in cold water than in hot, it is not possible to crystallize this salt by the usual methods. The impurities present also prevent the formation of good crystals on drying, and the finished material resembles a gray granular powder without crystal form.

There are many fine points in the neutralization of the distilled pyroligneous acid with lime which have never been properly studied. In commercial practice the neutralization is usually carried to a point which gives the best acetate of lime. If the neutralization is carried farther or not so far, difficulty is found in preparing a granular acetate, since there is a tendency for the material to separate out in a hard crust on the bottom of the evaporating pan instead of forming the usual granular crust on the surface of the liquid.

Since the pyroligneous acid contains both acetic acid and methanol, it must also contain a definite proportion of methyl acetate according to the equilibrium between the quantities of water, methanol and acid present. When the pyroligneous acid is neutralized, the methyl acetate is hydrolyzed to methanol and acid, but this takes place slowly and in most cases there are considerable amounts of methyl acetate still undecomposed in the distillate. This slow hydrolysis accounts for the fact that completely neutralized pyroligneous acid will become acid again on standing.

It might be possible to obtain slightly higher yields of methanol and acetic acid by making sure that the hydrolysis is complete before distilling the neutralized liquor, but if this must be done at the expense of difficulties with the quality of the acetate it is not considered to be worth the effort.

ACETATE SLUDGE

When the distilled pyroligneous acid is neutralized with lime, a considerable quantity of insoluble material settles out at the bottom of the tank. This so-called acetate sludge contains insoluble impurities from the lime and also insoluble organic compounds precipitated or polymerized by the neutralization of the liquid. This sludge was formerly settled out from the acetate liquor and thrown away without any serious attempt to wash it. It was soon found, however, that appreciable amounts of acetate of lime were being lost with the sludge, and various methods of washing have now been introduced. In some of the larger plants mechanical filters of different kinds are now used to remove the last traces of acetate from the sludge.

EFFICIENCY IN THE USE OF THE HEAT REQUIRED FOR REFINING

Since the refining of the hardwood-distillation liquors consists normally of several redistillations of the ordinary crude liquor, there is a chance to save considerable steam by the use of the principle of multiple-effect evaporation or in the use of exhaust steam for evaporating at reduced pressure. The multiple-effect principle has been applied in several ways. Triple-effect evaporators have been used on the green liquor or crude pyroligneous acid and also on the neutralized acetate liquor. A double-effect evaporation has been obtained by using one evaporator heated by steam for distilling the crude pyroligneous acid and then using the vapors from this evaporator for heating the acetate liquor in another evaporator.

Various types of evaporators have been used, and we have recently seen in operation some Klar ten or twelve years ago, aremba evaporators of copper with vertical tubes for use on the pyroligneous acid, Zaremba iron evaporators with horizontal tubes for use on acetate liquor, Buffalo Foundry & Machine Co.'s inclined-tube triple-effects and Badger evaporators for the double-effect combination in which the vapors from the pyroligneous acid are used to heat the acetate liquor.

DIFFICULTIES ENCOUNTERED IN THE USE OF EVAPORATORS

Varying results have been obtained, but the common objection to evaporators is the difficulty caused by the deposition of some form of tar either inside or outside the evaporator tubes. In one place the first-effect evaporator in which the crude pyroligneous acid was distilled gave a great deal of difficulty by the deposit of tar or pitch on the outside of the tubes. This, however, was finally avoided by allowing a part of the settled tar to flow into the evaporator along with the pyroligneous acid, the oils in the tar apparently dissolving the pitch from the tubes. In other cases, however, the crude pyroligneous acid has been evaporated without the presence of the settled tar and it is claimed that no difficulty has been encountered in fouling the tubes. In some places where there is no difficulty in the first-effect the vapors carrying over from this effect

seem to form a deposit on the inside of the tubes of the second-effect, and considerable trouble has been caused in this way. There seems to be no general agreement on the subject of the difficulties of tar deposition and how they may be best avoided, but it seems to be the general rule that evaporators working on wood-distillation products must be so constructed that the tubes both inside and outside can be readily cleaned.

When multiple-effect evaporators are operated at all efficiently there is a great saving of steam over the ordinary evaporation processes. It must be remembered, however, that the ordinary copper still is much simpler in construction and operation and is cheaper than the multiple-effect evaporator, and in cases where the cost of fuel is not high these points may make up the difference in steam efficiency. In one place a single-effect evaporator was in use on the crude pyroligneous acid and was heated entirely by exhaust steam. This evaporator was being used in place of four of the



MULTIPLE-EFFECT EVAPORATORS

ordinary copper stills which required pressure steam for their operation. This gives a good example of the possibility of steam economy in the refining of wood-distillation products.

SEPARATION OF THE METHANOL

Formerly the separation of the methanol from the neutralized pyroligneous acid was accomplished by continued redistillation in a series of ordinary pot stills without any kind of fractionating column. The first fractionating devices used in connection with this operation were the so-called Burcey pans, by which a certain amount of dephlegmation and fractional condensation were obtained. These Burcey pans were in use in most of the crude plants and were efficient enough, so that little difficulty was encountered in obtaining most of the methanol from the crude liquor in the form of crude 80 per cent methanol in one or two distillations. Column stills have replaced the Burcey pans in many plants with considerably increased efficiency, but a few of them are still in operation.

In places where triple-effect evaporators are used, the neutralized acetate liquor is usually run through a

continuous column still for the removal of the crude methanol before the liquor is run through the evaporators.

The use of column stills, particularly continuous stills, in concentrating the methanol is more efficient than the usual method of distilling the neutralized liquor in a lime-lee still and then concentrating the distillate from this still.

Continuous stills for the removal of the alcohol from the neutralized liquor are coming more and more into use and apparently give very satisfactory service.

In some places deposits of tar or pitch are formed in certain sections of these stills, but they do not often have to be stopped for the purpose of cleaning.

EFFECT OF THE PRESENCE OF METHYL ACETATE IN THE METHANOL LIQUOR

The effect of the presence of methyl acetate in the methanol liquor is of some importance on account of its effect on the determination of the percentage of methanol, which is always made by specific-gravity methods. Methyl acetate has a very high gravity in comparison with methanol, although its gravity is slightly less than that of water. On this account, if large quantities of methyl acetate are present, the determination of the value of the methanol by gravity is not correct, since the methyl acetate is not determined in proper proportion by gravity determination. Methyl acetate persists in the refining operations and is found in the final products of the separation of methanol.

BETTER QUALITY OF METHANOL

The quality of the refined methanol has gradually increased as demands were made for a better product and as experience in refining increased. The first refined methanols were of very poor quality, having considerable color and a very disagreeable odor. Since this product was used largely as a solvent, it was not necessary to prepare a pure alcohol, and although the color and odor were gradually improved, considerable quantities of acetone still remained in the refined alcohol. This is due to the fact that methanol forms with acetone a constant boiling mixture which cannot be separated by the most careful fractional distillation methods.¹² Fortunately, however, this constant boiling mixture has a high proportion of acetone which makes it possible to obtain by commercial distillation a very pure methanol, although the acetone separated from it contains also considerable quantities of methanol. Methyl acetate forms similar constant boiling mixtures with both methanol and acetone.¹³ At the present time, methyl alcohol without color or disagreeable odor and with only traces of acetone is produced in large quantities.

It may be desirable at this point to call attention to an error which constantly occurs in the literature on wood-distillation processes. A series of compilers, who have obtained their information from the printed page instead of from laboratory or plant, have handed down from one to another the tradition that acetone is separated from methanol in commercial refining plants by chemical methods. The methods mentioned are usually the formation of chlorine addition products of the acetone or the formation of a compound of calcium chloride with methanol from which the acetone can be removed by distillation. Although Klar, in 1910, was

¹²Haywood, *J. Phys. Chem.*, vol. 3, p. 349 (1899).

¹³Ryland, *Am. Chem. J.*, vol. 22, p. 384 (1899).

very emphatic in denying that these processes were then used commercially or had been used for years, occasionally one of these chemical methods for refining methanol will be mentioned in the literature as a modern commercial method.

EVAPORATION AND DRYING OF ACETATE OF LIME

The common method of handling the acetate liquor, after the methanol has been distilled from it, is to evaporate in shallow, steam-heated, iron pans and then dry the thick residue from these pans on the drying floor built on top of the retorts. In the case of the kiln plants this drying floor was especially built for heating by waste heat or by a special firebox. This process required pressure steam in the evaporating pan and considerable labor in operating the pans and in raking the acetate on the drying floor.

New methods have been introduced and are in common use in certain localities for evaporating and drying this acetate liquor in automatic apparatus requiring very little labor. The acetate liquor concentrated by some other method to a point very near the separation point is run into a shallow pan in which a steam-heated steel roll revolves, dipping into the concentrated acetate solution for a few inches on its lower surface. A series of scrapers, automatically controlled, scrape the partly dried acetate from the surface of the roll and drop it into the conveyor. The amount of moisture left in the acetate when it is scraped from the roll is regulated by the speed of revolution, by the steam pressure and by the number of times which the surface of the roll is scraped per revolution. Generally the acetate comes from this roll in the form of a thick mud, and this mud is further dried by being picked up on an endless wire belt and squeezed in between the links and between the upper and lower surfaces of the belt. The belt carrying the acetate mud then travels through a drier heated by steam or by some form of waste heat until the acetate is completely dried. It is then automatically removed from the belt by making the belt turn sharp corners to crack the lumps of acetate and by automatic tapping which shakes out the remaining fragments of dried acetate. In this way the acetate liquor is concentrated and dried and the finished acetate of lime dropped onto conveyors and carried to a storage bin without the necessity for any handling.

Destructive Distillation of Sawdust

Many publications on wood-distillation have described in some detail commercial methods for the destructive distillation of sawdust. The Halliday method is the

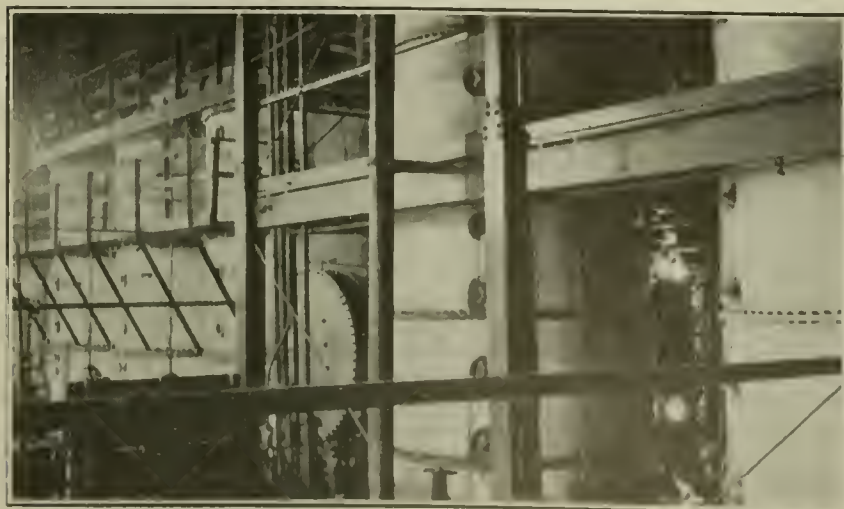
one most commonly described, and the picture of this apparatus has become familiar. It is, therefore, a fairly common impression that the destructive distillation of sawdust has been in commercial practice for many years. We are certain that until very recently no commercial process of sawdust distillation had ever been in operation in this country, and according to Klar's book published in 1910 no sawdust-distillation process had been in successful operation anywhere up to that time.

There are many difficulties in the way of successful destructive distillation of sawdust. In the first place, wood itself is a good non-conductor of heat and sawdust is even better in this respect, since a mass of sawdust contains many closed air spaces which are still better non-conductors. A stationary mass of sawdust is, therefore, very difficult to distill, since it is almost impossible for the heat required to pass through to the center of the mass. It is necessary, therefore, that the sawdust be stirred either by a rotating retort or by some kind of agitation within the retort. This immediately introduces other complications. Either a stirrer or a rotating retort requires moving parts which must be joined gas-tight to the stationary parts of the retort, and at the temperatures of destructive distillation this is not a simple problem. The agitation of the mass also stirs up a great deal of fine charcoal dust, which tends to be carried out of the retort with the vapors and to clog the condensers. If the process is to be continuous, it is also necessary to introduce the sawdust without introducing too much air and without allowing any of the products of the distillation to escape. The charcoal must also be removed through some kind of a gas-tight seal. The cooling and handling of large quantities of finely divided charcoal is also a problem which has not yet been solved; and this, together with the marketing of large quantities of such a product, again adds to the difficulties of sawdust distillation. Several methods for solving these problems have recently been suggested, and some of them have been carried out in commercial or semi-commercial units.

THE BRIQUETTING PROCESS

The American Wood Reduction Co. avoided many of the problems in connection with sawdust-distillation by making the sawdust into a solid block of wood before distillation. In other words, the sawdust or very small-sized wood was briquetted and distilled in the form of briquets. When sufficient pressure is applied to wood a very solid briquet can be formed without the use of any binding material. These briquets, however, when made of hard wood, tend to fall to pieces during destructive distillation; consequently the benefits of briquetting would be largely lost. It was found, however, that, if these sawdust briquets could be subjected to slight mechanical pressure during the distillation, they remained in one piece and fairly firm, regularly shaped pieces of charcoal could be made by this method.

The process finally developed by this company included the conversion of the waste wood in the form of sawdust or small chips into 4-in. briquets, which were loaded from an automatic loader into retorts, consisting of a series of horizontal tubes 20 ft. long and with an inside diameter slightly greater than that of the briquets. Each of these tubes was provided with a piston, by means of which a small pressure of 8 or 10 lb. per sq.in. could be exerted continuously against the column



ACID LIQUOR EVAPORATORS AND CONTINUOUS METHANOL STILL

of briquets during the distillation. On account of the small diameter of the tubes, each of which really acted as a single retort, the complete distillation could be finished in about three hours, and the temperature control was good enough so that unusually high yields were obtained. The cost of preparing the wood for distillation and the rather complicated and small-capacity apparatus was, therefore, compensated by the high yields and short length of time in the retort. A plant to use this process was under construction for the Bureau of Aircraft Construction during the war, and was about 80 per cent completed at the time of the armistice. This plant was never put into operation, and the process never had a trial on a commercial scale.

THE SAWTELLE PROCESS

The Sawtelle process also avoided some of the usual complications of sawdust-distillation by a combination of the distillation of the wood and the manufacture of producer gas from the charcoal. This was accomplished by using an up-draft gas producer with wood as fuel. The wood in the form of sawdust and fine chips forms a cone-shaped pile in the gas producer, the upper part of which is wood in the drying stage, the next layer wood in the stage of destructive distillation, and the lower layers charcoal in the process of manufacture into producer gas. The heat required for distilling and drying is furnished by the hot gas. Since charcoal is not a product of this process, the difficulties with charcoal dust and with cooling the finely-divided charcoal are not encountered. This process has operated successfully from the mechanical standpoint in a small commercial unit producer, but unfortunately the wood used in these trials was of unknown mixed species, and therefore no comparative figures on the yields of methanol and acid were obtained. There seems to be no reason, however, why this method should not give the maximum yields of both acid and methanol, since the process is a continuous one and the temperature can readily be controlled. In localities where there is a demand for the producer gas obtained, this process should be very promising, but under present conditions the presence of large quantities of hardwood waste in localities where there is also a demand for power is uncommon.

THE STAFFORD PROCESS

This process was developed with the idea of utilizing fully the exothermic reaction of wood-distillation. The process and apparatus is of the simplest, consisting merely of a large, well-insulated chamber into which the dry, warm wood is introduced continuously. The heat of decomposition of the wood is sufficient to bring an equal quantity of dry, warm wood to the distillation point; and the process is, therefore, continuous without the addition of heat from the outside. A thick layer of charcoal is kept in the bottom of the retort and partly cooled charcoal can be withdrawn continuously or at intervals. This process has worked very successfully at small-scale trials, and it is reported that it is now being tried out in a commercial-sized unit. No figures have been given on the yields obtainable by this process, but there seems to be no reason why the maximum yields of methanol and acid should not be obtained.

THE SEAMAN PROCESS

The Seaman process was developed and demonstrated in a commercial-sized unit several years ago. The apparatus consisted of a rotating inclined retort about

30 ft. long by 3 ft. in diameter. The hot, dry sawdust was charged at the upper end and the charcoal was removed continuously from the lower end. The ingenious devices" for introducing the sawdust without introducing air and for removing the charcoal without allowing the escape of gas were found to work very satisfactorily on this demonstration retort. The yield of acetic acid obtained in this apparatus was unusually high, but for some unknown reason the methanol yields were somewhat low. A commercial plant to use this process was ready for operation early in 1918, but many difficulties were encountered, especially the plugging of the condensers by charcoal dust which was carried over from the retorts. It is reported that these difficulties have now been overcome and that several of the retorts are now operating continuously and commercially.

It should be noted here that the problem of sawdust distillation is perhaps not so important as is generally believed. This is for the reason that hardwood sawdust cannot be obtained in quantities sufficient for running a commercial wood-distillation plant without transportation, and sawdust is too cheap and bulky a material to permit profitable transportation for any considerable distance. Therefore, the only sawdust-distillation process which will be of importance commercially is the one which secures such economical operation or such high yields that it can afford to purchase and grind up large pieces of wood to use along with the sawdust.

Removal of Glue Stains*

Casein and vegetable glues containing caustic soda produce stains on certain kinds of wood, notably the oaks, maple, cherry, elm, ash, birch and beech. Some glues stain the wood more than others, and those that contain the most alkali are likely to be most injurious. The staining is due to the action of the alkali in the glue on the tannins and other constituents of the wood, whereby a substance related to ink is formed. No means have yet been found for preventing this chemical action. Precautions can be taken, however, which will keep the discoloration from the finished surfaces.

The most trouble with glue stain in woodworking is caused by the penetration of the glue solution through thin face veneers. This seepage is very likely to occur if the veneer is less than $\frac{1}{16}$ in. thick and somewhat porous. The consistency of a glue in part determines whether it will be squeezed through the wood or not. It is quite obvious that under similar conditions a thin glue will penetrate farther than a thick glue. For this reason the quantity of water that is added to a glue might be diminished and "fillers" added when staining is feared.

If a panel is dried promptly, the caustic soda solution will have difficulty in coming to the surface. Rapid drying can be brought about by removing the panels from the press as soon as it is safe to do so, and placing them on stickers.

Casein and vegetable glue stains can be almost entirely removed by sponging the stained surface with an oxalic acid solution prepared by dissolving an ounce of oxalic acid crystals in about 12 ounces of water. Still better results may sometimes be obtained by moistening the wood first with a sodium sulphite solution made up in the same concentration as the oxalic acid. In this way very stubborn stains can be almost obliterated.

*U. S. Pat. 1,236,885.

*From Technical Notes, Forest Products Laboratory.

Chemical Control of the Process for De-inking Paper

By C. M. JOYCE

DURING the past fifteen or twenty years, numerous methods for de-inking waste paper have been proposed. Many of these have been tried on a large scale involving great expenditure for equipment and materials. The net result of all this effort, however, may be expressed by saying that most mills are just where they started. The paper maker of today has little faith in new de-inking processes; he is not inclined to spend any time or money trying them. For this reason he is called narrow and unprogressive.

A careful study of the causes of these failures would justify the paper maker in his attitude. Many of those who have proposed de-inking methods have never seen a mill at all, do not have the working knowledge to take account of the interrelations of the market for raw materials and finished paper, cost of chemicals, and special mill conditions. There is no need for extra refinement in de-inking newsprint when the only use for the finished pulp is box board and cardboard filler. There is no use in recommending chemicals worth more than the pulp.

A valuable process for recovering newsprint, discovered by Baskerville and Stevenson,¹ has not received the attention it deserves because it has not provided for the mill difficulties in handling slack sized paper. Mill superintendents immediately raised the question whether newsprint can be used successfully in quantity on account of its rapid absorption of water and tendency to form bunches difficult to disintegrate. A mass of newsprint introduced rapidly into a de-inking bath accumulates near the top, forming an unwieldy wet mass which will often break a paddle before it disintegrates. Without waiting to see how this trouble may be overcome, mill men, with recollections of previous failures, do not care to consider the process. So the old soda boil, followed by washing of the resultant steaming, bad smelling, yellow mass, persists while chemists look on with disgust at the primitive mill methods.

After such a pessimistic beginning, the reader of this paper will not expect a solution of this important problem and the writer will not be sanguine enough even to attempt to propose one. However, a few general principles have been developed out of years of wide effort with small results, and these will be set forth in the hope that they will suggest improvements which some mill men may find adapted to their conditions.

APPARATUS AND TREATMENT

In preparing book stock and newsprint, it is highly desirable to loosen the ink before subjecting the stock to any pulping process which imbeds the ink in the fiber in such a way that its removal is impossible. It is also desirable to use the mildest possible chemical treatment, best accomplished by adjusting the amount of soda ash to a minimum quantity. A temperature somewhat less than boiling is an undoubted advantage as it makes it possible to turn out a pulp less tendered and less yellow.

Had the outside chemist not already discredited himself by proposing chemicals whose price is out of

reason, and apparatus too expensive or unwieldy to handle, he might make a real improvement in the average mill by painstaking adjustment of the factors mentioned.

For the de-inking bath, a boiler can be fitted up for external circulation by connecting it at the bottom to the intake of a rotary pump which discharges tangentially near the top of the boiler. By means of a Y-valve connection, the contents of the boiler can be pumped to the washer when finished. The paper may also be treated with de-inking chemicals in an ordinary beater used with the roll lifted clear of the bed plate (so that the ink will not be ground into the fiber), with a steam supply to raise the temperature of the contents nearly to boiling. If the beater has been used only for cold water previously, the wooden filler between the roll knives should be treated to withstand hot water. For removing the loosened ink a Lancaster washer has been used successfully by many mills.

CHEMICAL CONTROL REQUIRED

The form of apparatus used is less important than the careful chemical control of the process. To obtain the desired quality of product, maximum production and minimum cost of chemicals the following factors must be considered: (1) Ratio of water to weight of paper treated, (2) amount and kind of chemicals used, (3) rate of circulation of alkaline bath, (4) temperature, and (5) time. Increasing proportions of water make the pulp flow more freely so that the ink is more readily loosened by the chemical treatment. The amount is of course limited inasmuch as too large a proportion of water curtails the production. The more freely the pulp flows and the greater the agitation, the smaller the amount of chemicals required, because they will more readily come in contact with the pulp. It is important to have perfect circulation in order to avoid the possibility of a bunch of paper lodging somewhere until the chemical treatment is ended and then becoming free and distributing ink specks throughout the whole mass. Not infrequently excess chemicals are added to overcome defects in reality caused by poor circulation, a practice which adds to the expense and tenders and yellows the fiber. The adjustment of the temperature is also important as too little heat impairs the chemical action and too much heat degrades the fiber. The time of treatment should be determined by taking samples every 15 minutes and washing them on a screen and continuing the treatment until no more ink specks appear.

The success of the chemical control depends on the intelligent co-operation of the chemist with the mill superintendent, a condition which now seems to exist only in the largest mills.

Leominster, Mass.

Paper Manufacture in Japan

The *Japanese-American Commercial Weekly* reports that investigation made by the Association of Japanese Paper Mill Owners shows that the volume of paper manufactured by them during 1920 totaled 565,926,000 lb., an increase of 46,785,000 lb. as against the year 1919.

During 1920, 23,120,000 yen worth of paper was exported and 17,400,000 yen worth was imported, the figures representing a decrease of 2,270,000 yen and 970,000 yen, respectively, as against the preceding year.

¹J. Ind. Eng. Chem., vol. 13, No. 3, p. 213 (1921).

The Hardness of Solid Solutions*

In Solid Solutions, Atoms of a Metal Replace Those of the Solute; Solubility Varies Inversely and Gain in Hardness Varies Directly as the Amount of Distortion in the Space Lattice, and Resultant Increase in Internal Energy

BY WALTER ROSENHAIN

National Physical Laboratory, Teddington, England

IT IS a well-known fact of metallurgy that the addition of one metal to another produces an increase of strength and hardness. In some alloys, this change of properties is accompanied by the formation of a new micro-constituent or phase, which is itself harder, and also, as a rule, more brittle than either of the constituent metals. In a very large and important group of alloys, however, the addition of the second metal, up to certain limits of concentration, does not lead to the formation of a second phase or constituent.

STRUCTURE OF SOLID SOLUTIONS

Alloys of this type, when they have attained an equilibrium condition, consist of an aggregate of polyhedral crystals, homogeneous in composition so far as their micro-chemical behavior indicates, and in most respects entirely similar to the constituent crystals of the pure metal, which forms the basis of the alloy. A typical example of this kind is furnished by the alloys of copper with zinc, containing up to about 30 per cent of zinc. Alloys of this type are generally described as "solid solutions," on the ground that the state of intimate mixture which exists in the liquid (molten) solution of the two metals in one another is preserved in these alloys after solidification. In Continental language, such crystals are more frequently termed "mixed crystals" ("Mischkrystalle"), but the present author prefers to avoid this term on account of a possibly misleading interpretation.

A further fact in connection with metallic solid solutions is also well known, but appears to require explanation. A solid solution alloy is always harder and stronger than the pure metal of which it mainly consists, and frequently this difference in physical properties is very marked. Thus, annealed pure copper has a Brinell hardness number of 36, and a tensile strength of about 13 tons per sq.in. An alloy of copper containing 30 per cent of zinc in solid solution, on the other hand, in the corresponding annealed condition, has a Brinell hardness number of 57, and a tensile strength of 20 tons per sq.in. It is the purpose of the present paper to suggest an explanation for this hardening and stiffening effect of the added metal in solid-solution alloys, and to show that this explanation leads to an inference which is in striking accord with well-known facts.

The explanation of the properties of solid-solution alloys which is put forward in the present paper is based upon a conception of the manner in which two metals may crystallize together in the form of solid-solution crystals. As a result of the X-ray analysis of crystal structure, mainly carried out by Sir William H.

Bragg and W. L. Bragg¹ and by A. W. Hull² it is now known that, in a metallic crystal, the atoms of the metal are arranged in certain definite ways on a space-lattice, and that this arrangement may differ in detail from one metal to another, not only in regard to the nature of the lattice (cubical or otherwise) and the occupied points, but also in regard to the normal inter-atomic distance or spacing of the lattice. On the view now put forward, the crystals of a solid solution of metal B in metal A are built up on the same space-lattice as crystals of pure A, the sole difference being that a certain number of individual atoms of A are replaced by atoms of B. It is obvious that the extent to which such an arrangement will be possible must depend upon the relation which exists between the atoms of the two metals. If both tend to take up a similar space-lattice arrangement, and if their normal inter-atomic distances do not differ very much, a single crystal may be built up, upon the normal space-lattice arrangement of A, using atoms of A and B indiscriminately, up to a considerable proportion of B. If the similarity of the two kinds of atom is sufficiently great, then such an indiscriminate construction might easily be conceived as being possible in all proportions between the two kinds of atom. In that case, we should expect to find that the two metals could form homogeneous solid solutions when alloyed in any proportion ranging from pure A to pure B. Such cases are, of course, well known among pairs of very similar metals, such as iron and nickel or silver and gold.

ATOMS OF LIKE SHAPE, FORCES AND NATURE FORM BEST SOLID SOLUTIONS

Where the similarity, in regard to crystalline habit and arrangement, of the two kinds of atom is less complete, it would be anticipated that, up to a certain concentration at either end of the series, the atoms would be built together, indiscriminately upon a single space-lattice, but that, beyond certain limits of concentration, the two kinds of atoms would become segregated into two kinds of different crystals, thus giving rise to a duplex structure of two distinct kinds of crystals, each consisting of saturated solid solution of one metal in the other. The degree of dissimilarity of the two kinds of atom would determine the exact concentration at which this separation occurs, and we would thus expect to find in metallic alloy systems all gradations, ranging from complete mutual "solid" solubility down to almost complete insolubility in the solid state; it is, of course, well known that such gradations are found among known alloys.

From the present point of view, however, interest

*Reprinted from *Proceedings of the Royal Society, Series A*, vol. 99, No. A698, p. 193.

¹W. H. and W. L. Bragg, "X-rays and Crystal Structure," p. 173.
²A. W. Hull, "A New Method of Chemical Analysis," *J. Amer. Chem. Soc.*, 1919.

centers on the determining factor which governs the limiting solid solubility of metal B in metal A. If the view of the structure of a solid-solution crystal indicated above is correct, it follows that the actual arrangement of the atoms on the space-lattice typical of metal A cannot exist entirely undisturbed when some of the atoms of A are replaced by atoms of B. The forces acting on any atom of A, for instance, when one of its neighbors in the lattice is an atom of B, cannot possibly be the same as those acting on an atom of A entirely surrounded by atoms of A; there must thus be some want of symmetry in the forces acting on an atom so placed, with a result which is perhaps best expressed by saying that such an atom will be pulled slightly out of its proper place, *i.e.*, that the space-lattice will be slightly distorted at such points. Now, it is evident that such distortion must affect the internal energy of the whole system, and this effect must increase with the increase in the amount of distortion which accompanies the presence of a larger number of atoms of B. A point will therefore be reached when the energy-content of the system as a whole will be less if the atoms of B are separated and arranged on a space-lattice of their own. Such an arrangement implies the existence of boundaries between two different kinds of crystal and the accompanying storage of energy in such boundaries, and it is the balance between the energy-content of the two geometrically possible types of arrangement which must determine the limiting concentration of the solid solution in each case.

POSITION OF DISSOLVED ATOMS IN EQUILIBRIUM

With a full knowledge of the forces at work between adjacent atoms it would be possible to calculate the limiting concentration of any solid solution from the character of the constituent atoms; in the present state of our knowledge, all that can be said is that the greater the extent to which the space-lattice is distorted in the neighborhood of "dissolved" atoms (atoms of "B") the lower will be the limit of solid solubility of B in A. During the process of formation of such a solid solution, a great deal must depend upon the uniformity with which the atoms of B are distributed through the space-lattice. If there is a concentration of the dissolved atoms in any region, then there must be a tendency for rearrangement to occur with a view to arriving at some symmetrical arrangement which shall correspond to the minimum energy-content. If such a distribution is really symmetrical, then an interesting result must follow, *viz.*, that in a solid solution which has been allowed to attain equilibrium conditions, the dissolved atoms will be distributed through the crystals in such a way as themselves to constitute some sort of space-lattice of their own. This is a conclusion which is capable of experimental verification by means of X-ray analysis; when the result is obtained, however, it will be important to realize that the existence of such a secondary space-lattice arrangement of the dissolved atoms (B) does not imply the existence of separate crystals of B. The further question of how far a solid solution which has attained such a state of symmetrical arrangement approaches to the character of a chemical compound need not be discussed here.

The most important conclusion which emerges from what has been said above is that the "solid solubility" of metal B in metal A will be, to a first approximation,

inversely proportional to the amount of distortion of the normal space-lattice of A caused by the substitution of an atom of B for an atom of A in that lattice. The importance of this consideration lies in the fact that this amount of distortion of the space-lattice of A by the presence of B also governs certain of the physical properties of the resulting alloy, particularly the hardness of the material and its resistance to mechanical deformation generally.

HARDNESS IS SLIP RESISTANCE

It is now well recognized that the ductility of metals, *i.e.*, their power of undergoing plastic deformation without rupture, resides in their essentially crystalline character. Plastic deformation takes place within the crystals of metals by a process of slip, occurring on gliding or cleavage planes,³ whereby the crystals accommodate themselves to the new shapes forced upon them by the deformation of the mass. It is precisely the power of the crystals to undergo such slip which governs the ductility of the metal, and their power of resisting slip which determines their power of resisting deformation. If this view is correct, then anything which tends to hinder the free occurrence of slip on the principal planes of a crystal will increase the hardness (or power of resisting deformation) and will lower the ductility of the material. The application of any appreciable amount of plastic deformation (or "cold work") is known to act in this manner, and does so, according to the views of Beilby⁴ by the partial destruction of the crystalline arrangement of the atoms within the crystals.

The view which it is desired to put forward here is that any even slight distortion of the space-lattice of the crystals of a metal by the presence of "dissolved" atoms of another metal, in the manner indicated in the earlier part of this paper, must serve as a hindrance to slip on the crystal planes. Strictly speaking, in fact, the crystal "planes" have ceased to exist in such a slightly-distorted crystal. The very facility for slip which renders metallic crystals soft and ductile depends upon the smooth regularity with which the atoms are arranged on their space-lattice, and if this smoothness is lessened by the slight distortion of the lattice, it is obvious that slip will be rendered more difficult, and this difficulty will increase, to a first approximation, proportionately to the amount of distortion existing in the space-lattice.

HARDNESS GREATEST WITH LIMITING SOLUBILITY

Combining this last inference with the one already drawn above in regard to the factor governing the limiting solid solubility of one metal in another, we arrive at the following conclusion: that since the amount of distortion which the introduction of a given "dissolved" atom produces in the space-lattice of the solvent metal governs both the limiting solubility of the dissolved metal and the degree of hardening produced in the solvent metal, we should expect to find that the hardening effect of one metal upon another in the form of a solid solution should, to a first approximation be inversely proportional to its solid solubility.

This very general conclusion, which—so far as the author is aware—has not been previously stated, ap-

³Ewing and Rosenhain, *Phil. Trans., A*, vol. 249 (1899).

⁴Beilby, "The Hard and Soft State in Metals," *Phil. Mag.*, August, 1904; also *Proc. Roy. Soc., A*, vol. 76, p. 462 (1905), and *Proc. Roy. Soc., A*, vol. 79 (1907).

Evaporation by Vapor Compression

BY BURTON DUNGLINSON

EVAPORATION cannot proceed, broadly speaking, unless there is a temperature difference between the heating medium and the liquid being heated. To obtain this temperature difference it is universal practice to employ vacuum systems, which, by reducing the pressure above the liquid, allow ebullition to take place at a lower temperature.

The temperature differences obtained with a triple-effect vacuum evaporator operating at usual vacuum and using exhaust steam at 3 lb. pressure, are shown in the following table:

APPROXIMATE TEMPERATURE DIFFERENCES OBTAINED WITH TRIPLE-EFFECT VACUUM EVAPORATOR

	First Effect	Second Effect	Third Effect
Vacuum (in inches of mercury).....	5	15	28
Pressure of steam (lb. absolute).....	17.7	12	7
Corresponding temperatures, deg. F.....	222	202	177
Boiling point at given vacuum, deg. F.....	180	155	130
Temperature differences, deg. F.....	42	47	47

This demonstrates a maximum temperature difference of 47 deg. F. and an average of about 45 deg. F.

Another way of obtaining this temperature difference is by compressing the evaporated steam and vapors and returning these, either to the heating system of the evaporator or to a second evaporator arranged in series with the first. To obtain a difference of 45 deg. for a solution, which does not increase appreciably in boiling point as concentration proceeds, it will be necessary to compress the evaporated steam to 20 lb. more than its original pressure.

This does not apply to most solutions met with in evaporator practice, since they usually have a considerable elevation of the boiling point before final concentration is reached. This means that, in order to obtain efficient evaporation per sq.ft. of heating surface, very high pressures must be employed, and in fact the compression systems usually require the use of double or triple stage rotary compressors for such industrial operations.

Where it is desired to produce only distilled water or at the most to concentrate a solution to not more than 5 deg. Bé. a simple expedient, which was the forerunner of the vapor-compression systems, has been found readily adaptable to single-effect evaporators.

This apparatus, known as the "Simplex" film evaporator, was developed in London mainly for evaporating sea water. It involves the adaptation of a steam injector to the vapor outlet of the evaporator, the mixed vapor being fed back to the calandria. The efficiency of such steam injectors is extremely low, and only a portion of the evaporated steam can be returned.

Since the whole principle of vapor compression systems depends on low temperature differences, with consequent low compressions, it naturally follows that multiple effects on some such system would have to be used in order to create the desired temperature differences and hence evaporation. Sea water contains about 3 per cent soluble chlorides and when saturated contains about 30 per cent of soluble chlorides. The rise in boiling point in this solution between the concentrations stipulated is about 9 deg. F.

THE SÖDERLUND-BOBERG EVAPORATOR

The Söderlund-Boberg evaporator consists of three elements connected with a multi-stage turbo-compressor. The steam from the evaporating spaces of all of the elements is compressed to a sufficient extent in the

first stage of the compressor for use in the heater of the first element. The excess of steam over that required in the first element is then compressed in the second stage of the compressor to render it fit for the second heater, and the residue from the second heater is then finally compressed in the last stage of the compressor to render it available for the last heater. Each element has its own circulating pump and the hot condensate from the three elements is combined and supplied to a common feed heater.

CONSTRUCTION AND OPERATING DETAILS

A sectional elevation of one element of the evaporator is shown in Fig. 1. The evaporator is comprised of a tall shell A, the greater portion of which is taken up by the calandria B. To the upper end of each tube C is fitted a ferrule (see insert Fig. 1) with a distributing nozzle E. The liquid, which is raised by a pump F from the lower portion G of the shell A, is fed into the tray H

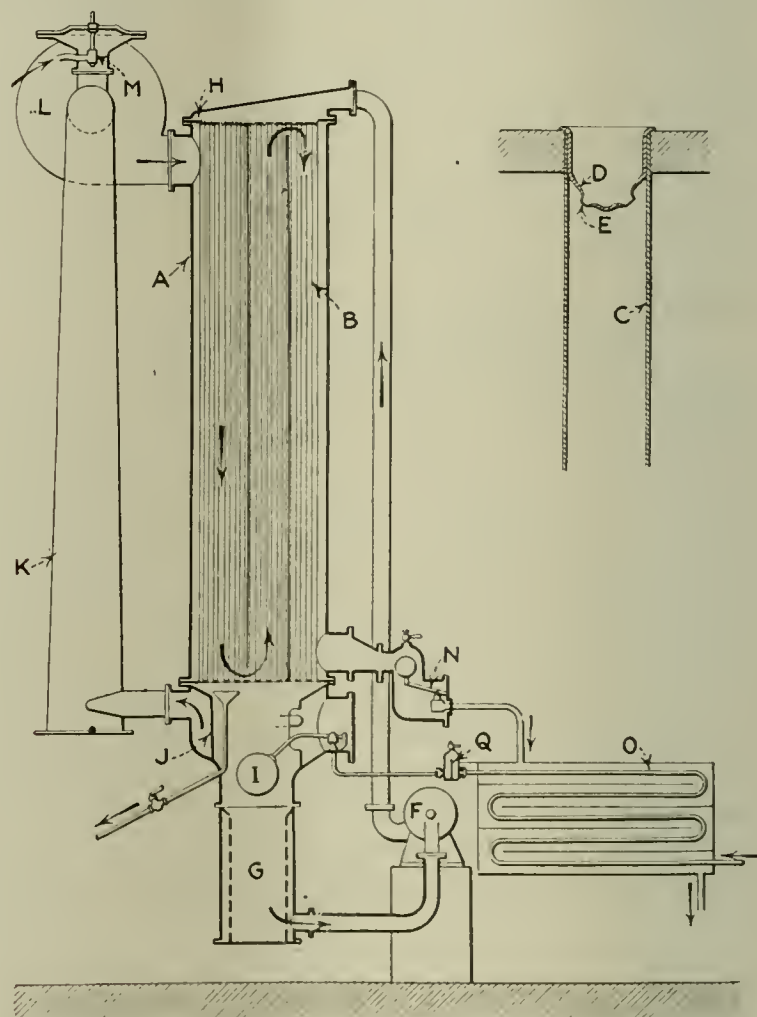


FIG. 1. SECTIONAL ELEVATION OF SINGLE STAGE SÖDERLUND-BOBERG EVAPORATOR

formed at the top of the calandria, and after passing through the nozzle in the ferrules is spread as a thin and rapidly moving film over the inner surface of the tubes C.

The liquid collects again in the bottom of the shell, to which fresh liquid is automatically admitted by the constant level feed I. Thence it is returned by the pump F to the distributing tray H. The steam which is given off by the films inside the tubes and that which is separated from the spray by the baffles J and by the tangential disposition of the steam entry passes to the compressor L. The required quantity of make-up steam is added to it on its way by the pressure-controlled automatic steam inlet M. The compressed steam enters the space around the tubes C and condensing on them is drained off as hot water through the steam trap N connected to a counter-current regenerator or pre-heater O.

The small quantity of non-condensable gases from the feed liquid escapes through the blow-off *Q* or is cleared out of the steam space either by the periodically blowing-off of a little steam or by the continuous emission of a small quantity of steam from this space.

The compressor is driven at a constant speed by a spur gear from a shaft which in turn is belt-driven directly by a gas or oil engine. The exhaust from the engine passes to a small boiler for generating the make-up steam.

CHARACTERISTICS OF FILM EVAPORATION

An important fact in connection with the claims of this system of evaporation is the insistence that a film of the liquid under treatment is circulated down the tubes. Although this is in direct opposition to the direction of flow to be met with in a standard film evaporator, it nevertheless demonstrates the advantages to be gained from the adoption of the film as a means to increased efficiency. An important point which is conceded to the film evaporator is the absence of scaling and incrustation. The writer has found in experiences with various liquids in film evaporators that the high velocities, rapid circulation and continuous motion in an upward direction tend to scour and burnish the tubes rather than to form scale. In this connection the patentees of the Söderlund-Boberg evaporator say: "Film evaporation is, however, notoriously beneficial as regards reduction of scale formation, and experience in climbing film evaporation has shown, what numerous trials with the Söderlund-Boberg evaporator have since confirmed, that the rapid circulation and uniform wetting to which the surface is subjected play an important part in reducing this tendency to within small limits."

MULTIPLE STAGE INSTALLATIONS

The evaporator when used in multiple stage may be considered as a series of units such as have been described. An installation designed for concentrating sea water is shown in Fig. 2. The condensates from the calandria of these units are combined and pass to a single heat regenerator. The concentrate from the bottom of the shell of the one element passes to the next element, and the vapor from all of the elements passes to the common compressor, where its tempera-

ture is raised enough for use in the first calandria. The uncondensed residue of steam then enters into a second compressor or into the second stage of the same compressor and is heated by compression for use in the next calandria.

It is claimed that with this system, producing salt from sea water, there is an evaporative ratio equal to 12 lb. of water per lb. of steam. Such results are truly remarkable and we may look forward to the time when this energy system really proves its value.

Sulphur in Malleable Cast Iron

BY LESTER C. CROME*

IT IS generally known that the evolution method for the determination of sulphur in such materials as white cast irons is not at all reliable. It is also true that the oxidation methods require too much time for advantageous use in a control laboratory. Being confronted with the problem of obtaining a rapid and accurate analysis of white cast irons, a thorough investigation of the problem was made, revealing some very interesting facts and also disproving some popular ideas concerning the determination of sulphur in white irons by the evolution method.

VARIATION BETWEEN EVOLUTION AND OXIDATION METHODS

Complete chemical analyses with duplicate determinations of carbon, evolution sulphur and oxidation sulphur were obtained on forty samples of white iron,

TABLE I. CHEMICAL ANALYSES OF THE WHITE CAST IRONS

No.	C*	Si	P	Mn	Sulphur* Evolution	Sulphur* Oxidation
1	2.75	0.94	0.173	0.29	0.050	0.050
2	2.63	1.05	0.167	0.31	0.050	0.051
3	2.95	0.58	0.068	0.03	0.066	0.070
4	2.77	1.08	0.171	0.31	0.041	0.051
5	2.72	1.03	0.168	0.30	0.043	0.047
6	2.78	0.73	0.078	0.05	0.058	0.101
7	2.47	0.93	0.169	0.28	0.043	0.084
8	2.64	0.94	0.172	0.27	0.040	0.083
9	2.98	0.71	0.080	0.06	0.058	0.102
10	2.53	0.75	0.168	0.20	0.037	0.037
11	2.74	0.93	0.167	0.28	0.042	0.045
12	2.87	0.89	0.076	0.05	0.060	0.062
13	2.55	1.07	0.165	0.29	0.040	0.071
14	2.57	0.85	0.172	0.23	0.041	0.076
15	3.01	0.78	0.075	0.06	0.056	0.088
16	2.59	0.88	0.170	0.28	0.052	0.081
17	2.70	0.94	0.161	0.30	0.043	0.070
18	2.77	0.82	0.173	0.30	0.041	0.074
19	2.81	0.87	0.167	0.25	0.053	0.073
20	2.76	0.94	0.168	0.29	0.047	0.077
21	2.73	0.92	0.171	0.29	0.047	0.083
22	2.68	0.81	0.155	0.25	0.050	0.052
23	2.77	0.94	0.169	0.33	0.049	0.058
24	2.51	0.87	0.170	0.29	0.048	0.055
25	2.71	0.94	0.169	0.28	0.051	0.053
26	1.34	1.52	0.183	0.15	0.096	0.106
27	2.12	1.32	0.181	0.34	0.066	0.119
28	2.55	0.75	0.171	0.23	0.046	0.097
29	2.61	0.93	0.159	0.28	0.050	0.103
30	2.50	0.82	0.176	0.28	0.051	0.110
31	2.51	1.08	0.166	0.23	0.047	0.099
32	2.28	0.78	0.178	0.26	0.080	0.130
33	2.41	1.02	0.172	0.18	0.049	0.100
34	2.44	0.97	0.172	0.18	0.047	0.094
35	2.46	0.96	0.171	0.18	0.047	0.095
36	2.40	0.96	0.171	0.17	0.047	0.095
37	2.92	1.82	0.138	0.79	0.044	0.086
38	2.43	1.01	0.171	0.18	0.045	0.098
39	2.62	1.06	0.169	0.28	0.056	0.103
40	2.44	1.00	0.194	0.25	0.046	0.047

* The carbon and sulphur values were all checked by duplicate determinations.

with the idea that they might reveal some relation existing between the evolution and oxidation values and some third quantity such as the percentage of combined carbon or the carbon:silicon ratio. The results of this investigation listed in Table I showed no such relation—in fact, proved the contrary.

These results classified the samples into three groups as follows:

*Chemist, Dayton Malleable Iron Co., Dayton, Ohio.

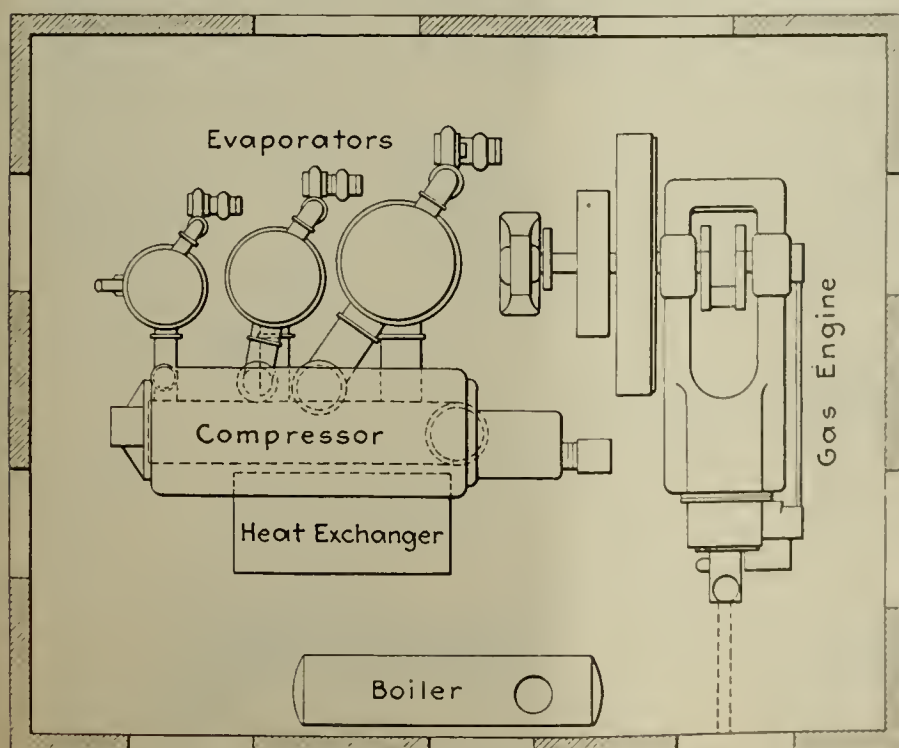


FIG. 2. MULTIPLE STAGE INSTALLATION FOR SEA WATER EVAPORATION PLANT

(1) In about 25 per cent of the samples (Nos. 1, 2, 3, 5, 10, 11, 12, 22, 25, 40) the evolution and oxidation values checked.

(2) In another group (Nos. 7, 8, 14, 28, 29, 30, 31, 33, 34, 35, 36, 37, 38) the evolution method gave only about one-half or less of the total sulphur.

(3) The remaining samples gave varying values falling in between these two.

Samples with nearly identical complete analyses could be found in each of the three groups.

MISSING SULPHUR EVOLVED BUT NOT CAUGHT

Samples giving only a small part of their sulphur by the evolution method were studied more thoroughly to determine what became of the missing sulphur. Accordingly several of them were picked and 10-g. samples treated with hydrochloric acid exactly as in the ordinary evolution method. After the samples had dissolved, their solutions were filtered. The filtrates were oxidized with bromine, evaporated with nitric acid after the addition of sodium carbonate and examined for sulphur according to the regular oxidation procedure. The results of this experiment showed that the solutions contained no sulphur whatever. The residues were carefully dried at 100 deg. C. and tested for sulphur by using both the nitric acid solution method, that of the U. S. Bureau of Standards, and by fusing with a potassium nitrate and sodium carbonate mixture. These results showed that only traces of sulphur remained in the residues.

From the results of these experiments, listed in Table II, it was evident that the sulphur not obtained by the

TABLE II. EXAMINATION FOR MISSING SULPHUR

No.	Sulphur by		Sulphur in	
	Evolution	Oxidation	Residue	Filtrate
35	0.047	0.096	0.006	Nil
7	0.043	0.084	0.007	Nil
8	0.040	0.083	0.007	Nil

evolution method must be evolved as some sort of a gaseous compound which is not absorbed by the ordinary media.

SULPHUR LOST ON ANNEALING

There is a popular idea that by annealing a cast iron it will give its total sulphur by the evolution method, even though it did not do so before. Accordingly two test-bars of the class where only half of the sulphur was evolved were placed in an electric muffle at 1,800 deg. F. and allowed to cool very slowly with the furnace. Then the sulphur was determined on these samples by both the evolution and oxidation methods. The results of both methods checked very closely, but instead of agreeing with the original oxidation value, they checked that of the evolution value before annealing. An amount of sulphur equal to the difference between the two had been lost.

This proved to be very interesting.

Then five typical samples were selected from each group, and bars from these heats that had been through the annealing process in the regular annealing ovens (carbon completely graphitized) were obtained and their sulphur was determined by both the evolution and oxidation methods. These results, in Table III, substantiated those of the preliminary experiment, showing that the sulphur not obtained by the evolution method in the white iron was lost in the annealing process. In

all cases the sulphur values of both methods checked on the annealed samples, but in some cases they were slightly higher than the original evolution value, due to the small amount of sulphur which is usually taken up in the annealing oven.

These results show that in cases where the total sulphur in the white iron is not obtained by the evolution method it must be present in two distinct forms. That which is obtained is doubtless in the form of manganese and ferrous sulphides, and the remainder must be in some other form, but just what it might be the results obtained thus far do not show.

TABLE III. SULPHUR VALUES ON REGULAR ANNEALED SAMPLES

No.	Sulphur Before Annealing		Sulphur After Annealing	
	Evolution	Oxidation	Evolution	Oxidation
1	0.050	0.050	0.056	0.052
2	0.050	0.051	0.060	0.056
10	0.037	0.037	0.052	0.056
12	0.060	0.062	0.066	0.069
22	0.050	0.052	0.060	0.065
7	0.043	0.084	0.055	0.051
8	0.040	0.083	0.052	0.048
29	0.050	0.103	0.061	0.058
30	0.051	0.110	0.058	0.054
31	0.047	0.099	0.061	0.059
14	0.041	0.076	0.052	0.049
16	0.052	0.081	0.064	0.062
17	0.043	0.070	0.054	0.053
19	0.053	0.073	0.063	0.060
20	0.047	0.077	0.064	0.060

There is one point practically certain, however: no matter in what form this sulphur does exist, it does not have the same deleterious effects on the iron as the ordinary sulphur as sulphides. This, however, is only as might be expected from the fact that this amount of sulphur is subsequently lost in the annealing process.

In view of this fact, it is possible to determine the sulphur in white cast irons by the evolution process, for even though it does not give the total sulphur in all cases, it always gives that which is injurious, and that is all that is desired to know in the control laboratory routine.

An Extensometer Calibrating Device

BY R. L. TEMPLIN*

MOST of the extensometers made in this country and used by the various industrial and technical school materials laboratories are purchased and accepted from the maker as being correct. The instrument will generally measure correctly when received, although this is not always the case, but even the best extensometers will not continue to measure correctly after considerable usage. In general, an extensometer indicating to the nearest 0.0001 in. is sufficiently accurate for the ordinary testing of materials in which it is desired to determine the proportional limit, elastic limit, yield point and modulus of elasticity. This is the accuracy required by the standards of the American Society for Testing Materials.

It is one thing to have an extensometer indicating to the nearest 0.0001 in., and quite another to have the instrument measure correctly to the nearest 0.0001 in. within, say ± 0.00002 in. Very few industrial or technical school laboratories are equipped to calibrate an extensometer, or if so equipped the calibration devices are so cumbersome that they are seldom used. By means of the rather simple device described in this article, it is possible to check the various types of com-

*Chief Engineer of Tests, Aluminum Co. of America.

mercial extensometers with a degree of accuracy sufficient for ordinary testing.

Since most commercial-type extensometers have some system of multiplying levers in order to magnify the

0.001 in. we will find that the error in the calibration device micrometer becomes the small part of the indicated error of the extensometer. Attacking the problem of calibration from this angle makes it unnecessary to have the calibration device read correctly to 0.00001 in. It has been found sufficient for practical use to have the calibration device indicate only to the nearest 0.0001 in.

DESCRIPTION OF INSTRUMENT

The calibrating device consists essentially of a steel tube in the upper end of which is fastened a standard micrometer head, indicating to the nearest 0.0001 in. and in the other end of which a rod slides so as to form a telescoping bar (see Fig. 1). The lower end of this rod is fastened into a suitable stand or base. It is hardly necessary to state that the bar must have an accurate fit in the tube. Also the small adjustable key which keeps the tube from rotating on the bar must be well fitted.

In order to provide a suitable bearing for the end of the micrometer screw, a steel ball is placed in the center of the bar. While this ball does not rotate during the operation of the instrument, it nevertheless affords an inexpensive and quite suitable bearing.

The weights attached to the cross-arm at the top of the tube are provided in order to make the action of the instrument positive at all times. They should weigh from 1 to 2 lb. each. The weights are attached rigidly to the arm at such a distance from the tube as not to interfere with the operation of any extensometer likely to be calibrated. The micrometer head is held in place by a clamp which is made as part of the weight arm.

The shoulder near the middle of the bar acts as a stop for the tube when the micrometer head is removed or the micrometer screw removed for adjustment. The bar and tube should have an outside diameter of $\frac{1}{2}$ in. in order to accommodate the different extensometers on the market, which are intended for use only on the standard 0.505 in. diameter test specimen. It is advisable to have punch marks or small drilled holes (No. 56 drill) on opposite sides of the bar and tube, 1 in. and 4 in. above and below the shoulder of the bar.

The accuracy of the instrument is, of course, based

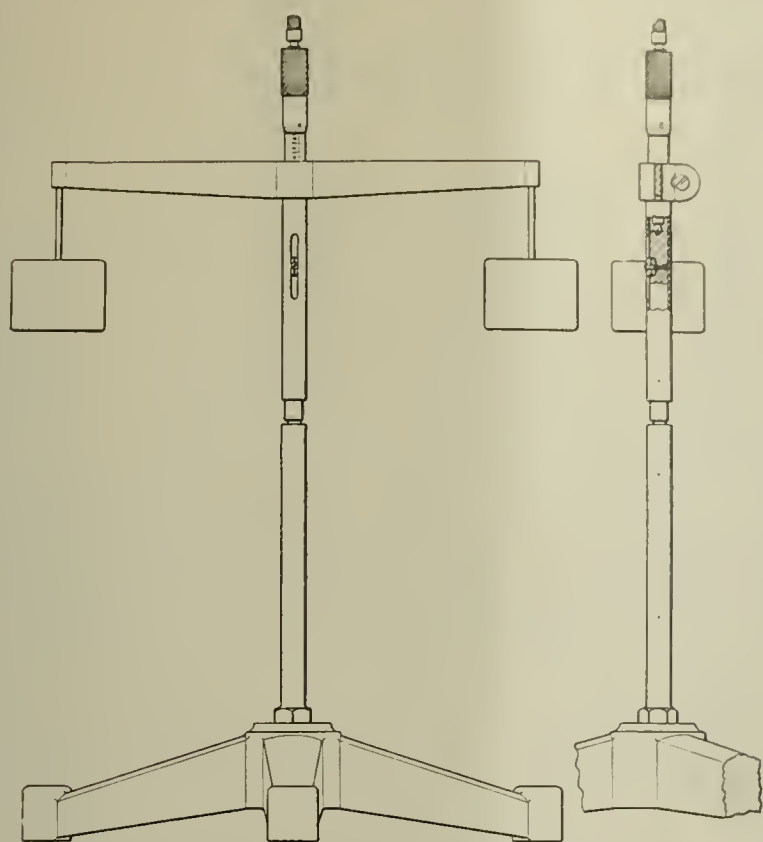
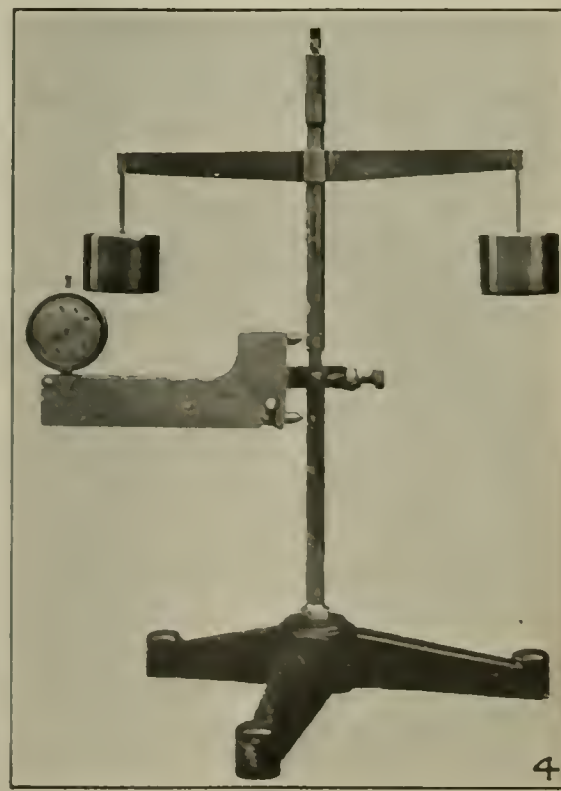
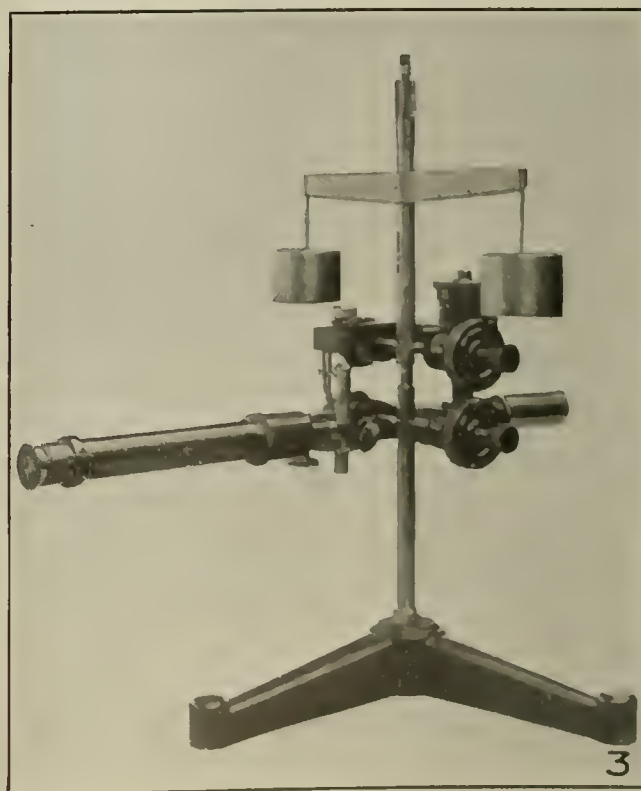


FIG. 1. SIDE VIEW AND CROSS-SECTION OF CALIBRATING DEVICE

strains whose magnitudes are to be measured, advantage is taken of this magnification in their calibration. Any error caused by an error in the length of one or all of the levers in an extensometer is multiplied considerably if the extensometer is made to function throughout its whole range of measurement. For example, the observed differences in the readings of the extensometer and calibration device throughout the range of deformation of 0 in. to 0.001 in. may be so small as to be directly comparable to the error of the calibration device micrometer, but if we extend the range of the calibration curve to ten or twenty times



FIGS. 2 TO 4. VARIOUS EXTENSOMETERS ARRANGED FOR CALIBRATION

Fig. 2. 2-in. Riehle extensometer. Fig. 3. 2-in. Ewing extensometer. Fig. 4. 2-in. Berry strain-gage.

upon the accuracy of the micrometer head, and for this reason the micrometer head which has been selected for the instrument should be calibrated. The U. S. Bureau of Standards is equipped for doing this at a nominal charge.

Some extensometers, because of their inherent design, will indicate strains accurately in but one direction. This is a common fault with instruments having indicating dials due to back-lash in the gear trains of the dials. The calibrating device will operate positively in either direction, so it is very well suited for checking up extensometers of this type.

METHOD OF PROCEDURE

In operation, the extensometer is attached to the instrument as shown in Figs. 2, 3 and 4. Care should be used not to clamp the extensometer too tightly on the tube, else the tube will be deformed enough to keep it from sliding freely on the bar. Since the extensometer readings are to be referred to the readings of the increments of the calibrating device, the extensometer is usually set at some even figure or preferably zero. If the extensometer has a zero adjustment, it

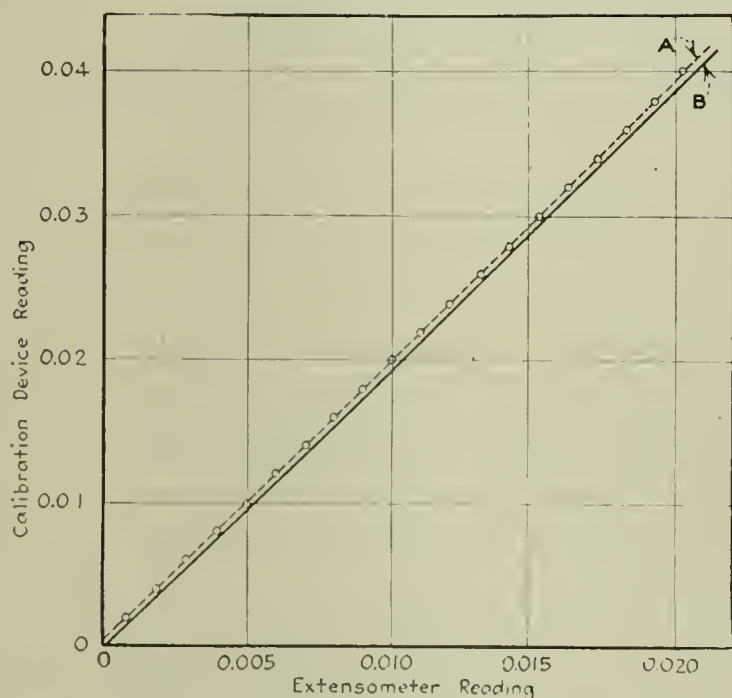


FIG. 5. CALIBRATION CURVE OF A 2-IN. RIEHLÉ EXTENSOMETER

saves considerable computation work to set the extensometer at zero simultaneously with the setting of the calibrating device. The micrometer screw is then turned a predetermined increment, 0.001 in. or 0.002 in., a reading of the extensometer noted, the micrometer screw turned the same additional increment and the extensometer reading again noted. This procedure is followed throughout the range of the extensometer. The data obtained are then plotted using the micrometer readings as ordinates and the corresponding extensometer readings as abscissæ. The scale used in plotting the data should best be selected so that the scale for the abscissæ or extensometer readings is as many times as large as the ordinate scale as the lever multiplication ratio of the extensometer. This will make the resultant curve have an angle of 45 deg. with the X- and Y-axes, if the extensometer is correct.

A sample calibration is shown in Fig. 5. This curve was drawn from data obtained in the calibration of a Riehle extensometer, using a 2-in. gage length. (See Table I.) Referring to the diagram, it is seen that the calibration curve A crosses the 45 deg. line. This indicates that the zero setting of the extensometer was at fault. By drawing a second line B, parallel to A and

TABLE I. CALIBRATION TEST DATA OF 2-INCH RIEHLE EXTENSOMETER

Micrometer Reading	Micrometer Difference	Dial Reading	Error
0.732	0.000	0.00000	0
0.730	0.002	0.00089	-0.00011
0.728	0.004	0.00190	-0.00010
0.726	0.006	0.00296	-0.00004
0.724	0.008	0.00400	0
0.722	0.010	0.00500	0
0.720	0.012	0.00602	+0.00002
0.718	0.014	0.00705	+0.00005
0.716	0.016	0.00800	0
0.714	0.018	0.00901	+0.00001
0.712	0.020	0.01000	0
0.710	0.022	0.01099	-0.00001
0.708	0.024	0.01200	0
0.706	0.026	0.01312	-0.00012
0.704	0.028	0.01413	-0.00013
0.702	0.030	0.01516	+0.00016
0.700	0.032	0.01621	+0.00021
0.698	0.034	0.01720	+0.00020
0.696	0.036	0.01825	+0.00025
0.694	0.038	0.01922	+0.00022
0.692	0.040	0.02018	+0.00018

passing through the origin, we get the true error of the extensometer. This curve shows that the extensometer gives measurements which are 2 per cent too large. To correct this error, it would be necessary to shorten one of the levers of the extensometer by 2 per cent.

If the multiplying ratio of the extensometer being calibrated is not correct, and the scale, dial or micrometer screw of the extensometer is correct, the resultant curve will be a straight line but will not make an angle of 45 deg. with the axis. In such a case a way can usually be found for changing the multiplication ratio of the extensometer.

By observation of the calibration curve it is easy to see whether the multiplying ratio should be increased or decreased. If the observed readings cause the curve to make an angle greater than 45 deg. with the X-axis, the multiplying ratio should be increased; if less than 45 deg., the ratio should be decreased. After making a slight *known* change in the ratio, usually by increasing or decreasing the length of one of the levers, a second calibration of the instrument is made. From the two calibrations and the known amount of alteration in the levers it is comparatively easy to make a second definite change in the levers which will cause the instrument to read correctly. The instrument, however, should be checked with another calibration after the final adjustments are made.

When the calibration curve is not a straight line, it is due to (1) careless setting of the micrometer of the calibration device, (2) inaccuracy of the micrometer screw of the extensometer or of the dial of the extensometer (generally because of the eccentricity of the gears in the dial), or (3) to a combination of these causes. In any case the calibration should be repeated using care to see that the micrometer of the calibration device is accurately set. A small hand magnifying glass will be found useful in setting the micrometer head. If after these precautions have been taken and it is still found that the calibration curve is not a straight line, and that the discrepancy between the curve and the 45-deg. line is considerable, then account of this discrepancy will have to be taken in the data obtained in the use of the extensometer, or a new micrometer screw or an accurate indicating dial or scale will have to be provided for the extensometer.

It has been the experience of the writer that it is usually best to check all the lever motions and working joints of an extensometer before using the instrument in order to make sure that they work easily

without lost motion. Where the extensometer is provided with a micrometer screw for checking or calibration purposes, as in the case of the Ewing extensometer, the reading of this micrometer screw is used as an additional check on the reading of both the extensometer scale and the micrometer of the calibration device. Ten readings are usually considered sufficient for a single calibration.

New Kensington, Pa.

Local Heating With a "Pyrotip"*

In practically every line of manufacture some means of local heating is required for various operations. The most common form is the gas flame, using illuminating gas with or without compressed air. In fine work, as in jeweler shops, the alcohol lamp and blow torch are used. For portable work the gasoline blow torch is commonly used. For more intense heat the oxy-acetylene flame is employed, as well as the electric arc, using either carbon or metallic electrodes.

A convenient and economical method of local heating is obtained by using the Pyrotip, which is the trade name given to a low voltage transformer that has been specially designed for work of this nature. The secondary of the transformer furnishes sufficient current to quickly heat up the point of an ordinary $\frac{3}{8}$ -in. carbon rod. The voltage is so low that an arc cannot

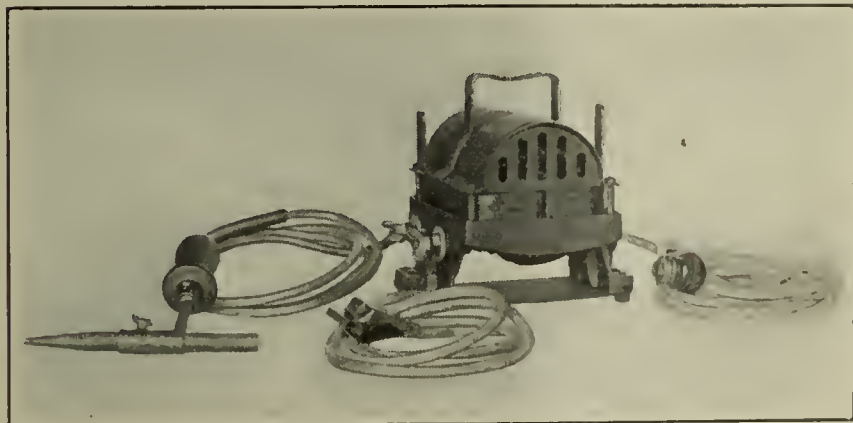
be drawn, but the temperature of the carbon point can be varied through a wide range by simply altering the amount of contact surface at the end of the carbon.

by conduction. The transformer can easily be used to heat soldering coppers by attaching a suitable holder to the low-tension terminals, and with advantage, since there is no danger of superheating and burning the end.

In jewelry stores a considerable amount of silver soldering is required in repairing broken silver spoons, gold rings, etc. The Pyrotip, utilizing a split or forked carbon electrode, is readily used. In this same line of work they have frequent need to melt down pieces of gold, silver, or platinum. The platinum works down in relatively small quantities, and it only takes a few seconds to melt down the platinum, whereas the gas ordinarily available requires a considerable length of time. It is also a simple proposition to utilize the same combination to melt down pieces of gold or silver from watch cases, putting them in small ingot form.

In the same way dentists can utilize the device for melting down old gold fillings, bringing them back to shape so that they can be used over again.

Dark glasses are desirable in this work, although not so essential as with other forms of local heating, due to the ease with which the eyes can be protected by properly manipulating the holder.



PYROTIP, FOR LOCAL APPLICATION OF HIGH TEMPERATURES

be drawn, but the temperature of the carbon point can be varied through a wide range by simply altering the amount of contact surface at the end of the carbon.

The most evident field for this device is in the melting or joining of lead parts or terminals of storage batteries. Lead, unless a clean surface is obtained, cannot be readily melted with a soldering copper. Temperature control, especially for lead burning, is accomplished by altering the depth of submersion of the carbon tip in the molten lead. That portion of the carbon which is submerged assumes a temperature but little above the melting point of lead, 326 deg. C. Just above the surface the carbon is much hotter, approaching 1,200 deg. C. when submergence is $\frac{1}{8}$ in., and 700 deg. when immersed $\frac{1}{2}$ in. The greater energy put into the lead under these conditions is dissipated without leaving a high temperature because of the greater contact surface between the carbon and the lead. It permits the lead to carry off the heat and radiate it more rapidly.

In direct soldering, the hot point of the carbon burns the tin in the solder; so successful work involves "tin-ning" the surfaces by other means, and then placing the hot point somewhat back from the joint and heating

Recent Chemical & Metallurgical Patents

British Patents

For complete specifications of any British patent apply to the Superintendent, British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Heat-Treatment of Rubber.—In the heat-treatment of rubber for reforming or vulcanizing, a solution is employed having its boiling point at or slightly above the temperature required, the solution being at or slightly below boiling point. Solutions of calcium chloride of various strengths are preferred, the boiling points of which rise approximately 10 deg. F. for every half-pound of salt to $1\frac{1}{2}$ pints of water. Several forms of apparatus are described. Articles or molds containing them may be immersed directly in the liquid, or placed in a jacketed vessel, the jacket of which contains the solution directly heated or circulated from an outside heater. Hollow bodies may have the hot solution pumped into their interiors. (Br. Pat. 161,648; H. GARE, Hazel Grove, Stockport, Cheshire. June 8, 1921.)

Recovering Tin From Scrap.—Tin scrap is treated with oleum to dissolve the tin, and the material is then lifted out of the acid and washed in water. Fresh acid is added to replace that used, and another batch is treated. After a time a basic sulphate SnSO_4 , SnO_2 deposits and is drawn off. The washing water contains some insoluble oxide, SnO_2 , and some tin in solution. The dissolved tin is recovered by precipitation as sulphide or iron is added to neutralize the acid and obtain metallic tin. External heat is not required in the process, but the acid bath is maintained by the exothermic heat and the periodical additions of fresh acid at a fairly constant temperature of 45-55 deg. C. and a strength of about 10 per cent free sulphur trioxide. (Br. Pat. 161,654; P. A. MACKAY, London. June 8, 1921.)

Pure Copper Sulphate.—Pure copper is dissolved in sulphuric acid or oleum in the presence of a soluble compound of a metal electro-negative to copper such as silver or mercury, or selenium. The electro-negative element may be added to the acid and then a solvent for it, such as nitric acid for silver or mercury. When blister copper is employed as raw material, one of its impurities may be used as catalyst, the necessary solvent, say nitric acid for silver or hydrochloric acid for selenium, being added. If an excess of copper is employed, the electro-negative metal used and any gold or silver in the copper are deposited on the excess

*From an article by E. A. Wagner in the *General Electric Review*, vol. 24, p. 628 (July, 1921).

copper and may be recovered. The process may be employed for refining copper. (Br. Pat. 161,656; P. A. MAC-KAY, London. June 8, 1921.)

Preparation of Oxyaldehydes.—Oxyaldehydes are prepared by the interaction of phenols or their derivatives with formaldehyde in the presence of a nitroso compound and a condensing agent. Preparation of vanillin by treating guaiacol and formaldehyde with *p*-nitrosodimethylaniline is described. Nitroso compounds specified are nitrosobenzene, nitrosonaphthalene, and *p*-nitrosodimethylaniline, hydrochloric acid being mentioned as condensing agent. (Br. Pat. 161,679; SOC. CHIMIQUE DES USINES DU RHONE, Paris. June 8, 1921.)

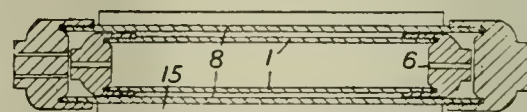
Organo-Mercuric Compounds.—Water-soluble derivatives of salicylic acid containing nuclear mercury are obtained by treating hydroxy-mercuric-salicylic acid anhydride or the like with a soluble cyanide at moderate temperatures and separating by fractional crystallization the resulting *o* and *p* compounds of the formula $\text{NC.Hg.C}_6\text{H}_3\text{OH.COOR}$, where R may be potassium. The reaction may be effected with cooling and in the presence of such quantity of water that both salts are separated, the liquid being iced before filtering. The product may be washed on the filter successively with ice water, 50 per cent alcohol, and concentrated alcohol, and lixiviated with three times its weight of water at 25 deg. C., to extract the more soluble *p*-compound, the residual *o*-compound being then recrystallized from hot water. Alternatively, the reaction may be effected in the presence of more water at ordinary temperatures; after heating, the *p*-compound is found in the solution and the *o*-compound remains undissolved. By adding acids to the aqueous solutions of the potassium salts the free acids may be precipitated. The silver salts may be prepared by adding silver nitrate. The potassium salts are suitable for therapeutic use. (Br. Pat. 161,922; not yet accepted; J. D. RIEDEL AKT. GES., Berlin. June 8, 1921.)

Treating Lead Zinc Ores.—Argentiferous lead-zinc sulphide ores are roasted with a halogen salt such as sodium, potassium, calcium or magnesium chloride in an oxidizing atmosphere at a temperature above 400 deg. C. but not high enough to volatilize lead chloride, the zinc sulphide remaining for the most part unattacked. To prevent any appreciable attack on the zinc the temperature should not exceed 500 deg. C. The air employed in the roasting is preferably moistened if dry. The product of the roasting is leached with hot brine to extract lead, some silver and any zinc chloride. The lead and silver are recovered in known manner—for instance, by cooling the solution and treating the deposited chlorides to separate the silver as argentiferous lead sulphate, the brine being used repeatedly. The residual ore is treated with a solvent for silver such as a solution containing 35 per cent calcium chloride and 3 to 5 per cent cupric chloride or 3 per cent hydrochloric acid or, if there is appreciable quantity of lead, the ore is first treated with hot brine containing hydrochloric or sulphuric acid to extract the lead. The used brine containing sodium sulphate and the lead salts obtained may be treated to desulphate the brine and obtain lead sulphate. In a modification, if there is some unoxidized lead sulphide remaining after the roasting or after the leaching with brine, the ore is leached with hot strong solution of calcium or magnesium chloride containing enough hydrochloric acid to convert the lead sulphide into chloride. This effects a good extraction of the silver and renders a subsequent extraction unnecessary. It is preferred to have a small quantity of zinc chloride present in the calcination, which may be derived from the ore if it contains some easily attackable zinc or may be added at the beginning or toward the end of the calcination, preferably as a mixture of sodium and zinc chlorides obtained by evaporating some of the brine used for leaching. (Br. Pat. 162,026; F. E. ELMORE, Boxmoor, Hertfordshire. June 15, 1921.)

Purifying Zinc Solutions.—A zinc-sulphate or other zinc solution is freed from foreign metals by treatment in the presence of a mercury salt with a subdivided metal electro-positive to the impurities. Zinc, aluminum and alloys thereof are suitable electro-positive metals; they may be powdered or granulated, zinc fume or blue powder being

advantageous. The mercury as mercuric chloride or nitrate, or, when zinc is to be electro-deposited, as mercuric sulphate, may be added as a solution or directly dissolved in the zinc solution before the treatment or at any suitable prior stage. Two pounds of mercury in the form of sulphate, and 40 lb. of zinc, suffice for 10 tons of crude zinc solution. This may be obtained from ore by treatment with spent electrolyte or other solution, and before the purification is brought to an acidity of 0.1 to 0.2 per cent, by means of incomplete neutralization, or by neutralization for the removal of silica, etc., followed by acidification. During the purification the liquid may be heated to 70-100 deg. C. and gently agitated. Copper, arsenic, antimony, bismuth, cadmium, nickel, cobalt and other metals are precipitated as a sludge, from which mercury can be recovered by distillation or otherwise. Iron may be removed before or after the above purification. If aluminum is used as the electro-positive metal, it may be subsequently removed, but is not injurious in the electro-deposition of zinc. (Br. Pat. 162,030; S. FIELD and METALS EXTRACTION CORPORATION, both in London; June 15, 1921.)

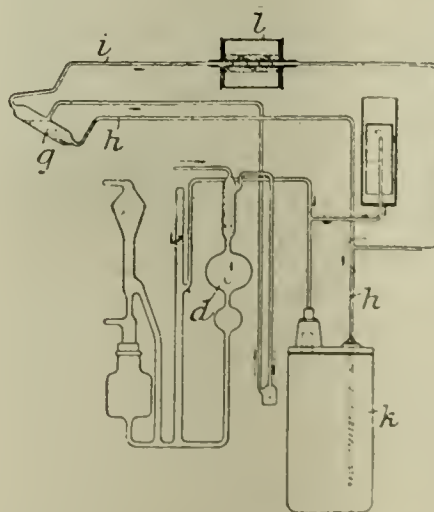
Spongy India Rubber.—In the manufacture of porous expanded india rubber by vulcanization in an inert gas under high pressure, a wax or resinous substance, such as ceresin, is added to the ingredients to minimize the diffusion of gas from the spongy mass. The wax or resin may be omitted from the outer layer, which then gradually loses its gas and forms a resilient skin which prevents excessive expansion of the interior mass. The ingredients are



placed in a shell 1 surrounded by an outer vessel 8, which is provided with a heating-jacket 15. Compressed gas is admitted to the vessel 8, and when a certain pressure is attained adjustable automatic valves in the passages 6 admit the gas to the inner shell. Heat is then applied, and temperature and pressure are gradually increased to the maximum values of about 305 deg. F. and 75 atmospheres. When vulcanization is complete, the temperature is first somewhat reduced and then the vessel 8 is rapidly exhausted. The automatic valves at 6 retain a pressure of about 100 lb. per sq.in. in the shell 1, which is allowed to remain until the product has cooled and is then released. A mixture of rubber and balata may be substituted for pure rubber if desired, but the proportion of rubber should not be less than one-third. (Br. Pat. 162,176; C. L. MARSHALL, Harlesden, London; June 15, 1921.)

Analyzing Gases.—Apparatus for carrying out two series of analyses is so arranged that in both series at least one constituent of the gas is always included; for example, in one series the percentage of carbon dioxide is determined,

and in the other series the total percentage of carbon dioxide, carbonic oxide, hydrocarbon and hydrogen. The two series of analyses may be recorded on a common diagram, the recording device being so constructed that alternate lines correspond to the two series of determinations. As shown, the first measuring-vessel *d* is connected to an oscillating vessel *g* containing liquid and which according to the position of the vessel seals one or other of the pipes



h, i; the sample therefore passes alternately to the absorber *k* when the percentage of carbon dioxide is to be determined, and to the oxidizing furnace *l* and then to the absorber *k* for recording the percentage of carbon dioxide, carbonic oxide, hydrocarbon and hydrogen. (Br. Pat. 162,249, not yet accepted; SVENSKA AKTIEBOLAGET MONO., Stockholm; June 15, 1921.)

Current Events

in the Chemical and Metallurgical Industries

Important Papers to Be Presented at the Seventh National Exposition of Chemical Industries

At the Seventh National Exposition of Chemical Industries, which will be held during the week of Sept. 12, 1921, in the Eighth Coast Artillery Armory, New York City, important papers will be presented on: Crushing, Grinding and Pulverizing; Evaporating and Drying; Power Plants in the Chemical Industries; Paints and Varnishes, and Industrial Problems. There will also be shown a series of motion pictures on subjects related to chemical and mining industries, handling of materials, and power plants.

The papers to be presented, according to the tentative program, are:

SEPTEMBER 13, 1921

Crushing, Grinding and Pulverizing

H. F. Kleinfeldt (Abbe Engineering Co.), "Ball and Pebble Milling for Pulverizing and Mixing."

S. B. Kanowitz (Raymond Bros. Impact Pulverizer Co.), "Grinding and Pulverizing With Air Separation."

L. H. Sturtevant (Sturtevant Mill Co.), "Crushing and Grinding Phosphate Rock."

M. I. Dorfman (Allis-Chalmers Mfg. Co.), "Dust Collection as Applied to Grinding and Pulverizing Problems."

H. Schiffin (Allis-Chalmers Mfg. Co.), "The Development of Compound Grinding Mills."

Industrial Problems

H. Austin (Ernest Scott & Co.), "Solvent Extraction of Edible Fats and Oils."

R. H. McLain (General Electric Co.), "Material Handling in Industrial Plants."

SEPTEMBER 14, 1921

Evaporating and Drying Program

E. G. Rippel (Buffalo Foundry & Machine Co.), subject to be announced later.

A. E. Stacy, Jr. (Carrier Engineering Corp.), "The Relation of Atmospheric Conditions to Chemical Processes."

H. S. Landell (Proctor & Schwartz), "Drying and Drying Problems."

Max Donauer (Elyria Enameled Products Co.), "Special Problems for Enameled Evaporators."

Arthur B. Stonex (Hunter Dry Kiln Co.), "Drying With Moist Air."

A. W. Lissauer (W. L. Fleisher & Co., Inc.), "Drying as an Air-Conditioning Problem."

J. D. Stein (Grinnell Co., Drier Division), "Atmospheric Drying by Means of Compartment, Tunnel and Continuous Belt Conveyor Driers, With Some Practical Applications."

W. H. Dickerson (Industrial Waste Products Co.), "Spray Drying."

H. Austin (Ernest Scott & Co.), "Evaporation."

SEPTEMBER 15, 1921

Paint and Varnish Program

R. S. Perry, Chairman.

H. A. Gardner (Institute of Paint and Varnish Research), "Reflection Factors on Industrial Paints."

L. P. Nemzck (Du Pont de Nemours & Co.), "Laboratory Control."

R. S. Perry (Perry & Webster, Inc.), "Paint and Varnish Waste Control."

Maximillian Toch (Toch Bros.), "Rust: Its Cause and Prevention."

Frank G. Breyer (New Jersey Zinc Co.), "Physical Testing of Paints and Paint Materials."

F. P. Ingalls (John W. Masury & Co.), "The Ideal Paint and Varnish Specification."

Ernest T. Trigg (Chairman, "Save the Surface" Committee, Paint Manufacturers Association of the U. S.), "Save the Surface and You Save All With Paint and Varnish."

G. B. Heckel (Secretary, Paint Manufacturers Association of the U. S.), "What Is Paint?"

SEPTEMBER 16, 1921

The Power Plant in the Chemical Industries

R. C. Beadle (Editor, *Combustion*), Chairman

R. M. Gordon (Solvay Process Co.), "Modern Boiler House Arrangement and Equipment" (illustrated).

John Primrose (Power Specialty Co.), "Suggestions for Reducing Heat Losses in Chemical Plants."

E. G. Bashore (Rice & Bashore), "Boiler Feed Water Treatment and Treatment Control."

A. R. Stevenson, Jr. (General Electric Co.), "Compressed Air Installation in Industrial Plants."

D. B. Rushmore, J. A. Seede and E. Pragst (General Electric Co.), "The Application of Electric Power in the Chemical Industry."

D. D. Chamberlin (Distillation Industries, Inc.), "A New Method for Coking Coal as Required for Industrial Fuel."

F. G. Anderson (Morse Chain Co.), "The Limitations of Silent Chain Drive."

The motion pictures to be shown are:

CHEMICAL INDUSTRIES

"The Story of Sulphur" (2 reels), Courtesy Texas Gulf Sulphur Co.

"Making Soap" (1 reel), Courtesy Baumer Films.

"Manufacture of Dynamite" (1 reel).

"Manufacture of Pyrex Glassware" (3 reels), Courtesy Corning Glass Co.

"Manufacture of Portland Cement" (2 reels).

"The Jewels of Industry" (8 reels), Courtesy the Carborundum Co.

(a) Creating Power From Water.

(b) Within the Power Plant at Niagara.

(c) In and About Niagara Falls.

(d) Power at Work in the Carborundum Plant.

(e) Making the Crystal Masses in the Electric Furnace, and

(f) Making Them Into Stones, Grinding Wheels, Paper and Cloth.

(g) Usual and Unusual Uses for Abrasives in Some Fifty Industries.

"The Electric Heart—The Dry Cell" (1 reel), Courtesy Baumer Films.

"Canning Electricity—The Wet Cell" (1 reel), Courtesy Baumer Films.

"The Making of Oleomargarine" (1 reel), Courtesy Armour & Co.

"The Manufacture of Dry Sausage" (2 reels), Courtesy Armour & Co.

"Du Pont Dyes"—showing their manufacture (2 reels), Courtesy Du Pont de Nemours & Co.

MINING AND THE CHEMICAL INDUSTRIES

"The Story of Rock Drilling" (4 reels), Courtesy Sullivan Machinery Co. and U. S. Bureau of Mines.

"Iron Mining Operations" (4 reels).

(a) Stripping.

(b) Exploration and Stripping.

(c) Underground Mining.

(d) Logging Operations.

"The Story of the Armco Ingot Iron" (3 reels), Courtesy American Rolling Mill Co.

"Mining Magnetic Iron Ore" (2 reels).

"Zinc Mining, Milling and Smelting" (4 reels).

"Manufacture of Zinc Oxide" (1 reel).

"Mining and Extraction of Radium From Carnotite Ore" (3 reels).

"Mine Explosion and Rescue" (1 reel).

"Exterminate the Mosquito" (1 reel).

HANDLING OF MATERIAL

"Saving Wasted Millions Through Material-Handling Equipment" (2 reels), Courtesy Economy Engineering Co.

"Use of the Steam Shovel in Mining" (1 reel).

"Transportation and Storage of Iron Ore" (1 reel).

"Transporting and Handling Coal by Various Means" (1 reel).

"Dredging Anthracite Coal" (1 reel).

THE POWER PLANT

"Conserving Coal and Saving Heat Values by Regulating Steam Pipes and Boilers" (1 reel), Courtesy Magnesia Association of America.

"The Cost of Careless Firing" (2 reels).

"Getting the Most Out of Coal" (1 reel).

"Modern Byproduct Coking" (2 reels), Courtesy the Koppers Co.

All films not otherwise credited are by courtesy of U. S. Bureau of Mines.

Senate Committee Busy on Tariff Bill

The greatest uncertainty prevails, as this is written, as to what the Finance Committee of the Senate may do in regard to protection for the dye industry. It is recognized by all who are following the matter closely that the committee is almost evenly divided on the subject. The most determined efforts have been made to convince the committee that the limited embargo plan is absolutely necessary to the maintenance and growth of this new American industry. On the other hand, the opposition has been equally energetic in the presentation of its contentions. It is admitted by each group that the action of the committee is anyone's guess.

Almost the same situation exists with regard to American valuations. In regard to that portion of the tariff bill, however, there seem to be more who believe that the committee will reject the scheme as it is carried in the House bill, with the probability that the committee will favor the Davis modification. During the hearings the committee seems to have been impressed by the arguments that the American valuation plan as passed by the House will be impracticable of administration in its application to many commodities, and that it will lay an intolerable burden on the appraiser. The committee also seemed to be impressed adversely by the prospect of price pyramiding in certain commodities. On the other hand, the committee has a thorough understanding of the difficulties and inequities certain to come from foreign valuations under existing conditions.

COMMITTEE INSISTS ON FACTS

An idea of the rather grueling character of cross-examination to which some of the witnesses before the Finance Committee were subjected may be obtained from the following extract from the stenographic report of the testimony of Henry Howard:

Senator REED. Do you believe that an article that can be sold abroad in competition with the world needs protection in America against foreign products?

Mr. HOWARD. I can imagine that there would be cases where it would need it.

Senator REED. Why?

Mr. HOWARD. To prevent dumping over here.

Senator REED. That is the only thing you can think of?

Mr. HOWARD. To prevent methods of unfair competition.

Senator REED. But if unfair competition could be employed in our markets, it could be employed against us abroad at the same time, could it not?

Mr. HOWARD. It could, but might not be.

Senator REED. You really want it so that the American manufacturer can sell in America on a high level and then dump his surplus in Europe?

Mr. HOWARD. I think that is probably a desirable thing to have.

Senator REED. Undoubtedly. I thought so.

Mr. HOWARD. And I think that it is the way it is generally tried to carry it out abroad, also.

Senator REED. That is to say, the American people must have a tax levied upon everything that we consume in order that the manufacturer can sell to them at a high price and sell abroad at a low price.

Mr. HOWARD. These conditions carried out to a reasonable extent make for the prosperity of the American people by enabling us to pay high wages.

Senator REED. And, carried out to a reasonable extent, you mean carried out far enough so that the American manufacturer makes a good fat profit here—

Mr. HOWARD. Makes a fair profit. Internal competition will prevent his making too big a profit.

According to some of the members of the committee, the arguments for or against duties have been composed too greatly of generalities. Senator Reed believes that industries asking for protection should submit statements showing the wage rate to both skilled and unskilled labor; statements as to gross profits, net profits, dividends, surplus, amounts of excess profits and other data, which would make the determination of tariff rates more intelligent.

TESTIMONY OF CHEMICAL MANUFACTURERS

A. G. Rosengarten, of Philadelphia, appeared before the committee to request a compensatory duty on mercurial preparations, since the House of Representatives increased the rate on quicksilver from 7c. to 35c. per lb. He suggested that the compensating duty on calomel, corrosive sublimate and other mercurial preparations should be 25 per cent ad valorem and 32c. per lb. Mr. Rosengarten also protested against the duty of 7c. per lb. placed on citrate of lime by the House. He pointed out that this is the crude material for the manufacture of citric acid on which a duty of 12c. per lb. was placed. Mr. Rosengarten argued that should those duties become effective, the Eastern manufacturers of citric acid would be compelled to close their works. Since 2 lb. of citrate of lime is required to make 1 lb. of citric acid, it would mean that the duty on the finished product is lower than the duty on the crude material. He suggested that not more than 2c. per lb. should be imposed on citrate of lime.

Frank Kidde, secretary of the Monmouth Chemical Co., protested against the proposed duty of 1c. per lb. and 15 per cent ad valorem on chlorate of potash. To have an ad valorem tariff on an American valuation basis, he said, would mean that the valuation would be based on a market value established by a single manufacturing group, which practically controls the manufacture of chlorate of potash in this country.

Dr. Max Mueller, of New York, asked that the photographic chemicals rhodal and metol be given rates of 30 per cent ad valorem and \$1.50 per lb. and 30 per cent ad valorem and 50c. per lb., respectively. These rates are necessary to protect two of the most widely used chemicals in the developing of photographic films, he stated.

Dr. Frederick W. Russe, of St. Louis, stated that 10c. per lb. is insufficient to protect the manufacture of medicinal tannic acid, and he asked for increased duty and a change in the method of classification.

A. S. Somers, representing the Association of Dry Color Manufacturers, pointed out the need for supplying specific duties for all colors and pigments derived from coal-tar products. He also called attention to compensatory duties which should be provided as a result of the increase in the rate of duty on quicksilver.

CANADIANS PROTEST

A very complete presentation was made by those interested in the chemical products made at Shawinigan Falls, in Canada. To enable Canadian industry to continue to purchase raw materials in the American market, Canadian finished materials cannot be barred entirely from the United States, it was argued. It was declared that Canadian glacial acetic acid is essential to the American dye and other

chemical industries if they are to compete in export markets. There are no producers of synthetic acetic acid in the United States, it was declared, nor is there any immediate prospect of this product being produced from acetylene gas synthetically, as now is being done in Canada. Glacial acetic acid, it was contended, should be left on the free list. To impose the 2c. per lb. provided by the House bill would penalize the American consumer, it was said, and place American dye and chemical industries at a distinct disadvantage in meeting competition abroad.

Ellwood B. Speare, representing the Goodyear Rubber Co., revealed that acetaldehyde and paraldehyde are being used with great promise in increasing the rate of vulcanization and for giving better quality to rubber. The use of these materials, he explained, is still in an experimental stage, and unless they can be obtained without payment of an excessive rate of duty he believes their use would have to be discontinued.

The Shawinigan industries also protested against a duty of 1c. per lb. on carbide. It was held that this rate is prohibitive. It would be impossible to ship to the United States if a duty of \$20 per ton were levied. It was stated that the item would yield no revenue and that it simply would have the effect of increasing the business of the Union Carbide Co. by about 15,000 tons annually.

Dr. H. C. Wright, representing the Manufacturers' Association, argued against any embargo privileges for aromatic chemical products in that the question of quality is paramount. It is absolutely essential to successful competition, he declared, to have the very finest products. He also stated that very few of the aromatic chemical products listed in the bill are produced in America equal in quality to the foreign product.

J. D. C. Bradley, of the American Agricultural Chemical Co., opposed the duty on potash. Among other things, he said:

I do not believe that this country can successfully compete with German or French potash unless actual deposits of potash salts are discovered. The potash produced from the Nebraska lakes is low grade and inferior in quality to the German article either for direct application or for use in mixed fertilizers. The California product contains a certain amount of borax, which is deleterious to plant life, and this company is unwilling to risk its use. Other companies who have used it have suffered heavy losses in consequence of the borax injuring the crops. It is now claimed that the amount of borax has been reduced to a safe percentage, but of this fact we are not as yet sufficiently convinced to risk using it in our fertilizers.

I cannot believe that Congress will consent to levy a tax upon the products of the soil and indirectly upon the very sustenance of every citizen.

DYE EMBARGO ESSENTIAL TO NATIONAL DEFENSE

Chemical warfare is not likely to be restricted, even if limitation of armament should be agreed upon, in the opinion of General A. A. Fries, the head of the Chemical Warfare Service. He expressed this belief to the Finance Committee of the Senate in response to an inquiry by Senator Penrose, the committee chairman. General Fries was called before the committee to testify as to the national defense feature of the dye embargo. He contended that such an embargo is absolutely essential to the development of materials necessary to the national defense.

In expressing the conviction that there would be no restriction placed on chemical warfare by any disarmament limitation agreement, General Fries, among other things, said:

"Chemical preparedness is the only means of national protection which can be developed and maintained in times of peace without cost to the country. The disarmament conference may result in restricting the construction of battleships and big guns, since that would reflect large economies for all the nations concerned, but for the United States to cease to prepare for the manufacture of war gases would put us at the mercy of an outlaw nation."

DYE CONSUMERS PRESENT VIEWS

Not all consumers of dyes are opposed to the embargo plan. Daniel F. Waters, Philadelphia, was among those who urged its adoption. He stated that American makers

are perfecting their processes, are reducing their prices and will soon be in a position to give entire satisfaction. Practically all of the consumers of dyes, however, opposed the plan, largely on the ground that it is impossible to get the necessary quality in most dyes of American manufacture. It was admitted that a few American dyes equal the German product, but that the great majority of the colors are not fast. Alfred A. Hodshon, a manufacturer of felt hats, declared that it had been necessary for his company to revolutionize its manufacturing methods so that hats could be dyed after they are molded. When German dyes were available, the dyeing was done before the molding process. He declared that American-made colors will not hold throughout the manufacturing process.

The committee apparently was impressed more by the testimony showing the delays and difficulties of securing importations, or even rulings, through the War Trade Board procedure, than it was by the statements as to lack of quality. The committee seems confident that American manufacturers will be able to attain the necessary quality standards, but very evidently is extremely dubious as to the practicability of any such administration as it is proposed to vest in the United States Tariff Commission.

Chemical Exposition Notes

MINERALS, METALS AND ALLOYS

To the user of minerals and metals the Seventh National Exposition of Chemical Industries, which will be held in the Eighth Coast Artillery Armory, New York, Sept. 12 to 17, offers exceptional possibilities for actual investigation, study, technical information and advice, whether it be a new alloy or the more precious metals.

There is, for instance, an alloy discovered in 1905. The average brass foundryman, after finding out that the metal had a fair percentage of copper, decided that it ought to be a simple proposition and proceeded to cast it in the same manner as he would brass. As a matter of fact it is difficult to cast. It is much more sensitive to oxidation, has a higher shrinkage, and demands a much larger percentage of metal in the gates and risers. It must be kept carefully covered and must be deoxidized before pouring. These difficulties are gradually being overcome, through the education of the foundrymen, especially through a plant service station where foundrymen can go for advice and information, where they may familiarize themselves with the use of the metal.

This particular metal is non-corrodible, strong as steel, tough and ductile. It can be machined, forged, soldered and welded both electrically and by the oxy-acetylene process.

There are many cases where ignorance of the best methods to employ in working with individual alloys or minerals with peculiar properties has prevented the best results or advantages to be obtained with these metals.

There will be a splendid exhibit of minerals, metals and alloys at the exposition, where the highest knowledge and experience of the chemical world will be at the command of any investigator.

Acting Chief Named for Bureau of Chemistry

Expecting that some time yet may elapse before the new chief of the Bureau of Chemistry will be selected, the Secretary of Agriculture has designated Walter G. Campbell as the acting chief of that important bureau of the Department of Agriculture. Dr. W. W. Skinner was designated at the same time to be assistant chief.

Mr. Campbell has been with the Bureau of Chemistry since 1907. He helped to organize the inspection work under the food and drugs act. In 1916 he was made assistant chief in charge of the enforcement of the food and drug regulations. He is a native of Kentucky and a graduate of the University of Kentucky.

Dr. Skinner is an agricultural chemist and has been with the bureau since 1904. He formerly was a member of the chemical staff of the Maryland Agricultural College. He has been charged with the enforcement of the beverage regulations promulgated in connection with the food and drugs act. He is a native of Maryland and was graduated from the Maryland Agricultural College and from George Washington University.

Transportation Arrangements for the British Chemists

The members of the Society of Chemical Industry of Great Britain and those of the Canadian Section who are to participate in the international session to be held on Sept. 8, in New York City, will enter the United States at Niagara Falls and on the evening of Sept. 5 will go by special train to Syracuse, where they will inspect the plant of the Solvay Process Co. The next day they are to proceed in the same cars to Albany, where connections will be made with the night boat "Berkshire," upon which accommodations for 150 have been reserved. The party will arrive at New York early the next morning, in time for the society meetings.

Members of the societies desiring to obtain accommodations on this train and on the boat, and who have not already made arrangements with their local officers, should advise Charles F. Roth, chairman of transportation for the co-ordinating committee, 52 East 41st St., New York, before Aug. 20. For members returning via the same route, a special fare upon the following certificate plan will apply.

The Trunk Line Association and the Southeastern Passenger Association have granted special rates equivalent to a fare (one way) and a half to those traveling from within their territories. Tickets can be purchased and used from Sept. 6, and the return coupon is good until midnight of Sept. 23. To obtain this reduced fare an identification certificate (which will be furnished upon application to C. L. Parsons, secretary, A.C.S., 1709 G St., N. W., Washington, D. C., or Allen Rogers, secretary, Society of Chemical Industry, Pratt Institute, Brooklyn, N. Y., respectively for these members) will be necessary and will suffice for each member, including his family.

Accommodations and arrangements for the entertainment of the visitors are in the hands of the co-ordinating committee of the American Chemical Society, with whom they are to hold the joint scientific sessions. It is expected that many of the chemists will bring their wives and daughters, and accordingly the ladies' entertainment committee, of which Mrs. L. H. Baekeland, of Yonkers, is the chairman, has an unusually complete organization and is making elaborate preparations for the entertainment of the ladies.

PROMINENT SCIENTISTS EXPECTED

At the head of the overseas delegation will be Sir William J. Pope, K.B.E., F.R.S., president of the Society of Chemical Industry, who two years ago was knighted for his valuable services in the production of mustard gas.

Among other prominent members will be Dr. Louis A. Jordan, Chevalier of the Crown of Italy, who was sent to aid the Italian Government in the making of explosives; Dr. Frederick William Atack, whose principal work has been the chemistry of dyes; Dr. Andrew McWilliams, one of the best-known steel metallurgists in Great Britain, and Dr. Andrew Smith, an explosives engineer of international reputation.

Some of the eminent Canadian chemists will be: Dr. R. F. Ruttan, past president of the Canadian Section of the society, chairman of the Advisory Council of Scientific Research and formerly vice-president of the parent society; Dr. Milton L. Hersey, one of the founders and past chairman of the Canadian Section, and Dr. C. R. Hazen, chairman of the Montreal Section.

Ceramics Work Being Expanded

Fully \$60,000 will be expended during the next twelve months at the ceramic experiment station of the U. S. Bureau of Mines at Columbus, Ohio. This sum includes with the Federal appropriations the amounts which have been contributed by industries interested in the research. In addition to the regular work of the station, the experimentation on heavy clay products and on the Georgia kaolins will be conducted at the Columbus station.

Due to the increased importance of the work at Columbus L. I. Shaw, the assistant chief chemist of the bureau, has been transferred to Columbus as chief assistant to the superintendent of the station. The vacancy in the Washington office has been filled by the designation of Dr. Andrew Stewart to act as assistant chief chemist.

Synthetic Organic Chemicals Defined

The Treasury Department has recently issued important regulations for the enforcement of the dye and chemical control section of the emergency tariff act of May 27, 1921. Among the provisions of interest to the chemical industry may be found the following:

The terms "synthetic organic chemical and synthetic organic drug," used in said section 501-a of the emergency tariff act are interpreted to apply to any substance which is known commercially as a chemical or drug and which contains carbon in chemical combination with other elements (excepting cyanides, cyanamides, carbides, carbonates and bicarbonates of metals or inorganic radicals), and which has been produced by any chemical process other than that necessary to extract, isolate or purify the substance from a natural source or to effect its separation from a more complex natural compound by hydrolysis or to form a salt.

Products obtained by fermentation, if such fermentation is carried on under controlled conditions, are considered to be synthetic organic chemicals. Distillation which simply separates a substance already formed from other substances does not make the product of such simple distillation a synthetic chemical or drug, but if the substance is subject to destructive distillation the products of such destructive distillation are considered to be synthetic organic chemicals or drugs.

In those cases where a particular substance may be either a natural or synthetic product it should be assumed that the substance is a synthetic product if it is known that the product produced is of a substantial commercial quantity. In cases of doubt the question will be referred to the department.

It is held that compounds or mixtures in part of coal-tar origin are included in the term "mixtures and compounds of such coal-tar products" as it occurs in the act, and that it was not the intent of the act to limit the term to mixtures and compounds wholly of coal-tar origin. When a product has sufficient coal-tar product mixed or combined with it to change materially its identity or character it shall be considered a "mixture or compound of such coal-tar product" within the meaning of the act.

American Peat Society to Meet in New York

The fifteenth annual convention of the American Peat Society will be held at the Hotel Commodore, in New York City, on Sept. 7, 8 and 9. Addresses will be made by well-known peat specialists of the United States and Canadian governments, by soil experts of various state experiment stations and by others interested in the engineering and bacteriologic aspects of the world's peat deposits. The program will include discussions of air-dried machine and powdered peat fuel, the cultivation of peat soils, the application of bacteriology to soil fertilization, the use of peat as a nitrogenous ingredient and conditioner of fertilizer and stock feed, the efficient handling of peat, false promotion, inefficient engineering and other subjects. An important announcement concerning the status and prospects of the industry and the society will be made by one of the officers. At the close of the meeting an opportunity will be given to visit one of the largest and most efficient peat plants in the world and to see the products being produced in commercial quantities.

French Edition of Specifications Now Available

The U. S. Department of Commerce has completed the translation and publication of the French-English edition of 61 A.S.T.M. specifications particularly applicable to export trade. These specifications form part of the Industrial Standard Series, of which the Spanish-English editions of the same specifications were the beginning. The specifications include those for rails and splice bars, structural and reinforcing steels, steel forgings and castings, steel wheels and tires, steel and iron tubes and pipe, boiler steels, wrought-iron products, pig iron, cast-iron pipe, malleable and gray-iron castings, copper wire, copper bars, spelter, bronze, cement, linseed oil and turpentine. Copies are being distributed by the Government to commercial attachés and trade commissioners, and arrangements for distribution in other channels are being considered. Copies of the specifications may be obtained by addressing the Superintendent of Documents, Washington, D. C.

New Bureau of Standards Standard Samples

A new standard sample of lead-base bearing metal No. 53 is now being issued with a provisional certificate. This sample has the approximate composition: Lead 79 per cent, tin 11 per cent and antimony 10 per cent, and contains in addition small amounts of bismuth, copper, iron and arsenic. The price of this sample is \$2 per 150 g., prepaid or parcel post c.o.d.

Renewal No. 33a of nickel steel No. 33 is also ready for distribution at the price of \$2.50 per 150 g.

Book Reviews

COPPER REFINING. By *Lawrence Addicks*. 6 x 9 in., 211 pages. New York: McGraw-Hill Book Co., Inc. Price, \$3.

If one had been asked six months ago where to find information on electrolytic refining of copper, he would have been somewhat at a loss. About the only English text on this subject, T. Ulke's "Modern Electrolytic Copper Refining," was written 20 years ago and has been out of print for some time. Texts on general metallurgy, and even treatises on the metallurgy of copper, present only the barest outline of refinery practice. For instance, Peter's "Modern Copper Smelting" contains a chapter dating from the 90's, and his later books seem to avoid the subject. Schnabel is useless. Gowland's excellent "Metallurgy of the Non-Ferrous Metals" compresses the matter into six pages.

Since Ulke's book has appeared, therefore, the only additional information available consists of articles scattered through the technical press, with perhaps the sole exception of Burns' monograph on the Great Falls Refinery.¹ Hansen, of the General Electric staff, also prepared a detailed consideration of the underlying electrochemistry (unfortunately not yet printed). Beyond this, one was forced to rely upon Greenawalt's "Hydrometallurgy of Copper," and Tobelmann's accounts of operations at Ajo.² The latter are discussing a fundamentally different problem, however; that of depositing pure copper from a sometimes impure solution, while the problem of electrolytic refining is to convert low-grade copper into one of highest purity.

It is therefore apparent that here existed a considerable gap in metallurgical literature. But to fill it was what might be called a labor of love, since it would circulate only among the more important technical libraries, and the relatively minute number of men occupied in this branch of copper production—there are only 11 refineries handling any important tonnage in the Western Hemisphere. Nevertheless the labor has been well done.

Addicks approaches the subject from an entirely different viewpoint than did Ulke. The latter neglected the chemistry and physics of the process and successfully attempted a symposium of refinery practice, showing how the various plants were laid out, and describing the minutiae of their construction. In many cases one was left wondering what reasons led to the choice of certain detail at Perth Amboy and another at Baltimore. Addicks, on the other hand, views the process from a managerial standpoint. His Chapter V on "Current Efficiency" is an instance. Current efficiency is first defined, then nine sources of loss are listed and discussed in detail. Any or all of them may be kept to a very low amount by means which are noted or are self evident to a competent designer reading the text, so that an efficiency of 99 per cent can be had if expense is no item. Good balanced operation approaches nearer 92 per cent. It is the 92 per cent which interests Addicks, and he emphasizes that a gain over this figure must not cost in other departments more than the coal it saves.

A further notable feature of the text is the pronounced stress the author places on an expense seldom mentioned, but nevertheless most important. This refers to the interest on metals tied up in the process. Such an item is of

greatest importance when figured against precious metals contained in the sludges, but an enormous mass of cheaper copper worth a far greater sum of money circulates perpetually through the plant, always in solution. Modifications to present practice are continually directed toward a reduction of this locked-up value.

A considerable portion of the text has been published serially in *CHEMICAL & METALLURGICAL ENGINEERING* during the last five years. Nevertheless, our readers will recognize the desirability of having the articles collected in a form handy for reference. The treatment of the subject is such that not only copper refinery men, but every engineer or chemist working with the electrodeposition of metal from aqueous solution, will get many valuable suggestions which he can apply directly to better his work. E. E. THUM.

Personal

W. M. BERRY of the Bureau of Standards, A. I. PHILLIPS of the American Gas Association and H. A. STRAUS, chief engineer of the Public Service Commission of Maryland, are the committee of engineers to investigate for the Maryland Public Service Commission the desirable quality of gas to be required in the city of Baltimore. Extended experiments on the efficiency of use and on other features bearing upon the general matter will be carried out in Baltimore jointly by the commission, the Baltimore Consolidated Gas & Electric Light Co. and the Bureau of Standards.

RAYMOND T. BOHN has been appointed chief chemist of the Nicetown plant of the Midvale Steel & Ordnance Co., succeeding Dr. G. L. Kelley, resigned.

S. A. COVILLE, gas engineer of the Maryland Public Service Commission, is to visit Canada and Europe investigating the influence of the standards for gas quality which have been adopted in those countries on the service to gas users. This work is in line with an extended investigation which the commission is now undertaking regarding the quality of gas to be required in Baltimore.

H. C. DICKINSON, who has been for some years chief of the automotive investigations division of the Bureau of Standards, has been granted a year's leave of absence from the bureau to become director of research of the Society of Automotive Engineers. He will, however, continue in some measure to co-operate in the Bureau of Standards' investigations by giving a small amount of his time to conference and direction of the work of this division. Work of the S.A.E. on research will not include any experimental investigations by the society itself, but will deal rather with an exchange of research information, the general study of research in progress within the industry and of interest to it, and an effort to secure proper arrangements for additional research work which is not now adequately cared for.

B. M. LARSEN has been elected a fellow in the University of Washington for electrometallurgical work in the Bureau of Mines Station at Seattle, Wash.

E. A. RICHARDSON has resigned as a member of the glass technology department, National Lamp Works of the General Electric Co., Cleveland, Ohio, to accept the position of chief chemist for the Libbey Glass Manufacturing Co., Toledo, Ohio.

WILFRED W. SCOTT has resigned as research chemist of the General Chemical Co. to accept the position of associate professor of chemistry in the Colorado School of Mines.

BRADLEY STOUGHTON, having resigned after more than eight years' service as secretary of the American Institute of Mining and Metallurgical Engineers, will resume his practice as a consulting engineer, making a specialty of financial investigations and reports to bankers, investors, directors, trustees and examining accountants on industrial plants, engineering enterprises, and iron and steel plants. His address will be, until Oct. 1, Engineering Societies' Building, 29 West 39th St., New York City.

¹*Transactions*, American Institute of Mining Engineers, 1913, vol. 46, pp. 703, 196.

²*Ibid*, 1916, vol. 55, p. 830; 1919, vol. 60, p. 22.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, Aug. 5, 1921.

Besides a slight tendency to show fractional declines, the chemical market during the past week showed signs of an early revival regardless of the mild inquiry due to the summer season. Producers of chemicals are getting business, and some of the largest interests say that the month just ended was responsible for the best volume of sales for any month of the year to date. Caustic soda has declined slightly on spot under the efforts of resellers to stimulate business. Soda ash seemed somewhat easier, but the change in spot quotations was of no importance. Producers of these two items have not announced any change in contract prices in the open market. Some of the leading caustic soda and ash plants are running as low as 15 per cent of normal, which is surely indicative that supplies are not increasing. Imported prussiate of soda experienced a period of competitive selling early in the week and business was placed at a shade under former quotations. Bichromate of soda seemed to withstand any forced selling and the market remained firm at former quotations. Bleach has attracted some interest at 2c. per lb. f.o.b. works in large drums. Foreign caustic potash has drifted slightly downward. Domestic oxalic acid is holding quite steady, with occasional slight concessions for foreign material. Sulphuric acid is moving quietly, with supplies sufficient to meet the present demand. Prices on sulphide of soda are steady enough for domestic goods, but the imported is being offered at lower prices. Camphor is moving at unchanged values. Barium chloride afloat was offered at \$47 per ton. Manufacturers of salt cake report sales as low as \$25 per ton, spot, in bulk lots. Copper sulphate has slackened somewhat since requirements for agricultural purposes have already been met.

INDUSTRIAL CONDITIONS IMPROVING

In the industrial world, all signs indicate that the period of liquidation of the raw material markets has passed. Recent changes are due mainly to conditions of supply and demand in specific lines. This is considered a normal condition. Wholesale prices of many classes of manufactures have been fully deflated. This is not true in all lines, but recent cuts in the price of steel and widespread reductions in wages indicate that adjustment in wholesale prices will not be delayed much longer. Retail prices show wide irregularities and high-cost stocks have been largely disposed of. Price stabilization is undoubtedly not far ahead. The textile industry is progressing in admirable manner. The American Woolen Co. opened its spring sales at well-maintained prices and reported a larger volume of business than last year. There has been a slight improvement noted in the steel industry. Mill operations are reported having increased 5 per cent in the Pittsburgh region. Several mills that had been closed down for some time have reopened. Freight car loadings have shown a very decided increase during the past ten days. Although there were complaints of slack business and mid-summer dullness, bank clearings held up quite well. Clearings are not far below those of last year. This is a very good indication when taking into consideration that commodity prices are very much lower than they were at this time last year. In general, the consensus is that the fall season will see a decided turn to the better in the chemical industry.

CHEMICALS

Imported caustic soda, 88-92 per cent, is quoted in most directions at 4½@4¾c. per lb. Trading has not shown much activity during the past week and in some quarters it was intimated that a firm bid at 4½c. would be accepted on a round lot. The latter figure is equivalent to the pre-war price on this material. Yellow prussiate of potash was offered

at lower figures by dealers and reports were current that small-lot sales have gone through on the basis of 2½c. per lb. The general range is from 2½@2¾c. per lb., depending upon the seller. The red variety is quiet, with sellers at 28@30c. per lb. Spot bichromate of soda is obtainable at 8c. per lb. and some sales have been recorded on this basis. Odd lots might be purchased at 7¾c. per lb. on a firm bid, but dealers were not inclined to name this price in the open market. Offerings were not heavy, but appeared to be sufficient to meet the current extent of the consuming demand. Prices on spot caustic soda have drifted to a lower level on resale stock. Prominent dealers quoted the market for standard brands at \$3.65@3.70 per 100 lb., but in some directions it was stated that \$3.60 could be done ex-dock New York. The general demand has not shown much activity during the past week and while it is not believed that resale supplies are heavy, there is a keener state of competition among the holders. Contract prices remain unchanged at 3¼c. per lb., basis 60 per cent, f.o.b. works.

Scattered trading in nitrite of soda was reported at 7c. per lb., with sellers generally quoting 7@7¼c. in the open market. Rumors were current that round lots might be purchased at slight concessions, but buyers are showing very little interest beyond the limit of actual requirements. Imported prussiate of soda showed somewhat of a decline during the beginning of the week, but strengthened considerably at the close. Sales have been reported at 11¼@12c. per lb., with most sellers asking the outside figure. Foreign shipments are offered on the basis of 1½c. per lb. c.i.f. New York. Imported sulphide of soda is being offered by dealers at 4½c. per lb. for the fused and 5½c. for the broken. Odd lots of the latter material could probably be purchased at 5@5½c. on a firm offer. Resale lots of light soda ash in single bags were a shade easier on spot, with sellers quoting \$1.90 per 100 lb., although 2c. per lb. was the prevailing asking price in most directions. Foreign shipments were offered at 1½c. per lb. c.i.f. and in one quarter 1¼c. was named for prompt shipment from England.

Leading factors in cobalt oxide report sales at \$2.35@2.45 per lb., depending on the quantity. Prevailing quotations are the lowest named so far this year. Dealers of cream of tartar quote 28½c. per lb. and might do a little better on a firm offer. Producers continue to ask 33c. per lb., but are not getting much business at this price. Odd lots of oxalic acid of foreign and domestic manufacture are quoted by second hands at 17@17½c. per lb. Some producers are accepting business at the outside figure at the works. The extreme range of prices is from 17@19c. per lb., depending entirely upon the quantity, brand and seller. Buyers of tin oxide are showing a little more interest at the late reduction named by producers. Small-lot sales were reported at 38c. per lb.

COAL-TAR PRODUCTS

The coal-tar products market during the past week presented an appearance of calmness on the surface, but the undertone was diversified, making the situation somewhat difficult to analyze. In some quarters business is fairly active. Some products seem to be in demand, and where the condition holds true, brisk selling is taking place. Other products are dull and cannot be moved even at price concessions. Inquiries, in general, are more numerous, with the foreign element showing greater interest. Small-lot orders still form the bulk of sales, but discriminating consumers are showing an inclination to buy ahead when they are convinced that the product is selling at the rock-bottom figure. The low-priced resale material is being cleaned out of the market, but on some products manufacturers are feeling the competition quite keenly. The full importance of the action of the House on the dyestuff measure is now being realized both by manufacturers and consumers, with the result that the mental attitude of the trade is most unsettled. The majority of makers feel that full protection will be accorded them, but some consumers are reserving purchases until legislative action of a more definite nature is taken.

Sales of fair-sized lots of aniline oil were made at 18c. per lb. Smaller quantities are moving at higher prices. In some quarters 24c. per lb. is asked, but little buying is

being done at this level. The resale market seems well supplied, and with the present weak condition, a slight reduction is very probable. Producers of *benzene* are firm at 27@33c. per gal. for prime goods and 25@30c. for the 90 per cent. The present demand is exceeding the supply. Many coke ovens are still shut down with a consequent curtailment of supplies. Sales of fair-sized lots of *beta naphthol* were made at 34c. per lb. Odd lots of resale goods can be picked up as low as 32½c., but usually this material has been found to be old goods of inferior quality. The price range on *phenol* is varied at 9½@14c. per lb., depending upon seller, with resale lots at the lower level. Official Government resellers are quoting 12c. per lb. The demand is light and competition rather keen. Stocks of *dimethylaniline* are not as large as formerly, and offerings were heard at the close of the week at 42c. per lb., with many disposed to ask up to 44@45c. Producers of *diphenylamine* ask up to 67c. per lb. Some odd lots were known to have sold down to 55c. per lb. Resellers are stronger in their views and it is doubtful if the 60@61c. price could easily be done. Supplies of *eresylic acid* are plentiful, but the demand showed a spurt, with some contract business placed. Consumers have shown more inclination to buy ahead. The 97-99 per cent is quoted at 68@75c. per gal.

WAXES

Dullness continues to feature the market in *beeswax*. Prices, however, remain unchanged and nominal at former levels. Pure refined white wax is quoted at 40@45c. per lb. African crude ranges from 14@16c. per lb. South American brands are quoted on a basis of 21@25c. per lb. With trading practically at a standstill, the market on *carnauba wax* presents a weak tone and prices are purely nominal. No. 1 is available at 40@42c. per lb. and the No. 2 at 38@40c. No. 2 North Country was nominal at 25c. per lb. No. 3 North Country closed at 13½c. per lb. Firmer cables on *Japan wax* were received from the Orient, which resulted in the withdrawal of some offerings from the market. Spot stocks, however, were quotably unchanged at 16½@17c. per lb. The demand was of a hand-to-mouth character. Weakness in *paraffine wax* was the ruling feature of the market. Trading continues limited to small lots and quotations are unsteady. While scale wax was quoted at 2c. per lb., carlots, f.a.s. N. Y., it was stated that this price could be shaded on a firm bid for a round lot. Match wax closed unchanged at 3¼c. per lb. The other grades of wax were also wholly nominal.

VEGETABLE OILS

While crushers of *castor oil* maintained prices on the basis of 9½c. per lb. for the No. 3 quality in barrels, outside lots were available at concessions. The recent advance in castor seed, however, has brought about a firmer undertone. There were offerings of *chinawood oil* for August arrival at New York at 11¼c. per lb., in barrels, with the market barely steady as a result of the prevailing quiet conditions. In some directions it was intimated that 11c. might be done for August oil. Spot material remained scarce and quotations of 13@14c. per lb. were merely nominal. August-September shipments from the Orient closed at 10@10¼c. c.i.f. New York, barrels included. No important transactions in the market were reported for *coconut oil*. Prices named showed little change. Manila operators ask on a basis of 7¼c. per lb., loose, August-September shipment, c.i.f. Pacific Coast, while 7½c. was asked c.i.f. N. Y. arrivals. Offerings of *crude corn oil* in the Middle West were scanty and prices were more or less nominal around 7@7¼c. per lb., sellers' tanks, f.o.b. Chicago, September delivery. Edible *olive oil* on spot was unsettled at \$1.90@\$2.25 per gal., with offerings in some directions rather liberal. Denatured on spot closed at \$1.25 per gal. *Lagos palm oil* was advanced to 6¾c. per lb. c.i.f. N. Y., the rise being in sympathy with higher prices in Liverpool. *Niger oil* was marked up to 5¾c. per lb. c.i.f. N. Y., prompt shipment from abroad. Domestic crude *peanut oil* closed at 7½@7¾c. per lb., prime basis, tank cars, f.o.b. mills, although recent business was placed at 7¼c. Oriental oil for prompt shipment from the Coast was scarce and closing prices were advanced to 7¼@7½c. per lb., sellers' tanks.

The St. Louis Market

ST. LOUIS, Mo., Aug. 5, 1921.

There has been a very pronounced improvement in the activity of the drug and fine chemical market and buying has measurably increased, indicating that the summer lull has been passed and that consumers' stocks are very low, and furthermore that the resale lots are diminishing. The market on heavy chemicals was quite active the past two weeks and with inquiries coming from many of the larger consumers for the first time in many months, the future on heavy chemicals is decidedly optimistic. An appreciable amount of business is originating from the dye and textile manufacturers, and as a whole the present condition gives a very promising appearance for the future.

Caustic soda demand has been very good. Several of the large contract buyers are beginning to take out their allotments. Carload prices range from \$3.75@\$4.50 per 100 lb., basis 73-75 per cent solid, f.o.b. point of production. *Soda ash* continues at the manufacturers' prevailing schedule. *Bicarbonate of soda* demand has been very dull with prices holding at \$2.75 per 100 lb.

The activity in *carbon bisulphide* still prevails and a very nice business is being transacted. *Hpyo* continues in a routine way. *Sulphur* continues to hold firm at \$2 per 100 lb. for the commercial in bags, with routine demand.

DRUGS AND PHARMACEUTICALS

The demand for *bismuth salts* has tremendously increased and manufacturers are in good position to fill orders promptly. Some certain *citrate salts* continue to move freely. Producers have reduced their price on *cream of tartar*, in spite of which the demand has been very good. A very good demand for *ether* from the hospital trade is being enjoyed. *Glycerine* has again declined and now holds at 14c. per lb. for both spot and contract with a fair demand. *Hydrogen peroxide* continues to move steadily through routine channels. *Iodides* have shown a fair increase. *Salicylates* are holding their own. *Sodium benzoate* is not moving as manufacturers expected. However, there has been a slight improvement. Factors have reduced their price on *strychnine*, but little is expected to result from this reduction, for the use of this commodity is limited and buyers will take on supplies only in about the same volume. *Zinc oxide* prices have not changed since June 27, although the demand during July for both leaded and lead-free fell off considerably. The manufacturers predict a picking up in the lead-free in the next two weeks and base these predictions on the increased demand since Aug. 1. *Zinc stearate* demand continues to increase.

ACIDS

Producers of heavy acids report a decided increase and are very optimistic regarding the future. *Sulphuric acid* is moving in a large volume to the oil-refining trade. Apparently consumers of heavy acids are again in operation and their stocks on hand are exhausted. Many inquiries for *benzoic acid* are being received and in many instances resulting in business. The market for *carbolic acid* retains the same steady tone that has been noted for some time past, with a fair inquiry and demand. The extreme hot weather which has recently prevailed has caused some increase in the demand for small quantities of *citric acid*. However, the situation still lacks any appreciable change. The demand for *phosphoric acid* has improved. Apparently the soft-drink manufacturers are substituting *tartaric acid* for *citric acid* and lately the consumption has been heavy.

VEGETABLE OILS AND PAINT MATERIALS

Linseed oil, after a temporary rise to 81c., has settled to 78c., basis raw. The demand for spot oil is fair, with no contracting being done. *Castor oil* enjoys a routine demand, with an advance of price to 11¼c., in returnable drums for No. 1 U.S.P. *Turpentine* demand continues very fair considering the dull period the paint trade is now experiencing. The price has stiffened continuously the past week and today is quoted at 61½c. per gal.

Lithopone continues in fair demand with price the same. *Red oxides* have been in fair movement the past two weeks for the first time this year.

The Iron and Steel Market

PITTSBURGH, Aug. 5, 1921.

Gradual improvement in the demand upon the steel mills can be seen, but the improvement is very slow, particularly in tonnage. It is in the lighter lines that the improvement is more noticeable, particularly in sheets and tubular goods. Wire products recently showed a decided gain in demand, but the demand has decreased somewhat in the past few days. In the heaviest lines, rails and shapes, there is practically no change, and thus tonnage does not show much gain. The best guess is that the production of steel ingots in July was just under 20 per cent of capacity, taking the month as a whole, but production at the middle of the month was somewhat under the average. The first half of August will probably show a rate measurably above 20 per cent.

The character of the demand upon the steel mills is still plainly marked as being for common everyday consumption, the increase in demand during the past three weeks being due to further depletion of stocks of steel in buyers' hands as well as distribution of stocks of various wares made of steel.

COMPETITION AND PRICES

There is not merely an "open market" in steel products, with each seller naming a particular price against each inquiry, but there is strenuous competition. The competition does not take the form of price slashing, the policy being rather reserved in that respect, and steel prices are now sagging rather than definitely declining. On the whole the steel market has really gone off rather gently. While there has been declines in some products that appeared rather spectacular, the fact in most cases was that what appeared like a straight reduction was really the open recognition of price-cutting that had been growing gradually. The general pace of decline is certainly much less rapid now and it is quite unlikely there will be any clear-cut breaks in future. The price on a 500-ton lot today may become the price on a 100-ton lot a fortnight hence and in a week or two the price on a single carload. Carload prices now may be quoted at 1.75c. for bars, 1.85c. for shapes and plates and 2.40c. for hoops or hot-rolled strips. In sheets the highest prices seriously asked are 2.40c. on blue annealed, 3.25c. on black and 4.25c. on galvanized. On some orders not particularly large as low as 3c. has been done on black and 4c. on galvanized, while it is rumored that in one or two special cases 3.75c. has been done on galvanized. An order of equal size in black would hardly bring out a price of 2.75c., the trend in close competition being to narrow the spread between black and galvanized to less than \$1 per 100 lb. The open quotation on plain wire is 2.50c., with \$2.75 regarded as the open market on rails.

Setting together the two facts that mills are rather reserved in cutting prices and altogether avoid any slashing, while it is generally claimed that to the average or typical mill present prices represent a loss, it may be surmised that mills are making quotations on a theoretical or prospective cost, based on what they expect to be able to do when they secure a fair rate of operation. With a mill operating at 15 or 20 or 30 per cent the actual computation of cost is not indicative of what could be done under reasonable conditions. The mills are in a condition never before experienced, for before the war it was a dictum that it was not feasible to operate a mill at less than about 50 per cent of capacity.

PIG IRON

A sale of 2,000 tons of basic iron made by a valley producer at \$18 furnace took \$1 off the quotable market. Bessemer is offered at \$20 valley, against \$20.50 a week ago. Foundry remains nominally quotable at \$19.50, though a firm offer for a round tonnage at a considerably lower price would probably bring results. The \$18 basic price is a phenomenon, since the transportation cost of assembling the coke, ore and limestone at a valley furnace is more than \$10. Sales at so much under present cost represent a desire to liquidate and an expectation that costs will be lower when it becomes necessary to make more iron. All the merchant furnaces in the valleys are idle.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots	Less Carlots
Acetic anhydride.....lb.	\$0.12½ - \$0.12½	\$0.40 - \$0.45
Acetone.....lb.	2.75 - 3.00	.13 - .13½
Acid, acetic, 28 per cent.....100 lbs.	5.00 - 5.25	3.25 - 3.50
Acetic, 56 per cent.....100 lbs.		5.50 - 6.00
Acetic, glacial, 99½ per cent, carboys.....100 lbs.	10.00 - 10.25	10.50 - 10.75
Boric, crystals.....lb.	.13½ - .14	.14½ - .15
Boric, powder.....lb.	.15 - .15½	.16 - .16½
Citric.....lb.		.44 - .45
Hydrochloric.....100 lb.	1.25 - 1.50	1.60 - 1.75
Hydrofluoric, 52 per cent.....lb.	.11½ - .11½	.12 - .12½
Lactic, 44 per cent tech.....lb.	.10 - .11	.11½ - .12
Lactic, 22 per cent tech.....lb.	.04½ - .05½	.06 - .07
Molybdic, C. P.....lb.	4.00 - 4.50	4.50 - 5.00
Muriatic, 20 deg. (see hydrochloric).....lb.		
Nitric, 40 deg.....lb.	.06½ - .06½	.07 - .07½
Nitric, 42 deg.....lb.	.07 - .07½	.07½ - .08
Oxalic, crystals.....lb.	.17 - .17½	.17½ - .19
Phosphoric, 50 per cent solution.....lb.	.13½ - .14	.14 - .18
Picric.....lb.	.20 - .25	.27 - .35
Pyrogallie, resublimed.....lb.		1.90 - 2.15
Sulphuric, 60 deg., tank cars.....ton		11.75 - 14.00
Sulphuric, 60 deg., drums.....ton		13.00 - 15.00
Sulphuric, 66 deg., tank cars.....ton	18.00 - 20.00	
Sulphuric, 66 deg., drums.....ton	21.00 - 22.00	22.50 - 23.00
Sulphuric, 66 deg., carboys.....ton		
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	21.00 - 22.00	
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	23.00 - 23.50	24.00 - 24.50
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	31.00 - 32.00	33.00 - 34.00
Tannic, U. S. P.....lb.		.90 - 1.00
Tannic (tech.).....lb.	.45 - .48	.50 - .55
Tartaric, crystals.....lb.		.27 - .28
Tungstic, per lb. of WO.....lb.		1.30 - 1.40
Alcohol, Ethyl.....gal.		4.65 - 4.85
Alcohol, Methyl (see methanol).....gal.		
Alcohol, denatured, 188 proof.....gal.		.31 - .36
Alcohol, denatured, 190 proof.....gal.		.38 - .42
Alum, ammonia lump.....lb.	.03½ - .03½	.04 - .04½
Alum, potash lump.....lb.	.03½ - .04	.04½ - .05
Alum, chrome lump.....lb.	.10 - .11	.11½ - .12½
Aluminium sulphate, commercial.....lb.	.01½ - .02	.02½ - .03
Aluminium sulphate, iron free.....lb.	.03 - .03½	.03½ - .04
Aqua ammonia, 26 deg., drums (750 lb.).....lb.	.07 - .07½	.07½ - .08
Ammonia, anhydrous, cyl. (100-150 lb.).....lb.	.30 - .32	.33 - .35
Ammonium carbonate, powder.....lb.	.08 - .08½	.09 - .10
Ammonium chloride, granular (white sal-ammoniac).....lb.	.06½ - .06½	.07 - .08
Ammonium chloride, granular (gray sal-ammoniac).....lb.	.06½ - .06½	.07 - .07½
Ammonium nitrate.....lb.	.07 - .07½	.07½ - .08½
Ammonium sulphate.....100 lb.	2.20 - 2.25	2.30 - 2.40
Amylacetate.....gal.		3.25 - 3.50
Amylacetate tech.....gal.		2.50 - 3.00
Arsenic oxide, (white arsenic) powdered lb.....lb.	.06½ - .07	.07½ - .08
Arsenic, sulphide, powdered (red arsenic) lb.....lb.	.11 - .11½	.12 - .13
Barium chloride.....ton	55.00 - 56.00	56.50 - 58.00
Barium dioxide (peroxide).....lb.	.20 - .21	.22 - .23
Barium nitrate.....lb.	.07½ - .07½	.08 - .08½
Barium sulphate (precip.) (blanc fixe).....lb.	.04½ - .04½	.04½ - .05½
Bleaching powder (see calc. hypochlorite).....lb.		
Blue vitriol (see copper sulphate).....lb.		
Borax (see sodium borate).....lb.		
Brimstone (see sulphur, roll).....lb.		
Bromine.....lb.	.41 - .42	.43 - .45
Calcium acetate.....100 lbs.	2.00 - 2.05	
Calcium carbide.....lb.	.04½ - .04½	.05 - .05½
Calcium chloride, fused, lump.....ton	23.50 - 24.00	24.50 - 25.50
Calcium chloride, granulated.....lb.	.01½ - .02	.02½ - .03
Calcium hypochlorite (bleach powder) 100 lb.....lb.	2.15 - 2.25	2.35 - 2.50
Calcium peroxide.....lb.		1.40 - 1.50
Calcium phosphate, tribasic.....lb.		.15 - .16
Camphor.....lb.		.75 - .78
Carbon bisulphide.....lb.	.06½ - .07	.07½ - .08
Carbon tetrachloride, drums.....lb.	.10½ - .10½	.11 - .12
Carbonyl chloride (phosgene).....lb.		.60 - .75
Caustic potash (see potassium hydroxide).....lb.		
Caustic soda (see sodium hydroxide).....lb.		
Chlorine, gas, liquid-cylinders (100 lb.).....lb.	.08 - .09	.09½ - .10
Chloroform.....lb.		.38 - .43
Cobalt oxide.....lb.		2.35 - 2.40
Copperas (see iron sulphate).....lb.		
Copper carbonate, green precipitate.....lb.	.19 - .19½	.20 - .21
Copper cyanide.....lb.		.50 - .62
Copper sulphate, crystals.....lb.	.05½ - .06	.06½ - .06½
Creosote of tartar (see potassium bitartrate).....lb.		
Epsom salt (see magnesium sulphate).....lb.		
Ethyl Acetate Com. 85%.....gal.		1.00 - 1.10
Ethyl Acetate pure (acetic ether 98% to 100%).....lb.		.50 - .52
Formaldehyde, 40 per cent.....lb.	.12½ - .13	.13 - .13½
Fusel oil, ref.....gal.		3.25 - 3.75
Fusel oil, crude.....gal.		1.75 - 2.00
Glauber's salt (see sodium sulphate).....lb.		
Glycerine, C. P. drums extra.....lb.		.14½ - .15
Iodine, resublimed.....lb.		2.65 - 3.75
Iron oxide, red.....lb.		.10 - .20
Iron sulphate (copperas).....ton	19.00 - 20.00	21.00 - 22.00
Lead acetate.....lb.		.11½ - .13
Lead arsenate, paste.....lb.	.09 - .09½	.10 - .11
Lead nitrate.....lb.		.15 - .20
Litharge.....lb.	.07½ - .07½	.08 - .08½
Lithium carbonate.....lb.		1.30 - 1.40
Magnesium carbonate, technical.....lb.	.09 - .09½	.10 - .11
Magnesium sulphate, U. S. F.....100 lb.	2.40 - 2.75	
Magnesium sulphate, technical.....100 lb.		1.20 - 1.60
Methanol, 95%.....gal.		.77 - .79
Methanol, 97%.....gal.		.80 - .88
Nickel salt, double.....lb.		.12 - .12½
Nickel salt, single.....lb.		.14 - .14½
Phosgene (see carbonyl chloride).....lb.		
Phosphorus, red.....lb.	.45 - .46	.47 - .50
Phosphorus, yellow.....lb.		.35 - .37
Potassium bichromate.....lb.	.11½ - .11½	.12 - .12½

	Carlots	Less Carlot
Potassium bitartrate (cream of tartar)..... lb.	\$. - \$.	\$0 28½ - \$0 29½
Potassium bromide, granular..... lb.		16 - 25
Potassium carbonate, U. S. P..... lb.	.35 - .40	45 - 50
Potassium carbonate, 80-85%..... lb.	.05½ - .05½	06 - 07
Potassium chlorate, crystals..... lb.	.08 - .08½	09 - 12
Potassium cyanide..... lb.		26 - 28
Potassium hydroxide (caustic potash)..... lb.	.04½ - .04½	.05 - .05½
Potassium muriate, 80% K.C.I..... ton	45 00 - 50 00	
Potassium iodide..... lb.		2 75 - 3 00
Potassium nitrate..... lb.	.09½ - .09½	10 - 12½
Potassium permanganate..... lb.	.26 - .27	27½ - 29
Potassium prussiate, red..... lb.	.28 - .29	29½ - 30
Potassium prussiate, yellow..... lb.	.21 - .22	22½ - 23
Potassium sulphate (powdered)..... per unit		1 35 - 1 35
Rochelle salts (see sodium potas tartrate).....		
Salammoniac (see ammonium chloride).....		
Sal soda (see sodium carbonate).....		
Salt cake..... ton		22 00 - 25 00
Silver cyanide..... oz.		1 35 - 1 38
Silver nitrate..... oz.		.40 - .41
Soda ash, light..... 100 lb.	1.95 - 2 00	2 05 - 2 50
Soda ash, dense..... 100 lb.	2.35 - 2 40	2 45 - 2 70
Sodium acetate..... lb.	.04 - .04	.04½ - .05
Sodium bicarbonate..... 100 lb.	2.75 - 2 40	2 50 - 2 75
Sodium bichromate..... lb.	.08 - .08½	.08½ - .09
Sodium bisulphate (nitre cake)..... ton	5 00 - 5 25	5 50 - 6 50
Sodium bisulphite powdered, U.S.P..... lb.	.05 - .05½	.05½ - .06
Sodium borate (borax)..... lb.	.05½ - .06	.06½ - .06½
Sodium carbonate (sal soda)..... 100 lb.	1.90 - 2 00	2 10 - 2 40
Sodium chl rate..... lb.	.07½ - .07½	.08 - .08½
Sodium cyanide..... lb.	.19½ - .21	.22 - 30
Sodium fluoride..... lb.	.11½ - .12	.12 - .13½
Sodium hydroxide (caustic soda)..... 100 lb.	3.60 - 3 70	3 80 - 4 40
Sodium hypsulphite..... lb.		.03½ - .03½
Sodium nitrite..... 100 lb.	2.10 -	2 30 -
Sodium nitrate..... lb.	.07 - .07½	.07½ - .08
Sodium peroxide, powdered..... lb.	.25 - .26	.27 - 30
Sodium phosphate, dibasic..... lb.	.04½ - .04½	.05 - .05½
Sodium potassium tartrate (Rochelle salts)..... lb.		.26 - .27
Sodium prussiate, yellow..... lb.	.11½ - .12	.12½ - .13
Sodium silicate, solution (40 deg.)..... 100 lb.	1.00 - 1 15	1 25 - 1 40
Sodium silicate, solution (60 deg.)..... lb.	.02½ - .03	.03½ - .03½
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	1 50 - 1 75	2 00 - 2 25
Sodium sulphide, fused, 60-62 per cent (conc.) lb.	.04½ - .04½	.05 - .05½
Sodium sulphite, crystals..... lb.	.03½ - .04	.04½ - .04½
Strontium nitrate, powdered..... lb.	.15 - .15½	.16 - .17
Sulphur chl ride, red..... lb.	.07 - .07½	.07½ - .08
Sulphur, crude..... ton	20 00 - 22 00	
Sulphur dioxide, liquid, cylinders extra..... lb.	.08 - .08½	.09 - .10
Sulphur (sublimed), flour..... 100 lb.		2 25 - 3 10
Sulphur, roll (brimstone)..... 100 lb.		2 00 - 2 75
Tin bichloride, 50 per cent..... lb.	.18 - .19	
Tin oxide..... lb.		.38 - .40
Zinc carbonate, precipitate..... lb.	.15½ - .16	.16½ - .17
Zinc chloride, gran..... lb.	.11 - .11½	.11½ - .12
Zinc cyanide..... lb.	.45 - .49	.50 - .60
Zinc dust..... lb.	.11½ - .11½	.11½ - .12½
Zinc oxide, XX..... lb.	.07½ - .07½	.08 - .09
Zinc sulphate..... 100 lb.	3.00 - 3 25	3 30 - 3 50

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude..... lb.	\$1 10 - \$1 15
Alpha-naphthol, refined..... lb.	1 25 - 1 30
Alpha-naphthylamine..... lb.	.35 - .40
Aniline oil, drums extra..... lb.	.18 - .21
Aniline salts..... lb.	.25 - .28
Anthracene, 80% in drums (100 lb.)..... lb.	.75 - 1 00
Benzaldehyde U.S.P..... lb.	1 00 - 1 25
Benzidine, base..... lb.	.85 - 1 00
Benzidine sulphate..... lb.	.75 - .85
Benzoic acid, U.S.P..... lb.	.60 - .65
Benzoate of soda, U.S.P..... lb.	.55 - .60
Benzene, pure, water-white, in drums (100 gal.)..... gal.	.27 - .32
Benzene, 90%, in drums (100 gal.)..... gal.	.25 - .28
Benzyl chloride, 95-97%, refined..... lb.	.25 - .27
Benzyl chloride, tech..... lb.	.20 - .23
Beta-naphthol benzoate..... lb.	3 50 - 4 00
Beta-naphthol, sublimed..... lb.	.70 - .75
Beta-naphthol, tech..... lb.	.32½ - .37
Beta-naphthylamine, sublimed..... lb.	1 75 - 1 80
Cresol, U. S. P., in drums (100 lb.)..... lb.	.16 - .18
Ortho-cresol, in drums (100 lb.)..... lb.	.25 - .27
Cresylic acid, 97-99%, straw color, in drums..... gal.	.68 - .75
Cresylic acid, 95-97%, dark, in drums..... gal.	.65 - .70
Cresylic acid, 50%, first quality, drums..... gal.	.45 - .50
Dichlorobenzene..... lb.	.06 - .09
Diethylaniline..... lb.	1 20 - 1 25
Dimethylaniline..... lb.	.42 - .50
Dinitrobenzene..... lb.	.26 - .28
Dinitrochlorobenzene..... lb.	.20 - .30
Dinitronaphthalene..... lb.	.30 - .40
Dinitrophenol..... lb.	.35 - .40
Dinitrotoluene..... lb.	.27 - .30
Dip oil, 25%, ear lots, in drums..... gal.	.40 - .45
Diphenylamine..... lb.	.60 - .65
H-acid..... lb.	1 15 - 1 25
Meta-phenylenediamine..... lb.	1 15 - 1 20
Monochlorobenzene..... lb.	.12 - .14
Monoethylaniline..... lb.	1 75 - 1 85
Naphthalene crushed, in bbls..... lb.	.06½ - .08
Naphthalene, flake..... lb.	.06½ - .08
Naphthalene, balls..... lb.	.08 - .09
Naphthionic acid, crude..... lb.	.70 - .75
Nitrobenzene..... lb.	.12 - .15
Nitro-naphthalene..... lb.	.30 - .35
Nitro-toluene..... lb.	.16 - .18
Ortho-amidophenol..... lb.	3 10 - 3 20
Ortho-dichlor-benzene..... lb.	.15 - .20
Ortho-nitro-phenol..... lb.	.80 - .85
Ortho-nitro-toluene..... lb.	.15 - .20
Ortho-toluidine..... lb.	.20 - .25
Para-amidophenol, base..... lb.	1 40 - 1 45
Para-amidophenol, HCl..... lb.	1 60 - 1 75

Para-dichlorobenzene..... lb.	.15 - .20
Paranitroaniline..... lb.	.75 - .80
Para-nitrotoluene..... lb.	.85 - .95
Para-phenylenediamine..... lb.	1 70 - 1 95
Para-toluidine..... lb.	1 25 - 1 40
Phthalic anhydride..... lb.	.50 - .60
Phenol, U. S. P., drums..... lb.	.09½ - .11
Pyridine..... gal.	2 00 - 3 50
Resorcinol, technical..... lb.	1 60 - 1 65
Resorcinol, pure..... lb.	2 25 - 2 30
Salicylic acid, tech., in bbls..... lb.	.19 - .22
Salicylic acid, U. S. P..... lb.	.20 - .25
Salol..... lb.	.75 - .80
Solvent naphtha, water-white, in drums, 100 gal..... gal.	.25 - .28
Solvent naphtha, rude, heavy, in drums, 100 gal..... gal.	.14 - .16
Sulphanilic acid, crude..... lb.	.30 - .35
Tolidine..... lb.	1 25 - 1 35
Toluidine, mixed..... lb.	.40 - .45
Toluene, in tank cars..... gal.	.25 - .28
Toluene, in drums..... gal.	.28 - .31
Xylidines, drums, 100 gal..... lb.	.40 - .45
Xylene, pure, in drums..... gal.	.40 - .45
Xylene, pure, in tank cars..... gal.	.45 -
Xylene, commercial, in drums, 100 gal..... gal.	.33 - .35
Xylene, commercial, in tank cars..... gal.	.30 -

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark..... lb.	\$0 24 - \$0 25
Beeswax, refined, light..... lb.	.27 - .28
Beeswax, white pure..... lb.	.40 - .45
Carnauba, Florida..... lb.	.58 - .60
Carnauba, No. 2, North Country..... lb.	.25 - .26
Carnauba, No. 3, North Country..... lb.	.13½ - .14
Japan..... lb.	.16 - .16½
Montan, crude..... lb.	.06½ - .06½
Paraffine waxes, crude match wax (white) 105-110 m.p..... lb.	.03½ - .03½
Paraffine waxes, crude, scale 124-126 m.p..... lb.	.02 -
Paraffine waxes, refined, 118-120 m.p..... lb.	.03 - .03½
Paraffine waxes, refined, 125 m.p..... lb.	.03½ - .03½
Paraffine waxes, refined, 128-130 m.p..... lb.	.04 - .04½
Paraffine waxes, refined, 133-135 m.p..... lb.	.04½ - .05
Paraffine waxes, refined, 135-137 m.p..... lb.	.05½ - .06
Stearic acid, single pressed..... lb.	.09 -
Stearic acid, double pressed..... lb.	.09½ -
Stearic acid, triple pressed..... lb.	.10 - .10½

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl..... 280 lb.	\$4 85 -
Rosin E-I..... 280 lb.	4 90 - 5 20
Rosin K-N..... 280 lb.	5 30 - 5 75
Rosin W, G-W, W..... 280 lb.	6 50 - 7 25
Wood rosin, bbl..... 280 lb.	6 25 -
Spirits of turpentine..... gal.	.63 -
Wood turpentine steam dist..... gal.	.61 -
Wood turpentine, dest. dist..... gal.	.59 -
Pine tar pitch, bbl..... 200 lb.	- 7 00
Tar, kiln burned, bbl. (500 lb.)..... bbl.	- 11 50
Retort tar, bbl..... 500 lb.	- 11 50
Rosin oil, first run..... gal.	.35 -
Rosin oil, second run..... gal.	.37 -
Rosin oil, third run..... gal.	.41 -
Pine oil, steam dist., sp.gr. 0.930-0.940..... gal.	\$1 80
Pine oil, pure, dest. dist..... gal.	1 50
Pine tar oil, ref., sp.gr. 1.025-1.035..... gal.	.46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla..... gal.	.35
Pine tar oil, double ref., sp.gr. 0.965-0.990..... gal.	.75
Pine tar, ref., thin, sp.gr. 1.080-1.960..... gal.	.35
Turpentine, crude, sp. gr., 0.900-0.970..... gal.	1 20
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990..... gal.	.35
Pinewood creosote, ref..... gal.	.52

Solvents

73-76 deg., steel bbls. (85 lb.)..... gal.	\$0 41
70-72 deg., steel bbls. (85 lb.)..... gal.	.39
68-70 deg., steel bbls. (85 lb.)..... gal.	.38
V. M. and P. naphtha, steel bbls. (85 lb.)..... gal.	.30

Crude Rubber

Para-Upriver fine..... lb.	\$0 16 - .17
Upriver coarse..... lb.	.09 - .09½
Upriver caucho ball..... lb.	.11½ - .12
Plantation—First latex crepe..... lb.	.14 -
Ribbed smoked sheets..... lb.	.12 - .12½
Brown crepe, thin, clean..... lb.	.15 -
Amber crepe No. 1..... lb.	.17 -

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls..... lb.	\$0 09½ - \$0 09½
Castor oil, AA, in bbls..... lb.	.10 - .10½
China wood oil, in bbls. (f.o.b. Pac. coast)..... lb.	.12 - .12½
Cocoonut oil, Ceylon grade, in bbls..... lb.	.09½ - .10
Cocoonut oil, Cochon grade, in bbls..... lb.	.10½ - .10½
Corn oil, crude, in bbls..... lb.	.08½ - .08½
Cottonseed oil, crude (f. o. b. mill)..... lb.	.07½ - .08
Cottonseed oil, summer yellow..... lb.	.09 - .09½
Cottonseed oil, winter yellow..... lb.	.09½ -
Linseed oil, raw, ear lots (domestic)..... gal.	.75 - .76
Linseed oil, raw, tank cars (domestic)..... gal.	.69 - .70
Linseed oil, in 5-bbl lots (domestic)..... gal.	.77 - .78

Olive oil, Denatured.....	gal.	\$1.25	—	\$1.30
Palm, Lagos.....	lb.	.06	—	.07
Palm, Niger.....	lb.	.05	—	.05
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.07	—	.07
Peanut oil, refined, in bbls.....	lb.	.10	—	.10
Rapeseed oil, refined in bbls.....	gal.	.90	—	.92
Rapeseed oil, blown, in bbls.....	gal.	.94	—	.95
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.08	—	.....
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.06	—	.....

FISH

Light pressed menhaden.....	gal.	\$0.42	—	.....
Yellow bleached menhaden.....	gal.	.44	—	.....
White bleached menhaden.....	gal.	.46	—	.....
Blown menhaden.....	gal.	.50	—	.....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$24.00	—	30.00
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	22.00	—	26.00
Barytes, crude, 88% @ 94% ba., Kings Creek.....	net ton	10.00	—	12.00
Barytes, floated, f.o.b. St. Louis.....	net ton	26.50	—	28.00
Barytes, crude, first grade, Missouri.....	net ton	7.00	—	.....
Blanc fixe, dry.....	lb.	.04	—	.04
Blanc fixe, pulp.....	net ton	45.00	—	55.00
Casein.....	lb.	.0	—	.07
Chalk, domestic, extra light.....	lb.	.04	—	.05
Chalk, domestic, light.....	lb.	.04	—	.04
Chalk, domestic, heavy.....	lb.	.03	—	.04
Chalk, English, extra light.....	lb.	.04	—	.05
Chalk, English, light.....	lb.	.04	—	.05
Chalk, English, dense.....	lb.	.04	—	.04
China clay (kaolin) crude, f.o.b. mines, Georgia.....	net ton	8.00	—	10.00
China clay (kaolin) washed, f.o.b. Georgia.....	net ton	12.00	—	15.00
China clay (kaolin) powdered, f.o.b. Georgia.....	net ton	18.00	—	22.00
China clay (kaolin) crude f.o.b. Virginia points.....	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points.....	net ton	15.00	—	25.00
China clay (kaolin), imported, lump.....	net ton	12.00	—	20.00
China clay (kaolin), imported, powdered.....	net ton	20.00	—	25.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	net ton	5.00	—	7.50
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27.00	—	30.00
Fullers earth, f.o.b. Mies.....	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Ia.....	net ton	15.00	—	18.00
Fullers earth, powdered, f.o.b. Fla.....	net ton	18.00	—	.....
Fullers earth, imported, powdered.....	net ton	24.00	—	27.00
Graphite, Ceylon lump, first quality.....	lb.	.07	—	.07
Graphite, Ceylon chip.....	lb.	.05	—	.05
Graphite, high grade amorphous crude.....	lb.	.02	—	.03
Magnesite, calcined.....	per ton	66.00	—	70.00
Pumice stone, imported, lump.....	lb.	.04	—	.50
Pumice stone, domestic lump.....	lb.	.05	—	.05
Pumice stone, ground.....	lb.	.06	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore.....	net ton	.....	—	10.00
Quartz (acid tower) 1 1/2 @ 2 in., f.o.b. Baltimore.....	net ton	.....	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	.....	—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange fine.....	lb.	.52	—	.53
Shellac, orange superfine.....	lb.	.55	—	.56
Shellac, A. C. garnet.....	lb.	.44	—	.45
Shellac, T. N.....	lb.	.45	—	.45
Soapstone.....	ton	12.00	—	15.00
Sodium chloride.....	long ton	12.50	—	13.00
Talc, paper-making grades, f.o.b. Vermont.....	ton	11.00	—	20.00
Talc, roofing grades, f.o.b. Vermont.....	ton	8.50	—	13.00
Talc, rubber grades, f.o.b. Vermont.....	ton	11.00	—	18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	10.00	—	14.00
Talc, imported.....	ton	30.00	—	40.00
Talc, California talcum powder grade.....	ton	18.00	—	40.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	per ton	\$37.50—40.00
Carborundum refractory brick, 9-in.	1,000	1250.00
Chrome brick, f.o.b. Eastern shipping points.....	net ton	60
Chrome cement, 40-45% Cr ₂ O ₃	net ton	30-32
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in ear lots, f.o.b. Eastern shipping points.....	net ton	33-35
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	36-40
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	30-35
Magnesite brick, 9-in. straight.....	net ton	70
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	77
Magnesite brick, soaps and splits.....	net ton	98
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	42-45
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	45-50
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	35-38

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00 — \$225.00
Ferrochrome per lb. of Cr. contained, 6-8% carbon, earlots.....	lb.	14 —
Ferrochrome, per lb. of Cr. contained, 4-6% carbon, earlots.....	lb.	15 —
Ferromanganese, 70-80% Mn, domestic.....	net ton	65.00 — 70.00
Ferromanganese, 70-80% Mn, English.....	net ton	65.00 — 70.00
Spiegeleisen, 18-22% Mn.....	net ton	26.00 — 27.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.50 —
Ferrosilicon, 10-15%.....	net ton	40.00 — 42.00
Ferrosilicon, 50%.....	net ton	65.00 — 68.00
Ferrosilicon, 75%.....	net ton	135.00 — 138.00
Ferrotungsten, 70-80%, per lb. of contained W.....	lb.	.45 — .50
Ferroumium, 35-50% of U, per lb. of U content.....	lb.	6.00 —
Ferrovandium, 30-40% of V, per lb. of contained V.....	lb.	4.25 — 4.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content.....	net ton	\$8.00 — \$10.00
Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃	unit	.30 — .33
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard.....	unit	30 — .33
Coke, foundry, f.o.b. ovens.....	net ton	4.00 — 4.50
Coke, furnace, f.o.b. ovens.....	net ton	2.75 — 3.00
Coke, petroleum, refinery, Atlantic seaboard.....	net ton	14.00 — 15.00
Fluorspar, lump, f.o.b. mines, New Mexico.....	net ton	12.50 —
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	20.00 —
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01 — .01
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	.22 —
Manganese ore, chemical (MnO ₂).....	net ton	50.00 — 55.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.55 — .60
Monazite, per unit of ThO ₂ , c.i.f., Atlantic seaport.....	unit	30.00 —
Pyrites, Spanish, fines, c.i.f., Atlantic seaport.....	unit	.12 — .12
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.12 — .12
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.11 — .12
Rutile, 95% TiO ₂ per lb. ore.....	lb.	.15 —
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	2.75 — 3.00
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	3.00 — 3.25
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	1.50 — 2.50
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.25 — 2.50
Vanadium pentoxide, 99%.....	lb.	12.00 — 14.00
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1.00 —
Zircon, washed, iron free.....	lb.	.03 —

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic.....	12.00
Aluminum, 98 to 99 per cent.....	24.50@25
Antimony, wholesale lots, Chinese and Japanese.....	4
Nickel, ordinary (ingot).....	41.00
Nickel, electrolytic.....	44.00
Monel metal, spot and blocks.....	35.00
Monel metal ingots.....	38.00
Monel metal, sheet bars.....	40.00
Tin, 5-ton lots, S. rails.....	25.75
Lead, New York, spot.....	4.35
Lead, E. St. Louis, spot.....	4.15-4.20
Zinc, spot, New York.....	4.55
Zinc, spot, E. St. Louis.....	4.20

OTHER METALS

Silver (commercial).....	oz.	\$0.61
Cadmium.....	lb.	1.00-1.25
Bismuth (500 lb. lots).....	lb.	1.50@1.55
Cobalt.....	lb.	3.00@3.25
Magnesium (f.o.b. Philadelphia).....	lb.	1.25
Platinum.....	oz.	65.00
Iridium.....	oz.	160.00@180.00
Palladium.....	oz.	48.00-52.00
Mercury.....	.75 lb.	43.50-45.00

FINISHED METAL PRODUCTS

Warehouse Price
Cents per Lb.

Copper sheets, hot rolled.....	20.25
Copper bottoms.....	27.75
Copper rods.....	19.25
High brass wire.....	16.75
High brass rods.....	13.75
Low brass wire.....	18.25
Low brass rods.....	18.25
Brazed brass tubing.....	27.00
Brazed bronze tubing.....	31.75
Seamless copper tubing.....	21.00
Seamless high brass tubing.....	18.50

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current	Cleveland	Chicago
Copper, heavy and crucible.....	9.00@9.25	9.25	9.50
Copper, heavy and wire.....	8.25@8.50	8.50	8.50
Copper, light and bottoms.....	7.00@7.25	7.50	7.25
Lead, heavy.....	3.00@3.25	3.25	3.25
Lead, tea.....	2.25@2.35	2.25	2.25
Brass, heavy.....	4.00@4.25	4.50	5.00
Brass, light.....	3.00@3.25	3.25	3.50
No. 1 yellow brass turnings.....	3.75@4.00	4.25	4.50
Zinc.....	2.00@2.25	2.00	2.25

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by 1/2 in. and larger, and plates 1/2 in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes.....	\$2.23	\$3.00	\$3.00
S ft steel bars.....	2.18	2.80	2.80
Soft steel bar shapes.....	2.18	2.90	2.90
Soft steel bands.....	2.50	3.20	3.20
Plates, 1/2 to 1 in. thick.....	2.18	3.00	3.00

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

California

BURBANK—The Western Glass Products Co., Hibernian Bldg., has awarded a contract to the Frank Meline Co., 6777 Hollywood Blvd., for the erection of a new 1- and 2-story, brick and steel plant, 100 x 500 ft., at Burbank, comprising an initial plant unit of a proposed large group of buildings.

BURBANK—The American Aluminum Metal Products Co., Los Angeles, is having plans prepared by Richard D. King, 519 Van Nuys Bldg., Los Angeles, for the erection of its proposed new plant at Burbank, the initial work to consist of a series of 7 buildings. The company has a 5-acre tract, and additional structures will be erected at a later date.

Delaware

WILMINGTON—The Atlas Powder Co., du Pont Bldg., has acquired a substantial interest in the United States Flashless Powder Co., with plant at Carreroft, near Wilmington, and in the future the companies will work in close co-operation. Operations at the plant will be continued as heretofore.

Florida

TAMPA—The Southern Bottle Mfg. Co., recently organized with a capital of \$150,000, has awarded a contract to Oatley & Jones, Tampa, for the erection of its proposed new plant at Gary, near Tampa, 1-story, 60x150 ft., with wing extension, 36x52 ft. I. F. Jones is president.

TAMPA—The Grass Fiber Pulp Co. is perfecting plans for the erection of a new plant at Leesburg, Fla., for the manufacture of paper pulp from saw grass. W. F. Stovall is president.

TAMPA—The Nu-Tex Brick Co. has commenced the construction of a local plant to be equipped for an initial daily capacity of about 30,000 bricks per day. It is proposed to place the plant in service at the earliest possible date.

CHIPLEY—The Chipley Leather Mfg. Co., recently incorporated, has awarded a contract for the erection of its proposed new local plant on property lately acquired, with initial structure to be 75x125 ft. The factory will be equipped as a tannery and leather finishing plant for the production of leather specialties from fish skins. C. B. Dunn is president, and Frank Tuttle, general manager.

Illinois

CHICAGO—The American Tar Products Co., 208 South La Salle St., is completing plans for the erection of a new 1- and 2-story tar-refining plant at Thirty-ninth St. and Fifty-second Ave., estimated to cost about \$1,000,000, with machinery. The Koppers Co., Union Arcade Bldg., Pittsburgh, Pa., is engineer for the project.

Louisiana

LEESVILLE—The Louisiana Oil Refining Co. and the Caddo Central Oil & Refining Co. are planning for the rebuilding of the portions of their local distributing plants, destroyed by fire, July 23, with loss estimated at about \$25,000.

Maryland

BALTIMORE—The Cooknut Corp., Lexington and Paca Sts., recently organized with a capital of \$500,000 to manufacture lard substitutes and kindred products, is completing plans for the first unit of its proposed new plant, to be located on Canton St. The main works will be 4-story, 80x100 ft., and will be supplemented with two 1-story structures, 28x56 ft., estimated to cost about \$135,000. The plant will be equipped for an initial production of about 60,000 lb. of material per day. W. R. Spruill is president.

BALTIMORE—The Maryland Vegetable Oil Co., Seventh Ave. and Sixteenth St., recently organized with a capital of \$1,000,000, has acquired property at the location noted for the erection of a new plant. Preliminary plans are under way. It is said that the works will cost in excess of \$200,000. The company is headed by Enos S. Stockbridge and Roland H. Brady.

BALTIMORE—The Greenmount Iron Mfg. Co., 833 Greenmount Ave., will soon call for new bids for the erection of the proposed addition to its iron foundry, estimated to cost about \$15,000. Former bids, recently received, have been rejected.

Massachusetts

SOUTHBIDGE—The Optical Abrasive Co., recently organized, has acquired a 3-story building in the Phillipsdale section, heretofore used as grist mill by the Phillips Co., for the establishment of a plant for the manufacture of abrasive products for optical grinding and other precision service. The structure will be remodeled and equipment installed at an early date.

AUBURN—The Bay State Brick & Stone Co., Haverhill, Mass., recently organized, has acquired the plant of the Worcester Brick Co. at West Auburn, which has been idle for about a year past. The company will make a number of improvements and proposes to commence production at an early date. George L. Baldwin, formerly connected with the Worcester company, is an official of the new organization.

Missouri

JOPLIN—The Chanute Smelter Co., Frisco Bldg., has completed plans and will commence construction at once on a new 1-story concentrating plant, 36 x 45 ft., estimated to cost about \$50,000. The structure will be located on the company's property at Baxter Springs, Kan.

SPRINGFIELD—The Springfield Tablet Mfg. Co., 300 North Jefferson St., recently organized with a capital of \$60,000 to manufacture writing tablets and other paper specialties, will install machinery and equipment in a local building. It is proposed to commence production at an early date. H. S. Jewell is president and manager; H. F. Chalfont is secretary and treasurer.

New Jersey

FORDS—The Norvell Chemical Co. is planning for the rebuilding of its local plant, destroyed by fire, July 25, with loss estimated at about \$400,000, including building and machinery. The main works was 3-story, 100 x 200 ft., and the plant gave employment to about 100 persons. The plant was formerly operated by the National Synthetic Co. Donald McKesson is president.

NEWARK—The Tower Mfg. Co., Doramus Ave., manufacturer of chemicals, is planning for the erection of a 1-story addition to its plant, 40 x 143 ft., estimated to cost about \$20,000.

NEWARK—The E. Walsh Co., 127-29 Ogden St., operating a metal working plant, has filed plans for the erection of a 1-story addition, 25 x 60 ft., to be equipped as a japanning shop.

New York

COLLEGE POINT—The I. B. Kleinhart Rubber Co., 725 Broadway, New York, has awarded a contract to the White Construction Co., 95 Madison Ave., for the erection of a new 4-story and basement plant at Fifth Ave. and Eighteenth St., College Point, estimated to cost about \$150,000.

NEW YORK—The Mexican Producing & Refining Co., 136 Liberty St., has acquired a building on Grand Blvd., Pallsades Park, N. J., under lease, for the establishment of a new oil laboratory. The structure will be improved and equipment installed at an early date. Montford S. Orth is president.

Ohio

WOOSTER—The Stellar Refinery Co., 607 Newark Bldg., Wooster, is taking bids for the erection of a new oil refinery at Marne, near Newark, O., estimated to cost about \$300,000 with equipment. The works will consist of a number of buildings, including power house and pumping plant. J. M. Jafflek is secretary.

CLEVELAND—The Sterling Brass Co., 1610-12 St. Clair Ave., has taken new bids on revised plans for the erection of its proposed new 2-story brass foundry and machine shop, 145 x 200 ft., at St. Catherine and East Ninety-third Sts., estimated to cost about \$60,000. S. L. Well is president.

Oklahoma

BRISTOW—The H. F. Wilcox Oil & Gas Co. is perfecting plans for the construction of a new local oil refinery, with initial daily capacity of about 500 bbl.

Oregon

PORTLAND—The Portland Vegetable Oil Mills Co. has construction well under way on its new local plant on site recently acquired, forming the previous works of the Foundation Co. The machinery and equipment is expected to be installed in September and October, having the plant ready for service during the latter month. It is estimated to cost close to \$500,000 with machinery. C. A. Edwards is one of the heads of the company.

Pennsylvania

ALLENTOWN—The plant of the Allen Chemical Co., Fourteenth and Fifteenth Sts., and the Little Lehigh River, has been sold to the Allen Typewriter Co. Chemical manufacture at the plant was discontinued some months ago. The new owner will equip the structure for the manufacture of typewriter parts. James K. Bowen is head.

PHILADELPHIA—E. F. Drew & Co., Inc., Swanson St., near McKean St., manufacturer of oil products, has filed plans for the erection of a 1-story extension at its works.

NEW CASTLE—F. A. Sieberling, formerly head of the Goodyear Tire & Rubber Co., Akron, O., and associates have taken over the local plant of the New Castle Rubber Co. The works will be improved and in the future will be operated under the name of the Lehigh Tire & Rubber Co.; it is proposed to commence production at an early date, providing equipment for an output of about 500 tires and a like number of tubes daily.

Tennessee

MEMPHIS—The Mexican Oil & Refining Co., 510 McCall Bldg., is planning for the purchase of new oil-refining equipment for installation at its plants. J. J. Mundy is engineer.

PARIS—W. G. Adams and associates are planning for the establishment of a new plant on local site for the manufacture of sassafras oil specialties. A company is being organized to carry out the project.

Texas

HOUSTON—W. J. Doyle, industrial land commissioner, Houston Belt & Terminal Co., is developing plans with local interests for the erection of a new sugar mill on a site near Houston, comprising about 60 acres of property. The new mill with machinery is estimated to cost about \$1,250,000. It will be equipped for an initial output of about 600,000 lb. of sugar daily. It is proposed to commence construction at an early date.

DALLAS—The Hercules Brick Co., recently organized, is perfecting plans for the construction of a new plant on a site totaling about 16 acres of land on the Trinity River. The works will be equipped for an output of about 150,000 bricks per day, and are estimated to cost about \$75,000 with machinery. A. B. Salin is manager.

DALLAS—The Trinity Paper Mills, 620 Dallas County State Bank Bldg., are perfecting plans for the construction of a new pulp and paper mill at McKinney, Tex. The company also proposes the erection of a similar mill in the vicinity of Fort Worth, Tex. George F. Lull is president.

Washington

SPOKANE—The Consolidated Diamond Oil & Refining Co., Hutton Bldg., is planning for the construction of a new oil refinery on a site near the city, with initial output of about 500 bbl. per day. The plant is estimated to cost about \$100,000.

West Virginia

STAR CITY—The Star City Glass Co. is planning for the rebuilding of the portion of its works recently destroyed by fire.

Wisconsin

WAUSAU—The Marathon Rubber Products Co. has awarded a contract to the Wisconsin Engineering & Construction Co., Wausau, for the erection of a new local plant to cost about \$15,000, exclusive of equipment.

New Companies

THE ROBERTSON CHEMICAL CO., Money Point, near Portsmouth, Va., has been incorporated with a capital of \$500,000 to manufacture chemicals and chemical byproducts. F. B. Stephenson is president, and C. W. Jones, secretary, both of Norfolk, Va.

THE PENETRO CHEMICAL CO., New York, N. Y., has been incorporated under Delaware laws with capital of \$500,000 to manufacture chemicals and chemical compounds. Arthur W. Britton, 65 Cedar St., represents the company.

THE POSO OIL CO., Los Angeles, Cal., has been incorporated with a capital of \$250,000 to manufacture petroleum products. The incorporators are J. C. Gillham, L. K. Adams, and C. B. Andrews, Merchants National Bank Bldg. The same incorporators have also organized the Poso Kern Oil, with capital of \$250,000 to manufacture petroleum specialties.

THE PABLO HUMUS CO., South Jacksonville, Fla., has been incorporated with a capital of \$10,000 to manufacture fertilizer products. Robert Ranson is president; and J. H. Hickman, vice-president and general manager, both of South Jacksonville.

THE OLYMPIA SPARK PLUG CO., 39 East Schiller St., Chicago, Ill., has been incorporated with a capital of \$5,000 to manufacture spark plugs and kindred specialties. The incorporators are Cornelius C. McMahon, Secor Cunningham, Jr., and Kenneth B. Hawkins.

THE PATUXENT GUANO CO., 407 Vickers Bldg., Baltimore, Md., has been incorporated with a capital of \$75,000 to manufacture fertilizer products. The incorporators are Harry T. Deford and Carroll W. Clark.

THE INSTANT PRODUCTS CORP., Boston, Mass., has been incorporated with a capital of \$100,000, to manufacture chemicals, paints and adhesive compounds, etc. Stanley Morin, 21 Cambridge St., is president and treasurer.

THE AMERICAN GASOLINE CORP., 29 South LaSalle St., Chicago, Ill., has been incorporated with a capital of \$250,000, to manufacture petroleum and petroleum products. The incorporators are Lewis H. Scurlock, W. C. and T. Shelby Black.

THE HAXAGON CHEMICAL CO., 67 Margaretta St., Newark, N. J., has filed notice of organization to manufacture chemicals and chemical byproducts. Frank E. Fitch, 20 Whittlesey Ave., East Orange, N. J., heads the company.

THE WATERPROOF PAPER PRODUCTS CO., Herkimer, N. Y., has been incorporated with a capital of \$50,000, to manufacture paper goods of various kinds. The incorporators are J. R. Hyer, J. Thompson and C. L. Palmer. The company is represented by C. L. Earl, Herkimer.

CHARLES E. CAMPBELL, INC., Elmhurst, L. I., has been incorporated with a capital of \$50,000, to manufacture rubber products. The incorporators are Charles E. Campbell, K. K. Hillabrant and I. G. Wolf, Elmhurst. The company is represented by Baucher & Ganty, 51 Chambers St., New York.

THE HAGAMAN REFINING CORP., Ranger, Tex., has been incorporated with a capital of \$150,000, to manufacture refined petroleum products. The incorporators are M. H. Hagaman and G. A. Clements.

THE ENAMEL PRODUCTS CORP., East Stroudsburg, Pa., has been incorporated with a capital of \$50,000, to manufacture enamelware specialties. Louis Rupprecht, East Stroudsburg, is treasurer.

THE EAST HAMPTON CORK CO., New York, has been incorporated with a capital of \$50,000, to manufacture cork products. The incorporators are A. and R. L. Miller, and S. R. Kaufman. The company is represented by Zodikow & Wieder, 305 Broadway.

THE QUICK KLEAN KEMICAL CO., Worcester, Mass., has been incorporated with a capital of \$10,000, to manufacture chemicals

and chemical byproducts. William Blumenthal is president; Samuel N. Baron, vice-president, and Morris Goldsmith, 37 June St., treasurer.

THE NEVADA-VENTURA OIL SYNDICATE, 422 American Ave., Long Beach, Cal., has filed notice of organization to manufacture petroleum products. The company is headed by D. M. Allen, Charles H. Read and W. H. Young.

THE GRAND RAPIDS METAL PRODUCTS CO., Grand Rapids, Mich., has been incorporated with a capital of \$25,000, to manufacture metal goods. The incorporators are John C. Miller, and Edgar R. Freeman, Grand Rapids.

THE CLERGAS CHEMICAL CORP., Rochester, N. Y., has been incorporated with a capital of \$50,000, to manufacture chemicals and chemical byproducts. The incorporators are R. J. Fisher, C. H. Gunn and J. E. Britton. The company is represented by Sutherland & Dwyer, Insurance Bldg., Rochester.

THE CO-SERVICE OIL CO., Newark, N. J., has been incorporated with a capital of 8,000 shares of stock, no par value, to manufacture oil products. The incorporators are M. E. Russell, E. B. Irons and M. B. Walls, Newark. The company is represented by Benjamin Natal, Court House Square Bldg., Camden, N. J.

THE GROVE CHEMICAL CO., 1200 South Grove St., Irvington, Newark, N. J., has filed notice of organization to manufacture chemicals, lacquers and kindred products. Carl P. Olson, 844 Lyons Ave., Irvington, heads the company.

THE TONKIN FLAKE GRAPHITE CO., New York, N. Y., has been incorporated with a capital of \$150,000, to manufacture refined graphite products. The incorporators are J. J. Tonkin, I. Loewenberg and I. Oliver. The company is represented by Price Brothers, 271 Broadway.

THE ATLANTIC COTTON OIL CO., New York, N. Y., has been incorporated with a capital of \$100,000, to manufacture refined oil products. The incorporators are S. L. Lemmon, J. B. Pruyn and G. H. Salmon. The company is represented by F. J. Knorr, attorney, Albany, N. Y.

THE WAMESIT CHEMICAL CO., Tewksbury, Mass., has been incorporated with a capital of \$100,000, to manufacture chemicals and chemical byproducts. George Stevens is president; and John H. Murphy, 8 Shattick St., Lowell, Mass., treasurer.

THE MICHIGAN REFINING CORP., Detroit, Mich., has been incorporated with a capital of \$100,000, to manufacture petroleum specialties and coal-tar products. The incorporators are Elmer Burell, Henry J. Jebb and Nevin Sturgeon, 1533 Elmhurst Ave.

THE PENNSYLVANIA CHEMICAL & RESEARCH CO., Pittsburgh, Pa., has been incorporated with a nominal capital of \$5,000, to manufacture chemical specialties. R. T. Rosell, Pittsburgh, is treasurer.

THE PUENTE HILLS OIL CO., Los Angeles, Cal., has been incorporated with a capital of \$600,000, to manufacture petroleum products. The incorporators are F. B. Clark, R. L. Brown and R. L. Colby, Chamber of Commerce Bldg., Los Angeles.

THE DU-RITE PRODUCTS CO., New York, N. Y., has been incorporated with a capital of \$25,000, to manufacture varnishes, polishes and kindred products. The incorporators are F. J. McEvoy and J. D. Ohlssen. The company is represented by H. S. Cook, 38 Park Row, New York.

W. A. RARICK, INC., Nanticoke, Pa., has been incorporated under Delaware laws, with capital of \$1,000,000, to manufacture dynamite and other high explosives. The incorporators are Thomas J. Morgan and T. J. Jones, Nanticoke; and William J. Thomas, Mountain Top, Pa. The company is represented by Arley B. Magee, Dover, Del.

THE HARING PAPER CORP., New York, N. Y., has been incorporated under Delaware laws, with capital of \$100,000, to manufacture paper products. Samuel B. Howard, 65 Cedar St., represents the company.

THE ARTESIA OIL CO., Los Angeles, Cal., has been incorporated with a capital of \$500,000 to manufacture petroleum products. The incorporators are J. H. Savage, E. A. Reed and P. E. Keeler, Long Beach, Cal. The company is represented by P. E. Keeler, First National Bank Bldg., Long Beach.

THE PENINSULA TIRE & RUBBER CO., Tampa, Fla., has been incorporated with a capital of \$1,500,000 to manufacture tires and general rubber products. A. B. McMullan is president; S. H. Rogers, Jr., secretary; and H. A. Van Auken, general manager.

Capital Increases, etc.

THE FOLEY PAPER MILLS, Rochester, N. Y., have filed notice of increase in capital from \$25,000 to \$50,000.

THE CAMPBELL MFG. & FOUNDRY CO., Muskegon, Mich., has filed notice of change of name to the Muskegon Castings Co.

THE THOMPSON & NORRIS CO., 212 Concord St., Brooklyn, N. Y., manufacturer of paper products, a New Jersey corporation, has filed notice of increase in capital from \$500,000 to \$2,000,000.

THE RAVENSWOOD GLASS CO., 4247 Lincoln Ave., Chicago, Ill., manufacturer of glass specialties, has filed notice of increase in capital from \$25,000 to \$50,000.

THE DIAMOND COLOR CO., Bloomfield, N. J., has filed a petition in bankruptcy, with liabilities stated at \$30,000. The company operates a plant at 67 Willett St., for the manufacture of chemicals and dyes, etc.

THE ATLANTIC BOTTLE CO., 90 West Broadway, New York, N. Y., manufacturer of glass bottles, has filed notice of increase in capital from \$60,000 to \$300,000.

THE REEDY FOUNDRY CO., 4600 Iowa St., Chicago, Ill., has filed notice of increase in capital from \$75,000 to \$150,000.

THE FRANKLIN OIL & GAS CO., Houston, Tex., has filed notice of change of name to the Cold Test Lubricant Corp.

Coming Meetings and Events

AMERICAN CERAMIC SOCIETY will hold its twenty-first annual meeting at St. Louis, Feb. 27 to March 2, 1922.

AMERICAN CHEMICAL SOCIETY, THE SOCIETY OF CHEMICAL INDUSTRY and the American Section of the latter society will hold a joint meeting in New York, Sept. 6 to 10.

AMERICAN GAS ASSOCIATION will hold its third annual convention in the Congress and Auditorium Hotels, Chicago, the week of Nov. 7.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in Lake Placid, N. Y., Sept. 29 and 30, and Oct. 1.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its annual winter meeting at Baltimore, Md., Dec. 6 to 9. Headquarters will be at the Southern Hotel and the sessions will be held in the Engineers' Club.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its fall meeting at Wilkes-Barre, Pa., Sept. 12 to 17.

AMERICAN MINING CONGRESS AND NATIONAL EXPOSITION OF MINES AND MINING EQUIPMENT will hold its twenty-fourth annual convention in the Coliseum, Chicago, Oct. 17 to 22.

AMERICAN PEAT SOCIETY will hold its fifteenth annual convention at the Hotel Commodore, New York City, Sept. 7, 8 and 9.

AMERICAN SOCIETY FOR STEEL TREATING will hold its third annual convention and exhibition Sept. 19 to 24 at Indianapolis.

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SEVENTH) will be held during the week of Sept. 12 in the Eighth Coast Artillery Armory, New York City.

NEW JERSEY CHEMICAL SOCIETY has discontinued meetings for the summer and will resume them in October.

SOCIETY OF CHEMICAL INDUSTRY (BRITISH) at the invitation of the Montreal section will hold its annual meeting in Montreal and other Canadian cities during the week of Aug. 29, 1921. Details will be printed in this magazine from time to time.

SOCIETY OF INDUSTRIAL ENGINEERS will hold its fall meeting at Springfield, Mass., Oct. 5 to 7.

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY will hold its fall convention with the American Pulp and Paper Mill Superintendents' Association, at Washington, Philadelphia, Spring Grove, York, York Haven, Pa., and Wilmington, Del. Oct. 18 to 20.

The following meetings are scheduled to be held in Rumford Hall, the Chemists' Club, New York: Oct. 7—American Chemical Society, regular meeting; Oct. 14—Société de Chimie Industrielle, regular meeting; Oct. 21—Society of Chemical Industry, Grasselli Medal; Nov. 11—American Chemical Society (in charge), Society of Chemical Industry, American Electrochemical Society, Société de Chimie Industrielle, joint meeting; Nov. 18—American Electrochemical Society, regular meeting; Dec. 2—Society of Chemical Industry, regular meeting; Dec. 9—American Chemical Society, regular meeting.

CHEMICAL & METALLURGICAL ENGINEERING

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ELLWOOD HENDRICK
Consulting Editor
ERNEST E. THUM
Associate Editor
SIDNEY D. KIRKPATRICK
Assistant Editor

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY and IRON & STEEL MAGAZINE

ALAN G. WIKOFF
R. S. McBRIDE
CHARLES N. HULBERT
Assistant Editors
CHESTER H. JONES
Industrial Editor
J. S. NEGRU
Managing Editor

Volume 25

New York, August 17, 1921

Number 7

For the Edification of Readers and Advertisers

MAY we have your indulgence while we talk shop for a moment? Contrary to the impression of an earlier day, the editorial conduct of a modern technical magazine is not a chance feature of the publishing business. On the contrary it is the result of a deliberate policy that forms, or should form, the foundation for the whole superstructure of service which is the magazine's *raison d'être*. Now a modern magazine serves three groups of people: the readers, the advertisers, and the publishers. All contribute to the success of the undertaking, and each must profit by what he puts into it or he will not continue to invest. The reader must have a sense of value received for the subscription price; the advertiser must feel assured of the buying power of the circulation; and the publisher must realize a fair return on his investment which is the recognized reward for his enterprise and risk. Let any one of these elements fail to realize a reasonable degree of satisfaction over an extended period of time, and the whole structure will fall to the ground.

Perhaps it is not overstating the case to say that not only will editorial competence assure the reader a reliable and useful professional tool, but that editorial integrity will also constitute a basic guarantee of the magazine's value to the advertiser. In other words, high standards of editorial ethics and practice will react to the benefit of not only the reader but of the advertiser as well, and ultimately of the publisher. It is of course assumed that equally high standards of business practice are recognized; but for the moment we are emphasizing the value of editorial integrity, because it is in that department that a surrender to low standards would work fundamental harm and perhaps ultimately ruin the publication through loss of confidence and prestige.

With this brief preamble we offer for the edification of our subscribers and advertisers the standards of editorial practice recently adopted by the Editorial Conference of the New York Business Papers, Inc., of which CHEMICAL & METALLURGICAL ENGINEERING is a member. Certainly they represent the best thinking of the day on the part of an important group of editors, each of whom has pledged himself

1. To consider first the interests of the subscriber.
2. To work for truth and honesty in all departments of his publication.
3. To publish in an impartial way, free from personal opinion, the news of the industry in which his paper circulates.
4. To disregard advertising considerations in the editorial conduct of his paper.
5. To be a leader of thought in his editorial columns and make his criticisms constructive, with the object of bringing his industry to higher levels of thought and practice and to a greater measure of public service.
6. To support in his columns such worthy measures of

public interest as their importance justifies and the space available permits.

7. To give proper credit for articles taken from other publications, and to avoid unfair practices in competition with them.

It will be noted that the interest of the subscriber, the reader, is the editor's first consideration. This is quite logical, for if the editor cannot produce a magazine that readers will buy continuously and in large volume, it will have no value as an advertising medium and will yield no revenue to the publisher. The magazine is made primarily for the reader because if his interest and loyal support can be maintained he becomes a receptive and impressionable audience for the advertiser. Confidence thus gained editorially is automatically converted into a business asset.

Probably none of the other standards enumerated above requires elucidation unless it be No. 4. It is a difficult standard to phrase; but it is intended to express editorial independence of that baneful influence which was more characteristic of the early days of business publishing, but which is still sometimes exerted on the editorial department by advertisers. The purpose of that influence is variable. Sometimes it is merely to gain additional publicity through the text pages. Occasionally it takes the form of propaganda, more or less insidious and difficult to recognize. But its most pernicious manifestation is an attempt to influence editorial policy or to suppress publication of articles, using as a club the threat to withdraw advertising patronage.

Of course it is the sincerest recognition of the value of the text pages that advertisers should want "reading notices" and all that category of trade items published therein; but the editor is not justified in publishing them unless they interest or instruct the reader. Certainly it is a mistaken point of view to regard the publication of such items as an advertising perquisite. And as for allowing editorial policy or purpose to be swayed by pressure from an advertiser, second thought will make it very clear that such a course would lead to editorial and business practices of the most pernicious character, bordering on bribery and blackmail if not actually descending to them. The very thought is abhorrent and quite inconsistent with the fundamental truth of science and honesty of engineering. Editorial integrity should not only be expected but demanded by advertisers.

As a whole we regard the standards of the New York business paper editors with approval and satisfaction and subscribe to them with pleasure, feeling that they will aid in bringing the whole field of business and technical publishing "to higher levels of thought and practice and to a greater measure of public service." Publisher, advertiser and reader could ask no more; and in devoting his primary attention to the reader's interests the editor feels that he is contributing directly to the consummation of this desirable state of affairs.

Who Knows About Internal Strain?

A PAPER by JAMES E. HOWARD, reprinted on another page of this issue, brings to mind the need of investigations in a neglected field, but necessary before the mechanical engineer and designer can make the best and most economical use of the quality materials furnished by modern metallurgy. We refer to work immediately directed at the everyday problems of stresses and strains; questions which arise from the service requirements of steel and the best methods to meet them. Such things are most essential for intelligent and scientific design, and there ought to be a ready fund of information about them; but very little is available and less is being presented. Efforts of metallurgists are largely concentrated upon the production of uniform metal of superior physical properties; they leave it almost wholly to the user to determine the kind of service these steels shall enter, and doubtless in most cases they are unfamiliar with many matters pertaining to the actual problems which the uses of steel's present. The user, on the other hand, rests secure in the thought that if a certain part shows a high percentage of failures, it can be "redesigned," or made of another metal selected from the almost bewildering number now available.

Engineers and scientists have really been progressing but slowly into the general problem of distribution of stress in a resisting solid. HOOKE enunciated his law that the "power of a spring is proportional to its stretching" in 1676, but an arithmetical figure for this proportion was not forthcoming until 1807 when YOUNG described the physical constant now known as Young's modulus. POISSON, twenty years later, established the ratio between lateral contraction and longitudinal extension. The problem of a shaft in torsion was not solved by SAINT VENANT until 1855, and about that

same time the simplified beam formula $M = \frac{pI}{E}$ came into general currency. Since that time there has been little more than the production of a maze of figures, symbols and equations based on Hooke's and Poisson's laws, attempting to determine the stress distribution in rectangular beams without using several slightly erroneous but simplifying assumptions, and in flat or curved plates. When the beam becomes a column, or is a built beam, or the plate has a few holes or notches, either internal or external, then even this mass of figures, not understandable to any except expert mathematicians, becomes useless, and the engineer must rely upon his good friends Common Sense and Factor of Safety.

Prof. COKER has but recently taken a long step forward by constructing models of glass, celluloid or other transparent amorphous substances, and has been able to exhibit visibly the distribution of stress by the production of beautiful colored patterns due to double refraction of transmitted polarized light. He finds, for instance, that the distribution of stress at a contact surface is all important in that region. Its distribution, easily found by these models, is in such cases of much more importance than its exact magnitude, found laboriously, if at all, by complicated mathematics—for by proper experimentation methods may be devised to remove dangerous concentrations. Once removed by correct design, who cares how big they might have been?

Something has been done in studying the mechanism of failure. LÜDER (in 1859) noticed that plates or rods loaded slightly higher than the elastic limit developed geometric surface markings, indicating regions within which a shearing deformation had taken place. Experiments of this kind have been a very useful guide for workers in the theory of elasticity, and in indicating where dangerous stress intensities will develop in intricate shapes. Much more valuable information has been forthcoming in the last few years following the recognition of the fact that metals are crystalline aggregates, and by the microscopic study of deformation, normally caused by slip among cleavage planes in the crystal itself. This at least has given us a good idea of the way to harden and strengthen metal and just what happens when a metal is overstrained.

However, these studies are of conditions which exist at very high loads, loads which are much beyond those an engineer would like to impose on his structure. What he expects of the metallurgist is homogeneous metal, free from internal notches and invisible defects. The metallurgist must ever strive to approach this ideal. Nor can he remain entirely indifferent to questions which merit the designer's most careful attention: How much less is the resistance to shear on a plane which already bears a certain tension? How much tension will metal endure when it is prevented by sidewise constraint from contracting laterally? What is the relation between the stresses set up in a piece by a load at rest, or the same load dropped one foot? Do the same forces come into play in resisting indentation and cutting?

Studies of minute movements in the interior of opaque bodies are bound to be very difficult; but that is no reason why they should be dodged.

Patent Litigation of Unusual Interest

SELDOM has a case in the courts attracted the interest of the chemical industry in so great measure as has the litigation over the patents for synthetic phenolic resins. As a result of a second long-drawn-out legal contest, three more of the original patents of Dr. BAEKELAND have just been declared valid and infringed. In the case under trial the patents were those relating to the molding and application of the synthetic resinous material, while it will be recalled that in the previous suit the so-called varnish and solution patents were those in question. The present suit was brought against a user rather than the manufacturer of the synthetic gum, although, as pointed out in the Court's opinion, the trial largely hinged on a consideration of the nature of the synthetic product itself. Naturally the manufacturer of the infringed product was deeply interested in the success or failure of his customer's case and stood squarely behind the defendant in all discussion relating to questions of patentability.

Judge CHATFIELD'S opinion is an exact and comprehensive survey, which is of historical importance both from the technological and purely legal viewpoints. Elsewhere in this issue a few pertinent paragraphs have been abstracted from the opinion, but the character of the document is such as to warrant a much more extended study by all who are interested in the scientific and commercial aspects of this important chemical industry.

We have previously referred to the contest as one of

long duration and perhaps we have been too critical of the processes of law and justice. Many cases, especially under the older régime of patent litigation, have extended over periods of many years, so that in this particular instance action may not have been unusually slow. The complaint was filed Sept. 18, 1917, but it was not until March 31, 1919, that the case could be brought to trial. The taking of testimony extended over many weeks and the final arguments were heard on June 22, 1919. Two years then elapsed, during which the presiding judge prepared his opinion and rendered his decision. To some this may seem excessive and sufficient even to call for the use of a catalyst or organic accelerator. When one considers, however, the great mass of testimony involved and its technical and scientific nature, it is evident that much careful, time-consuming study is required.

Turning our attention again to the Court's opinion, we are immediately struck with an interesting and logical comparison. Judge CHATFIELD declares that "if artificial diamonds could be produced, no one could claim as invention the substance already known as diamonds, and if the imitation could not be told from the original, no inventor could control all the material of that nature, whether produced naturally or artificially. But the inventor who does finally invent a process for manufacturing genuine diamonds, by artificial means, will be able to claim as an inventive product that material which any one is producing by the steps covered by his invention, if he obtains a patent therefor.

"Thus in all the BAEKELAND patents, the product which is sought to be patented is not the material, which can only be identified as an infusible and insoluble condensation product of phenol and formaldehyde. But BAEKELAND can validly claim a new product, which is produced by exactly the steps which he has described and which makes use of the ideas which he recognized and claimed as invention in arriving at a result which may then contain or even be substantially composed of a substance that of itself is not patentable, provided it can be shown that it was manufactured in a way not taught by the prior art, and can be identified by the original methods or steps in the process."

Newspaper

Electrochemistry

IT DOES beat all what we read in the newspapers! Here is a gem of wisdom sent in by our electrochemical friend who led us into temptation that landed us in trouble about rhodium when we failed to observe that there is also a plant of that name. The item is taken from the *New York Sun* of Aug. 9, and was printed under the caption Kitchen Economics: "If a needle is held between the lips while peeling onions, water will be kept from the eyes, and it also prevents smarting." What kind of galvanic action does it set up? Was it meant for girls with metallic lips? We have always felt that there was a considerable electric charge in some lip tissue, but we have never undertaken research with cooks or scullery maids. On the other hand, one doesn't have to be a cook or a scullion to peel onions. We have done it ourselves, but in all our long, modest life we have not been given to understand that our lips were especially charged with electrons. Chemists working with mercaptans might make a note of this alleged phenomenon of the needle—and then they might as well forget it again for all the good it is likely to do them.

The Ups and Downs of Steel

JULY, 1921, will probably go down in history as the month of lowest production of steel in these modern times. Production of ingots in July was at the rate of about 11,000,000 gross tons a year, or about 21 per cent of actual capacity, the lowest rate being struck at the middle of the month, since when there has been an improvement, one that will probably continue indefinitely, though perhaps at a slow rate. The July rate was approximately one-fourth the average rate maintained during the first nine months of 1920. Approximately the same rate was struck for a short time after the panic of October, 1907, but for production in a year as little as 11,000,000 tons one must go back to 1900. Production in the best year before the war was almost three times as great.

In contrast with this very low rate in steel production there is the fact that the railroads have been and are hauling a little more freight, measured by ton-miles, than in their best year before the war, that having been the fiscal year ended June 30, 1913, when the revenue ton-miles were 301 billion.

One is reminded that old descriptions of the steel industry are more apposite than ever. The late ANDREW CARNEGIE coined the phrase "prince or pauper" industry. The late JAMES M. SWANK had previously referred to "chill or fever" and "feast or famine." That is, the producers of steel are either princes or paupers, buyers have either a fever or a chill, orders for steel suggest either a feast or a famine.

Being in large measure a construction material, steel exhibits variations in demand according to the volume of construction. Men eat bread and wear clothes every day, but only occasionally build a house, a factory or a power plant. Other factors, however, magnify the peaks and troughs in the demand upon the steel mills. Between the steel mills and the ultimate consumption there is a volume of material, including rolled steel products and various wares made from steel, in the hands of manufacturing consumers, wholesalers and retailers. When business is active this is a stream, but when business becomes bad the stream becomes a reservoir, which has to empty itself. Manufacturing consumers whose policy had been to keep a three or six weeks' supply of steel on hand liquidate their stocks, intending for a time to depend on carload shipments.

During the war there were fears that the steel industry was getting oversized for a normal peace-time consumption. Such fears may have been right or they may have been wrong, but that has nothing to do with the present condition, for the reason that the increase in capacity since 1914 has been about 50 per cent, so that a 20 per cent operation of today's capacity means the same tonnage as would have required 30 per cent of the capacity before the war.

Meanwhile the wear and tear of the machinery, implements and structures made of steel goes on, and men's vision grows as to the bridges, buildings, power plants and other things they will be able to employ usefully in future. Eventually the steel trade will "come back." Just now, as the reservoir between mill and ultimate consumption is being depleted of steel and manufactures of steel, the mill demand is working its way up to a normal relation to general business. Stocks of steel and of manufactures of steel have been in process of liquidation.

Readers' Views and Comments

The Microscope; Its Design, Construction and Applications

To the Editor of Chemical & Metallurgical Engineering

SIR:—Under "Book Reviews" in your issue of June 29, 1921, I find a review of the very excellent symposium on "The Microscope; Its Design, Construction and Applications" held during 1920 by the Faraday Society.

I find that Dr. Boylston, in quoting the summary of an investigation by Prof. Benedicks of the new Reichert metallographic outfit, which was largely designed by me, leaves out an important sentence reading as follows: "It was found to produce excellent results at the very highest magnifications." Benedicks considers this sentence as the main result of his investigation and mentions the other points cited by Boylston simply as "points of a more general character," since six out of the seven points mentioned do not refer to the apparatus under investigation, but to the subject in general.

Prof. Benedicks has published several other papers on the same apparatus, in which he goes more into details of the results of his investigations than he did in his short paper contributed to the Faraday Society symposium.

The success of this excellent symposium is undoubtedly due to the untiring efforts of Sir Robert Hadfield, and I was glad to accept his invitation to contribute a short paper to the same symposium.

New York City.

HERMAN A. HOLZ.

Note on Alloying Tellurium With Some White Metals

To the Editor of Chemical & Metallurgical Engineering

SIR:—Referring to the paper on the above subject by J. H. Ransom and C. O. Thieme on page 102 of the July 20 issue of your journal, there should be little difficulty in proving that tellurides of the white metals are formed instead of leaving the matter in the "probable" class, as is done in the authors' last paragraph. Indeed, I have no doubt that the authors actually did obtain tellurides, since in my own work on this subject more than fifteen years ago I invariably obtained them. This could be proved by the fact that the lumps which formed over the metal gave hydrogen telluride when treated with a weak acid.

The "glow" which the authors noted as taking place when the tellurium was immersed in the alloys and metals which they were using was due to the chemical action resulting in the formation of a telluride. Telluride of aluminum is a particularly interesting body, because it not only gives hydrogen telluride when treated with weak acids but even when treated with water only, making it the most convenient reagent that I know of for generating this gas. Aluminum telluride is itself easily made by melting aluminum in a scorifier or porcelain crucible and dropping tellurium into it.

Magnesium telluride is also an interesting compound and is made the same way, but care should be taken not to superheat the magnesium above its melting point or

an explosion takes place and the magnesium telluride is found mainly on the walls and roof of the muffle. I always preferred to wear a mask and heavy goggles when making magnesium telluride, for the reaction is violent and comes in the hazardous class.

The selenides may be prepared in the same manner. It should perhaps be recalled to mind here that anyone experimenting on producing hydrogen selenide or hydrogen telluride should be most careful about inhaling either of the gases. To most persons they seem far more poisonous than sulphuretted hydrogen. As to hydrogen selenide, may I recall the classic quotation that "its discoverer, Berzelius, had his olfactory nerves paralyzed for six months by inhaling a bubble of the pure gas"? Judging from my own experiences, in the one whiff that he must have caught before paralysis set in he had enough olfactory sensations to have lasted him longer than the six months specified.

New York City.

DONALD M. LIDDELL.

Determining Factors for the Life of a Pneumatic Tire

To the Editor of Chemical & Metallurgical Engineering

SIR:—I trust it is permissible to call attention to a few corrections that should be made in the article on pneumatic tires, page 153. The subject matter is more mechanical than chemical, but as long as it was seen fit to publish this text, it is only proper that certain misleading ideas should be corrected in order that the readers of CHEM. & MET. should get complete facts on this great industry.

First, there are three types of pneumatic tires—square-woven fabric, thread fabric (so-called cord) and rope cord.

Second, use of cord fabric reduces the internal friction and heat developed in woven fabric tires, but it does not minimize these faults. The rope cord tire is built so there is a layer of gum rubber surrounding each of the ropes of the carcass. There is no rubbing between ropes and therefore this class of tire will not develop as much heat under the most severe road conditions as either of the two other types. In short, the rope cord tire practically reaches the ideal condition mentioned in the article.

Third, the rope cord tire is being manufactured at about 30 to 50 per cent less cost than cord fabric tires of similar size. The rope cord tire surpasses the fabric and ordinary "cord" tire in resiliency, absence of internal heat, gasoline mileage, bursting strength and cost of manufacture. The time is not far distant when the woven fabric tire and the cord fabric tire will both find themselves supplanted by the rope cord tire.

Fourth, a breaker strip functions to distribute the pressure occasioned by running over a stone or other angular projection so that the carcass of the tire will not receive a blow concentrated on a small area.

Fifth, iron cores are not used in building rope cord tires. The process is simple and eliminates much of the trouble from overflow, wrinkling of plies and breakers, bead weakness and other mechanical difficulties.

Arlington, N. J.

O. W. PICKERING.

British Chemical Industry

FROM OUR LONDON CORRESPONDENT

LONDON, July 21, 1921.

IT was long considered axiomatic that Manchester was the ultimate pulse for trade movements and at the present moment the distinctly improved tone and increased volume of business and employment in the cotton trade are considered to foreshadow a steady revival in the chemical industry and in the trade of the country. Important orders from America and India have contributed to this, but the absence of cheap coal is still a great handicap, as Belgian and German competition are likely to keep the majority of blast furnaces out of action for some time. Coal also remains the obstacle to a revival in the glass, pottery and similar trades, but the outlook in the chemical and dyestuff industries generally is better than for some time past, and although the immediate demand is small, it is known that stocks are now very low in most cases.

DELEGATES TO SOCIETY OF CHEMICAL INDUSTRY'S AMERICAN MEETING

Excluding the ladies of the party, the total number of members who have so far reserved passages is twenty or twenty-five. Sir William Pope, the president; Dr. J. P. Longstaff, the secretary, and E. V. Evans, honorary treasurer and chief chemist of the South Metropolitan Gas Co., are the official members of the party, which also includes the following, among others:

E. A. Alliot, of Manlove, Alliot & Co., filter press and mechanical plant specialists; F. W. Attack, well known in the dye industry, editor of the "Chemists' Year Book" and a leader in the movement toward compilation of compendia in English similar to Beilstein, etc.; R. H. Clayton, of the Manchester Oxide Co.; F. W. Gamble, of Allen & Hanbury, Ltd., manufacturer of pharmaceutical products; C. S. Garland, a vice-president of the society and chairman of Lighting Trades, Ltd., a subsidiary company to Nobel Industries; Captain C. J. Goodwin, honorary treasurer of the Chemical Industry Club, London, and the official delegate of the chemical engineering group of the society, a partner in Oscar Guttman & Sons, consulting chemical engineers; W. Heap, L. A. Jordan, chemical engineer to the British Xylonite Co., Ltd.; J. MacWilliam, consulting metallurgist, Sheffield; J. Reid, of the Caldercruix Paper Mills, Airdrie, Scotland.

So far no visitors are announced from France, but it is always possible that there may be a last-minute rush from this country and in some cases, such as for instance, Emile Mond, business engagements prevent members from participating in the full programme and they may sail at a later date. P. le Good, the advertising manager, is also of the party and it is understood that a stall at the Exposition of Chemical Industries has been reserved by the society, at which full information regarding its publications and other activities will be available.

PARLIAMENTARY AND INDUSTRIAL NOTES

The committee stage of the key industries bill was something of a farce and perhaps it was just as well that the "guillotine" prevented further futile discussion. The bill is to come into operation on Sept. 30 and as regards "dumping" will not apply to any

British dominion. As regards depreciated exchanges it will not now apply to cases where the currency concerned is less than 33½ per cent below the sterling par value.

Very encouraging reports have been received unofficially regarding the progress of the Claude process of nitrogen fixation and the various groups of experts who have seen demonstrations consider it to be commercially far superior to the Haber process. Considerable improvements have been effected in the process as disclosed by the patents so far published, particularly as regards the Claude method of hydrogen manufacture and the type of solvent used for same. Catalysis is said to proceed smoothly even in the presence of relatively considerable quantities of carbon monoxide.

In this connection, the discovery by the Catalpo interests (British Patent 164,808) that colloidal clay will synthesize ammonia at 450 deg. C. and at atmospheric pressure is of peculiar interest. Water vapor, it is stated, can be used instead of hydrogen and the use of this new catalyst is also advocated for hydrogenations and for the manufacture of acetaldehyde and formaldehyde.

LEADING CHEMICAL CORPORATIONS PASS DIVIDENDS

One result of the recent depression in trade, industrial unrest and Continental competition has been the passing of dividends in the case of firms like Nobel Industries and the British Dyestuffs Corporation. In the case of Nobel Industries considerable courage must have been displayed by the directors, for in spite of the fact that the profits for the past year were on a par with those earned in the previous two years, it was considered wise to keep all cash resources liquid. In such cases the directors themselves are usually holders of large blocks of shares and are therefore hit more heavily than the other shareholders and it is felt that foresight and caution of this kind will meet with its due reward later on. The case of the British Dyestuffs Corporation looks rather more serious, as it is the interim dividend on the preference shares that has been passed, but recent events and the changes in the management referred to in my previous letters have probably contributed to the present difficult position. As was generally expected, the report of the profiteering committee exonerated the dyestuffs industry but at the same time recommended caution and watchfulness in the future.

GENERAL NOTES

The annual meeting of the Association of British Chemical Manufacturers was a spectacular success, but doubt is expressed as to whether the actual work done apart from organization really corresponds to the claims made. This applies equally to the newly formed Association of Chemical Plant Manufacturers and considerable time will probably elapse before the notorious inertia of the British chemical industry can be finally overcome and really useful results attained. The annual report of the Alkali Works Inspectors follows traditional lines and its contents confirm the above opinion to some extent. Molybdenum metal is attracting interest at the moment and very large contracts could be placed provided supplies were obtainable at well under \$200 per ton.

Action of Lime in Magnesium Oxychloride Cements

Detailed Study and Discussion of the Action of Lime Impurities Occurring in Magnesite on Magnesium Oxychloride Cements—Methods of Determining and Differentiating Active From Inert Lime

BY MAX Y. SEATON, CLAUDE R. HILL AND L. C. STEWART

PLASTIC calcined magnesite differs from dead-burned or metallurgical magnesite in being burned at a much lower temperature. Dead-burned magnesite, in which periclase formation has gone on to a greater or less extent, does not react with magnesium chloride. The material now in use by the oxychloride industries is prepared by calcining any reasonably pure natural magnesite, such as occurs in Greece, in Venezuela, in Washington and in California, to a temperature of 700 to 1,100 deg. C. in shaft, Scott or rotary kilns. The commercial product is a white or light-colored powder, containing ordinarily 75-85 per cent MgO, 5-10 per cent CO₂ and H₂O, 1-2 per cent R₂O₃, 5-7 per cent SiO₂ and 3-6 per cent CaO.

The testing of plastic calcined magnesite has long been a serious problem to users of this material. An attempt has been made to regulate quality by specifying a definite chemical analysis which the material must meet to be accepted. Unfortunately, it has been found that poor as well as good calcined magnesite will meet these chemical specifications. The industry in general is coming to believe that a specification for this product should be written on the basis of physical tests only, with entire elimination of chemical analysis. The physical tests ordinarily recommended are those for fineness of the calcined magnesite, and for strength, constancy of volume, setting time, and resistance to water of the finished cement. Tests of this nature unquestionably furnish valuable information as to the quality in calcined magnesite. It is interesting to compare such test results with the results of chemical analysis and particularly to search for special analytical determinations which might throw light on the question of quality before totally abandoning the use of chemical tests. One determination which is frequently stated as being of particular value is that of the amount of lime in the calcined magnesite, and some investigation of the meaning of this determination seems warranted.

INERT AND ACTIVE LIME

From the start some distinction as to the form in which the lime occurs must be made. In many oxychloride cement mixes marble dust or limestone powder is deliberately used as an aggregate without exerting any harmful influence on the properties of the cement. Such forms of calcium carbonate act merely as inert material, their effect on the character of the cement being roughly equivalent to that of a fine sand or ground silica of equal fineness. The report of the presence of a definite amount of lime in a calcined magnesite is accordingly meaningless unless the form in which it occurs be also specified. It is well established that addition of calcium oxide or hydroxide to an oxychloride mix markedly diminishes its strength. Lime in this form or, more exactly, any form of lime which exerts an injurious effect on the quality of an oxychloride can

well be designated as "active lime," and it would be expected that a determination of the content of lime of this character would be of considerable value.

The reduction in strength caused by addition of lime to oxychloride cements has been mentioned by several writers. Quantitative data are quoted by Rourke.¹ A tabulation of his results is given in Table I, where the effect of lime addition on the cement formed from two different magnesites is shown.

A similar set of determinations in which strengths at both seven days and thirty days were investigated is shown in Table II. The very marked decrease in strength should be carefully noted.

TABLE I. EFFECT OF LIME CONTENT, AS DETERMINED BY ADDITION OF LIME

No. Lime Added	3.70%	Tensile Strength, Lb. per Sq. In.	0.67%
1	329	364	486
2	328	320	470
			826
			653

TABLE II. EFFECT OF ADDITION OF Ca(OH)₂ TO CALCINED MAGNESITE

1 part magnesite, 2 silex, 5 sand, by weight.		22 deg. Bé.	MgCl ₂
		Tensile Strength, Lb. per Sq. In.	
Per Cent Ca(OH) ₂		7 Days	30 Days
0	.....	490	882
1	.....	397	562
3	.....	347	473
6	.....	150	247
10	.....	207	230

Several different possibilities for the determination of active lime may be considered. One such method is indicated by the work of Duschak.² This method rests on the difference in solubility between calcium and magnesium hydrates in water. Duschak points out that if a sample of calcined magnesite be agitated with water for some time, the alkalinity of the water will correspond to the content of calcium oxide present in the original sample. The procedure which he finally adopted was the leaching of the sample with water by standing over night, followed by filtration and by titration with standard acid, using phenolphthalein indicator, the next morning. If the magnesite was burned at a temperature exceeding 1,000 deg. C., the lime was slowly and incompletely dissolved, but magnesites burned at lower temperatures gave good results. The method is simple and rapid as far as working time is concerned. It has been carefully investigated and the effect of various modifications in the procedure studied. In the series of experiments following, 2 g. of the calcined magnesite under investigation was added to 300 c.c. of CO₂-free water and agitated on a shaking machine for various periods of time and under varying conditions.

The rate at which lime is extracted is of course of importance. Table III gives some data on this subject.

¹University of Wisconsin Bulletin 879.

²CHEM. & MET. ENG., vol. 23, p. 628.

It should be noted that when continuous agitation is employed a time very much shorter than that used by Duschak is apparently sufficient to completely remove the lime. Longer agitation, in fact, appears to reduce slightly the alkalinity of the solution. The effect of temperature on the determinations is indicated from the comparative determinations at four hours' agitation. This factor exerts apparently only a minor effect on the amount of free lime found.

TABLE III. EFFECT OF TIME OF AGITATION ON PER CENT CaO IN WATER SOLUTION

Time	Magnesite No. 12. Temperature 18 deg. C.	
	Per Cent CaO From Phenolphthalein	Per Cent CaO From Alkalinity—Methyl Orange
0.25 hr.	1.49	1.57
0.50 hr.	1.47	1.55
1.0 hr.	1.43	1.48
2.0 hr.	1.49	1.55
4.0 hr.	1.53	1.63 (20° C.)
	1.41	1.52 (87° C.)
	1.30	1.40 (3° C.)
8.0 hr.	1.34	1.47
16.0 hr.	1.25	1.39
24.0 hr.	1.11	1.24
2 days	1.30	1.40
4 days	1.21	1.36
8 days	1.26	1.42
15 days	1.47	1.54

The reduction in alkalinity on long agitation can possibly be accounted for by action of the calcium hydrate solution on the glass of the bottles. That such an effect does exist is shown in Table IV, where the titrations of dilute calcium hydroxide solutions after varying periods of shaking are given. This effect, too, is seen not to be a major one, but is of about the order of the reduction in alkalinity shown in the previous table.

TABLE IV. EFFECT OF GLASS BOTTLE ON ALKALINITY OF Ca(OH)₂ SOLUTION

Time Shaken, Hours	Titrated to Phenolphthalein End Point C.e. N/10 Acid	
	Without Filtration	After Filtering
0	5.04	5.04
4	4.90	4.62
8	4.88	4.66
24	4.88	4.66
48	4.82	4.68

Maximum difference is equivalent to 0.18 per cent CaO, figured on basis of usual determination.

Question may be raised as to the meaning of the alkalinity titration—that is, as to whether all of the alkalinity is due to lime. Duschak has given some data on this point. Additional figures are given in Table V, in which a comparison of the amount of calcium oxide

TABLE V. DETERMINATIONS OF ACTIVE LIME BY MODIFICATIONS OF WATER METHOD

Magnesite	Per Cent CaO by Alkalinity of H ₂ O		Per Cent CaO by Precipitation as Oxalate	Per Cent CaO by Alkalinity of 5 per Cent NaCl	
	Phth.	M.O.		Phth.	M.O.
1	0.34	0.45	0.23	0.95	1.53
2	0.37	0.43	0.38	0.83	1.15
3	0.29	0.39	0.27	1.19	1.61
4	0.43	0.50	0.44	0.92	1.20
5	0.72	0.80	0.76	1.04	1.23
6	0.72	0.78	0.71	1.17	1.26
7	1.03	1.07	1.14	1.26	1.40
8	1.34	1.43	1.47	1.70	1.85

as determined by titration of the alkalinity of the solution and calcium oxide determined by precipitation of the lime as oxalate is given. It is seen at once that the alkalinity may be taken as a measure of the calcium content of the solution. In this same table the effect of addition of sodium chloride to the water is shown. The results in this case are very much higher than when no sodium chloride is used. In particular the quite wide difference between the methyl orange and

the phenolphthalein titrations on the sodium chloride solutions from certain magnesites should be observed. It is probable that this is due to the increased solubility of calcium carbonate in the presence of sodium chloride.

ACTION ON MAGNESIUM CHLORIDE SOLUTION

There seems little doubt that the method described above will indicate the amount of calcium oxide or of calcium hydroxide actually present. Such lime, which may be designated as "free lime," does not necessarily comprise the total of the so-called active lime in the calcined magnesite. For example, the phenomenon of a striking reduction in strength of oxychloride cements on addition of small quantities of precipitated calcium carbonate has been frequently observed. Such calcium carbonate will show essentially zero alkalinity when agitated with water, yet its effect on the strength of oxychloride cements is almost as great as that of calcium hydroxide itself. It is felt, too, that an analytical method which approaches somewhat more closely to the conditions existing during the formation of the magnesium oxychlorides would be less open to criticism than the method given above. The solution used in mixing oxychloride cement is not water, but is a solution of magnesium chloride. Calcium oxide or hydroxide will of course react with such a solution with the precipitation of magnesium hydroxide and the introduction of calcium chloride into the reaction mixture. The literature indicates that certain forms of calcium carbonate will react in much the same way.

Some study of an analytical method in which leaching with magnesium chloride solutions is employed was accordingly undertaken. The method finally adopted was the agitation of 2.5 g. of calcined magnesite with 300 c.c. of 0.75 per cent magnesium chloride solution. After a specified period of agitation, the solution is made up to 500 c.c., filtered, and an aliquot part, usually 100 c.c., taken for analysis. Calcium is determined in the solution by double precipitation as oxalate, using the precautions which are always necessary when calcium is to be determined in the presence of a large quantity of magnesium. Use of such a method divides

TABLE VI. ACTIVE, RESIDUAL AND TOTAL LIME IN CALCINED MAGNESITE

Magnesite No.	Active CaO MgCl ₂ Method	CaO in Residue	Sum	Total CaO on Separate Sample
K	1.53	2.82	4.35	4.34
L	2.82	0.81	3.63	3.89

the total lime present in the magnesite into two portions, as shown by Table VI. This table indicates the lack of relationship between total calcium oxide and active calcium oxide and indicates, too, the possible accuracy of the analytical determination involved.

The rate at which the active calcium present reacts with the magnesium chloride must be studied before the time of agitation can be definitely set. Some data on this subject are given in Table VII which shows that twenty-four hours' agitation is sufficient to remove by far the majority of the lime which will react, although some small reaction occurs even after this period.

On the basis of the data so far submitted, three methods for determination of active lime may be considered.

Agitation with water and determination of alkalinity with phenolphthalein indicator.

Agitation with 5 per cent sodium chloride solution and determination of alkalinity with methyl orange indicator.

TABLE VII. EFFECT OF TIME OF SHAKING ON PER CENT CaO BY MgCl₂ METHOD

Magnesite No. 13			
Time	Per Cent CaO	Time	Per Cent CaO
2 hr.	2.80	2 days	3.49
4 hr.	3.02	4 days	3.54
8 hr.	3.19	8 days	3.93
16 hr.	3.47	15 days	3.67
24 hr.	3.45		

Agitation with magnesium chloride solution and determination of calcium chloride in the solution.

Comparison of the results obtained from the application of these three methods is given in Table VIII.

TABLE VIII. COMPARISON OF METHODS FOR ACTIVE CaO

MgO No.	Alk. in H ₂ O Phth. Ind. Method 1.	Alk. in 5% NaCl M.O. Ind. Method 2.	MgCl ₂ Method Method 3.	Ratio 3:1	Ratio 3:2
1	0.34	1.53	1.54	4.53	1.02
2	0.37	1.15	2.00	5.41	1.74
3	0.29	1.61	1.59	5.48	0.99
4	0.43	1.20	1.88	4.37	1.57
5	0.72	1.23	2.30	3.19	1.87
6	0.72	1.26	3.35	4.65	2.66
7	1.03	1.40	3.28	3.18	2.34
8	1.34	1.85	4.00	2.95	2.16

It is seen at once that there is apparently no relation between the values thus obtained on the eight different calcined magnesites investigated. The ratio between the values is far from constant. Methods 2 and 3 are closer than methods 1 and 3, but even here the variation in ratio is very great.

DETERMINATION OF CALCIUM CHLORIDE PRODUCED IN CEMENT

The real test of the value of any such methods is, of course, their comparison with conditions existing during formation of the oxychloride cement. As has been indicated, a method involving treatment with magnesium chloride would be expected to be closer to practice than one employing leaching by water only. For a further study small amounts of oxychloride cement were prepared from three different calcined magnesites, using the strength and amount of magnesium chloride solutions ordinarily used in practice. These cements were allowed to set for varying periods. They were then powdered and agitated for a considerable time with neutral alcohol. It would be expected that this procedure would remove the majority of the calcium chloride formed by reaction of the active lime with magnesium chloride, although there is, of course, a possibility of the formation of small quantities of calcium oxychloride which might not be decomposed under such conditions. The alcoholic solution was then filtered and calcium determined in it, the results being calculated back to the basis of the original sample of calcined magnesite.

Results are given in Table IX. They indicate that the amount of lime reacting in such oxychloride cement mixtures is about midway between the amounts found by the water and by the magnesium chloride method. That they are considerably higher than the results found by leaching with water is, of course, good evidence that lime in other forms than that of calcium oxide or hydroxide does react in such cements in the ordinary mixes used in the field.

The results so far obtained have not entirely conformed to those reported by Duschak, who believes that all of the lime which will influence oxychloride cement formation can be leached out of a freshly burned sample of magnesite by water. It is suspected that the discrepancies in the results of the two laboratories may be

traced to the fact that the magnesites investigated here are commercial calcined magnesites which have, of course, been exposed to the air for varying periods during their shipment from the California producers, instead of being freshly burned samples such as were examined at Berkeley. Comparison was accordingly made between different methods as applied to freshly burned magnesite and to magnesites which had been exposed to the air for varying periods.

A sample of natural magnesite rock was burned for two hours at 750 deg., a burning condition which with this particular rock gave a good quality plastic calcined magnesite. Determinations of active lime were then made by three methods on this freshly burned product as well as on samples of it which were exposed on watch glasses to laboratory air for various periods of time. The results are shown in Table X. They are particularly interesting in indicating that the three methods correspond much more closely on freshly burned magnesite than they do on a material which has been weathered for a moderate period. This is further evidence that calcium carbonate may in certain instances behave as active lime and is a good argument for the adoption

TABLE IX. REACTION OF LIME IN OXYCHLORIDE CEMENTS COMPARED TO ACTIVE LIME ANALYSES

Magnesite No.	Age of Cement, Hr.	Per Cent Lime Reacting in Cement	Active Lime H ₂ O	Active Lime MgCl ₂
2	24	0.92	0.37	1.54
2	60	0.92	0.37	1.54
8	24	2.33	1.34	4.00
8	60	2.48	1.34	4.00
9	24	2.33	1.24	3.97
9	60	2.33	1.24	3.97

of the magnesium chloride rather than the water method for a determination of this constituent in commercial calcined magnesite.

TABLE X. EFFECT OF WEATHERING OF CALCINED MAGNESITES ON ACTIVE LIME CONTENT

Time Exposed to Air	Ignition Loss	Active Lime			Ratio 3:1	Ratio 3:2
		Method 1	Method 2	Method 3		
0	1.09	3.14	4.18	4.69	1.49	1.12
1	3.62	2.52	2.94	4.17	1.65	1.42
2	4.00	2.46	3.09	3.90	1.58	1.26
5	5.73	1.05	1.58	3.07	2.92	1.94
10	5.86	0.72	1.62	3.26	4.53	2.01
20	6.97	0.59	1.36	2.45	4.15	1.80

CHLORIDE SOLUTION METHOD PREFERABLE

For use on routine samples of commercial calcined magnesites, then, it is felt that in spite of its obvious advantages in speed and in ease of manipulation, determination of alkalinity of extract is not as truly representative of the content of active lime as is the value arrived at by application of the magnesium chloride method. It is very probable that on freshly burned material, particularly on calcined magnesites burned at such a temperature as to completely remove the carbon dioxide from the lime, the water method will give results of approximately the same value as those found by the other procedure. This circumstance may make the water method of value to a producer, but cannot give it first place for use by a magnesite consumer, located a considerable distance from the calcining plant.

An additional argument for use of the magnesium chloride method for active lime is found in the fact that a definite relationship between certain physical properties of oxychloride cements and active lime content of the calcined magnesites employed, as determined by the magnesium chloride method, has been found to exist. In view of the lack of parallelism of results obtained by

the three methods, such a relationship obviously would not apply if free lime, determined by leaching with water or sodium chloride solution, were considered.

It is unnecessary to go into detail at this time on the methods used for physical testing of oxychloride cements and on the meanings of the various determinations as they have recently been published in this journal.³ It need only be pointed out that a determination of the water resistance of oxychloride cements as defined by the relation between strengths of the dry cement and strength after wetting is of great interest as pointing to the comparative permanence of different products. A test of this type is conveniently made by determining the modulus of rupture of flat bars of the oxychloride cement $\frac{1}{2}$ in. thick under three conditions—namely, dry, immediately after wetting for a definite period, and after wetting and redrying for a definite time. The standard procedure in making water-resistance tests in this laboratory involves preparation and aging of the bars for fourteen days, spraying some of the bars for three 24-hr. periods with intervening 24-hr. drying periods and determination of the strength immediately after final spraying and after forty-eight hours additional drying in comparison with the strength of unsprayed bars. Water resistance is expressed both as the percentage of strength retained after wetting and after wetting and drying and as the "classification factor" of the magnesite, this being a numerical expression involving wet, dry and recovered strengths, the wet strength appearing as the second power on account of its relatively great importance. The formula employed for its calculation is

$$\frac{(\text{Wet strength})^2 \times \text{recovered strength} \times 10}{(\text{Dry strength})^2}$$

The derivation of this expression may be clearer if it be considered in the form

$$\left(\frac{\text{Wet strength as per cent of dry strength}}{\text{of dry strength}} \right)^2 \times \left(\frac{\text{recovered strength as per cent of dry strength}}{\text{per cent of dry strength}} \right) \times \left(\frac{\text{dry strength}}{\text{in lb. per sq.in.}} \right) \times 100,000$$

³CHEM. & MET. ENG., vol. 25, No. 6, p. 233, Aug. 10, 1921.

This reduces to the same fraction as that given above. The constant term is introduced merely to give a number of reasonable size.

All such water-resistance tests are made on an oxychloride cement containing 12.5 per cent of calcined magnesite, 25 per cent of ground silica or silix, and 62.5 per cent of standard sand. These ingredients are mixed with a magnesium chloride solution of 22 deg. Bé. The reason for the adoption of such a test procedure cannot be discussed in detail here, but some results obtained by the application of this test may prove of interest.

In Table XI are given water-resistance tests made by this method on thirty-one different magnesites in comparison with analytical determinations of different constituents. Careful examination of the table will show that there is no relation whatever between the physical strengths reported and the per cent ignition loss, carbon dioxide, silica, iron and aluminum oxides, or total calcium oxide. It will be noted that the magnesites in the table are arranged in the order of their content of active lime. A study of the table will show that there is apparently no relation between the per cent of this ingredient and the physical tests reported. Experience has shown that other factors in the composition of a calcined magnesite not expressible by chemical analysis have such a vital influence on the strength and permanence of the oxychloride cements resulting that they are apt to obscure any relation existing between lime content and physical strengths when a single sample of magnesite is considered. Only when a sufficient number of determinations are averaged to cancel out these other factors would it be expected that the real relationship would appear.

Such average results are given in Table XII. In this the magnesites are divided into four classes depending on their content of active lime. If the mean values of active lime for each class are compared with the average physical strengths for each class, a definite relationship will at once become apparent. Per cent wet strength decreases rapidly as the content of active lime increases. This relation is brought out perhaps more clearly by Fig. 1, which shows graphically the relation between

TABLE XI. RELATION BETWEEN ACTIVE LIME AND PHYSICAL PROPERTIES—INDIVIDUAL RESULTS

Magnesite No.	Loss on Ignition	CO ₂	SiO ₂	R ₂ O ₃	Total CaO	Active CaO MgCl ₂ Method	Modulus of Rupture, Lb. per Sq. In.			Wet Strength as per Cent Dry Strength	Recovered Strength as per Cent Dry Strength	Classification Factor	Free Lime H ₂ O Method
							Dry	Wet	Recov.				
1	8.05	5.52	3.12	0.74	3.33	0.78	1,115	519	1,081	43	89	1,990	0.63
2	8.24	3.32	6.27	1.23	3.65	0.97	1,097	495	767	45	70	1,550	0.42
3	7.17	1.58	6.42	0.45	3.14	1.01	1,187	585	948	49	80	2,280	0.44
4	5.98	1.78	5.59	0.61	3.31	1.17	1,197	566	1,000	47	84	2,220	0.38
5	7.92	3.62	5.49	1.14	2.64	1.18	1,633	759	1,726	46	105	3,560	0.46
6	5.98	1.78	5.59	0.61	3.31	1.29	1,197	566	1,000	47	83	2,200	0.38
7	14.44	2.76	2.46	0.71	3.50	1.30	1,012	637	884	63	87	3,500	0.42
8	8.35	3.25	5.07	0.80	3.58	1.44	1,232	642	977	52	80	2,660	0.44
9	10.65	4.07	8.09	1.32	4.34	1.53	1,277	594	1,188	46	93	2,510	0.48
10	6.98	1.68	7.01	0.42	3.64	1.57	1,010	618	854	61	84	3,160	0.48
11	9.23	4.37	5.10	0.72	4.42	1.58	1,336	446	842	33	63	920	0.40
12	9.09	1.54	2.09	1.20	3.40	1.61	1,486	273	604	18	40	190	0.36
13	9.32	4.16	5.82	0.54	4.03	1.62	1,243	672	1,118	54	90	3,260	0.63
14	4.94	1.04	9.23	1.25	3.19	1.62	1,172	569	971	49	82	2,310	0.63
15	5.35	1.90	2.86	0.50	3.15	1.62	1,515	448	1,214	30	80	1,090	0.50
16	7.78	5.73	6.81			1.65	1,876	519	1,110	28	59	870	0.48
17	11.25	2.08	1.33	1.42	2.49	1.75	1,588	324	1,199	20	71	480	0.46
18	5.54	1.40	2.91	0.90	4.24	2.02	885	481	799	54	90	2,330	0.48
19	3.70	2.75	3.96	0.63	2.76	2.20	1,330	430	686	32	52	710	0.71
20	6.95	2.54	7.65	1.21	3.75	2.27	1,378	97	300	7	22	15	1.01
21	7.91	2.08	1.41	0.59	2.44	2.32	1,580	525	967	33	61	1,050	0.69
22	5.74	3.17	7.14	1.30	5.35	2.32	1,198	110	422	10	35	42	0.55
23	6.31	3.08	9.73	2.42	6.85	2.38	811	416	719	51	89	1,880	1.77
24	9.08	0.58	11.90	1.12	4.43	2.44	1,066	400	758	38	71	1,090	0.08
25	6.65	1.85	5.74	0.33	2.70	2.57	1,436	296	528	21	37	230	0.61
26	8.25	2.42	6.36	0.72	5.60	2.61	1,261	170	441	13	35	75	0.53
27	5.25	2.85	6.10	0.56	4.74	2.71	1,257	385	698	31	56	670	0.42
28	4.65	1.85	5.74	0.33	3.89	2.82	1,691	60	125	4	7	2	0.63
29	3.57	2.22	8.70	1.01	3.71	3.03	1,159	80	276	7	24	14	0.57
30	8.69	3.44	13.34	2.03	4.28	3.07	1,011	252	810	25	80	610	1.11
31	2.95	2.80	3.45	0.88	4.48	3.65	1,604	132	198	8	12	12	0.44

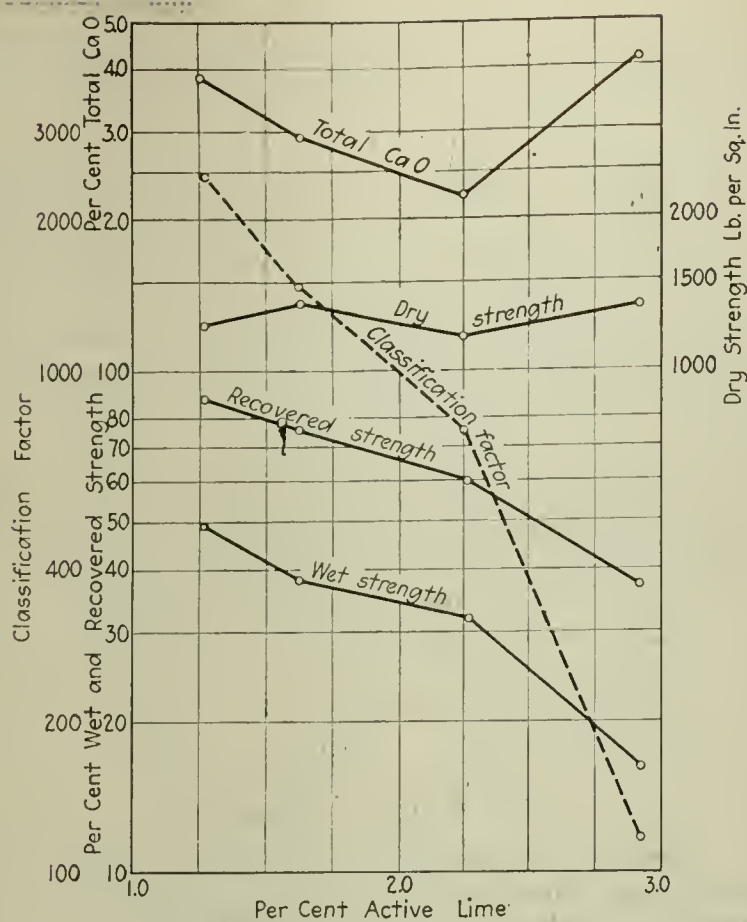


FIG. 1. RELATION BETWEEN WET AND RECOVERED STRENGTH AND PER CENT OF ACTIVE LIME

which will be brought about by active lime. The amount of water in the mix will remain essentially unchanged, but magnesium chloride will be removed by chemical action and the resulting solution will have a lower content of this salt than that originally used for the mixture. Such a reduction radically reduces the strength and water resistance of oxychloride cements, as is shown from Table XIV, which gives the average results of reduction in chloride strength from 22 to 20 deg., Bé. on five different magnesites.

TABLE XIV. EFFECT OF CHLORIDE STRENGTH ON PHYSICAL PROPERTIES OF OXYCHLORIDE CEMENT			
Gravity of Chloride Solution, Deg. Bé.	Average of Five Magnesites		
	Modulus of Rupture		
	Dry	Wet	Recovered
22	1,453	616	890
20	1,293	417	827

In the 1:2:5 mix employed for these tests, in which approximately 1.3 c.c. of magnesium chloride solution will be required for each gram of magnesium oxide used, the presence of 1 per cent of free lime in the calcined magnesite will result in a reduction in gravity of the magnesium chloride solution of approximately 1 deg. Bé., together with the introduction of an amount of calcium chloride equal to about 3 per cent of the $MgCl_2 \cdot 6H_2O$ present. When the summation of these two effects is considered, it is not at all surprising that the influence of active lime is as striking as it is.

Although a definite relation has been found to exist between active lime content and physical properties of an oxychloride cement produced from a given magnesite, it should be thoroughly understood that such an effect is observable only when results from a large number of magnesites are averaged. Important as the effect is, it can very easily be overbalanced by other factors. It is not safe, accordingly, to say that a magnesite having any definite percentage of active lime is dangerous or that one containing active lime lower than certain amounts will be a good product. The results should not be taken as any argument for the adoption of chemical tests for calcined magnesite, but merely as an additional indication of the necessity of the investigation of the physical properties of the oxychloride cements produced from a given sample of plastic calcined magnesite before any definite conclusion as to the quality of this material can be reached.

SUMMARY

Methods for determination of "free" and of "active" lime in plastic calcined magnesites have been indicated, and the distinction between total lime and active lime in such a material brought out.

A relation between active lime content of calcined magnesites and physical properties of the oxychloride cements produced from them has been brought out.

The relationship between active lime content and physical properties of oxychloride is apparent only when average results from many samples are considered. Other factors may completely obscure the relation in a test on a single sample.

Active lime content is accordingly not a definite indication of poor quality in a magnesite, although a magnesite containing active lime in large amount should be regarded with suspicion.

Physical tests of oxychloride cements must still be regarded as the only safe criterion of the quality of magnesites used in the oxychloride industries.

National Kellastone Co.
Chicago, Ill.

TABLE XII. RELATION BETWEEN ACTIVE LIME AND PHYSICAL PROPERTIES—AVERAGE RESULTS

Per Cent Active Lime	Mean Value	Wet Strength as per Cent	Recovered Strength as per Cent	Dry Strength, Lb.	Per Cent Total CaO	Classification Factor	Per Cent Free Lime
0-1.5	1.27	49	84	1,221	3.85	2,460	0.45
1.5-2.0	1.62	38	74	1,390	2.95	1,490	0.49
2.0-2.5	2.28	32	60	1,182	2.23	730	0.87
2.5-4.0	2.92	16	37	1,234	4.20	116	0.62

In both Tables XI and XII the per cent of free lime, as indicated by the water solubility method previously described, is given for comparison. It is evident that this determination bears no direct relation to physical properties of the oxychloride cements.

Some explanation for the phenomena noted must be sought. The presence of active lime in a calcined magnesite will result in two different actions. In the first place calcium chloride will be introduced into the magnesium chloride solution. The effect of such an introduction on physical strengths is brought out from Table XIII, which shows that when any large amount

TABLE XIII. EFFECT OF CALCIUM CHLORIDE ON PHYSICAL PROPERTIES OF OXYCHLORIDE

Per Cent $CaCl_2$ Added to $MgCl_2$	Modulus of Rupture		
	Dry	Wet	Recovered
0	1,158	604	828
5	936	432	768
10	570	114	240

of calcium chloride is added a marked reduction in the strength and water resistance of the oxychloride cement appears.

An even more important feature affecting the physical strength is the reduction in gravity of chloride solution

Internal Service-Strains in Steel*

Discusses the Effect Which Forces and Movements Taking Place Within the Metal Itself, Between Crystals and Even Between Atoms, Induced by Conditions Other Than External Loading, May Have Upon the Successful Employment of Steel in Industry

BY JAMES E. HOWARD†

DISCUSSIONS upon the properties of materials have seldom taken so important a direction as that which is called for under the present general discussion. In general, the ultimate object of employing the materials of construction is to utilize their ability to resist stresses. Their value depends upon their ability to endure successfully stresses of different degrees continued over different intervals of time, having reference to the external loads which are imposed upon them.

Practically all of the materials of construction are affected by internal strains. Opposing internal strains may be present in individual members when apparently they are in a state of repose; that is, when no external forces are acting upon them. These internal strains are no less real than those which are the direct results of external loads. The resultant strains in any given member, under working conditions, is the algebraic sum of the internal strains and those which are caused by external loads.

STRAINS MAY BE RESIDUAL OR ACQUIRED

Under many conditions of service the state of internal strain of the material demands consideration. This is peculiarly the case with steel rails which are exposed to destructive forces and which acquire in service internal strains of high degree. Bridge members acquire internal strains, cooling strains during fabrication of component parts and strains when they are assembled, to which are finally added those due to dead and live loads.

The original properties of materials are generally made the subject of careful determination, while scant consideration has been given those phases through which materials pass under exposure to service conditions, involving the introduction of internal strains which at times culminate in rupture. These original properties may be imparted to steel by various means, by chemical composition, by heat and by mechanical treatment. The ability of the steel to resist different stresses in service is not definitely shown by the values of the original properties. It is commonly assumed that a favorable relation exists between the original properties and service stresses, when certain initial properties are imparted to the steel, furnishing a reason for imposing exacting requirements upon their original state, although the relations have not been clearly established.

It is a very welcome diversion therefore to have attention invited to the subject of internal strains and the effects of prolonged stresses, matters which are so intimately connected with the safe and proper use

of materials. It is somewhat difficult nevertheless in taking up a subject so comprehensive as the present one to choose the features to be commented upon. Attention, however, will be directed to certain features which are among those less frequently taken into consideration in discussions upon the physical properties of steel. Reference will only be made to examples which have come within the experience of the writer.

STRENGTH DEPENDS ON CONDITIONS OF LOADING

In dealing with steel a query is at once suggested; namely, what constitutes the maximum range in strains which steel will endure, under either temporary or permanent loads and without loss of integrity. Temporary strains of tension in steel music wire have been shown amounting to 0.015 per unit of length. Under stress of compression, hardened steel endures a strain of 0.020 per unit of length. These strains represent stresses of 450,000 and 600,000 lb. per sq.in. respectively. They stand as extreme examples of elastic extension and compression which have come to notice, and are far beyond any elastic strains made use of in the arts. Music wire, in the upper octaves of a pianoforte, probably affords an example of maximum working stresses under which steel is placed for long continued periods, strains of about 0.006 per unit of length, more or less.

Examples of reversed strains, in the same member, have not been observed approaching those which steel has displayed while under stresses in one direction only. Steel subjected to alternate stresses of 50,000 lb. per sq.in. tension and compression each has shown apparently complete restoration in length after release of stress, thus showing an aggregate elastic movement of 0.003½ per unit of length. Its ability to display this aggregate movement was impaired when over-straining loads in either direction were applied; loads which caused the introduction of permanent sets of either tension or compression.

Herein is observed the effect of a structural change resulting from stresses which permanently disturb the relative positions of the component parts of the steel. It appears to be a characteristic of the effect of alternate stresses that a reversal of direction of strain is attended with less total or aggregate elastic resilience than steel is capable of displaying when strained in one direction only. It is doubtful whether steel will be found which will endure long continued alternate stresses, in which the strains exceed a small percentage of the aggregate strains of tension and compression in separate members. In the experience of the writer the limiting stress, under repeated alternate stresses, which steels are capable of enduring 100,000,000 repetitions or more is in the vicinity of 45,000 lb. per sq.in.

*A contribution to a general discussion on "The Failure of Metals Under Internal and Prolonged Stress," held by the Faraday Society, April, 1921.

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In commenting upon this feature years ago, Shreve inferred from the results of Wöhler and Spangenberg that 30,000 lb. per sq.in. was the limiting stress for irons.

STRENGTH IN CUBIC COMPRESSION

Judging from experience with other materials and noting also that no change occurs in the physical properties of mild steels after exposure to cubic compression several times the elastic limit in tension, it is inferred that steels will endure cubic compression without limit. Destruction of integrity of a material results from separation of the adjacent particles, but that integrity does not admit of being impaired by forces of compression when received simultaneously in three directions, however great those forces may be. It follows that the maximum intensity of a force of compression may be very great without injury provided there is a progressive graduation from the center of effort to the periphery of the stressed area. For this reason intense impinging pressures such as those which occur between the head of a rail and the tread of a wheel, although injurious, are less damaging to the metal either of the rail or wheel than such pressures would be under conditions of uniformly distributed stresses.

In a sense, the most stable condition in which steel exists is the annealed state. It was early observed that the value of the modulus of elasticity of steel was modified when the metal was materially overstrained and had received a substantial permanent set. This value is temporarily lowered. A stress-strain curve with the steel in this condition shows an area of lost work, between ascending and descending stresses. A struggle apparently goes on within the steel to recover from this overstrained state, and after the lapse of a few days or weeks the normal value of the modulus is regained.

INTERNAL STRAINS IN FORGED OR ROLLED STEEL

The denseness of steel is modified by treatment. Heating and quenching, annealing and cold working, all result in changes in volume. It has even been found that changes in the dimensions of forgings take place more in one direction than another. By means of a strain gage, forgings have been found to contract when annealed more in length than in lateral directions. In this behavior of forgings there appears to be evidence of an interstructural or intermolecular state of strain which affects the general mass of the metal. This is not the usual manner of strain in which one portion of the volume in a state of internal compression is balanced by another part of the volume in a state of tension, but a diffused state of strain in which the microconstituents may play the principal parts.

Not unlikely a relation may exist between the viscous resistance of steel at forging temperatures and this interstructural state of strain. The behavior of steel forgings in this respect suggests an interesting line of inquiry.

Internal strains make their appearance in steel cooled from the ingot or cooled after the operations of forging or rolling. The parts first to cool are usually left in a final state of compression, unless modified by complexity of form in the steel member. Earlier strains in the steel, experienced during the period of cooling, are reversed in the cold metal.

Under normal conditions of air cooling, internal

strains are modified by the cross-section dimensions of the steel member. Since the acquisition of internal strains is influenced by the rate of cooling, large forgings of compact form are expected to be less affected than forgings or rolled shapes having thin webs and flanges. In steel rails, with thin flanges, internal strains of compression not infrequently reach a magnitude equivalent to a stress of 15,000 lb. per sq.in. In the heads of the heavier rails cooling strains equivalent to 5,000 lb. per sq.in. compression represent ordinary values.

Steel structural members, channels, angles and plates also acquire cooling strains after they emerge from the rolls. Built-up compression members, of which they may form component parts, will initially contain cooling strains of considerable magnitude. Recent examinations of structural shapes have shown the presence of internal strains of compression equivalent to 12,000 lb. per sq.in. This value is three-fourths of the usual allowable stress for compression member in current engineering practice. Since no account is usually taken of the presence of internal strains in structural members exposed to compressive stresses, the omission is worthy of note.

COOLING AND QUENCHING STRAINS

The usual range of internal strains in air-cooled steel members may be greatly extended by accelerated rate of cooling, by exposure to a current of air, by an air blast, or by cooling with water from a medium high temperature, but not so high as to result in thermal hardening. Rapid cooling of steel rails from the finishing temperatures of the rail mill by means of an air blast is capable of introducing internal strains of compression exceeding 40,000 lb. per sq.in. Forgings reheated to about 900 deg. F. and cooled with water acquire internal strains of compression comparable with those resulting from an air blast on rails at finishing temperatures.

Local heating followed by normal air cooling also results in the introduction of internal strains; that is to say, unequal heating of steel, as well as unequal cooling, is a cause for internal strains. By means of an oxy-acetylene torch internal strains may be introduced, and changes in dimensions effected at will, either in plus or minus directions, according to the locality on which the torch is applied. The side of the member locally heated finally contracts in length while the opposite side expands. The heated side dilates, is overstrained by the cooler and stronger side and is eventually shortened. Admonitions upon the manner of heating and quenching machine small tools are based upon causes such as here described.

Heating by frictional resistance and quenching by the conductivity of the cold surrounding metal introduce internal strains and lead to the rupture of metals. Brake shoes in railway service furnish familiar examples of such action. The treads of wheels are occasionally affected in like manner. Examples of "wheel-burnt" rails, so called, are numbered by thousands, that is rails which have been intensely heated along elements on the running surface of the head by the slipping of wheels. All phases of heating, quenching and annealing are confined within shallow depths of metal on the heads of those rails, and this occasionally results in rupture. The severe structural effects which may result from wheel burning will be realized upon giving consideration to the difference in the rate of transmission of heat through the cross-section of the rail and the rate of transmission of strains.

It is necessary to exercise care in machine tool operations to avoid the introduction of internal strains. A light feed and depth of cut, employing a tool with a sharp cutting edge, is necessary in the machining of steel in a lathe or planer to avoid the introduction of internal strains. Internal strains of compression are commonly introduced in machine operations. It has been found, however, that excessive cuts and feeds may result in the introduction of strains of tension. Punching and shearing of steel for use in important places has long been objected to. The introduction of high-speed, blue-chip, tool steels has brought about machine tool practice encroaching upon the objectionable features of punching and shearing.

EFFECT OF COLD ROLLING ON STEEL RAILS

The introduction of internal strains of most common occurrence is found in the case of steel rails in railway service. All rails are cold rolled and acquire a state of internal strain resulting from the wheel pressures. Cooling strains resulting from manufacture are present in the rails when placed in the track. These strains in part remain unaffected by subsequent conditions of service. Those in the flanges of the base commonly remain undisturbed. It is quite a different affair, however, in the head of the rail. Here the original cooling strains are immediately augmented by the wheel pressures. Internal strains in the rail head next the running surface not infrequently attain a magnitude equivalent to 20,000 lb. per sq.in. stress. The internal strains next to the running surface are those of compression.

Necessarily there must be strains of tension in some part of the cross-section of the rail to furnish the required reaction. They are found along the central zone of the head, where the measured values have reached 8,000 lb. per sq.in. tension.

This condition acquired by the rails in the track is the explanation, in the opinion of the writer, which accounts for the development of transverse fissures. The most strained fibers in tension in the head are interior fibers. Transverse fissures commonly have their origins in eccentric position, the majority being located on the gage side of the head. No other common cause has been found to account for the formation of these fissures of interior origin.

SHATTERED ZONES AND BRITTLENESS UNDER CUBIC TENSION

Shattered zones have been found in some rails along the center line of the head and at the junction of the web and the base. No failure has resulted from the shattered zone in the base. It has not been ascertained whether the presence of shattered metal in the head promotes the development of transverse fissures by furnishing a nucleus from which they may extend or on the other hand whether the internal strains caused by the wheel pressures are diffused and expended in the looseness of the central zone when shattered metal is present. Shattered rails are found which have not displayed transverse fissures and transverse fissured rails are met in which there is no evidence of a shattered zone.

These shattered zones appear to be the result of shrinkage strains, acquired when the rail is cooling, after the last pass in the rail mill. The shattered metal does not extend to the hot sawed ends of the rails, but terminates about the same distance from the rail ends as the distance in from the peripheral metal of the

head to the shattered zone. This circumstance fixes the period during which these zones are formed.

The idea does not appear untenable that brittleness, in the sense of inability to display permanent extension, may be displayed by steel at any temperature, under conditions of cubic tension. The only opportunity for steel to reach such a state, in which there are simultaneous strains of tension in three directions, seems to be during the operation of cooling at the period when the peripheral metal has reached a state of compression and exerts tension on the interior. At some stage during the operation of cooling there is a reversal of strain from tension to compression in the peripheral metal. The higher the temperature at which this reversal takes place, the lower the prevailing tensile strength of the steel. At the finishing temperature of rails, while there is considerable viscous resistance to the steel, it then has but little tensile strength. Even with a lowered modulus of elasticity at finishing temperatures only a minute strain would seem necessary to separate adjacent particles and prove adequate to cause these shattering cracks. Since all forged and rolled shapes are subject to cooling strains of this kind, it is obviously desirable to clear up matters connected with the phenomenon. As the case now stands, shattered zones have been found in some rails and not in others. Those which have displayed this phenomenon, by chance or otherwise, have been of the harder grades of steel.

EFFECTS OF SURFACE DEFECTS

A slight surface defect or interruption in continuity is known to have a serious effect on steels exposed to repeated alternate stresses, leading to premature rupture. This is quite evident from the failure of steels in which the structural defect was located remote from the plane of maximum fiber stress. The rupture of steel occurs when two adjacent particles are separated beyond their radius of action or molecular bond, whatever descriptive term may be used in this connection. Progressive fractures develop under such conditions. Since the presence of a surface defect produces a result similar to an increased fiber stress on the metal as a whole, it is inferred that an actual increase in fiber stress is experienced in the vicinity of the defect. Carrying the inference one step farther, it appears reasonable to believe that internal strains may augment those of external origin, the algebraic sum of the two representing the actual fiber stresses which affect the steel. Carrying the inference still farther, although now approaching a debatable state, it may be argued that actual separation of adjacent particles occurs when and only when the local strain between them reaches a maximum and that this maximum has a relation to the original tensile strength of the steel. In support of this last inference is the behavior of steel under repeated alternate stresses conducted at different temperatures. At a blue heat, in the range of 400 deg. and 600 deg. F., at which period the tensile strength is above that at ordinary temperatures, steels under repeated stresses endure several times the number of repeated loads which they sustain at atmospheric temperatures. That is at the time of increased tensile strength there is an accompanying increase in its endurance of repeated stresses.

A field but partially explored presents itself in tracing the phases through which steels pass in their approach to the final stage of rupture, involving among

others the query at what stage and by means of what treatment can the progress of rupture be arrested and the steel restored to its original state. Unlimited endurance, in a practical sense, is now experienced by limiting the fiber stresses within a certain range. High initial physical properties are imparted to steels by special treatment, heat and mechanical. The question of ultimate endurance is not fully met by subjecting steels of exceptionally high original properties to a comparatively small number of alternate stresses. Results already gained are gratifying but they still leave undetermined basic questions pertaining to long continued stresses.

Stress-strain curves under loads once applied and advanced until rupture takes place, as performed in ordinary tests by tension, are practically straight lines until the elastic limit is reached. Early sets, if such appear, may conjecturally be attributed to the influence of internal strains pre-existing in the steel, in localities where the elastic limit is reached prior to that of the general mass of the metal. There is lack of harmony between the opinion often expressed that a permanent set occurs under every stress however small it may be, and the example of music wire sustaining stresses far above 100,000 lb. per sq.in. over periods of years and with the ability to sustain a temporary stress of 460,000 lb. per sq.in. tension.

Evidence does not seem to have been presented in support of the statement that any stress however small will cause a permanent set in steel, and that perfect elasticity or complete resilience after the application of a force of tension does not constitute a fundamental property in steels. The limited consideration which has been given to the matter of internal strains is believed to account for certain popular impressions.

In conclusion, it may again be remarked that attention has commonly centered upon the original properties and characteristics of steels, and the means by which these original properties are modified, overlooking the wide range of conditions which affect the endurance of the metal, the phases through which steels pass under conditions of service, and which lead in the direction of ultimate rupture.

German Sales of Potash

According to a recent dispatch from Berlin 419,000 metric tons of potash (K_2O) was sold in Germany between Jan. 1 and July 31, 1921. It is reported that the inland prices received did not cover the cost of production and that the profits on foreign sales of the same material were less than in the like period of 1920.

Phosphates in Morocco

The first shipment of 300 tons of phosphates has just been made from Onedzem according to a dispatch from Casablanca, Morocco, dated Aug. 2. This is regarded as an industrial event of prime importance, in view of the enormous beds of this material now awaiting development in the Onedzem district.

Rumania Abolishes Export Duties on Some Chemical Products

A decree issued by the Rumanian government on Aug. 1 states that export taxes on the following chemical products have been abolished: alcohol, glucose, calcined and crystallized soda, sulphuric and acetic ethers, amylacetate and crude sulphuric acid.

Comparative List of Imports and Exports of Chemicals for Fiscal Year Ended June 30, 1921

Imports decreased 43 per cent, exports decreased 25 per cent during the fiscal year 1921 compared with 1920, according to official figures of the Department of Commerce just made public. An analysis of imports shows that crude materials fell from \$2,141,000,000 in 1920 to \$1,051,000,000 for the year just closed, indicating that mill consumption fell off materially during 1921, hence the lessened demand for the raw materials of foreign countries. Imports of crude foodstuffs and food animals fell from \$622,000,000 to \$452,000,000; of manufactured foodstuffs, from \$891,000,000 to \$842,000,000, or a decline of \$219,000,000 in our purchases of foreign products.

The emergency tariff act became effective May 27. During May we imported about \$62,000,000 worth of foodstuffs, crude and prepared, while in June the total of these imports was \$40,000,000.

Manufactures for further use in manufacturing fell from \$801,000,000 to \$543,000,000, again reflecting the depression in industry. But imports of completed manufactures scored a decrease of but \$1,000,000, or from \$745,000,000 to \$744,000,000 in value. The pre-war average was under \$450,000,000.

On the export side of the sheet crude materials decreased from \$1,969,000,000 to \$1,288,000,000, the two years compared. A falling off in sales to other countries which have been fairly well stocked with American crudes was somewhat balanced by increased purchases on the part of Germany. Crude foodstuffs increased from \$626,000,000 to \$979,000,000, being the only group to show an increase over 1920. Manufactured foodstuffs fell off from \$1,514,000,000 to \$779,000,000. Partly manufactured goods decreased from \$991,000,000 to \$687,000,000, while completed manufactures showed a decrease from \$2,835,000,000 to \$2,643,000,000.

To sum up, our imports decreased from \$5,238,000,000 in 1920 to \$3,654,000,000 in 1921, while our exports decreased from \$8,109,000,000 to \$5,516,000,000. This includes the miscellaneous group and foreign merchandise exported.

Handbook on Shellac Industry in India

The Government of India has issued a "Report on Lac and Shellac" as part of "Indian Forest Records," which Trade Commissioner C. C. Batchelder believes to be very useful and of interest to users of shellac. It is a comprehensive book, the result of investigations made into the sources of supply, methods of production, manufacture, transportation and distribution, fluctuations of prices and volume of exports. It not only shows in a colored map the places where the lac is produced, but presents graphically in charts the variations in London and Calcutta prices from 1901 to 1919, with the London stocks and the effect of large stocks upon Calcutta prices.

Explanations are given of the variations in quality due to methods of preparation and cultivation, together with much other technical information, such as the way to restore the solubility of relatively insoluble shellac.

Of immediate practical use are the lists of the principal manufacturers, dealers, and exporters in the different lac centers. There is also a list of other literature on the subject.

Decision in Bakelite Patent Suit

THE U. S. District Court, Eastern District of New York, on Aug. 2, 1921, rendered its decision in the patent suit of the General Bakelite Co. of New York vs. the General Insulate Co. of Brooklyn. Three Bakelite patents relating to various uses and applications of synthetic resins were involved and all were declared valid and infringed.

The original bill of complaint was filed by the Bakelite Company on Sept. 18, 1917, and the trial, which began on March 31, 1919, was not concluded until June 22, 1919. The counsel for the General Bakelite Co. were Charles Neave and Maxwell Barus, of Fish, Richardson & Neave, and C. P. Townsend, of Byrnes, Townsend & Brickenstein. John H. Lee, of Dyrenforth, Lee, Critton & Wiles, and J. Edgar Bull, of Gifford & Bull, were counsel for the defendant. The trial was conducted before Judge Thomas I. Chatfield.

It will be recalled that in a previous patent suit¹ against George J. Nickolas & Co. of Chicago, where three other Bakelite patents were involved—namely, Nos. 954,666, 1,018,385 and 1,037,719, covering specifically the manufacture of Bakelite varnishes and solutions—the General Bakelite Co. obtained a decree adjudicating the validity and infringement of these patents.

The General Insulate Co. of Brooklyn is engaged in a molding business and produces insulating material resembling hard rubber. It uses as its raw material the synthetic resin, purchased from the Redmanol Chemical Products Co. of Chicago, either in the form of a fine powder or as hard, brittle sheets. The case necessarily involved consideration of the character of the Redmanol product, and that company, although it was not a party to the suit, stood behind the defendant in all matters relating to patentability. To quote from the opinion of the court, "the Redmanol company has as freely and fully presented its evidence as if the action had been against the Redmanol company, for infringement of the plaintiff's patents, in the manufacture of the synthetic gum itself."

CLAIMS OF THE PATENTS IN ISSUE

The suit was brought on the following United States patents: The so-called heat and pressure patent, No. 942,699, which grew out of an application filed July 13, 1907; the indurated product patent, No. 942,852, which was a division of the application of the previous patent; and the so-called mixture or molding patent, No. 939,966, which was issued upon an application filed Jan. 28, 1909.

The following claims were in suit in the first patent:

"1. The method of producing a hard, compact, insoluble and infusible condensation product of phenols and formaldehyde, which consists in reacting upon a phenolic body with formaldehyde, and then converting the product into a hard, insoluble and infusible body by the combined action of heat and pressure."

"2. The method of making articles containing an insoluble and infusible condensation product of phenols and formaldehyde, which consists in reacting upon a phenolic body with formaldehyde, producing thereby a reaction product capable of transformation by heat into an insoluble and infusible body, forming the article from said reaction product, and rendering the article hard, insoluble and infusible by application of heat and pressure."

"4. The method of making articles containing an insoluble and infusible condensation product of phenols and formaldehyde, which consists in reacting upon a

phenolic body with formaldehyde, producing thereby a reaction product capable of transformation by heat into an insoluble and infusible body, forming the article from said reaction product compounded with a filling material, and rendering the article hard, insoluble and infusible by application of heat and pressure."

The claims in issue in the next patent are 5 and 6:

"5. As a new composition of matter, wood cell tissue impregnated with an infusible and insoluble condensation product of phenol and formaldehyde."

"6. As a new composition of matter, a fibrous or cellular material impregnated with an infusible and insoluble condensation product of phenol and formaldehyde."

The claims of patent No. 939,966 in suit are:

"1. The method of molding articles which consists in comminuting a partial reaction product of phenol and formaldehyde, molding the mass under pressure, and transforming the same into an insoluble and infusible condensation product."

"2. The method of molding articles which consists in comminuting a partial reaction product of phenol and formaldehyde, molding the mass under pressure, and transforming the same in the mold into an insoluble and infusible condensation product."

"3. The method of molding articles, which consists in preparing a comminuted mixture of a partial reaction product of phenol and formaldehyde and a filling material, molding said mixture and transforming the partial reaction product into an insoluble and infusible final condensation product."

The prior patents relating to the subject of molding and hot pressing are dismissed with the statement:

They taught nothing as to the creation of synthetic condensation products, and left the prior art with mere knowledge of melting, dissolving, solidifying, pressing, turning, boring, polishing and cutting materials, which proved the demand for substances which were never thought of until phenolic condensation products were discovered.

THE MANASSE, LUFT AND STORY PATENTS

Detailed consideration, however, was given to the few patents for the prior art of making synthetic compounds of phenols with formaldehyde. Among these the ones of particular interest are the patents of Manasse, Luft and Story. The following paragraphs referring to the history and extent of these patents are abstracted from Judge Chatfield's opinion:

The earliest patent that should be considered is that issued to Otto Manasse, in the United States, No. 526,786, Oct. 2, 1894. Manasse was seeking to describe a method or process of producing phenol-alcohols by using alkaline or neutral condensing agents, in aid of the reaction of formaldehyde on phenol or phenol-like substances. After mixing the phenol dissolved in the alkaline or neutral condensing agent with formaldehyde, and acidulating the resultant mixture, he separates the oxybenzylalcohol from the watery solution by extraction by ether. He then evaporates the solution so as to obtain a semi-fluid mixture which is treated with steam, thus driving off the residues of formaldehyde and phenol which have not entered the reaction. On cooling and filtering a resinous body is left, which apparently is the synthetic product in which both the plaintiff and the defendant in this case are interested. But Manasse rejects this resin and treats further the solution in order to obtain crystals, which in turn, when dissolved in benzene show a separation of oxybenzylalcohol from the parahydroxy-benzylalcohol which remains in the form of an amorphous powder in the solution.

Luft states (U. S. Patent 735,278, Aug. 4, 1903) that he is seeking to obtain a plastic compound, which in the German patent he calls a "resinous mass," by making use of the "known fact that upon boiling phenols with aldehydes, and especially with formaldehyde, in the presence of acid, a mass results which when fresh is viscous and very plastic," and is capable of use in the arts.

Luft apparently began to work with the resinous mass which Manasse filtered out and discarded.

Luft's process is expensive, and he never, so far as his own knowledge or the disclosure of his patent is concerned, got beyond the fusible and soluble state. It is

¹CHEM. & MET. ENG., vol. 13, No. 7, p. 711, July, 1915.

evident, as was shown in court, that present knowledge of the art in the hands of an expert makes it possible so to manipulate the Luft process as to produce an insoluble and infusible final product, but Luft never did this nor taught it by his patent disclosure alone.

The Story patents, British, No. 8,875, of 1905, French, No. 353,995; of Sept. 25, 1905, and the French Addition, No. 9,861, applied for Sept. 29, 1908, describe the production of a condensation product by the action of aldehydes on phenols.

Story uses commercial carbolic acid containing 95 per cent of phenols with formalin containing about 40 per cent of formaldehyde. He pours his viscous product into molds which he dries at a temperature below 100 deg. C. He takes 50 parts of commercial carbolic acid and 30 parts of formalin and produces a substance which, having once become hard and dry, he states is insoluble in any known solvent and is not attacked by acids or alkalis. He states that in the viscous state it may be dissolved in alcohol, acetone, benzol or other suitable solvent, and furnishes a good varnish for many purposes, from which the solvent may be removed by heat.

The Story patent is particularly interesting because the Redmanol company manufactures and is putting upon the market in large quantities a product which evidently is produced according to the Story description. This result is obtained by long drying and heating, in some instances this period of heating at temperatures around 50 deg. C. lasting for over a year. Story suggests the adding of coloring matter or inert substances while in gelatinous state, and suggests in the addition patent drying at much higher temperatures in order to produce hardness and insolubility.

Experiments during the course of the trial have satisfactorily shown that Story, as well as Luft and De Laire, can be ultimately operated so as to produce the infusible and insoluble substance which is known as "Bakelite C." This is the same substance which is shown and described in the Aylesworth U. S. patent, and which is also referred to in U. S. patent to Stephan, No. 812,608, Feb. 13, 1906, on application filed Dec. 6, 1904. But Stephan was seeking to make an antiseptic powder. His insoluble product was an accidental and not desired substance, obtained if his compound was heated too long. He produced an acid product, and certainly was not teaching the production of the insoluble substance, nor did he anticipate any of the other patents under consideration.

BAEKELAND'S PATENTS

The earliest application of any one of the Baekeland patents was Feb. 18, 1907, and the public description of Baekeland's researches was made in 1909, when various articles were read before the New York Section of the American Chemical Society, and printed in the *Journal of Industrial and Engineering Chemistry* during that year. These dates will become of importance when we consider that the Baekeland patent involving the use of hexamethylenetetramin, which patent was in interference in the Patent Office with applications by Redman, Goldsmith and Steinmetz, and out of which interference a patent was issued to Goldsmith for the so-called dry hexamethylenetetramin method, and to Baekeland for the wet hexamethylenetetramin method. The date is also important in connection with the defendant's claim that Baekeland did not know of the prior art patents when he applied for the heat and pressure patent in 1907. But he discussed these patents in his amendments of March 17, 1908.

Evidently Baekeland was aware of the chemical formation of hexa as early as the proceedings in the Patent Office resulting in Patent No. 942,809, which was issued Dec. 7, 1909. He specifies the use of ammonia as early as October, 1907 (application No. 397,560). There seems to be no reason why his patent No. 1,038,475 should be held invalid because it makes use of certain knowledge described in a co-pending application, even though that co-pending application was of an earlier date.

Even if Redman was entitled to a valid patent for the description of the preparations used by him in the so-called dry hexa method, the defendant using the Redman product would still be liable to a charge of infringement of the patents in suit, whether the hexa be added in a two-step or a one-step process, or in a wet or dry reaction. But the two-step process has in some respects a commercial advantage.

It is also urged that the use of hexa does not in any

event infringe the Baekeland patents calling for use of formaldehyde and ammonia. This is a mere verbal argument, as hexa is well within the limit of equivalents but may still be the basis for an improvement of the method patent.

The defendant seeks to escape the charge of infringement by urging the defense presented by the Redmanol company, that hexa was not covered or disclosed by the specifications and claims of any of the Baekeland patents, until Patent No. 1,038,475, and that the use of hexa by Redman constituted a new invention, giving him the right not only to manufacture synthetic reactive gums, with this substance and with carbolic acid, but also to make the various products by the use of dyes and fillers and the employment of molding processes, which Baekeland has attempted to obtain by the patents in suit, and the others described in this case.

FORMALDEHYDE AND AMMONIA EQUIVALENT TO HEXA

As has been stated in his earlier patents, Baekeland discloses the use of substances engendering formaldehyde. It is apparent that hexa is immediately formed upon the introduction of ammonia and formaldehyde. The independent discovery by Redman of the possibility of using hexa, in order to avoid the necessity of drying out the water or moisture remaining in the original reaction product, was antedated by Baekeland's writings and patent specifications, which specifically claim ammonia and the substances engendering ammonia as a part of the Baekeland series of inventions. Redman's invention is therefore dependent upon his methods of manufacture at atmospheric pressure and with a dry compound of formaldehyde and ammonia, rather than from the use of hexa as such.

The use of hexa, therefore, does not get the synthetic gum outside of the Baekeland disclosures and claims. If the defendant makes use of the processes patented by Baekeland, when applied to the substances described by Baekeland, in the production of the commercial material covered by the Baekeland inventions, then it cannot escape the charge of infringement by showing that this material was produced by the Redmanol company with hexa, instead of with formaldehyde and ammonia separately. In other words, hexa is but an equivalent for formaldehyde and ammonia, and the defendant company is using this equivalent in carrying out the process of the Baekeland patent. In this sense the defendant is in a position analogous to a contributory infringer if the Redmanol company were a primary infringer.

CONTENTIONS OF THE DEFENDANT

The defendant contends that the specifications and claims of the heat and pressure patent (No. 942,699) show only, and that the evidence in the case proves that Baekeland had in mind only, the use of counter pressure to prevent violent expulsion of ammonia. It is claimed that he later attempted to include molding pressure, when he realized the need of securing the chemical reaction during the molding and heating process. But while the original claims were not as broad as those finally allowed and were evidently drawn without any attempt to include in words the molding pressure, the language of the specifications shows clearly both understanding of the need and use of molding pressure, and indicates Baekeland's intent to include it in his claims. His subsequent amendments were therefore allowable and there is no reason for limiting the valid range of the patent as issued.

In a similar way, the defendant argues that the only novel feature claimed in the indurated material patent (942,852) as originally presented, was to secure the removal of moisture during an old or well-known reaction for the purpose of impregnating or hardening wood. The separation of water was an essential step, but was not the only one disclosed, and the specifications fully support the claims as finally allowed. One of the materials to be indurated was cellular wood flour, and the impregnation and induration was had in order to make this into blocks or solids. The history of the patent in the Patent Office shows that Baekeland appreciated, at least, the possibility of claiming more than was expressed by the apparent understanding of the examiner and the present contention of the defendant.

The claims are valid and cover molding, with wood flour, and coloring material.

Patentability having been shown, the claims upheld in form and the defendant proved to have infringed, the plaintiff may have a decree.

The Chemistry, Manufacture and Uses of Nitrocellulose

History of Nitrocellulose — Relation to the Chemistry of Cellulose — Comparison of Early and Modern Methods of Manufacture—Military Demands for Smokeless Powder and Peace-Time Uses in Pyroxylin Plastics, Artificial Silk and Leather, in Medicine and Photography

By HUGO SCHLATTER

Formerly Chief of Chemical Products Division, Hercules Powder Co.

THE history of modern high explosives may be said to date from the middle of the last century, although picric acid and some of the fulminates were discovered much earlier. The early history and the discoverers of these products are therefore well known from contemporary literature, and in this respect they differ a great deal from the oldest explosive, black powder, whose history is shrouded in mystery. The year 1846 saw the discovery of both nitroglycerine and guncotton or nitrocellulose, both of which have played and are still playing such an important rôle in human history.

It is true that Braconnot and Pelouze had nitrated starch and paper some years earlier with nitric acid alone, but Schönbein, of Basel, first prepared nitrocellulose from absorbent cotton by means of a mixture of nitric and sulphuric acids, and realized its true significance and value.

A few weeks after this discovery the German Böttger obtained the same result and the two inventors combined to exploit the product. Schönbein had great hopes for his nitrocellulose. In a letter to Faraday he said that he expected that it would soon displace black powder as a propellant for firearms. It was many years, however, before this hope was realized, although a number of plants were put up in short order.

The first guncotton plant was erected in the same year at Faversham, in England, but in July of the next year the whole plant was destroyed by an explosion, with the loss of twenty-one lives. In 1848 similar accidents occurred in the French factories at Bouchet and Vincennes. The result was that its manufacture was prohibited and that the German Confederation refused to purchase the process. The inventors succeeded, however, in selling their secret to Austria and two plants were operated under the direction of an artillery officer, Baron von Lenk, until 1862 and 1865, respectively, when they also blew up and put a stop to further work there. Although Lenk had been extremely careful to purify his guncotton by washing for two weeks in water, boiling with soap and finally treating it with waterglass, his accidents as well as the previous ones in England and France were due to insufficient stabilization rather than from incomplete neutralization of the acids.

DIFFICULTIES CAUSED BY INSTABILITY

In the meantime an English chemist, Sir Frederic Abel, had come to the conclusion that the instability was due to traces of acid retained so tenaciously in the fine capillary of the cotton fiber that simple washing or neutralization with alkaline solutions did not completely eliminate them. In order to reach these traces of acid he broke up the fibers by pulping them in the beating engine of the paper industry. He also devised

a test, still known as the Abel heat test, for revealing the smallest traces of acid. Beating or pulping of the nitrocellulose is still practiced, although it is now realized that this does not remove all causes of instability, as will be shown later. In 1865, when Austria stopped manufacturing guncotton, England had two plants, one at Stowmarket and one at Waltham Abbey. The latter was under Abel's management and had in 1872 a production of 250 tons.

Aside from the troubles due to instability, there was another reason why guncotton did not immediately displace black powder as a propellant. It was too brisant—i.e., its rate of detonation was too great—and could not be sufficiently controlled, even by pressing it into solid blocks under heavy hydraulic pressure, to make it safe for use in rifle or cannon. Its chief military use was, therefore, as a charge for mines and torpedoes.

EARLY USES FOR NITROCELLULOSE

In the meantime nitrocellulose has found uses in the peaceful arts, and the developments here resulted later in serviceable nitrocellulose powders. Schönbein himself had observed that by varying the conditions of nitration he was able to obtain nitrocellulose insoluble, partly soluble or entirely soluble in a mixture of ether and alcohol. As early as 1848 Maynard made use of this solution in medicine under the name of collodion, which is still used as a dressing for wounds. In 1851 Scott Archer introduced the use of the same solution in photography. From that time on the use of nitrocellulose, or pyroxylin as it was generally called in the industry, increased rapidly as new solvents were discovered. In 1869 Hyatt obtained his patent covering the use of camphor as a latent solvent or plastifying agent for pyroxylin and thereby laid the foundation for the present enormous celluloid industry. It is true that Parkes and Spill had previously used camphor and camphor oil in nitrocellulose solutions to obtain a plastic film, but Hyatt depended on heat and pressure to develop the latent solvent powers of the camphor. Another extremely important patent is that of Stevens covering the use of amyl acetate, which inaugurated the lacquer and artificial leather industries that have since reached such huge proportions.

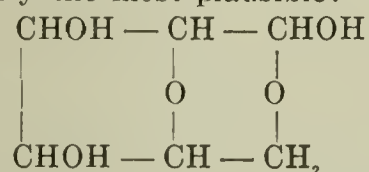
In working with these industrial plastics it was found that they burned with comparative slowness. This observation led the French chemist Vieille to the development of a completely gelatinized nitrocellulose powder in 1886. Nobel, who had invented dynamite, two years later (in 1888) patented smokeless powders consisting of nitroglycerine and nitrocellulose. From that time on these two types of nitrocellulose powders slowly but surely pushed black powder out of the place it had held in military affairs for centuries. In this

country, however, it was not until after the Spanish-American War that smokeless powder was finally adopted as the service propellant.

CHEMISTRY OF CELLULOSE AND NITROCELLULOSE

After this somewhat hasty review of the history of nitrocellulose we come to its chemistry. To be strictly accurate, it is not nitrocellulose at all, but cellulose nitrate. Furthermore, nitrocellulose, at least that found in regular practice, is not a definite compound, but a mixture of nitrocelluloses. This is due in part to the fact that the cellulose from which it is made is not a definite compound, but consists of a mixture of more or less mature or developed cellulose. Since both cellulose and nitrocellulose are colloids, whose properties gradually blend into those of the next higher or lower type, it is impossible to separate the different stages by crystallization and difficult if not impossible to separate them by fractional solution or precipitation.

We know very little about the structure or the size of the cellulose molecule. A number of structural formulas have been proposed, but none seems to correspond completely to the facts. The one proposed by Green is probably the most plausible:



Recent work by Pictet and Sarasin, published in *Comptes rendus* in 1918, promises to throw some light



FIG. 1. FEEDING THE COTTON INTO THE PICKERS PRIOR TO DRYING

on this question. They distilled cellulose under reduced pressure and obtained a crystalline product of the formula $\text{C}_6\text{H}_8\text{O}_5$ which forms a triacetate and a tribenzoate and may be the simple or unpolymerized mother substance of cellulose.

The usually accepted formula of nitrocellulose is $\text{C}_6\text{H}_{10-n}\text{O}_5 \cdot n(\text{ONO}_2)_n$ where n is 0 for cellulose and ranges from 1 to 12 for the different types of nitrocellulose. Those containing less than 7 $(\text{ONO}_2)_n$ groups are commercially unimportant. The most highly nitrated compound containing 14.16 per cent of nitrogen or 12 NO_2 groups has not been obtained, because the nitrating acid required for this stage begins to have a denitrating action before the nitration is com-

plete. Military guncotton (13.25 per cent of nitrogen) approaches most nearly to endeka-nitrocellulose, pyro-nitrocellulose (12.60 per cent of nitrogen) for the manufacture of United States smokeless powder corresponds to deka-, pyroxylin or soluble cotton for lacquers and dopes (12 per cent of nitrogen) to ennea-, and the nitrocellulose for plastics (11 per cent of nitrogen) corresponds to octonitrocellulose.

It is doubtful, however, whether any of these nitrocelluloses have ever been prepared in the pure state; certainly they have not in factory operations. A mixture of a number of them is always obtained, and the art consists in getting as uniform a product as is possible. As a matter of fact, the nitrogen content is not even a good indication of the suitability of a given nitrocellulose for any particular use. While it may be stated that a nitrogen content outside of certain limits will make the product unsuitable for a certain use, a product falling within these limits may be just as unsuitable. For instance, it is possible to make a nitrocellulose of 12.8 per cent nitrogen which is 95 per cent or more soluble in ether-alcohol solution, while another nitrocellulose of the same nitrogen content is less than 15 per cent soluble in this solvent. Nitrocellulose with less than 11.8 per cent or more than 12.3 per cent of nitrogen is generally unsuitable for gelatinizing nitroglycerine, but a nitrocellulose having 12.1 per cent of nitrogen may make just as "leaky" a gelatine. However, the nitrogen content has its importance and gives us valuable indications.

PROPERTIES OF NITROCELLULOSE

There are a great many solvents for nitrocellulose.¹ The commoner ones are the esters of the lower fatty acids and alcohols, acetone and other ketones, commercial wood alcohol (which contains acetone and other ketones), ether-alcohol mixtures, aromatic nitro-compounds, camphor and essential oils. Some of them will dissolve only certain types. Solubility in ether-alcohol mixture, for instance, forms the basis for the classification of nitrocellulose as soluble and insoluble nitro-cotton. The latter, containing generally more than 12.8 per cent nitrogen, is also known as guncotton. The former is often referred to as collodion cotton.

Nitrocellulose when ignited burns with great rapidity. It will take fire spontaneously when heated to a temperature of 186 deg. C., or lower, depending on its stability and the rate of heating. Even at ordinary temperatures it will lose nitrogen slowly, although very slowly if properly stabilized. This decomposition is a progressive one, the rate increasing if the products of decomposition are left in contact with it. For this reason stabilizers are added to smokeless powder which will bind the oxides of nitrogen as they are formed. The common stabilizer for pyro powders is diphenylamine. Vaseline, used in British cordite, oils, and various gums have similar properties. When gelatinized, nitrocellulose burns much more slowly. The combustion products vary with the pressure under which combustion takes place. In the open, oxides of nitrogen are always formed and a small carbonaceous residue remains. Under high pressures the combustion is more nearly perfect. It has been shown that a nitrocellulose containing 12.44 per cent of nitrogen should burn completely to carbon monoxide, nitrogen

¹See Worden, Edward C., "The Nitrocellulose Industry," New York, (1911).

and steam. On account, however, of a small amount of alcohol and stabilizer left in smokeless powder, its nitrogen content has been fixed at 12.6 per cent in order to insure practical smokelessness.

PREPARATION OF THE CELLULOSE

Cellulose is widely distributed in nature. Any of its various forms after proper preparation can be used, but in this country the usual raw material is linters obtained from the cotton seed after the best spinnable cotton has been removed. The great demand for powder during the World War would have made it necessary, if the war had continued another year, to use cellulose prepared from wood, such as the Germans had been doing since early in 1915. No matter what the source of cellulose, it has to undergo considerable preparation in order to make it suitable for nitration. Mechanical impurities have to be removed by dusting, and particles of seed, hull and the natural oils are taken out by boiling under a pressure of about 80 lb. in a 2 per cent solution of caustic soda. During this boiling care has to be taken to insure absence of air, which would cause the formation of oxy-cellulose and later give rise to nitrating troubles. After digestion the soda is carefully washed out and recovered. The cellulose next receives a mild bleaching treatment with bleaching powder, which is again completely removed, and the product is then dried. Chemical pulp made by the soda, sulphite or sulphate process is treated in the same manner and makes a satisfactory raw material for nitrating, especially when it can be mixed with linters, a mixture which is handled more easily than the short-fibered pulp. Wood pulp, however, is more bulky than linters and its use reduces the output.

When the bales of purified cellulose are received at the nitration plant they have to be opened up by being run through pickers. These machines consist either of drums that are studded with teeth or of corrugated circular plates rapidly revolving in opposite directions such as the Cogswell mill. The cellulose is then carefully dried from its natural 6 or 7 per cent of moisture to a content of less than 1 per cent. These preparatory operations are necessary in order that the cellulose will take up the nitrating acids readily and completely. Unopened lumps of cotton or high moisture would cause local overheating, uneven nitration and low yields.

The Government specifications for cellulose for nitrating prescribe an ash content of less than 0.8 per cent, ether soluble or fat content of less than 0.4 per cent, and no more than traces of salts of lime or bleach. Private manufacturers usually also place an upper limit on the allowable amount of oxy-cellulose as shown by the solubility in 10 per cent caustic soda solution.

EARLY METHODS OF MANUFACTURE

In the original process of nitration earthenware vessels were used that stood in iron troughs through which water circulated for cooling. Only 1 or 2 lb. of cotton was nitrated in each pot. After two or three hours the excess of acid was removed in a hand press and the nitrated cotton, still containing considerable acid, was permitted to stand in covered stoneware pots for twelve hours more to insure thorough nitration. At the end of that time the nitrocellulose was freed from more acid by centrifuging and then washed with water. This method was cumbersome and danger-

ous, since fuming off occurred quite frequently. The second nitration was soon abandoned and the cotton was left in the acid for twelve hours, after which it was centrifuged and submerged in water. As it was soon found that nitration, especially for the lower grades, could be carried on in a much shorter time, the pots were placed on turntables holding four or eight pots so that one pot after another would be brought up to the centrifugal and the process became a more or less continuous one—i.e., one man would dip cotton all the time and another would wring out the nitrated cellulose as the pot came up to the centrifugal. The



FIG. 2. AFTER THE MOISTURE CONTENT IS REDUCED TO 1 PER CENT THE DRIED COTTON IS WEIGHED INTO CONTAINERS AND SENT TO DIPPING POTS FOR NITRATION

next step was to carry on the nitration in the centrifugal itself. This arrangement is economical only where the time of nitration is quite short, as otherwise the ratio of output to investment would be too small. In order to provide a better and more uniform action of the acid, these nitrating centrifugals are often provided with a slow speed, which induces a slow circulation of the acid through the holes of the basket and back over the top of the cotton.

In the Thompson displacement system nitration is carried on in shallow earthenware pans provided with false bottoms and central outlet holes. The pan is filled with acid and the cotton immersed in it. A perforated plate is then laid over the cotton and cold water slowly run over the top. This water layer effectually seals the acid from contact with air and prevents loss of acid by fuming. After a certain length of time (one to one and one-half hours) more water is allowed to flow in and the acid is withdrawn at the same rate at the bottom of the pan until all of the acid has been displaced—a process which requires about one and one-half hours. This system is most economical in its consumption of acid, provided means are at hand for concentrating the weak acid formed during the last stage of displacement. It is not well adapted to the manufacture of soluble nitrocellulose on account of the difference in solubility between the different layers, since the bottom layer remains in contact with the acid almost twice as long as the top layer.

DESCRIPTION OF A MODERN INSTALLATION

The most modern system provides for the intimate and immediate mixing of acid and cotton in a different way. This system is installed in a four-story building. The top floor houses the motors for driving the machinery. On the next floor below four dipping pots for each unit, provided with agitators, are arranged in

the form of a square. These dipping pots discharge through valved pipes into the centrifugal on the second floor of the building. The centrifugal is discharged through its bottom into a bowl located on the ground floor. A stream of water entering this bowl tangentially submerges the nitrocellulose and carries it through a trap and earthenware flume to the boiling tubs, where the preliminary purification is carried on. The acid fumes, which were very objectionable in the old pot system, are sucked away by a fan from each dipping pot and each centrifugal. Occasionally there is a fume-off or "fire," which may be caused by foreign material in the cotton or a drop of oil or condensed moisture dropping into the centrifugal. In such a case the whole house is filled with fumes and the operators have to take refuge on the balconies that run the length of each floor. For these emergencies large exhaust fans with airplane propellers are provided, which clear the atmosphere in the course of a few minutes, thus confining the loss to the individual charge, whereas in the older systems often all the charges on the floor were lost, due to the inability of the workmen to return and attend to the work. The fumes coming regularly from the houses are conducted to absorption systems and recovered.

A charge consists of 1,600 to 1,700 lb. of acid and 32 lb. of dry cotton. The composition of the acids and the temperature of nitration depend on the type of nitrocellulose desired. In general it may be said that nitrogen content increases with increasing total acidity.

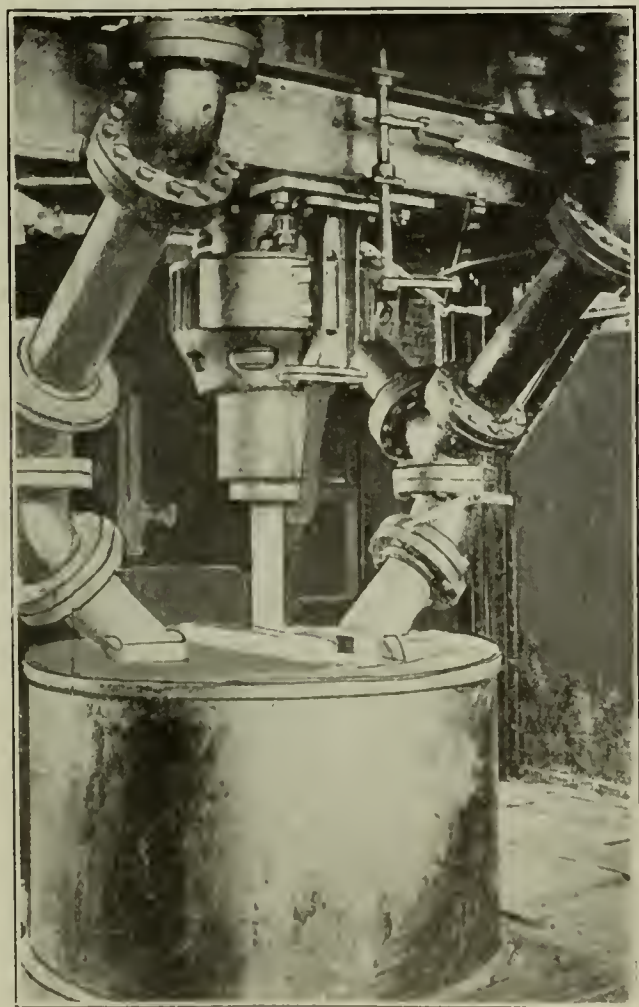


FIG. 3. CENTRIFUGAL SEPARATION OF NITRATING ACID

Increase in ratio of nitric to sulphuric acid, decrease in temperature and increase in time of nitration all increase the viscosity. The influence of nitrosyl-sulphuric acid or of the lower oxides of nitrogen is not thoroughly understood, but undoubtedly, other things being equal, increasing either lowers nitrogen content and viscosity. In addition the nitrosyl-sulphuric acid



FIG. 4. POACHERS IN WHICH FINAL PURIFICATION TAKES PLACE

has an oxydizing effect on the cellulose, resulting in compounds of low stability, which are destroyed during the purification treatment and hence lower the yield. Moisture in the cotton has a very serious effect on the product in that it dilutes the nitrating acid so that the interior of the fiber is nitrated to a lower degree than the exterior. This gives a non-uniform product, which will show itself in "granularity" or precipitation in the solutions. This, of course, is of less importance where the nitrocellulose is used for its flammable qualities, as in smokeless powder or guncotton, than where it is to be used as a solution, as in the lacquer industry.

BOILING PROCESS TO INCREASE STABILITY

It has previously been mentioned that the early troubles in the development of nitrocellulose were due to improper purification and that Abel introduced pulping to break up the fiber in such a way that the acid retained by capillarity might be completely removed. Even complete removal of acid does not, however, "stabilize" nitrocelluloses. This is due to the fact that the raw material is not pure mature cellulose, but always contains oxy- and hydro-celluloses in addition to less mature or complex cellulose molecules. The nitrates of these bodies as well as the lower nitrates and the sulphates of the pure cellulose which are always formed are unstable bodies. Fortunately they are rather easily broken up by boiling in acid water.

The first step in the purification is therefore prolonged boiling in water containing about 0.1 per cent of sulphuric acid. Extended experiments have shown that more than forty hours' boiling is unnecessary. The prescribed treatment for pyro-nitrocellulose intended for the manufacture of smokeless powder consists therefore of four boiling periods, the first one of sixteen, the other three of eight hours' duration each, with change of water after each boiling. The boiling tubs are generally equipped with a false bottom and a central stack or pipe into which the steam is introduced in order to provide circulation and even heating of the water, somewhat on the principle of the steam injector.

After the completion of the boiling the nitrocellulose is transferred to beaters or Jordans, where it is reduced to a fine pulp. These machines are well known to the paper industry and require no description. From the beaters the pulp is pumped to the poachers, which are simply large wooden tanks equipped with agitators. (See Fig. 4.) Here final purification takes place. As the principal purpose of this purification is the removal of the last traces of acid and the decomposition

products produced in the preliminary boiling, the requirements of the Army and Navy specifications seem somewhat excessive. These call for twelve hours' boiling with five changes of water—i.e., six periods of boiling followed by ten cold-water washings. During this boiling a small quantity of soda may be added. As a matter of fact, millions of pounds of smokeless powders which met all tests have been made from nitrocellulose that had only two periods of boiling (or a total of six hours) and five cold-water washings at this stage of the process.

OTHER METHODS OF PURIFICATION

The purification treatment described applies to nitrocellulose for making smokeless powder. For other purposes this can be much simplified. A great deal of nitrocellulose has been made and no doubt is still made for lacquers and dopes by washing only in warm water and dilute soda solutions. Some boiling should be given, however, but not too much, as excess of boiling has a bad effect on color and clearness of the solutions. Beating may be omitted entirely for this purpose.

Where a particularly white nitrocellulose for colorless or water-white solutions is required, the pulp is given a bleaching treatment with any of the well-known bleaching agents, such as bleaching powder, sodium hypochlorite or permanganate and oxalic acid. It is essential that whatever bleach is used all traces of it must be thoroughly washed out. After the purification treatment the pulp is washed and the water is reduced to about 30 per cent by wringing the pulp in centrifugal machines. Sometimes a wet machine such as is common in the paper industry is used, but this does not reduce the moisture to the same extent.

DEHYDRATION WITH ALCOHOL

In order to remove the last 30 per cent of water, the nitrocellulose was formerly dried by means of hot air. This was a dangerous proceeding, as it was inevitable that dust would accumulate in corners or on steam pipes, where it would gradually decompose and finally take fire, usually causing the loss of the whole house. This drying is now done by means of alcohol, as alcohol is a constituent of most solvents, and where it is not a solvent, the small quantity remaining does no harm. Dehydration by alcohol may be carried on in several ways. The usual method employs a hydraulic press. The equivalent of 50 lb. of dry nitrocellulose, but in the wet condition, is placed in the cylinder of a hydraulic press and compressed to a cake 16 in. in diameter and about 8 in. high, a pressure of about 250 lb. being used. (See Fig. 5.)

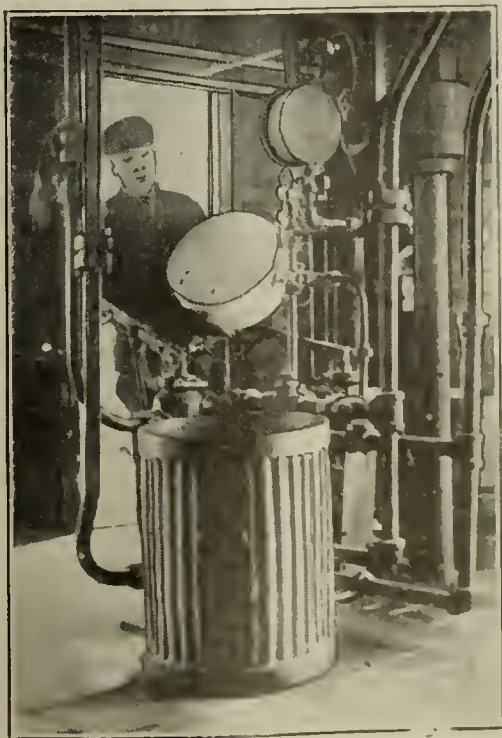


FIG. 5. DEHYDRATING PRESS SHOWING CAKE READY FOR TREATMENT WITH ALCOHOL



FIG. 6. CONVEYOR CARRYING NITROCELLULOSE TO FINAL PACKING HOUSE

Seventy-five lb. of strong alcohol is then pumped through the cake, being uniformly distributed over it by perforations in the top piston. Actual displacement of the water takes place, as can be shown by taking samples of the discharge. When all this alcohol has been pumped in, the block is saturated with strong alcohol in place of water, and the excess is removed by applying a pressure of 3,500 lb. for a short time. The whole operation with experienced operators takes less than four minutes, and it is therefore the quickest and most efficient method. When the block is removed from the press it contains from 20 to 25 per cent of alcohol, depending on the length of pressing and the character of the nitrocellulose. The block is now broken up in order to make the individual particles more accessible to solvents, and is ready for any of its various uses. Nitrocellulose is not dehydrated for use in gelatine dynamite or charges for torpedoes and mines. In the former case the small percentage of moisture, amounting to perhaps 0.3 per cent of the weight of the dynamite, does not make any difference. In the latter the guncotton is compressed under very high pressure, thus reducing the moisture to about 12 per cent. Guncotton with this percentage of moisture can be detonated by the detonation of a small quantity of dry guncotton.

MILITARY AND PEACE-TIME USES

The uses of nitrocellulose are many and varied. There is probably not a household that does not contain it in one form or another, nor would the World War have been possible on its enormous scale without nitrocellulose powders. As previously mentioned, its first uses were in medicine and in photography, and these uses still continue and have in the latter case reached enormous proportions. Most moving picture and camera films are made from it, and photographic papers receive a preliminary treatment with nitrocellulose solutions. Collodion is still used as the carrier for the sensitive emulsion used in photo-engraving.

During the years of the World War, of course, its largest use was for smokeless powders. Before the war the total capacity of the country for cannon powder was probably not far in excess of 40,000 lb. per day, or 12,000,000 lb. annually. At the time the armistice was signed facilities had been provided to turn out this quantity in less than four days. Most of

the plants that produced this enormous quantity have since been dismantled. Military smokeless powders consist of nitrocellulose alone or of a mixture of nitroglycerine and nitrocellulose. Most countries outside of Great Britain use the former, but even Great Britain was forced to come to it during the war.

One of the largest peace-time uses for nitrocellulose is found in the celluloid or pyroxylin plastic industry. Celluloid, being a trade name protected by registration in the Patent Office, other manufacturers sell this product under such names as Fiberloid, Viscoloid, Pyralin and Herculoid, etc. The methods of manufacture used by the different companies are very similar. The nitrocellulose is prepared with few exceptions, at least in this country, from a pure rag tissue paper. It can, however, be made successfully from cotton. The main consideration is to get a raw material that is clean.

Other important uses are found in the artificial leather and lacquer industries. The first artificial silk was made from nitrocellulose, and fiber silk of this type still holds its own against more recent processes as shown by the construction of a plant for its manufacture in this country within the past year. Nitrocellulose is also used in a variety of other ways such as in solid alcohol, gas mantles, nail polishes and as a coating for gas mantles.

From this brief outline some idea of the importance and magnitude of the nitrocellulose industry and of the interesting problems connected with it should be conveyed. The nitrocellulose industry is based on cellulose, and cellulose itself presents a great many problems. As has been mentioned before, its constitution or chemical structure is still unknown. It has been pointed out elsewhere that original American contributions to cellulose chemistry have been very few. To encourage research and discussion in this field a Cellulose Section has been established by the American Chemical Society. It is hoped that all who are interested in this subject will enroll in this section and take part in future meetings, which should prove profitable and interesting.

Lead and Zinc Pigments Marketed in the United States, 1919-20

The following table shows the amount of lead and zinc pigments marketed in the United States in 1920, with the value and average selling price of each, compiled from reports made by producers to the United States Geological Survey, Department of the Interior. Figures for 1919 are also shown for comparison.

An increase in the quantity sold was shown by every product except zinc oxide, in which there was a loss of 15 per cent, but the average price per ton of zinc oxide showed a slight gain. There was also an increase in the average selling price of the other pigments. The greatest gains in 1920 were made by litharge, in which the gain in sales was 33 per cent and the gain in average price per ton was \$61.11, or 44 per cent.

LEAD AND ZINC PIGMENTS MARKETING IN THE UNITED STATES, 1919-20

	1919			1920		
	Quantity, (Short Tons)	Value Total	Per Ton	Quantity, (Short Tons)	Value Total	Per Ton
White lead:						
Dry	30,085	\$4,845,788	\$161 07	33,678	\$6,351,798	\$188 60
In oil	109,005	21,579,234	197 97	112,017	25,986,100	231 98
Red lead and						
orange mineral..	32,362	5,314,255	164 21	34,431	7,523,089	218 50
Litharge	46,739	6,431,801	137 61	62,329	12,386,185	198 72
Zinc oxide	117,639	20,591,877	175 04	99,444	17,859,736	179 60
Lead zinc oxide..	27,591	4,009,024	145 30	30,460	4,467,532	146 67

Chemical Dips Prevent Blue Stain in Lumber*

Blue stain is the most troublesome of the sap stains which discolor wood. It is caused by a fungus which germinates on the sapwood and penetrates its cells in search of starches and sugars. This action of the fungus causes no perceptible weakening of the wood, but the discoloration which results lessens the value of the lumber for many purposes, such as interior finish, flooring and basket and box veneers. The stain at first may be no more than a bluish spot or stream on the surface, but later, as the fungus develops, the discoloration may involve all of the sapwood and become too deep to surface off. The blue-stain fungus can revive in timbers after long periods of inaction brought on by lack of moisture.

GREEN LUMBER MOST AFFECTED

Warm weather and a comparatively high moisture content of the wood are the most favorable conditions for the growth of the blue-stain fungus. Most of the infection occurs in green lumber which is piled without ample ventilation between the boards in the mill yard or during shipment.

As yet no absolutely dependable means of preventing blue stain has been found, other than kiln drying the lumber. The ordinary kiln-drying process is entirely effective against blue stain, but there are many cases in which this means of prevention is not feasible. Staining during air seasoning can be largely controlled by open piling. This affords free circulation of the air and so hastens drying, but not always sufficiently under adverse weather conditions to discourage the stain fungi.

CHEMICALS USED TO PREVENT STAIN

The treatment of the green lumber with antiseptic dips is the most effective method which is generally applicable at the present time. For this purpose the chemicals commonly used are sodium carbonate and sodium bicarbonate. Neither is a sovereign remedy under severe conditions, such as continuous rainy periods during the warm months, but will go far towards keeping the stock clean. In rainy seasons an 8 per cent solution of sodium carbonate is desirable, but in drier weather half this strength should suffice. A high grade of soda ash should contain about 58.5 per cent alkali, and every effort should be made to conform to this standard of purity. When sodium bicarbonate is used, an 11 per cent solution should be employed in wet weather and 5 to 6 per cent in dry weather. This chemical when dry should contain about 37 per cent alkali.

POINTS TO BEAR IN MIND

In the use of these chemical dips, the following points should be kept in mind: The solutions should be carefully mixed and the concentrations in the dipping tanks should be kept uniform by means of a hydrometer; the solutions should be heated when applied, the bicarbonate solution not above 120 deg. F., however, because it is broken into the carbonate by excessive heating; the stock should be dipped as it comes from the saw; after dipping it should be carefully piled so as to insure ample ventilation. Narrow, chemically treated cross strips are preferable to the wide untreated strips commonly employed, since treated crossers tend to eliminate stain at the point of contact.

*From U. S. Forest Products Laboratory Technical Notes.

Some Points in the Design of Blast-Furnace Gas Cleaners*

Methods for Determining the Velocity and Moisture Content of Hot Gases Flowing Through Large Pipes
—Calculations for a Heat Interchanger Built to Cool Gas From a Ferromanganese Furnace at
1,200 Deg. F. to 400 Deg. F. Without Increasing Its Absolute Humidity

BY N. H. GELLERT
President Gellert Engineering Co.

THE problem of cleaning gases issuing from a blast furnace has never been a simple one. Various methods of cleaning gases have been discussed so thoroughly in papers which have been read in the past before technical societies interested in this general subject that there is no need of reviewing this subject again at this time.

It is of course essential in the very beginning to know the condition of the blast-furnace gas before there can be any intelligent attempt to clean the dust and fume from the gas. In general, blast-furnace gases contain from 2 to 10 grains of dust per cu.ft. of gas at standard conditions of temperature and pressure—namely, 62 deg. F. and 29.92 in. Hg. This dust exists in the form of both dust and fume. The fume is so finely subdivided, however, that in a great many respects it acts as a perfect gas.

In order to determine how to apply a cleaner to the blast-furnace gas, there are at least four things which must be investigated: Velocity and volume, dust content, moisture content and temperature.

The equipment necessary to make a volume determination, as a rule, is a Pitot tube of a standard type, a manometer tube, rubber tubing, some boards and nails, measuring rule and a few tools. A gas-measuring station location should be selected in the gas main where the most uniform gas flow conditions are ap-

the circular main should then be calculated. The velocity of the gas flowing through the main is greater at the center than near the walls. Therefore to get the average gas velocity it is necessary to take a large number of velocity readings across one or preferably two diameters of the main. By dividing the main into equal areas as in Tables I and II it is possible to get the average main velocity in the simplest way and with the least expenditure of time. The average velocity of the total gas flow will be the average of the velocities at the mean velocity points of the equal area zones.

TABLE II. DIAMETER AND RADII OF CONCENTRIC RINGS FOR FIVE EQUAL AREAS

Area	Diameter of Outer Edge of Ring	Mean Velocity Point	
		Distance From Center	Distance From Sides of Pipe
1	44.7	15.8	34.2 and 65.8
2	63.2	27.4	22.6 and 77.4
3	77.5	35.4	14.7 and 85.3
4	89.4	41.8	8.2 and 91.8
5	100.0	47.4	2.6 and 97.4

Under normal conditions the following formula applies to blast-furnace gases.

$$V = 2.9\sqrt{TH}$$

Where

V is the gas velocity in ft. per sec.;

T is temperature in deg. F. plus 460, and

H is velocity head in inches of water.

There have been two methods developed for determining the vapor volume and the resulting volume of the gas mixture. Both methods check within 10 per cent for moisture and within less than 1 per cent for totals of gas and moisture. The formula resulting from one of these methods is:

$$V_f = V_w \times \frac{V_s}{T_s} \times T_f + V_m \times \frac{T_f}{T_m} \times \frac{P_m}{P_f}$$

Where

V_f is volume of gas at conditions in main in cu.ft.;

V_w is volume of vapor at main conditions in cu.ft.;

V_m is volume of dry gas at meter conditions in cu.ft.;

T_f is absolute temperature at main conditions;

T_m is absolute temperature of gas at meter;

T_s is absolute temperature of the saturated vapor or steam at the pressure of gas main;

P_m is absolute pressure of meter in inches of mercury. It equals $B - P_m$ if pressure is negative (B is 29.92 in. Hg when standard);

P_f is absolute pressure of gas main or flue. It equals $B + P_f \times 0.0735$ if pressure is positive;

P_f is absolute pressure in inches of water in flue or main;

V_g is the vol. of dry gas at main conditions in cu.ft.;

V_s is specific volume of unit mass of water as saturated vapor at pressure of main.

TABLE I. DIAMETER AND RADII OF CONCENTRIC RINGS FOR TEN EQUAL AREAS

Area	Diameter of Outer Edge of Ring	Mean Velocity Point	
		Distance From Center	Distance From Sides of Pipe
1	31.6	11.2	38.8 and 61.2
2	44.7	19.4	30.6 and 69.4
3	54.7	25.0	25.0 and 75.0
4	63.2	29.6	20.4 and 79.6
5	70.7	33.5	16.5 and 83.5
6	77.5	37.1	12.9 and 87.1
7	83.7	40.3	9.7 and 90.3
8	89.4	43.3	6.7 and 93.3
9	94.9	46.1	3.9 and 96.1
10	100.0	48.7	1.3 and 98.7

proximated. The conditions are always adversely affected by bends, connections, off-takes, explosion doors, manholes, etc. If a straight portion of main can be found four to ten times the diameter in length and without valves, off-takes or some other interfering object, the conditions may be assumed to be good for gas measurements.

After this station has been located, it is necessary to determine the inside dimensions of the main in which the flow of gas is to be measured. If the main is horizontal, care should be used in sounding the inside bottom of the main for any deposits of flue dust which may reduce the total cross-sectional area. The area of

*Extracts from a paper read before the Cleveland Section of the Association of Iron and Steel Electrical Engineers, April 11, 1921.

TABLE III. VALUES OF $\frac{V_s}{T_s}$ FOR 1,000 g. SATURATED STEAM AT VARIOUS PRESSURES EXPRESSED IN POUNDS, ABSOLUTE

Absolute Pressure, Lb. Sq. In.	Saturation Temp., Deg. F.	$\frac{V_s}{T_s}$	Absolute Pressure, Lb. Sq. In.	Saturation Temp., Deg. F.	$\frac{V_s}{T_s}$
10	193.2	0.1300	23	235.5	0.0560
11	197.8	0.1179	24	237.8	0.0533
12	202.0	0.1081	25	240.1	0.0515
13	205.9	0.0995	26	242.2	0.0495
14	209.6	0.0925	27	244.4	0.0476
15	213.0	0.0863	28	246.4	0.0458
16	216.3	0.08075	29	248.4	0.0442
17	219.4	0.0760	30	250.4	0.0427
18	222.4	0.0718	31	252.3	0.0413
19	225.2	0.0680	32	254.1	0.0400
20	228.0	0.06435	33	255.8	0.0388
21	230.6	0.0613	34	257.6	0.0377
22	233.1	0.05845	35	259.3	0.0365

TABLE IV. VALUES OF $\frac{V_s}{T_s}$ FOR 1,000 g. SATURATED STEAM AT VARIOUS PRESSURES EXPRESSED IN INCHES OF WATER*

Pressure in In. Water, Below 1 Atm.	Saturation Temp.	$\frac{V_s}{T_s}$	Pressure in In. Water, Above 1 Atm.	Saturation Temp.	$\frac{V_s}{T_s}$
20	209.5	0.093	20	214.2	0.0840
18	209.8	0.0925	18	214.0	0.0844
16	210.0	0.0920	16	213.8	0.0846
14	210.2	0.0915	14	213.5	0.0851
12	210.5	0.0909	12	213.3	0.0855
10	210.8	0.0904	10	213.0	0.0860
8	211.0	0.0899	8	212.8	0.0864
6	211.2	0.0894	6	212.6	0.0868
4	211.5	0.0889	4	212.4	0.0873
2	211.7	0.0885	2	212.2	0.0877
0 or 1 atm.	212.0	0.0881	0 or 1 atm.	212.0	.....

* One atmosphere equals 14.7 lb. per sq. in., 29.92 in. Hg, 33.93 ft. of water at 60 deg., or 407.16 in. of water at 60 deg. One inch of water equals 0.0735 in. of mercury.

In Europe the practice has been somewhat different from that in the United States, as there were early efforts to develop dry cleaners. As a matter of fact, dry cleaners have been operating in Europe for some time and have been mainly objectionable for two reasons: High cost and possible damage to the cleaner.

The cleaners built in Europe were of the bag type and while they cleaned the gas more effectively than any primary cleaner could and even went so far as to prepare the gases for gas engine purposes, the bags, being of a flammable nature, necessarily were subject to destruction whenever the heats put through the cleaners exceeded the safe limits of the material of which the bags were made. The high cost also of installation of this type of cleaners militated very greatly against their adoption and perhaps was the chief reason why such dry cleaners were not installed in this country.

Perhaps a third feature which militated against the use of these dry cleaners was the fact that the sensible heat lost in the cooling of the gas robbed the gas of a great deal of the economies which might be obtained were the sensible heat retained.

Any screen type of cleaner which attempts to filter out particles of dust and fume, even when the filtering medium is not destroyed by the normal heats of the blast-furnace gas, must be sufficiently fine in nature to present a hole smaller than the finest particle of dust and fume going through in order to remove successfully the objectionable solid material in the gas. If the screen is so fine that it will remove the particles of fume, the back pressure will be high and the screen will clog up quickly. If the screen is designed with apertures large enough to prevent any considerable back pressure, the fine particles of fume and dust will go through. The problem, therefore, of screening the fume and dust out of the blast-furnace gas is not a simple one.

It is very evident on further thought that conditions arise when the gas discharging from the furnace top is

very hot and it is impossible to utilize any system of dry cleaning without destroying the cleaning medium. For instance, in the manufacture of ferromanganese, the gases discharging from the furnaces have temperatures running as high as 1,500 deg. F. As steel glows red hot at temperatures of this kind, some necessity arises for cooling the gas to such a point that destruction of the steel does not take place. If it is desirable to cool the gas which is as high as 1,300 deg. F. to a temperature between 400 and 500 deg. so as not to lose the sensible heat which is present in the gas at this lower temperature, care must be taken not to add water for cooling purposes, as the amount of water present when the gas is saturated at 400 deg. F. is so great that it would seriously handicap combustion in the stoves and boilers. A cooler therefore must be of such a type that the heat is transferred from the gas into the water through tubes and not by direct contact.

In actually designing one of these coolers for a ferromanganese furnace the following formulas were used; and it was possible to check the design of this cooler after it went into operation. The results obtained are within 85 per cent of the calculated figures.

Sh = specific heat of gas;

Gw = wt. of gas per hr.;

Gt_1 = temp. of inlet gas;

Gt_2 = temp. of outlet gas;

Wt_1 = temp. of inlet water;

Wt_2 = temp. of outlet water;

C = constant (5);

A = condensing area in sq.ft.

$$A = \frac{Gw \times Sh(Gt_1 - Gt_2)}{[\frac{1}{2}(Gt_1 + Gt_2) - \frac{1}{2}(Wt_1 + Wt_2)] \times C}$$

$$Wt_2 = \frac{Sh \times Ws}{W} \times (Gt_1 - Gt_2) + Wt_1$$

$$\frac{W}{K} = 5 \quad K = Gw.$$

A typical example of calculation per 200 tons pig iron per twenty-four hours is as follows:

200 tons coke per day = 400,000 lb. coke per day
 65 cu.ft. gas per lb.
 26,000,000 cu.ft. gas per day
 1,080,000 cu.ft. gas per hr.
 18,000 cu.ft. gas per min.
 1,080,000 cu.ft. gas per hr.
 Wt. per cu.ft. blast-furnace gas = 0.081 lb.
 Spec. heat blast-furnace gas = 0.24
 Temp. inlet water = 60 deg. F.
 Temp. outlet water = 150 deg. F.
 Temp. inlet gas = 1,200 deg. F.
 Temp. outlet gas = 400 deg. F.
 $1,080,000 \times 0.081 = 88,000$ lb. gas per hr.

$$A = \frac{88,000 \times 0.24 \times (1200 - 400)}{[\frac{1}{2}(1200 + 400) - \frac{1}{2}(60 + 150)] \times 5}$$

$$A = \frac{21,100 \times 800}{(800 - 105) \times 5} = \frac{16,880,000}{695 \times 5}$$

$$A = 4,850 \text{ sq.ft.}$$

1 length 4-in. pipe 30 ft. long has area of 30.14 sq.ft.
 $4850 \div 30.14 = 161$ lengths.

Check:

5 B.t.u.'s transmitted per sq.ft. per hr. per deg. difference in temperature

Then:

4,850 sq.ft. is area.

$$(1,200 + 400) - (150 + 60)$$

2

Then:

B.t.u.'s transmitted per hr. = $4,850 \times 695 \times 5 = 16,900,000$

Now gas given up is 88,000 lb. gas per hr.

Specific heat = 0.24

Difference in temperature, 800

Then B.t.u.'s given up by gas per hr. = $88,000 \times 0.24 \times 800 = 16,850,000$

B.t.u.'s

Water used:

Difference in temp. 90 deg. F.

B.t.u.'s absorbed, 16,900,000 per hr.

16,900,000

$$\frac{16,900,000}{90} = 187,000 \text{ lb. per hr.} = 22,600 \text{ gal. per hr.} = 376.6 \text{ gal. per min.}$$

Chemical Stoneware Manufacture

Production of Chemical Stoneware Involves Ceramic Problems Different From Other Wares for Varying Uses in Chemical Plants—Preparing the Body—Aging the Clay—Fabricating the Pieces—Drying and Burning—Finishing the Burned Ware—Plant Control

By CHESTER H. JONES

POTTERY bodies, common brick, terra cotta, etc., may be likened to cast iron in general qualities of strength and methods of working the raw materials, common stoneware may be compared to malleable iron in physical properties, but chemical stoneware is the *steel* of the ceramic industry. The clay is first weathered, treated and aged, then worked, rolled, pugged and beaten until the resultant product can be handled almost like slabs of leather; it is erected section by section into the shape desired; the piece is tempered in the drying, with time an important factor after the manner of steel, and then it is soaked in the heat of the kiln up to 2,700 deg. F. until complete vitrification is attained throughout the entire body. Thus the finished piece can resist maximum mechanical shocks, temperature changes and acid attack. It may be hammered vigorously without breaking.

As a testimonial to the resistance to temperature variations the first thing that strikes the eye of the visitor at the plant of Maurice A. Knight, at Akron, Ohio, is the apparatus appearing on one of the stacks shown in Fig. 1. Several years ago two 50-gal. acid receivers and two 1½-gal. monkey pumps were mounted in this position. They are subjected to flame from the stack on one side and cold wind and sleet on the other throughout the winter months, yet no deterioration is apparent.

For acid-resistant qualities in general two different bodies are manufactured. One, where hot concentrated fumes like hydrochloric and nitric acids with little condensation must be retained, requires a more porous body to resist expansion and contraction; the other, where corrosive liquids or condensation products are in contact, demands a denser body to obviate possible seepage.

RAW MATERIALS

The clays used in manufacturing chemical stoneware must have high bonding strength, small drying and burning shrinkages and a rather wide range of vitrification. Crushed stoneware scrap is often added as grog to reduce the shrinkage. The Bureau of Mines has issued a valuable bulletin (Technical Paper 233, "The Properties of Some Stoneware Clays," by H. G. Schurecht) describing various tests and properties of these clays as found in the Ohio and Pennsylvania fields.

In general there are seven different clays used at the Maurice A. Knight plant, so blended as to produce as many different stoneware bodies. The manufacture of the different wares requires the study of the chemical engineer co-operating with the ceramist in order that the mix of clays for the body may be varied to meet the conditions of different applications in any acid system. Two clays may have approximately the same

chemical composition but vary in grain size. Tougher bodies are produced by mixing them to get a varying size of silica grain. The chief constituents are alumina, silica and some magnesia with minimum content of iron, lime and alkali salts. Fineness of grain is the most essential physical feature. All clays are carefully analyzed in both the chemical and ceramic laboratories.

The clays arrive by rail, coming principally from the Ohio, Tennessee and New Jersey fields. Some English clays are also used. They vary from plastic ball clay to high-grade plastic fireclay. The raw material is weathered in stock piles for periods ranging from one to six months. The superintendent in charge of purchasing inspects all clay as it is mined, watching the strata closely to be sure the raw product of the pit is uniform.

Dry grinding is employed at this plant in preparing the clay. The whole operation is carried on without the use of blungers or filter presses. A better body for chemical stoneware is obtained by this method, because a considerable amount of salts ordinarily washed out by the blunging and filtering method are retained



FIG. 1. TWO 50-GAL. ACID RECEIVERS AND TWO 1½-GAL. MONKEY PUMPS (ON TOP OF STACK)

to give added toughness and strength as well as longer life to the burned piece. Not only is the clay more easily cut and worked in the plastic stage, but during the firing these ingredients assist in distributing the vitrification through the body to produce a tougher ware.

The ware is often rougher in appearance than is that made by the wet process, but actual breaking tests have shown the burned piece to have greater strength. Toughness and thorough vitrification of body to resist corrosive action are, of course, first requisites of chemical plant apparatus.

The clay mix first enters the two dry pans, one of which is shown in Fig. 2, where it undergoes a long period of grinding. Grog or broken stoneware is ground with the clay for some of the bodies. When the material has reached sufficient fineness it is drawn off to an inclined floor, at the bottom of which are three chaser mills. The fine clay is introduced to these mills, where a certain amount of water is added—just enough to secure a workable product. Grog is used only in batches for making larger ware.

From two and one-half to four hours is required for this operation. The chaser mill resembles the dry pan in general appearance except that the wheels have only



FIG. 2. DRY PANS

a 3-in. face and the pan remains stationary while the horizontal axle carrying the wheels is revolved about a vertical central shaft. At the same time this axle is being turned on a pivot normal to its axis the wheels sliding upon it are "chased" back and forth from the center to the outer edge of the pan, thus grinding the wet clay over all parts of the bottom.

The chaser is an old piece of equipment in the clay industry and has been largely superseded by the wet pan and other processes. Its output is limited both because of size of batch and because of speed of operation. The quality of product turned out is of the finest

and toughest texture, mainly because the method tempers as well as grinds the clay.

When each chaser batch is finished as determined by an operator who becomes expert on the "feel" as well as the formula, it is transferred to the concrete aging pits, where it remains for varying periods, the longest being about six months. During this time it is covered with sacking or burlap, which is moistened each day.



FIG. 3. AUGER MACHINE

The practical effect of aging this clay is to increase its plasticity and toughness. It has a "rubbery" appearance and feel.

Recent research into the reason for aging clay and the phenomena involved has indicated that during the aging period there is a growth of green filamentous algæ as examined under the microscope. This growing is accompanied by the evolution of CO and CO₂. The next point is to determine why the presence of this algal growth increases the plasticity, and the work of H. Spurrier and others will be awaited with interest.

When the clay is removed from the aging pits the edges and surfaces are trimmed off. These trimmings, together with clay trimmings from subsequent forming processes are used in making chemical brick. Thus only the very tough dense product from the inner part of each pile is used in forming other chemical ware. Two-ton Bonnot repress brick machines with others are located on the same floor as the aging pits. The clay for various shapes and vessels is transported on shelf elevators to the upper floors, where it enters the structural departments.

Next in importance to the scientific selection of raw materials and careful preparation of the plastic, tough clay under technical control come the design and erection of the piece to give the best service in the chemical plant. This is truly a function of chemical engineering—namely, to evolve the most suitable mechanical device that will best handle the certain phase of the chemical process. The potter is guided by the engineer to devote his skill and training to chemical plant design.

The technique of stoneware manufacture requires considerable mechanical care. Shrinkage in drying and burning must be taken into consideration in the original dimensions of the wet piece. This varies from 8 to 12 per cent of the volume, with an average of 10 per cent, in the drying and firing shrinkage. Accuracy of measurement is very necessary since many of the parts must fit together when erected in place.

The section devoted to the manufacture of stoneware pipe employs a J. D. Fate auger machine shown in Fig. 3. The sacking in the right foreground covers the operating stock of clay to prevent surface drying.

"The 'Why' of Aging Clay," *J. Am. Cer. Soc.*, vol. 4, No. 2.



FIG. 4. MANIFOLD FOR NITRIC ACID

All working piles, as well as newly formed ware about the plant, are kept thus protected. In the case of the latter protection is necessary to prevent too rapid drying and surface cracking.

The clay is thrown into the chamber of this machine and pipe is extruded through suitable dies on the left end, the clay being forced out by a slowly revolving screw. This method produces pipes free from laminations, such as may occur in sewer pipe presses. Fig. 4 shows some special nitric acid manifolds. The main length is formed in the auger machine, while the branches are made by hand and on the potter's wheel or jigger. Other small pieces are turned on ordinary machine lathes. The whole is assembled by careful hand work. Chamotte pipes do not require a tight vitreous body, because they convey only hot gases with no condensation. Fireclay would disintegrate if used for this purpose. This open, porous body is of course not used where much liquid is present.

Another machine used in making pipe sections is the sewer pipe press operated by steam pressure. It will produce pieces from 2 in. to 36 in. in diameter, but is used only for the smaller bores, where the possibility of laminations is minimized. The converging pressure during the molding of the smaller diameter pieces works the clay to prevent such laminations. Larger bore pipe such as tower sections are all hand built the same as receivers and jars.

Large pieces of chemical stoneware are made entirely by hand. Plaster of paris molds are first built in take-down sections. One of these assembled molds appears on the extreme left of Fig. 5. The pieces in the foreground are finished filter bottoms resting in the bottom mold with the side sections of the mold removed.

The clay for this construction is battled and rolled out into sheets near the required thickness and of such dimensions as the modeler can pick up from the table and transfer to the mold. These sheets are easily handled, being quite tough and flexible. The modeler



FIG. 5. FINISHED FILTER BOTTOMS

slaps them into the mold and proceeds to work them into place, taking special care to see that the line of juncture with adjacent pieces is entirely eliminated by working the plastic material to a firm weld. A joint thus made is said to be stronger and less apt to break than other parts of the piece. The whole operation reminds the spectator of movements carried on in the welding of steel tanks.

When the work is complete and the clay has become one piece, the sides of the mold are immediately removed, the bottom of the mold being left for a support until the air drying is completed. Wet cloths are thrown over the top, as seen in the left of Fig. 6, to prevent premature drying. Finally these are removed, as seen on the right in the same picture, and the heaviest piece may be lifted by the rim in transferring to the driers—a fact which roughly demonstrates the bonding strength of the clay.

Further question of shape may be noted in these large pieces. Examination of the foremost piece in Fig. 5 will show that the vertical outline is not straight, but curves outward toward the bottom. This is necessary, because the moisture aided by capillary action settles to the bottom during drying and would warp the piece unless provided for in the first place. This ware



FIG. 6. LARGE PIECES OF CHEMICAL STONEWARE

when burned will have the perfectly straight edge as intended by the designer. Like irregularities must be worked in throughout the fabrication of all sorts of shapes. In the tank department units up to 500-gal. capacity can be made, but it is recommended that sizes be limited in general to 200-gal. capacity so that in case of accidental breakage less solution will be lost.

One of the large-quantity products of the Knight company is the etching machine which is sold to engravers, photographers and printing establishments. Several of these are shown ready for the drying room in Fig. 7. The four holes in the side of the box permit the introduction of four revolving paddle wheels, one of which is seen lying across the top of the box, with others drying on the floor in the immediate foreground. The piece of clay pipe lying across the top of each box is a temporary support to hold the walls in place during drying and burning.

Thin sections of dense clay are required in the manufacture of this ware and other containers and condensers for hydrochloric and nitric acids. Here the temperature changes are not great, but liquid must not seep through the pores. Battery jars and electrolytic cells likewise require a dense body, but the sides are built heavier to support the electrodes. The pieces shown in Fig. 8 are parts for the electrolytic cell units in the process of air drying.



FIG. 7. ETCHING MACHINES

The finished piece shown in the foreground of Fig. 9 is a 2-in. bore 100 ft. condenser coil for nitric acid, one which always attracts attention to the apparent intricacy of the modeler's work. Its manufacture is, however, quite simple. The support is first built up and then the necessary length of pipe is taken moist as it comes from the auger machine and wound into place by hand, care being taken to allow for necessary shrinkage in drying and burning. A piece of asbestos sheet is inserted between each lug and the section of pipe which rests upon it. This prevents the pipe from burning to the lug in the kiln and permits the entire coil in contracting to slip over the lugs. When the piece is finished, the coil may contract and expand independently of the movement of the supports. The asbestos pieces are changed to a ceramic material by

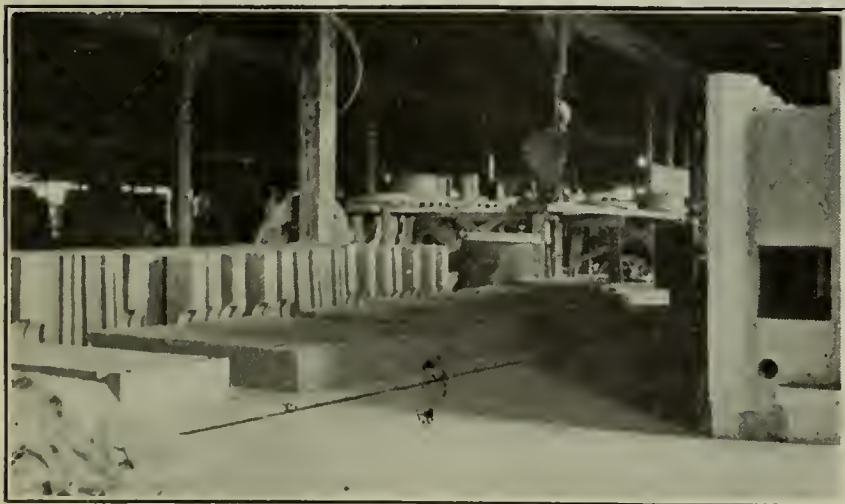


FIG. 8. PARTS FOR ELECTROLYTIC CELLS IN PROCESS OF DRYING

the heat and resemble burned clay. They remain in place to give an even support to the coil.

The development has just been completed of a porous chemical stoneware acid carboy stopper. It is shaped like a button head rivet with slightly tapered shank and with crossed groove in the head to receive the wires for binding over the mouth of the carboy. The smooth surface on the under side of the head fits against the rim of the mouth and a rubber or asbestos washer is inserted between.

The clay body is burned porous so that gas will leak through to the outer air but so that liquid will not permeate the pores to any extent. The release of gas prevents the blowing out of stoppers. The importance of this feature is readily recognized by shippers of concentrated nitric acid, who are familiar with fires started in cars and warehouses during warm weather

by the carboys breaking and acid igniting the packing and crating. These stoppers are made on a press which machines the shank and under portion of the head and molds the head in the same operation. It is manufactured by the Baird Machine & Manufacturing Co. of Detroit and produces fifteen stoppers per minute.

Stoneware cocks and faucets are made from clay stock specially selected from the center of the aging pits. The shapes are worked up in the jigger, a potter's wheel with mold top, and are worked by hand to give the desired key or bowl. The key and bowl of such faucet travel as mates through the entire process. They are identified by numbers stamped in the plastic clay, which differs from common practice of stamping a lead plug inserted after burning.

In making faucets, pipe, etc., the threads are cut in



FIG. 9. CONDENSER COILS FOR NITRIC ACID

the wet clay on a machine tool lathe, which insures clean, fine threads after the ware is burned. Comparison with molded threads at once shows the value of this operation. The lathe used is a standard metal-cutting machine made by the Strong, Carlisle & Hammond Co.

After the two parts of a faucet have been through the kiln, the key is mounted, tapered end up, in a jigger and revolved while the operator holding the bowl grinds it to a perfect fit. Wet carborundum dust is applied as the only abrasive which will cut the vitrified material. Fig. 10 shows faucet parts in the grinding room. In the manufacture of stoneware pumps the piston is ground to the cylinder in exactly the same manner. Perfect hollow spheres used for valves in automatic acid lifts are produced by grinding. Nitrating kettles and autoclaves with stirrers having fitted stuffing boxes all made of stoneware may be operated under gas pressure of 40 lb. and upward. All such parts may be lubricated with ordinary oils or greases.

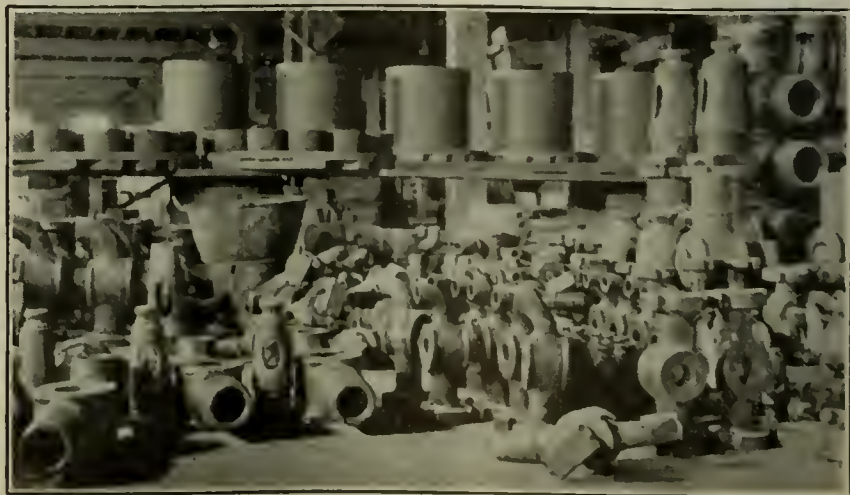


FIG. 10. FAUCET PARTS IN THE GRINDING ROOM



FIG. 11. METHODS OF LOADING WARE IN THE KILN

With the clay worked to so many shapes and sections in the same piece, the process of proper drying becomes most important. As previously mentioned, all possible skill is used in the fabrication to preserve the body from warping with the 10 per cent shrinkage occurring in drying and firing. The removal of moisture must be very slow at first to prevent surface cracking and produce tough body.

The finished pieces are first allowed to set in the air of the molding rooms under wet sacking covers as mentioned and shown in the preceding photographs. The period in the room air drying just before the clay becomes set is the critical point where the wet sack covering is most important.

The actual structure of a mass of clay to be dried is made up of grains of material, each grain being surrounded by a pool of water, which gives cohesion to retain the shape. During the drying process the capillaries in the mass become smaller. The water on the exposed surface evaporates and the water inside flows to the surface through the capillaries. Shrinkage is caused by the removal of these pools of water and by the particles coming in closer contact. Aside from the capillaries, there are still pores between the particles.

In this first part of the drying process carried on in the air of the room for periods varying from one to eight weeks the shrinkage is proportional to the water removed due to this contraction of capillaries. The subsequent removal of the water in the hot driers is not accompanied by much shrinkage. In surface evaporation the safe rate of drying must not be greater than the rate at which the water comes from the inside of the mass through the capillaries; otherwise surface strains are set up, causing cracks, because the plastic interior is non-compressible.

After the ware has undergone the initial set, it is removed to the hot drier, which consists essentially of

a large room with shelves located over a grated wooden floor beneath which steam pipes are laid. Here it is allowed to remain from three days to two weeks—that is, until all but the hygroscopic water is driven off, leaving the ware ready for the kiln.

The burning equipment of this plant consists of six 30-ft. periodic down-draft kilns, each one connected with individual flue of a double stack. High-grade Pittsburgh coal is employed for fuel.

Fig. 11 shows ware stacked in the kiln ready for burning. Chemical brick or tile is piled up from the floor for a height of about 3 ft. to form a checkerwork for an equal distribution of the draft over the whole kiln. This also lifts the finer structure pieces to the best heat zone of the kiln. Chemical brick is then a sort of byproduct of the molded ware, not only because the trimmings of the aging pit and modeling room are used as raw material but also in regard to this need of a distribution bottom in the kiln setting. The resulting brick are therefore made from much better material and burned more cheaply than could be accomplished in the case of manufacturing the one product.

No cones are used in recording the temperatures during burning. An indicating Price temperature recorder is located in the foreman's office, and a recording instrument of the same type is placed in the general manager's office, as shown in Fig. 12. The multiple switch in the upper left hand corner is used for switching the instrument to connect with any kiln. The recorder marks the sheet by perforating at intervals with an electric spark. The electricity is furnished from dry cells contained in the case to the right of the instrument.

The burning time varies from five to eight days, depending on the size and thickness of the ware. The first operation, which consists of water smoking, is carried on for two or three days at a temperature up to



FIG. 12. KILN TEMPERATURE RECORDS

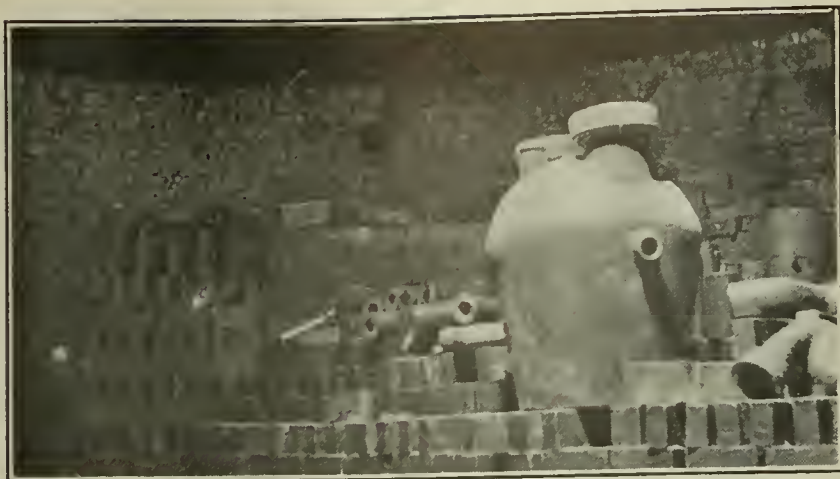


FIG. 13. CLOSE-UP VIEWS OF FINISHED WARE
IN THE KILN

300 deg. F. While the material from the hot driers is apparently dry, it still contains a large quantity of hygroscopic water as well as the water chemically combined with the clay. During this period a large amount of white steam issues from the stack. The driving off must be carried on slowly or the water will be too quickly converted to steam and the clay body be damaged. This is particularly true in the case of dense stoneware clays where the pores are exceedingly small, permitting only a slow passage of water vapor from the interior of the body.

When this period is completed as determined by moisture tests of the stack gases, the drafts are opened and the firing increased up to 1,000 deg. F. This step is to drive off the water of crystallization or chemical combination, which occurs quite rapidly at this temperature. The temperature rises quite slowly at this time, however, because a large quantity of the heat is absorbed in breaking off the water. At the same time any carbonates present are broken up to form oxides and CO_2 , which absorbs additional heat. The end of this operation may be determined by weighing the test-pieces until loss of weight is no longer evident.

During the latter part of this period the oxidation of any materials like ferrous oxide, carbon, sulphur, etc., that may be present takes place. Since chemical stoneware clays are selected nearly free from such elements, the vitrification stage is almost immediately entered upon. It requires about two days' time to raise from the water smoking stage, about 300 deg. F., to the vitrification or maximum temperature, 2,600 to 2,700 deg. F. Vitrification really begins at the lower temperature, but does not become apparent to the observer until the higher temperatures are reached. The high soaking temperature runs about twenty-four hours from 2,000 deg. F. up to the maximum, 2,700 deg. F.

It is here that the size of grain of the different clays, as mentioned at the beginning of this article, exerts the most profound influence in governing the kind and amount of body fluxing. The fineness of grain insures more ready assimilation of every particle to form a homogeneous body completely vitrified throughout. It makes for a tough, strong body impervious to corrosive attacks in the finished piece. True in case of the heavy, thick sectioned pieces where grog is used to give firm skeleton to hold this mass to shape when in the hot colloidal condition, the bits of grog do not melt down. It will be recalled, however, that this grog was ground from previously burned stoneware in the first place and is therefore tough and impervious to acid.

During the high soaking period a few pounds of com-

mon salt is thrown into each firebox to give a glaze to the ware. This is in no way for the purpose of adding to the acid-resisting properties, but is simply to give a finished appearance. Finally, the fires are permitted to die down and the kilns to cool for three or four days before opening.

Fig. 13 is a close-up view of the interior of a kiln, with the finished ware in place. Note that the shapes are stacked on the brick checkerwork as mentioned above. The shapes vary in size from carboy stoppers to large receivers. No saggars or containers are used. In some cases bats separate the larger pieces to prevent fusion of the glaze. The maximum life of kilns burning this class of ware is about ten years, but arches, bag walls and fireboxes must be repaired every six months. It will be seen in comparing this picture of the burned ware with that of the unburned ware in Fig. 11 that they have become darker in appearance. They are in fact changed in color to a brownish red.

The ware is finally sent from kiln to finishing plant, where it is ground to accurate surfaces on revolving grinding tables using carborundum as an abrasive. All vesse's undergo tests for ability to retain liquids.

APPARATUS MANUFACTURED

While some standard pieces are turned out, it is just as cheap to produce the desired ware from customer's blueprint. It is easily recognized from the foregoing paragraphs that the operations of manufacture require hand skill of individual craftsmen in every stage, which of course is as readily applied on special pieces as on the standard. Order number and blueprint number are stamped and burned in every article.

The field of use for chemical stoneware embraces acid manufacturers, acid users, etching plants, printing plants, photographic houses, electrolytic plants, paper mil's, steel galvanizing and pickling plants, soap manufacturers, fertilizer producers, ink, dye, paint, insecticide and pharmaceutical manufacturers. Reclaiming plants for rubber and bleaching houses use a considerable variety of stoneware apparatus. Producers of organic chemicals of all sorts and even laboratories in the industries employ some small chemical stoneware utensils, such as sinks, waste pipe lines, burner guards, funnels, pitchers, filters and jars.

An acid-proof cement, high in silica and free from soluble salts, is ground in pebble mills to pass 80-mesh screen and bagged for the market. It may be used in chemical plants in the construction of masonry work which will come in contact with hot or cold, strong or weak and liquid or gaseous acids. This powder is mixed on the job with enough 30 to 40 deg. Bé. silicate of soda solution to make a uniform stiff mortar. About forty parts by weight of the solution is required for one hundred parts of cement powder. The cement will harden at ordinary temperature with free access of air.

ORGANIZATION

Every workman in the plant is his own foreman, an ideal condition for the development of true craftsmanship. There is no piece work whatever. The entire organization is headed by one general manager and his assistant. The whole forms a body of contented workmen functioning through personal contact with one head.

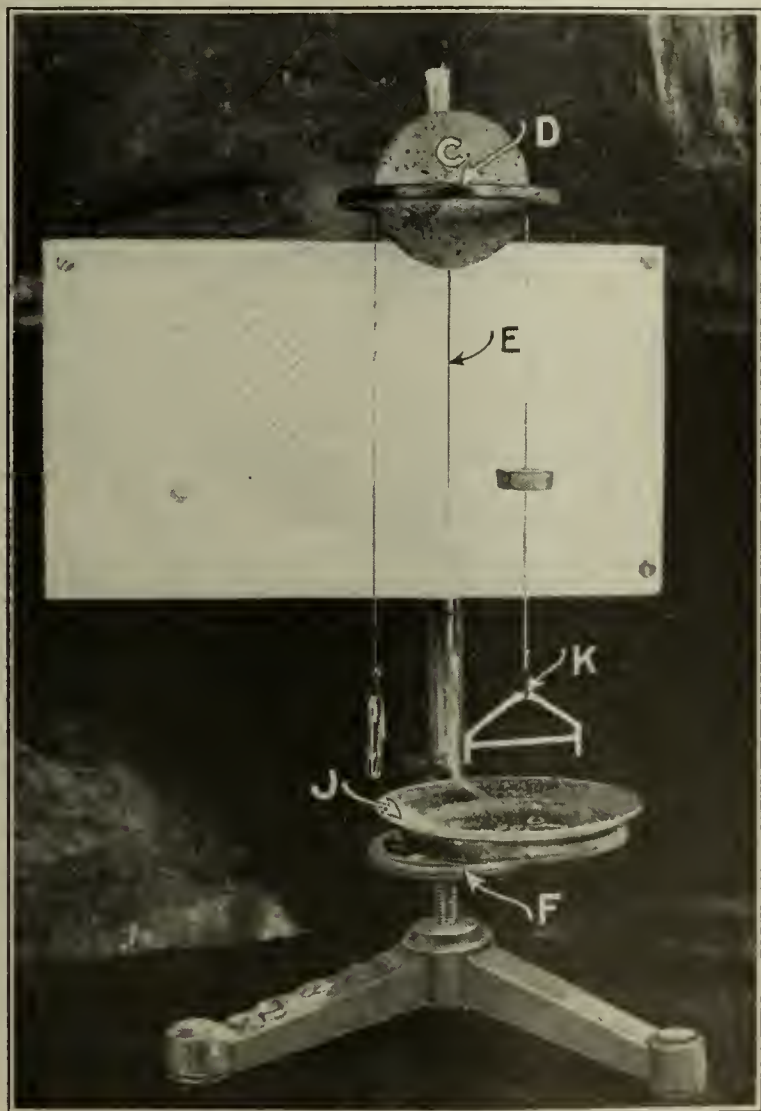
The writer is indebted to Maurice A. Knight for courtesy and information furnished in the preparation of this article.

Synopsis of Recent Chemical & Metallurgical Literature

Measurement of Surface Tension.—A. W. Fahrenwald, ore dressing engineer of the Bureau of Mines, has devised a simple instrument for measuring the surface tension of liquids by measuring the pull required to rupture a film of known width. A full description is given in the August 13, 1921, issue of *Mining and Scientific Press*. As shown in the accompanying illustration a 2½-in. cork *C* is pivoted on knife edges *D* and carries a pointer *E* indicating equal horizontal movements of the center of gravity of the pointer.

Over the cork is swung a No. 50 cotton thread, counterweighing a silver or aluminum bar *K* whose horizontal member (6 cm. long) is sharpened into a knife edge below. Small horns at the end are to prevent the film pulling away at the ends.

If the watch glass *J* containing the liquid to be measured is raised by means of band-wheel *F* until the liquid engages the knife edge, and then slowly lowered, a plane film will



DEVICE FOR MEASURING SURFACE TENSION

be drawn out. Tension existing in this film rotates the indicator. Two characteristic points will be observed. The first breaking in water, for instance, will swing the pointer up to about the 80 dyne graduation, as the upper surface of the horizontal bar comes through the surface film. Then as the liquid is lowered further, a film will be drawn from the lower edge, and the pointer will drop to a constant reading, representing the true tension.

The method is independent of the wetting of the bar by the liquid to be tested. It measures the force required to break a film of considerable length, and the experiment can be done in a few seconds.

The conversion formula is

$$S = \frac{981W}{2L}$$

where *S* is the surface tension in degrees per centimeter; *W* is the weight in grams producing the same deflection in the pointer; 981 dynes equals one gram and *L* is the width of film. The influence of the horns may be estimated by drawing a film from them without touching the knife edge to the surface.

Using this method, the surface tension of water at 20 deg. C. figures 92.85 dynes per cm., a figure in close agreement with the most accurate figures published.

Critical Review of Wet Process for Manufacture of Portland Cement.—The question whether the wet or dry process is best for the manufacture of portland cement from hard, dry raw materials is still an open one in this country. A critical comparison of the two processes was made by Richard K. Meade in the Cement Mill Section of *Concrete* for May, 1921.

The author first considers in detail the following advantages claimed for the wet process:

(1) That a better and more uniform cement can be manufactured by the wet process than by the dry, owing to the fact that a more satisfactory mixture of the raw material can be made, a more constant composition can be maintained, and the particles of material can be brought into more intimate contact.

(2) That wet materials can be more easily ground than dry, the operation requiring less power and the repair item being less. That the output of the mills is also greater, which decreases the investment in the plant and consequently lessens interest, depreciation, etc.

(3) That the raw materials do not need to be dried, which effects a saving of the fuel and equipment necessary for this, with the labor, power, repairs, overhead, depreciation on the latter, etc.

(4) That the clinker of the wet process is more easily ground than that of the dry.

(5) That wet materials are more easily handled than dry.

(6) That there is less dust connected with the wet process than with the dry.

Turning to the advantages of the dry process, the author states that these lie almost entirely in the fact that less coal is employed for burning. Data on the fuel requirements of the two processes are tabulated for eight plants with dry process rotary kiln (three plants using oil and five powered coal as fuel) and for six plants with wet process rotary kilns (three using gas and three pulverized coal). The average heat requirements per bbl. of cement were found to be 1,219,000 B.t.u. for the dry and 1,696,317 B.t.u. for the wet, a difference of 477,317 B.t.u. Since good Pennsylvania and West Virginia gas slack has a heating value of approximately 14,000 B.t.u. per lb., this difference is equivalent to 34 lb. of coal.

It has long been recognized that the rotary kiln is wasteful of heat and that its actual efficiency probably does not amount to more than 25 per cent. Most advocates of the wet process have held that the other 75 per cent could be very

TABLE I. HEAT LOSSES OF THE ROTARY KILN

	Per Cent
Carried off by the hot clinker.....	13
Carried off by the stack gases.....	40
Utilized to decompose carbonates.....	27
Lost by radiation, etc.....	20
Total	100

readily put to useful work in driving off the water from the wet slurry. A review of the heat balance of the rotary kiln, however, shows that this is by no means the case. Table I may be said to summarize fairly the situation in a dry process plant.

Even a glance at Table I will show that the only portion of the loss which can be utilized in evaporating water is that represented in the waste gases, or, in other words, 40 per cent of the total heat of the fuel and not 75 per cent. It would not be possible, however, to recover even all of the 40 per cent carried off by the waste gases because some

heat would have to remain in the gases to produce draft, unless fans were used.

The percentage of water in the slurry of the wet process varies considerably. As a general rule, however, at least $\frac{1}{3}$ of the slurry is water, or about 300 lb. per bbl. of cement.

To evaporate 300 lb. of water from an initial temperature of 60 deg. C. would require 336,720 B.t.u. In the dry process, assuming 87 lb. of coal per bbl. of cement and 10 per cent excess air, there would be about 1,233 lb. of waste gases leaving the kiln at 1,600 deg. F. and containing 545,552 B.t.u. If the gases were to leave the kiln at 400 deg. F.—a temperature sufficient to produce the necessary draft—they would contain only 119,048 B.t.u., or 426,504 B.t.u. less than at 1,600 deg. F. This difference is more than sufficient to evaporate the 300 lb. of water and heat the vapor to 400 deg. F. ($336,720 \text{ B.t.u.} + 54,000 \text{ B.t.u.} = 390,720 \text{ B.t.u.}$). Thus it is seen that 87 lb. of coal would produce a barrel of cement by the wet process provided that the waste gases left the kiln at 400 deg. F. In practice, however, the temperature of the waste gases from a wet process kiln is from 800 to 1,100 deg. F. This accounts for the greater fuel consumption.

By the use of waste heat boilers a final temperature of 400 deg. F. may be reached. In the dry process, as indicated above, the 1,233 lb. of gases at 1,600 deg. F. containing 545,552 B.t.u. can give up 390,720 B.t.u. in cooling to 400 deg. F. This is equivalent to 11.6 boiler hp., or 401 lb. of steam at and from 212 deg. F. If delivered to a modern turbine plant (which is usually rated at 17.5 lb. of steam at 200 lb. pressure and 100 deg. superheat per kw.-hr.) the power output would be 20 kw.-hr. Approximately 10.5 boiler hp. is being actually recovered per bbl. of clinker in many plants. In some instances this steam is being used in old equipment, but where employed in modern turbine installations, an output of 16 to 18 kw.-hr. is being obtained, or enough to operate the entire plant, including both clinker and raw mills.

It is, of course, possible to install waste heat boilers with wet process kilns, but in this case 121 lb. of coal gives about 2,000 lb. of gases at about 900 deg. F. containing approximately 500,000 B.t.u. While the total heat in the waste gases is about the same as in the dry process, more coal has been required and the greater volume of gas, coupled with its lower temperature, makes the amount of recoverable heat much less than in the dry process.

In conclusion the author points out that the possible saving of the wet process in grinding and drying is much more than offset by the saving of the dry process in fuel, while the advantages claimed for the wet process as to lack of dust and better quality of product are not borne out by either facts or theories.

Recent Chemical & Metallurgical Patents

British Patents

For complete specifications of any British patent apply to the Superintendent, British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Decolorizing Carbon.—A decolorizing carbon is prepared from the waste filter-press residues from the refining of edible oils, such as cottonseed oil or shea-nut oil, by heating them in a reverberatory or similar furnace at a temperature just above the flash-point of the oil they contain, and with restricted admission of air. The product, which is a porous carbonaceous mass, is cooled out of contact with the air, washed with dilute acid to neutralize any alkaline salts formed by the incineration of contaminating soaps, and finally pressed into cakes and dried. Lamp-black is collected as a combustion product in the flue of the furnaces. (Br. Pat. 162,117; De Bruyn, Ltd., and C. Revis, both in London; June 15, 1921.)

Electrolytic Production of Boron.—Boron is produced by electrolysis of fused boric acid made conductive by the ad-

dition of a suitable substance such as borax. Both electrodes may be metallic or the anode may be of retort carbon. Carbon monoxide and carbon dioxide formed in the latter case assist in the operation. The process is carried out in a closed vessel having an outlet pipe for gases. The vessel may be of insulating material or of metal and in the latter case forms the cathode. The cables pass through the wall of the vessel or through the cover. Boron so produced may be used as a reducing agent in metallurgy. (Br. Pat. 162,252, not yet accepted; C. Constant and V. Raisin, both of Paris; June 15, 1921.)

Electric Furnace.—In an electric furnace pairs or groups of electrodes of uniform thickness are brought into contact and are maintained in contact by hand or by automatic devices. Means are provided to permit the substitution of new electrodes when the old ones are nearly consumed. Meters are preferably used with each pair of electrodes to facilitate the control of the voltage. A high current density is used so that heat generated through the resistance of the electrodes themselves contributes to the general heating effect. The arrangement is stated to be applicable to rotary furnaces consisting of a horizontal cylinder of large diameter provided with lateral cylindrical or conical drum-shaped extensions of a less diameter. The electrodes are introduced through the walls of the cylinder around the extensions which may be used for charging. (Br. Pat. 162,285; not yet accepted. A. H. Pehrson, Stockholm; June 22, 1921.)

Catalytic Hydrogenation of Fats.—A catalyst for use in the hydrogenation of fats or oils consists of nickel wool which has been activated by the action of an acid such as nitric acid upon its surface followed by conversion of the layer of nickel salt to oxide and reduction in hydrogen. The reaction chamber is packed with the activated nickel wool and the oil and hydrogen passed through in counter-current. After use the catalyst is regenerated by first removing nickel soaps by washing with the hot oil, then removing the oil by solvents and finally heating in hydrogen. According to the provisional specification, the nickel wool may be activated by alternate oxidation and reduction, the catalyst may be electrically heated, and a number of reaction vessels may be arranged in series. (Br. Pat. 162,370. E. R. Bolton, London; June 22, 1921. See also Br. Pat. 162,382.)

Cleaning Electrolytically Iron or Iron Alloy Surfaces.—Iron or iron alloy surfaces which are to receive a deposit are electrolytically cleaned in an acid solution of a copper salt. A suitable solution contains 10 to 12 per cent of sulphuric acid and 5 to 10 per cent of copper sulphate. If the surface is very dirty, it is connected first as cathode and then as anode; otherwise it may be employed as anode only. A current density of 150 to 500 amp. per sq.ft. and a pressure of 8 to 20 volts may be employed. The other electrode may be of lead and may form the lining of the vat. Temperatures from that of the atmosphere up to 120 deg. F. are allowable. Grease is removed before the above treatment. After the electrolytic cleaning the surfaces may be directly coated with iron, nickel or cobalt. Worn surface of machinery may be refaced by this process, the deposited iron being case-hardened if desired. (Br. Pat. 162,391. R. J. Fletcher, London; June 22, 1921.)

Process for Desulphurizing Iron and Steel.—In a process for desulphurizing iron and steel the iron bath is freed from phosphorus, manganese, etc., and the slag layer is removed and replaced by a new thick layer of highly basic slag into which specially prepared carbon, having approximately the same specific gravity of the slag, is immersed for the purpose of converting in a neutral atmosphere the sulphur into calcium sulphide and at the same time remove the last traces of oxygen in the form of carbon monoxide. The carbon is prepared by mixing finely ground coke with tar and forming the mixture under great pressure into blocks provided in some cases with perforations. When required, the slag bath is regenerated after the molten iron has been removed, by passing a current of air over or through the slag. (Br. Pat. 162,618; not yet accepted. Koppers, Essen, Germany; June 22, 1921.)

Current Events

in the Chemical and Metallurgical Industries

Embargo Extension Bill Passed by House

The Longworth bill extending the embargo on dyes and chemicals was passed by the House on Aug. 11 by a vote of 186 to 91. The action was taken promptly after the receipt of the following letter from President Harding to Representative Longworth:

I have your note calling my attention to the fact that the bill extending the provisions of the emergency tariff act relating to the protection of the American dye and chemical industry is to be before the House on the morrow. I am sure that the Secretary of the Treasury has already called the attention of your committee to the extreme desirability of extending this protective provision. Surely, we would be both unmindful and unjust if we failed in a suitable protection of this industry until the new and complete tariff revision act is made effective.

In recommending the passage of the bill, the committee submitted the following:

Under the present emergency tariff law the provision relating to the control by the Government over importations of dyes and chemicals expires three months after the date of the approval of the act—namely, on Aug. 27, 1921.

It now seems evident that the permanent tariff law will not be enacted until some months thereafter. Therefore, during the time elapsing between Aug. 27 and the final enactment of the tariff law the rates of duty of the Underwood law would apply to all importations of dyes and chemicals. These rates of duty are admittedly insufficient to prevent importations of enormous quantities of these chemicals to an extent sufficient to seriously menace or even destroy the American coal-tar and synthetic chemical industry.

Dye Embargo Argued Extensively at Senate Hearings

The dye embargo still hangs in the balance before the Senate Committee on Finance at the time of this writing. The hearings were prolonged unexpectedly. The committee had planned to terminate those on the dye embargo and on the American valuations a full week sooner than it did. The importance of this concession can be realized only by those having first-hand knowledge of the pressure under which the Finance Committee is working as a result of the pending tariff and taxation legislation. The extension of the hearings signifies that the Finance Committee attaches the greatest importance to the proposal that more than duties are required to protect the dye industry. Owing to the important bearing that these two matters will have on the action which the committee will take on the remainder of the tariff bill, an early decision is to be reached in the matter of the dye embargo and the type of valuation which is to be used.

LETTER FROM THE SECRETARY OF WAR

As a result of the extension of the hearings a very full presentation has been made of the entire dye proposition. One of the most important points emphasized in favor of the embargo was the relation it has to the national defense. The Secretary of War, who for many years was a member of the Senate and whose opinion has great weight with that body, wrote a forceful letter to Senator Penrose, the chairman of the Finance Committee, in which he urges the embargo in the interest of national defense. His letter, in part, is as follows:

One of the most startling discoveries of the World War was the fact that the United States could mobilize, train and equip with clothing three or four million men far quicker than it could supply the cannon, the rifles, and the ammunition for them. Notwithstanding that from 1914 to 1917 our great steel industries and our

rapidly developing chemical industries had been working feverishly to increase their facilities to supply ammunition and guns to the Allies, it was more than a year after we entered the war before those industries were able to supply ammunition, war gases, guns and rifles to meet American needs. Even then our chemical industries were so undeveloped in 1917 that it was necessary for the Government to build tremendous high explosive plants, as at Nitro, W. Va., and practically all poisonous gas plants for supplying gases and smoke materials to the United States Army.

The use of high explosives and war gases will unquestionably be far greater in any future struggle than in the World War. Inasmuch as the coal-tar industry, which is the base of all dyes, is also the base of all high explosives and most of our war gases, it is of the most vital importance to preparedness that the dye industry be developed to the fullest possible extent in this country. It is felt that this danger is so great that I urge the enactment of the embargo feature of the Fordney tariff bill as submitted by the Ways and Means Committee of the House as the only way to prevent crushing our chemical market by German competition.

CONSIDERATIONS URGED BY DYE MANUFACTURERS

Joseph H. Choate, representing the American Dyes Institute, was examined at length by the committee. His testimony necessarily covered the same ground many times, due to questions asked by members of the committee duplicating questions which had been asked previously by another member. Among the considerations which Mr. Choate urged as proper in governing the final decision of the committee are these:

First. Now, and now only, can we secure a real dye industry. While the Germans retain their present advantages, and the power and necessities of the great trust compel that attack which we deem inevitable, their commercial warfare will instantly kill our industry unless whatever protection is provided is truly efficient. Once killed, it could never be revived. If it be not saved now and promoted as well as protected, American capital will never again go into it, and a world monopoly will be handed back to Germany for all time.

Second. Since it is certain that there will never be another opportunity to provide the United States with a real dye industry, it is the duty of Congress, if it believes such an industry to be essential, to take no chances. The stake is too great for any gamble; and to adopt any method of protection with doubt as to its efficacy is to gamble with an interest vital to the whole country. According to the overwhelming weight of the testimony, we submit, no tariff practically enactable can furnish the protection needed.

Third. Only the complete protection and efficient promotion of our dye industry can insure the safety of the textile makers themselves. As long as the German industry is in one single hand, and that hand at the disposal of its government, it can and will be used to further any national ambition.

Fourth. If capital is to be attracted into and kept in the dye industry the necessary special protection must be assured for a period long enough to permit the development of most of the missing dyes. The testimony leaves no real doubt that three years is wholly inadequate.

CHOATE ANSWERS ARGUMENTS OF METZ

By far the most formidable witness who appeared in opposition to the embargo was Herman A. Metz of New York. Realizing that, Mr. Choate took pains to answer his arguments in detail. Among the things which Mr. Choate told the committee in that connection is the following:

Mr. Metz gave no figures anywhere as to the manufacture of dyes which would support his contention that the industry can survive in this country when protected only by an ordinary tariff. He laid great stress, however, upon the manufacture of salvarsan. As to that, I would like to have the committee remember that

he told you that salvarsan was a product in making which no byproducts were produced. That sort of manufacture is relatively simple when compared with the enormous complications of dye making, involving a great many byproducts, which are really the key to the situation.

It is true that he did reduce the price from \$2.25 to 27c. That shows the remarkable effect of the competition to which he was subjected, and it also shows that the pre-war price in our market of a commodity on which the Germans had a monopoly was probably excessive.

Mr. Metz says that dye plants are no more fitted for the manufacture of explosives than are breweries. Notice that he does not say that they are not fitted for making poison gas. He does not attempt to contradict General Fries on that. He says the only dye plants good for war purposes are those which include nitrating plants. All considerable dye plants have nitrating plants, and a very large proportion of the dyes that are made require nitrating sooner or later. He says there are only eight plants in the country that nitrate. In that connection permit me to say that one of the witnesses to be heard later will show the existence of at least thirteen plants which nitrate.

Mr. Metz says, "I am not afraid of the Germans." Why should he be? Just before that he had said, "I am a representative of the great Hoechst concern."

DEFENSE OF WAR TRADE BOARD

Vigorous denial that the War Trade Board has shown favoritism in issuing import trade permits was made by Henry B. Thompson, chairman of the advisory committee, War Trade Board. It had been alleged by an earlier witness that he had applied for a permit for a certain product from Germany, but was turned down with the explanation that it could be had in this country.

Mr. Thompson told the committee that he was a manufacturer and that he dyed cotton goods and certain lines of the textile industry. He said that in all his experiences with American dyes they answered his purposes splendidly and that he expected to continue to use them, despite any importation of foreign colors.

"Give the American manufacturer an opportunity to produce what is wanted," Mr. Thompson said. "The only thing we lack today, I must admit, are certain vat colors, but we can get along without them. The industry in America has made wonderful progress, and as soon as we are able to get together an efficient staff of organic chemists we shall gladly meet competition. The cry for German dyes has caused no one any serious suffering. We can match any shade—that is, we can match it in a way that will be acceptable to the trade."

HOSIERY MANUFACTURERS OPPOSE EMBARGO

George Demming, representing the National Association of Hosiery and Underwear Manufacturers, declared that Henry B. Thompson, who appeared as a representative of the advisory committee of the State Department in matters pertaining to dye imports, made the following assertion to the Finance Committee nearly two years ago:

"It is true we do not make the vat dyes in this country, and it is true that the mill men should have them. They must have them. But we expect to have them in six months or a year."

Mr. Demming cited that language in an effort to discredit Mr. Thompson's statement that the embargo could be dispensed with after three or four years. Senator Smoot suggested that it would take fifty years of embargoes to give the dye makers the encouragement that they desire.

Mr. Demming, continuing along the same line, said: "Two years ago Nicholas Longworth, one of the principal proponents of this present proposed legislation, got up on the floor of the House, and in the most emphatic and deliberate way, in a prepared speech, said that all that the American domestic dye manufacturer needed was two years of an embargo, and that then they could turn out all these dyes and take care of ourselves. I remember hearing that speech. We have had that embargo for over two years, and now they want three years more of it."

At another point in his testimony Mr. Demming said: "The licensing law in England is not only a very different law from that proposed here, as I will show to you, but it

is also for the protection of a company over there in which the government participates and which the government controls. Now that is very different from the embargo and licensing proposed here for the benefit of private individuals to roll up any profit for themselves that they can under the umbrella of that embargo and licensing."

CHEMICAL WARFARE HEAD TESTIFIES

The Finance Committee paid particularly close attention to the testimony of General Fries, head of the Chemical Warfare Service. A brief extract from General Fries' testimony follows:

We have felt that the embargo was a success during the war in building up this industry from, say, 7 plants to 82, and that if it had done that during this time, the embargo, continued for some time, would eventually develop our industry to the point where we would be making practically all the dyes that Germany is making and we would be utilizing all of the coal-tar products. In other words, before they do that they have got to change over many beehive coke ovens to those that will save the coal tar.

Looking at it from the result before the war, when we had a duty on dyes and when we had made practically no progress, and looking at the progress we made under the six- or seven-year embargo due to the war, which was a total embargo, it would seem the part of wisdom, to me, to continue that embargo long enough to develop the other 40 per cent of these coal-tar products and the other 500 or 600 dyes that are not made in this country.

SENATOR DEMANDS FACTS

Senator Watson, of Indiana, at one point during the hearing, gave expression to the following:

Men who are opposed to the embargo get themselves into a frame of mind where they are willing to believe that Germany is not making dyes, while the men who are in favor of an embargo get themselves into a frame of mind where they are willing to believe that unless we enact some legislation soon Germany will flood us with dyes in thirty days and thereby destroy the dye industry in America. Why do you not get down to facts and tell us whether the American industry can be saved in the absence of an embargo and whether or not the American valuation plus a certain rate will protect the American industry?

Chemical Warfare Training Plan Outlined

The War Department has issued the following order to govern the training and the instruction of the Army in chemical warfare:

1. The conduct of a special service school for the training and instruction in chemical warfare, both offensive and defensive, for the following:

(a) Selected officers of the Chemical Warfare Service for preparation for duties as gas officers for divisions, corps and armies and for other technical duty in the Chemical Warfare Service.

(b) Selected non-commissioned officers of the First Gas Regiment for preparation for emergency commissions.

(c) Selected officers and non-commissioned officers of combatant arms in the duties of regiment and battalion gas officers and non-commissioned officers. Officers and non-commissioned officers so instructed will be available as instructors in chemical warfare in their own units.

(d) Selected officers and non-commissioned officers of the National Guard and Organized Reserves for duty as stated in paragraph (c) above.

2. Provision for officers of the Chemical Warfare Service as instructors in both offensive and defensive chemical warfare at General Service Schools and at certain Special Service Schools as directed by the War Department.

3. Provision for personnel of the Chemical Warfare Service for representation upon the staffs of corps areas, departments and divisions.

4. Provision for the availability of such portions of the First Gas Regiment as are necessary for demonstrations and for instructional purposes at Special Service Schools.

5. Provision for suitable units of special gas troops for corps areas and departments during periods of field training and the operation of such troops during these periods.

Joint Meeting of T.A.P.P.I. and Paper Mill Superintendents

The joint fall meeting of the American Pulp and Paper Mill Superintendents' Association and the Technical Association of the Pulp and Paper Industry will be held at Washington, D. C., York, York Haven and Spring Grove, Pa., Oct. 18 to 21, 1921. Closing meetings will be held at Philadelphia and Wilmington. As now arranged, the first day of the meeting will be spent in Washington with headquarters at the industrial building of the Bureau of Standards. The second day will include mill and plant visitations in York, York Haven and Spring Grove, the third day will be spent in Philadelphia and the fourth in Wilmington.

A revised draft of the program of meeting and mill visitations follows:

TUESDAY, OCTOBER 18

9 a.m.—Assembly at industrial building of the Bureau of Standards for reading and discussion of papers and group meetings arranged by T.A.P.P.I. Service Committee, and committee of A.P. & P.M.S.A.

12:30 p.m.—Luncheon, Bureau of Standards.

2 p.m.—Inspection of sections of the Bureau of Standards; visits to paper and dye laboratories of the Bureau of Chemistry; optional visits to Government Printing Office, Bureau of Engraving and Printing, and mill of District of Columbia Paper Manufacturing Co.

7 p.m.—Supper at New Willard Hotel, followed by smoker and continuation of papers, group meetings and discussions.

12 p.m.—Take Pullman cars for York, for visits to York, York Haven and Spring Grove, Pa.

WEDNESDAY, OCTOBER 19

Breakfast on arrival at York. Visits to plants in York and York Haven, followed by trip in afternoon to Spring Grove. Leave York for Philadelphia in evening.

THURSDAY, OCTOBER 20

Breakfast in Philadelphia at Bellevue-Stratford, association headquarters, where members and guests will register for visits to the various mills and plants to be inspected during the day.

7 p.m.—Banquet at Bellevue-Stratford.

FRIDAY, OCTOBER 21

Excursion to Wilmington, Del. Leave Philadelphia for Wilmington by early train. Breakfast at cafeteria of Pusey-Jones Co. on arrival, followed by visits to following plants: Pusey-Jones Co., du Pont company's plant at Carney's Point, inspection of laboratory of dye works of the du Pont company.

The chairman of the local committee of arrangements is Fred A. Curtis, chief of paper section, Bureau of Standards, Washington, D. C.; Grellet N. Collins, of Dill & Collins, Philadelphia, is in charge of arrangements for Philadelphia district; W. S. McClellan, of P. H. Glatfelter Co., for the York district, and Harvey G. McDowell for Wilmington.

American Tar Products Co. to Build New Chicago Plant

The American Tar Products Co., a \$5,000,000 corporation with plants in St. Louis, Milwaukee, Youngstown, Birmingham and Steubenville, Ohio, has purchased approximately forty acres at the southwest corner of Pershing Road and Fifty-second Ave., Chicago, upon which it will construct a new plant. The ground has already been broken and contract entered into to purchase the byproducts of the Chicago Byproducts Coke Co., materials being conveyed by pipeline from the latter plant. The operations carried on will involve the reduction of a large number of byproducts from coal tar, including roofing, waterproofing, wood preservatives, creosote oil and other products. An extension of the Illinois Central R.R. is to be constructed into the plant, which is also located on the Chicago & Illinois Western R.R. and the drainage canal. This company is building barges to carry raw materials from points on waterways to the plant and also will have several hundred tank cars in operation. Samuel H. Bingham is president of the company.

Chemical Exposition Notes

GLASS AND PORCELAIN

Glass and porcelain for the chemical industries will occupy an important position in the exhibits at the Seventh National Exposition of Chemical Industries, to be held in the Eighth Coast Artillery Armory, New York, Sept. 12 to 17. There will be a remarkable display covering a wide range of optical measuring instruments, photomicrographic apparatus, photographic lenses, microscopes, projection apparatus, ophthalmic lenses and instruments, range finders and gun sights, searchlight reflectors, stereo-prism binoculars, magnifiers, cups and cylinders.

A complete exhibit of glass enameled iron and steel equipment, small laboratory utensils, stills, evaporating dishes, condensers, cascade dishes, vacuum pans, autoclaves and tilting kettles will also occupy space, where reduction of costs and improving operations will be explained by experts.

Chemical and scientific porcelains for laboratory uses will hold a place of importance. Special stress is laid on heat resistance in these wares. Crucibles which do not crack or become unfit for use after several heats are of great interest to the chemist or scientific experimenter.

It is reported that dishes made from a glass composition which is entirely unaffected by nitric, sulphuric and hydrochloric acids, regardless of temperature or concentration, and offers great resistance to the action of phosphoric acid, casseroles perfected to meet the requirements of chemical and steam baths, will be a part of this display.

New Chemical and Oil Companies

During the month of July a total of twenty-nine companies was organized, with capital of \$50,000 and over, to manufacture chemicals, chemical byproducts, drugs, dyes and affiliated products. The aggregate capitalization was \$3,265,000, representing a slight decrease as compared with the corresponding figures for the month of June, set forth in a recent issue of *CHEMICAL & METALLURGICAL ENGINEERING*. The decline, as compared with the same month of 1920, is marked, for in July, 1920, the total capitalization of chemical organizations reached \$21,475,500. For the first seven months of the present year the total indicated investment of new companies in this line stands at \$68,890,000; the figures for the same period in 1920 approximate \$131,207,000.

During the same month sixty-nine companies were chartered with capital of \$50,000 in the oil industry, with total indicated capitalization of \$38,777,000, the smallest figures for any month of the present year. As compared with the preceding month of June, the decrease was \$13,843,000. In July, 1920, a year ago, the record was \$116,841,000.

European Nitrogen Developments

A supplementary report issued by the British Nitrogen Products Committee states that Brunner Mond & Co., Ltd., in addition to taking over the government factory at Billingham, has organized a subsidiary company, which is concentrating its attention on the design of a new nitrogen-fixation plant with an annual capacity of 7,000 tons of fixed nitrogen. It is also reported that a company to be known as Cumberland Coal, Power & Chemicals, Ltd., has been organized for the purpose of manufacturing synthetic ammonia under the patents of the Claude process.

Germany's productive capacity for synthetic ammonia in 1920, according to a report just issued by the German Government, was 424,000 tons, as compared with 247,300 tons for the rest of the world.

Pottery Workers Accept Wage Reduction

At a conference between the United States Potters' Association and the National Brotherhood of Pottery Operatives at Atlantic City, N. J., Aug. 5, the employees agreed to an immediate reduction of 10 per cent in wage scale, with an additional 9 per cent reduction in January, 1922. At the different sessions it was set forth that the pottery industry at the present time is operating at less than 50 per cent of normal, without very encouraging outlook for early resumption.

Plans for the Symposiums on Gas Chemistry and Filtration at New York Meeting, A.C.S.

The plans of the Division of Industrial and Engineering Chemistry of the American Chemical Society outline two series of papers and discussions which should prove extremely interesting to many industries. The symposium on gas chemistry, which will be held on the afternoon of Sept. 8, will be devoted to four principal subjects: Coke-oven problems, low-temperature carbonization, gas works control, and gas analysis and its applications.

FORMATION OF SECTION ON THE CHEMISTRY OF GASES AND FUELS IN PROSPECT

If the interest in the program and problems presented at the symposium seems to justify it, plans may be made for the formation of a regular section of the society to deal with the chemistry of gases and fuels. It is emphasized by the committee in charge of the meeting, C. H. Stone, H. E. Howe and R. S. McBride, that the symposium will deal with the chemical problems rather than with engineering problems which are commonly considered at the meetings of the American Gas Association. However, it is hoped that the co-operation and attendance of all engineers as well as chemists will be had.

Further suggestions regarding speakers or subjects which receive attention at the meeting should be addressed to the secretary of the symposium, R. S. McBride, 610 Colorado Building, Washington, D. C. Those having articles which they desire to present at the September meeting on any phase of gas or fuel chemistry should send the abstract of their paper with title and author to H. E. Howe, Marine Biological Laboratory, Woods Hole, Mass., on or before Aug. 18.

FILTRATION SYMPOSIUM

Dr. D. R. Snerry, who has organized the symposium covering the different phases of filtration, announces that sixteen papers have already been promised for presentation at the meeting.

All papers are to be illustrated with lantern slides, whenever possible, and a full opportunity will be given to members to question the authors.

The subjects to be treated include: Theory of filtration, rates of flow, general operating experiences, filtration apparatus, general engineering experiences, filter bases, plate and frame filter presses, suction filters, dumping filters, squeezing filters, centrifugal filters, pulp filters, new ideas in filtration apparatus, filter cloths, filter papers, filter alloys and crystalline filter bases.

Wilkes-Barre Meeting of the American Institute of Mining and Metallurgical Engineers

The semi-centennial anniversary meeting of the American Institute of Mining and Metallurgical Engineers will be held at Wilkes-Barre, Pa., Sept. 12-15, 1921. Anthracite coal and its production will be the chief subject to be discussed, although a number of interesting papers are scheduled to be read before the Metal Section of the Institute. Convention headquarters will be at the Irem Temple.

PROGRAM OF THE MEETING

R. V. Norris is the general chairman of the local committee, of which Paul Sterling is the general secretary. The program of the meeting follows:

MONDAY, SEPT. 12

Coal Section

2:30 p.m.

- "Mechanical Mining of Anthracite," by H. D. Kynor.
- "The Ashley Planes," by C. H. Stein.
- "Anthracite Preparation," by D. C. Ashmead.
- "Anthracite," by Donald Markle.
- "The Slush Problem," by John Griffen.

8 p.m.

- "The Lynch Plant," by Howard N. Eavenson.
- "General Description Anthracite Field," with maps and sections, by E. W. Parker.

Metal Section

8 p.m.

- "Application in Rolling of Effects of Carbon, Phosphorus and Manganese on Mechanical Properties of Steel," by W. R. Webster.
- "Thacher Process for Molding and Casting Propeller Blades and Wheels," by E. Touceda.
- "Making a 5 per cent Nickel-Cast-iron Alloy in an Electric Furnace," by D. N. Witman.

TUESDAY, SEPT. 13

In the morning automobile trip through Wyoming Valley, visiting breakers and mine plants. Leave Irem Temple, 9 a.m. sharp.

Luncheon as guests of the International Correspondence Schools, Scranton.

At 2 p.m. Technical Session in International Correspondence Schools auditorium.

Discussion on "Mine Fires," by Douglas Bunting.

"Electric Power a Factor in the Anthracite Field," by W. A. Thomas.

"Determination of Electrical Equipment for a Mine Hoist," by Graham Bright.

"The Automatic Substation for Coal Mines," by R. J. Wensley.

Also at 2 p.m. Americanization Session. Meeting of Committee on Industrial Relations for discussion of papers. Discussion will be introduced by E. E. Bach, Director of Americanization for State of Pennsylvania, and chairman of Institute subcommittee on Americanization.

Return to Wilkes-Barre by special train on Laurel Line. 8 p.m.

"The Hoisting Plant of the Pittsburgh Terminal Railroad-Coverdale Mine," by M. D. Kirk.

"Power Installation at Coverdale," by C. M. Means.

"Octagonal Ventilation Shaft of Davis-Daly Copper Co.," by J. L. Bruce.

"Application of Pulverized Coal to Boilers," by J. M. Fuller.

WEDNESDAY, SEPT. 14

9 a.m. and 2:30 p.m.

General joint meeting conducted by Society of Economic Geologists.

Papers of the Society of Economic Geologists and the following papers of the Institute:

"Stratigraphy of the Anthracite Region." Discussion led by James F. Kemp.

"Petroliferous Rocks in the Serra da Baliza," by E. P. de Oliveira.

"General Geology of Catorce Mining District," by C. L. Baker.

"Geology of the Namma Coal Field," by Edel Moldenke.

9 a.m.

Session on Mine Accounting. "Capitalization and Valuation of Mine Development," by J. B. Dilworth. (Discussion).

Luncheon. Complimentary to members and guests of the Institute at the Wyoming Valley Shovel Works.

General Technical Session

2:30 p.m.

"Queen Nine-hearth Roaster," by J. Moore Samuel.

"Flotation of Pyrite," by W. S. Morley.

"Relation of Gypsum Supplies to Mining," by D. H. Newland.

(Members may attend, instead, trips as arranged by the Ladies' Committee.)

8 p.m. Dinner and ball at the Irem Temple given to the visiting Institute members by the Anthracite Section.

THURSDAY, SEPT. 15

All-day excursion by automobile, starting from Irem Temple at 9 a.m. sharp. Lunch en route.

FRIDAY, SEPT. 16

Visits to points not provided for in the program will be arranged for, as far as practicable, after adjournment on Friday, if members will make their desires known to the local committee.

New Chemical Laboratory, Yale University

The new chemical laboratory at Yale University, New Haven, Conn., contract for which has recently been awarded to the Thompson-Starrett Co., 49 Wall St., New York, will occupy a portion of the Pearson-Sage Square, near the present Sloan Physics Laboratory. It will have a ground floor area of about two acres, with extensive space given over to private research laboratories, general chemical laboratories, recitation rooms, lecture rooms and library. The exterior will be of brick and brownstone, with slate roof to harmonize with neighboring structures. The building will be known as the Sterling Chemical Laboratory, and is estimated to cost about \$1,500,000.

Zinc Dust in 1920

The zinc dust produced in the United States in 1920, as reported to the U. S. Geological Survey by twelve plants, showed an increase in 1920 as compared with 1919 of over 70 per cent in both quantity and value.

ZINC DUST PRODUCED IN 1919-1920

	1919			1920		
	Quantity (Short Tons)	Value Based on Sales	Average Price per Lb. Cents	Quantity (Short Tons)	Value Based on Sales	Average Price per Lb. Cents
Prepared "Blue powder"...	4,083	\$801,366	9.8	9,066	\$2,009,117	11.1
"Atomized" zinc dust.	2,515	524,694	10.4	2,273	512,833	11.3

Personal

N. E. AUSTIN, of New York, has resigned as treasurer of the Triangle Commercial Corporation, to become connected with the Eli Chemical Products Co., Inc., 206 East 128th St.

G. A. BOLE has resigned his position as professor of chemistry at Alfred University, Alfred, N. Y., to become associated with the ceramic station of the Bureau of Mines at Columbus, Ohio.

J. P. BONARDI has resigned from the Bureau of Mines, with which he has been associated for the past five years, to accept the position as manager of the assay and chemical department of the Mine & Smelter Supply Co., Denver, Col., beginning his new duties Aug. 15.

WILLIAM BURGESS, of Trenton, N. J., recently appointed by President Harding as a member of the Tariff Commission, has resigned as vice-president of the United States Potters' Association. The office will be filled at the next annual meeting of the organization to be held at Washington, D. C., in December.

W. A. DALZELL, of Moundsville, W. Va., has been re-elected president of the Fostoria Glass Co. C. B. Roe has been re-elected vice-president and general manager.

Baron GERARD DE GEER has left the Domnarfvet Steel Works and is now manager of Nyhammars Bruks Aktiebolag, Nyhammar, Sweden.

J. R. DAVIES, formerly secretary of the Chicago Section, American Chemical Society, has been appointed chief chemist and assistant plant manager of the chemical works of the Calumet Baking Powder Co. at Joliet.

L. I. LOGHRY has resigned from the Mount Joy Magnesia Co., Mount Joy, Pa., and has accepted the position of chief chemist for the Knickerbocker Portland Cement Co., Hudson, N. Y.

G. ST. J. PERROTT, associate physical chemist of the United States Bureau of Mines Experiment Station, Pittsburgh, Pa., is to be sent to Birmingham, Ala., to study the physical properties of coke in relation to its production and use in the blast furnace.

W. N. ROACH, formerly engaged in patent work for the War Department, has left that service to start a private patent practice in Washington. Mr. Roach has been with the War Department since August, 1918.

L. I. SHAW, assistant chief chemist of the Bureau of Mines, has transferred his activities from Washington to the ceramic station at Columbus, Ohio, to co-operate with R. T. Stull in research on ceramics. His immediate work will be concerned with physical chemistry as applied to ceramics and involves work with colloids.

R. J. TAIT, chemist for the Grasselli Chemical Co., New York, has been transferred to the Cleveland, Ohio, office of the company, to be connected with the sales department there.

Obituary

DR. WALLACE CALVIN ABBOTT, president of the Abbott Laboratories, which he founded and built into one of Chicago's most prominent chemical establishments, died at his home on July 4. Born in 1857, he was educated at Dartmouth College and took the degree of M.D. at the University of Michigan in 1885. Dr. Abbott was a pioneer in the field of alkaloidal medication, and his incessant labors through his writings and his personal contact have made his influence on the medical profession in this respect profound. Dr. Abbott was co-author, with Dr. William F. Waugh, of "The Practice of Medicine" and of "Positive Therapeutics." He was editor-in-chief of *The American Journal of Clinical Medicine*, now in its twenty-eighth year.

GEORGE H. ELLIS, vice-president of the Chicago Section of the American Chemical Society in 1900, died on July 10. Mr. Ellis belonged to the earlier generation of chemists who did much for the development of industrial chemistry in the West. He was born in 1864 and received the B.Sc. degree from the University of Illinois in 1885. As chemist for the C. B. & Q. R.R. from 1885 to 1893 he acquired sufficient experience to establish himself as a consulting chemist, maintaining an office in Chicago for ten years thereafter. A great deal of his attention was devoted to the paint trade, and in 1903 he became secretary and treasurer of the George W. Pilkington Co. In 1909 he was elected president of the Johnson Magnetic Paint Co., which office he held until his death. He was the author of "Notes on White and Tinted Paint Analysis."

HARRY M. GRAY, president and general manager of the Como Chemical Co. of Kokomo, Ind., a member of the Chicago Section, A.C.S., died at Kokomo on July 3.

PROF. CHARLES L. WEIL, consulting engineer, died at his home in Port Huron, Mich., July 16. Prof. Weil was actively identified with the Diamond Crystal Salt Co. as consulting engineer, and in addition maintained an engineering office in Port Huron. He was born in North Andover, Mass., in 1865. His engineering education was obtained in the Massachusetts Institute of Technology, from which he graduated in 1888. After a short period as draftsman with the Worthington Pump Co. he became instructor at Lehigh University, leaving there in 1893 to take charge of the engineering department of Michigan Agricultural College, where he remained for thirteen years. During his connection at M.A.C. Prof. Weil designed and installed a complete new power plant for the college which was a model of its kind at the time and most of which is still giving satisfactory service. He also instituted many important changes and improvements in the engineering department of the college. From M.A.C. Prof. Weil went to Detroit to engage in consulting work, later moving to Port Huron on account of the close connection which he established with the Diamond Crystal Salt Co. at St. Clair, at the same time continuing his consulting practice. Prof. Weil was probably the country's foremost engineer in the evaporation and manufacture of salt. His work was not limited to this phase of engineering, however, as he was active along many other lines, particularly power plant work. He was a member of the Detroit Engineering Society, Michigan Engineering Society and the American Society of Mechanical Engineers.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, Aug. 15, 1921.

The chemical market during the past week presented no signs of pressing liquidation which seemed so persistently continuous early in the year and there was a little indication of speculative activity. The closing prices as a rule were very near the finals of the previous week. Prices generally are firmer, and although buying orders are still limited to small lots, as before, the number of such lots has been on the increase. Occasional orders for carlot quantities were heard during the week, especially in the cases of soda ash and fused sulphide of soda. Business all around would be much better were it not that the month of August is known as a vacation period and apt to be featured by the dullest trading of the year. Barium chloride buyers are becoming more confident as they realize that domestic makers will be unable to compete with importers' prices. Imported goods in most lines still figure largely on the market. Light soda ash did not vary much. Solid caustic soda touched \$3.60 per 100 lb., which is the lowest figure recorded for the past few months.

Bichromate of soda held its own around formerly quoted prices and prussiate of soda was firm around 11½c. per lb. Borax is finding a better market and leading producers say that considerable improvement has taken place in the amount of buying. The demand for this chemical has emanated from various sources. Muriate of potash was a shade easier and quiet. Bleaching powder is moving in very good shape at the works, with spot material rather scarce and prices firmer. Arsenic is experiencing the usual dullness incident to this period of the year. Consuming industries have not shown much departure from the conservatism lately displayed. Sales of several carlots of fused sodium sulphide were made around 5½c. per lb. It is believed that these purchases were made for use in the dye trade. Fair trading in imported caustic potash was noted around 4½c. per lb. Soapmakers are buying this material. Caustic soda and soda ash have also prompted attention from leading soapmakers. Paper mills have bought quantities of bleaching powder at the works. Enamellers are showing more interest in borax. Textile mills are taking on miscellaneous supplies of chemicals and dyestuffs, but are not inclined to operate far ahead. Tanneries are showing more interest in the market and laundry supply houses are taking on moderate quantities of oxalic acid and Japan wax.

CHEMICALS

Calcined carbonate of potash, 80-85 per cent, is obtainable at prices ranging from 5@5½c. per lb. The market is generally quoted at the outside figure by sellers. The movement has not involved large proportions during the past week, as buyers appeared satisfied to operate from hand to mouth. Higher grades are quoted up to 6½c. per lb., depending upon the quantity. Sales of imported caustic potash, 88-92 per cent, have been reported at 4¼@4½c. per lb., and it is possible that 4c. would be accepted in some directions on a firm offer for a round lot. Consumers have taken on large quantities of this chemical and are showing fair interest in additional supplies. Competition is naturally keen to get what business is passing and this is accountable for the irregularity displayed in quotations. Prominent sellers of imported muriate of potash quote the market at 85@90c. per unit of K₂O. This is equivalent to approximately \$42.50@\$45 per ton. The market has been a tame affair with inquiries and offerings rather limited. Rumors are current that domestic barium chloride makers are seriously considering the abandonment of further attempts to manufacture, in which case they expect to take over agencies for foreign producers. Prices now named for spot delivery of imported prime white material is \$52 per ton and shipment goods is offered openly as low as \$46 per ton. Buyers

are much more confident in the market at these figures and sales in good quantity are reported by all holders. Domestic makers were not offering or quoting any material. Resale caustic soda of standard make has sold at prices extending from \$3.60@\$3.70 per 100 lb. The inside price was quoted ex-store and the outside ex-dock. Dealers have experienced a fair call for this chemical for domestic use, but transactions have been similar to those of other items—namely, small lots. At the works, producers quote 3¼c. per lb., basis 60 per cent, for contracts.

Prices on ammonium carbonate are somewhat lower at 7@9c. per lb., according to quantity and grade. Prices on permanganate of potash are lower from importers at 25@27c. per lb. A slow demand was noted. Prominent copperas dealers offer prime green crystals on the basis of \$19@\$20 per ton in barrels and \$17.50 per ton f.o.b. works in bags. Activity has not been along elaborate lines, but the market appeared quite steady at the above-named prices. Spot prices of oxalic acid have been lowered in some directions and sales of both foreign and domestic from 17c. down to 16¼c. per lb. It was stated that offerings of foreign material were scarce at the close, as the embargo is having a tendency to hold supplies. Producers report sales at 17½c. per lb. and upward, depending upon the brand and quantity. The inquiry for sulphate of ammonia has remained dull throughout the week and consumers are apparently satisfied to let the market take care of itself temporarily. Prominent sellers stated that they were asking \$2.15 per 100 lb. for goods in bags, but they would probably accept a shade under this price on any kind of a firm offer for a round lot. Occasional sulphuric acid sales of the 60 deg. Baumé went through at \$11@\$13 per ton, according to seller. Rumors were heard that sales have been put through f.o.b. works a shade under the inside price. The 66 deg. sulphuric acid is quoted at \$18@\$20 per ton. Business in arsenate of lead is showing the usual midsummer dullness after a period of fair recovery. A satisfactory volume of business was placed with the insecticide trade, but the bulk of demand has been satisfied. Manufacturers offered the paste at 9c. per lb. and the powdered at 15@17c. per lb., according to quantity. Alcohol buying is confined to small quantities with consumers still showing hesitation about placing orders for bulk lots. Prices are nominal and in general will be maintained, although some shading is occasionally done on firm business. Ethyl, 188 proof, is quoted at \$4.65@\$4.75 per gal.; denatured, 180 proof, is 31@32c. per gal.; 188 proof, 35@36c. per gal, and 190 proof, 37c. per gal. Methanol is 78c. per gal. for the 95 per cent and 80@88c. for the 97 per cent.

COAL-TAR PRODUCTS

Business has been very dull for the handlers of coal-tar products during the past week. The topic of principal interest has been the tariff, and few firms concerned have not sent representatives to Washington to give their views of the case. Immediate interest attaches to the efforts to extend the emergency tariff bill until such time as final action on the Fordney bill might be taken. Further efforts are being made to have the Senate include the licensing provision in the present measure. In the meantime, attempts to sell goods in the spot market are sporadic and few buyers are coming into the market without strong inducements. There were some reports of business with export buyers. Benzene is still scarce, although the limited scale of consuming operations has prevented any sharp advances. Makers' quotations are unchanged at 27@33c. per gal. Resellers who have supplies are able to demand premiums over these figures. One of the large consumers of naphthalene offered a heavy lot of crushed material in the market and found buyers at 6¼c. per lb. Refiners' prices are held at former levels, but without any business of consequence. The consuming demand for phenol has taken the greater part of all the low-priced material that was recently offered in the market and it is possible that 10c. per lb. is the present low price. It may be possible that on a firm offer bids of 9½c. per lb. would not be refused. Makers' prices on H acid continue to rule in the absence of activity. Quotations are given as \$1.15@\$1.25 per lb., although it is possible that outside holders can offer limited quantities at concessions.

Manufacturers quote technical *sulphanilic acid* at 27@30c. per lb., according to quantity. Interest is scattered with a few small lots moving. Further signs of weakness in *beta naphthol* are evident in the stand of makers. While no definite defections are admitted by producers, a keen rivalry exists, with each cutting prices for new business. The resale market is quoted at 32@35c. per lb., according to quantity. A few sales of comparatively small lots have been put through, but little consuming demand is noted. The resale market in *dimethylaniline* is practically bare of stocks, but some makers have reduced prices to 45c. per lb. in lots of 10 drums or more and are doing some business at this figure. Other makers quote 60@65c. per lb., according to quantity, but admit that they are not pushing sales. Occasional inquiries are coming into the market for limited quantities. The market on *diphenylamine* is firm in makers' hands at 65@70c. per lb., with resale lots cleaned out. Small lots of *paranitraniline* in resellers' hands have moved recently at 75c. per lb., but the quantities offered at this figure are trifling and have not affected the manufacturers' market of 79@82c. per lb. Interest has been slow. Prices on *aniline oil* have been steady at recent levels. Makers will do 20c. per lb. on firm business in returnable drums. Outside lots of more or less inferior quality can be had in reasonable quantity as low as 18c. per lb.

VEGETABLE OILS

A good inquiry was reported for *chinawood oil* for nearby as well as forward delivery, and with cables from primary sources higher, the undertone at the close was quite firm. Scattered sales of less than carlots were reported at 14c. per lb., while prompt shipment oil from points near by sold on the New York equivalent of 12½c. per lb. For September arrival at New York 11½c. was asked, with August-September shipment from the Orient quoted nominally at 11½c. per lb. c.i.f. New York. Internal difficulties in China may result in a smaller movement of oil to the ports and operators here believe that a shortage in the supply may exist later on. A sale of 500 tons of *Manila coconut oil* for September shipment was reported on the basis of 7½c. per lb., loose, c.i.f. San Francisco. Further offerings were reported on this basis during the week, although a generally firmer feeling was in evidence in sympathy with the strength in copra. A sale of 15 tanks of domestic Ceylon type oil was put through at 8½c. per lb., sellers' tanks, f.o.b. Jersey City. Sales of crude *corn oil* went through during the week at 7c. per lb., sellers' tanks, f.o.b. point of production, Middle West. The market closed firm, with asking prices ranging from 7¼@7¾c. per lb., f.o.b. mills. The market for *edible olive oil* was irregular on selling pressure from abroad and nominal prices for high-grade material on spot ranged from \$1.80@\$2.25 per gal. Denatured oil on spot closed at \$1.20 per gal. The recent rise in exchange, coupled with higher cables from Liverpool, caused prices to hold firm despite the inactivity of large operators. *Lagos oil* on spot sold in a small way as high as 7½c. per lb. *Lagos* for shipment settled at 6¾c. asked c.i.f. N. Y., with niger quoted at 5¾@5¼c. per lb. Prices on *linseed oil* are quoted lower on a sharp slump in the Argentine seed market. Quotations are based on 73c. per gal. in barrels, carload lots. Buyers are showing little interest except in small lots for prompt and no interest at all in future deliveries. Offerings of crude *peanut oil* were scanty, and the market closed with prices on the domestic products more or less nominal at 7¼@7½c. per lb., tank cars, f.o.b. mill. Oriental oil for August shipment from the Coast held at 7½c. per lb., tank car basis.

The Chicago Market

CHICAGO, Aug. 12, 1921.

There was no change in the demand for industrial chemicals during the past two weeks. Dealers report a fair volume of small orders and are apparently satisfied with the movement of their stocks. There is no difficulty in procuring supplies of most items and as a rule prices are unchanged. Buyers are showing no tendency to anticipate on their requirements and are buying supplies only for immediate consumption.

The demand for *caustic soda* continues light with no change in price noted. The solid 76 per cent is available

at \$4@\$4.10 per 100 lb. and the ground at \$4.65@\$4.75. Supplies are small with little or no pressure to sell. The request for *soda ash* improved somewhat and prices were steady at \$2.60 per 100 lb. for barrels. *Sal ammoniac* continued quiet and supplies were available at 7½@7¾c. per lb. for the white granular. There was no improvement in the demand for *carbon tetrachloride* and the price was unchanged at 11c. per lb. *Carbon bisulphide* was quiet and easy at 6¾@7c. per lb. The movement of *formaldehyde* was slow and supplies were plentiful at 13½c. per lb. for barrels. *Glycerine* was quiet with the inquiry light and few sales reported. Material c.p. was offered freely at 14½c. per lb. for single drums. *Iron sulphate* was in fair request and small sales were noted at \$1.90 per 100 lb. *Lead acetate* was in poor demand with supplies available at 13c. per lb.

A better inquiry was noted in some quarters for *caustic potash*, one dealer reporting a good volume of small orders at 6½c. per lb. for the 88-92 per cent material. *Bichromate of potash* was available at lower prices and moved better in some directions. The prevailing quotation was 14c. per lb. for spot goods. Supplies of *sodium bichromate* were smaller with the inquiry improved. Several small sales were noted at 9½c. per lb. Small sales of *sodium acetate* were reported at 4½c. per lb. *Bicarbonate of soda* was unchanged as to price and a fair movement was noted at \$2.60 per 100 lb. Dry *bisulphite of soda* was offered at 6c. per lb. in single barrel lots. *Hyposulphite of soda* was quiet and unchanged as to price. Pea crystals were available at \$4.05 per 100 lb. Supplies of imported *zinc chloride* were offered at 8½c. per lb. in single cask lots.

There were no developments of consequence in the acid market, the prevailing tone being quiet with prices steady. The 28 per cent commercial grade of *acetic acid* is moving in a fair way at \$2.50@\$2.75 per 100 lb. for barrels. *Glacial acetic* is extremely quiet and supplies are offered at 9¾@11c. per lb. according to the quantity and holder. *Oxalic acid* is in brisk demand and 18c. per lb. appeared to be the inside quotation on spot goods. The heavy acids are in slightly better request and firm as to price. *Sulphuric acid* is quoted at \$19@\$20 per ton in tank cars f.o.b. works.

VEGETABLE OILS

Trade in *linseed oil* failed to show any marked improvement, although the inquiry was reported as fair from the smaller consuming trade. Small lots of the boiled are quoted at 77c. in drums with the usual reduction for the raw.

NAVAL STORES

Business in the naval stores market was of a quiet character the last few days. Small sales of *turpentine* were noted, but nothing in a large way. The market on turpen-

The Iron and Steel Market

PITTSBURGH, Aug. 12, 1921.

Demand upon the steel mills continues to increase, although very slowly. At the middle of July, marking the low point in production, steel production was at slightly under 20 per cent of capacity, while the increase, roughly speaking, is at the rate of one or two points a week. Continuance of the present improvement seems well assured, but would mean a rate of no more than 35 or 40 per cent by November. With improvement in general business, freer inception of construction projects and railroad buying there would be additional improvement in steel demand, but it is quite uncertain whether such influences will be marked between now and the end of the year.

From the monthly report of the American Iron and Steel Institute, giving the steel ingot output of thirty large companies, it may be estimated that production in July was at average rates of approximately 18 per cent by the independents, 25 per cent by the Steel Corporation and 21 per cent by the steel industry as a whole, the rate being under 20 per cent at the middle of July, but increased by the present time to well above 20 per cent. The July production was at the rate of about 11,000,000 gross tons of steel ingots a year, actual production having been 40,881,392 tons today was 63c. per gal. in drum lots. *Rosins* were quiet and easy, the "G" grade being available at \$6.75 per 280 lb. for less than carlots.

in 1920 and 30,284,682 tons in 1912, the best year before the war. The best estimate of actual capacity seems to be 52,500,000 tons.

STEEL CORPORATION'S UNFILLED OBLIGATIONS DECREASE

The Steel Corporation's unfilled obligations decreased by 287,544 tons during July, to 4,830,324 tons at the end of the month. For five successive months these decreases have run just a little bit under the shipments, the differences between estimated shipments and decrease in unfilled tonnage averaging about 100,000 tons a month, or about 7 per cent of capacity. March shipments were at fully 50 per cent of capacity, while July shipments were at only about 25 per cent of capacity. The showing is precisely in line with the character of the corporation's business. In 1920, when the independents had largely advanced prices, the Steel Corporation accepted contracts from its regular customers such as were expected, roughly speaking, to carry the customers to the middle of the year. With the great decrease in activity it requires much longer to work out the contracts. In recent months the corporation has been receiving most of its business in the form of specifications against these contracts, and with declining prices these specifications have been the subject of negotiation. The independents, on the other hand, obtain most of their business in the form of strictly new orders.

The downward sequence in the degree of market activity is approximately as follows: Sheets, bars, tubular goods, wire products, tin plates, plates, structural shapes, rails. Sheet mill operations are above 30 per cent of capacity, while rail production is almost nil.

DEMAND FOR STEEL PRODUCTS INCREASING SLOWLY

Demand for steel products continues to increase slowly, and is expressed almost wholly in small-lot business, largely carloads, for as prompt shipment as can be made, and this means in many cases shipment within two or three days of receipt of the order, a fortnight being an unusually long period. Thus, whether buyers have "confidence" in the future of prices or not, they are taking very little risk. What they have confidence in is their ability to liquidate their purchases promptly and collect the money.

A close analysis of prices for steel products generally indicates that while there was a more or less steady decline for months the condition at present and in the past week or two is that of prices having barely a sagging tendency. There is no thought that prices will advance from the present level, but the lowest point under present cost conditions is not far away. By "cost" is not meant the actual cost at present, with the overhead and other expenses falling upon a very small production, but the cost with a fair operating rate and present wage rates, freight rates and other factors.

PRICES

Regular prices, generally applicable to carload lots, are: Bars, 1.75c.; shapes and plates, 1.85c.; hoops and bands, 2.40c.; blue annealed sheets, 2.40c.; black sheets, 3c.; galvanized sheets, 4c.; plain wire, 2.50c.; wire nails, \$2.75. On particularly desirable orders most if not all of these prices are subject to concessions, but the concessions are only \$1, \$2 or \$3 a ton and as to bars, shapes and plates the concessions are hardly any larger than buyers were able to obtain a fortnight ago. Thus it is not entirely certain that the market is even sagging, whereas until quite recently it was very plainly declining. A broadening in the market, with orders offered in larger sizes, may bring about lower prices, but only by small margins. With present wages and freight rates the average price of finished steel products is unlikely to go \$5 a ton below prices now quoted as regular, these prices already being subject to some concessions, as indicated.

Pig iron shows a slightly steadier tone, attributed to stocks of bessemer and foundry grades having become relatively small, though there is still plenty basic. The valley market remains quotable at \$20 for bessemer, \$18 for basic and \$19.50 for foundry. A sale of 500 tons of bessemer was made this week at \$21.44, delivered Pittsburgh, or 52c. under the equivalent on valley iron, as the valley-Pittsburgh freight is \$1.96.

General Chemicals CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots	Less Carlots
Acetic anhydride.....lb.	\$0.12 $\frac{1}{2}$ - \$0.12 $\frac{3}{4}$	\$0.40 - \$0.45
Acetone.....lb.	2.75 - 3.00	.13 - .13 $\frac{1}{2}$
Acid, acetic, 28 per cent.....100 lbs.	5.00 - 5.25	3.25 - 3.50
Acetic, 56 per cent.....100 lbs.	10.00 - 10.25	5.50 - 6.00
Acetic, glacial, 99 $\frac{1}{2}$ per cent, carboys, 100 lbs.	10.00 - 10.25	10.50 - 10.75
Boric, crystals.....lb.	.13 $\frac{1}{2}$ - .14	.14 $\frac{1}{2}$ - .15
Boric, powder.....lb.	.15 - .15 $\frac{1}{2}$	.16 - .16 $\frac{1}{2}$
Citric.....lb.	1.25 - 1.50	.44 $\frac{1}{2}$ - .45
Hydrochloric.....100 lb.	.11 $\frac{1}{2}$ - .11 $\frac{3}{4}$	1.60 - 1.75
Hydrofluoric, 52 per cent.....lb.	.10 - .11	.12 - .12 $\frac{1}{2}$
Lactic, 44 per cent tech.....lb.	.04 $\frac{1}{2}$ - .05 $\frac{1}{2}$	.06 - .07
Lactic, 22 per cent tech.....lb.	4.00 - 4.50	4.50 - 5.00
Molybdic, C. P.....lb.	.....	.....
Muriatic, 20 deg. (see hydrochloric).....lb.	.06 $\frac{1}{2}$ - .06 $\frac{3}{4}$	.07 - .07 $\frac{1}{2}$
Nitric, 40 deg.....lb.	.07 - .07 $\frac{1}{2}$	.07 $\frac{1}{2}$ - .07 $\frac{3}{4}$
Nitric, 42 deg.....lb.	.16 $\frac{1}{2}$ - .17	.17 $\frac{1}{2}$ - .18 $\frac{1}{2}$
Oxalic, crystals.....lb.	.13 $\frac{1}{2}$ - .14	.14 $\frac{1}{2}$ - .18
Phosphoric, 50 per cent solution.....lb.	.20 - .25	.27 - .35
Picric.....lb.	.....	1.75 - 1.90
Pyrogallol, resublimed.....lb.	.....	11.00 - 13.00
Sulphuric, 60 deg., tank cars.....ton	.....	13.00 - 15.00
Sulphuric, 60 deg., drums.....ton	18.00 - 20.00	.....
Sulphuric, 66 deg., tank cars.....ton	21.00 - 22.00	22.50 - 23.00
Sulphuric, 66 deg., drums.....ton	.....	.....
Sulphuric, 66 deg., carboys.....ton	21.00 - 22.00	.....
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	23.00 - 23.50	24.00 - 24.50
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	31.00 - 32.00	33.00 - 34.00
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	.....	.85 - 1.00
Tannic, U. S. P.....lb.	.45 - .48	.50 - .55
Tannic (tech.).....lb.	.....	.27 - .28
Tartaric, crystals.....lb.	.....	1.30 - 1.40
Tungstic, per lb. of WO.....lb.	.....	4.65 - 4.75
Alcohol, Ethyl.....gal.	.....	.....
Alcohol, Methyl (see methanol).....gal.	.....	.....
Alcohol, denatured, 188 proof.....gal.	.....	.35 - .36
Alcohol, denatured, 190 proof.....gal.	.....	.37 - .38
Alum, ammonia lump.....lb.	.03 $\frac{1}{2}$ - .04	.04 - .04 $\frac{1}{2}$
Alum, potash lump.....lb.	.10 - .11	.11 $\frac{1}{2}$ - .12 $\frac{1}{2}$
Alum, chrome lump.....lb.	.02 - .02 $\frac{1}{2}$	.02 $\frac{1}{2}$ - .02 $\frac{3}{4}$
Aluminum sulphate, commercial.....lb.	.03 - .03 $\frac{1}{2}$	.03 $\frac{1}{2}$ - .04
Aluminum sulphate, iron free.....lb.	.07 $\frac{1}{2}$ - .07 $\frac{3}{4}$	.08 - .08 $\frac{1}{2}$
Aqua ammonia, 26 deg., drums (75 lb.).....lb.	.30 - .32	.33 - .35
Ammonia, anhydrous, cyl. (100-150 lb.).....lb.	.07 - .07 $\frac{1}{2}$	.08 - .09
Ammonium carbonate, powder.....lb.	.06 $\frac{1}{2}$ - .06 $\frac{3}{4}$	.07 - .08
Ammonium chloride, granular (white sal ammoniac).....lb.	.06 $\frac{1}{2}$ - .06 $\frac{3}{4}$	.07 - .07 $\frac{1}{2}$
Ammonium chloride, granular (gray sal ammoniac).....lb.	.07 - .07 $\frac{1}{2}$	.07 $\frac{1}{2}$ - .08 $\frac{1}{2}$
Ammonium nitrate.....lb.	2.20 - 2.25	2.30 - 2.40
Ammonium sulphate.....100 lb.	.....	3.25 - 3.50
Amylacetate.....gal.	.....	2.50 - 3.00
Amylacetate tech.....gal.	.06 $\frac{1}{2}$ - .07	.07 $\frac{1}{2}$ - .08
Arsenic oxide, (white arsenic) powdered lb.	.11 - .11 $\frac{1}{2}$	.12 - .13
Arsenic, sulphide, powdered (red arsenic) lb.	52.00 - 54.00	55.00 - 57.00
Barium chloride.....ton	.20 - .21	.22 - .23
Barium dioxide (peroxide).....lb.	.08 - .08 $\frac{1}{2}$	.08 $\frac{1}{2}$ - .09 $\frac{1}{2}$
Barium nitrate.....lb.	.04 $\frac{1}{2}$ - .04 $\frac{3}{4}$	.04 $\frac{3}{4}$ - .05 $\frac{1}{2}$
Barium sulphate (precip.) (blanc fixe).....lb.	.....	.....
Bleaching powder (see calc. hypochlorite).....lb.	.....	.....
Blue vitriol (see copper sulphate).....lb.	.....	.....
Borax (see sodium borate).....lb.	.....	.....
Brimstone (see sulphur, roll).....lb.	.27 - .28	.28 $\frac{1}{2}$ - .30
Bromine.....lb.	2.00 - 2.05	.05 - .05 $\frac{1}{2}$
Calcium acetate.....100 lbs.	.04 $\frac{1}{2}$ - .04 $\frac{3}{4}$	.04 $\frac{1}{2}$ - .04 $\frac{3}{4}$
Calcium carbide.....lb.	23.50 - 24.00	24.50 - 25.50
Calcium chloride, fused, lump.....ton	.01 $\frac{1}{2}$ - .02	.02 $\frac{1}{2}$ - .02 $\frac{3}{4}$
Calcium chloride, granulated.....lb.	2.30 - 2.50	2.60 - 3.00
Calcium hypochlorite (bleach powder) 100 lb.	.....	1.40 - 1.50
Calcium peroxide.....lb.	.....	.15 - .16
Calcium phosphate, tribasic.....lb.	.....	.72 - .74
Camphor.....lb.	.06 - .06 $\frac{1}{2}$	.06 $\frac{1}{2}$ - .07 $\frac{1}{2}$
Carbon bisulphide.....lb.	.10 $\frac{1}{2}$ - .10 $\frac{3}{4}$	.11 - .12
Carbon tetrachloride, drums.....lb.	.....	.60 - .75
Carbonyl chloride (phosgene).....lb.	.....	.....
Caustic potash (see potassium hydroxide).....lb.	.....	.....
Caustic soda (see sodium hydroxide).....lb.	.08 - .09	.09 $\frac{1}{2}$ - .10
Chlorine, gas, liquid-cylinders (100 lb.).....lb.	.....	.38 - .43
Chloroform.....lb.	.....	2.35 - 2.40
Cobalt oxide.....lb.	.....	.....
Copperas (see iron sulphate).....lb.	.19 - .19 $\frac{1}{2}$	.20 - .21
Copper carbonate, green precipitate.....lb.	.....	.50 - .62
Copper cyanide.....lb.	.05 $\frac{1}{2}$ - .05 $\frac{3}{4}$	.06 - .06 $\frac{1}{2}$
Copper sulphate, crystals.....lb.	.....	.....
Cream of tartar (see potassium bitartrate).....lb.	.....	.....
Epsom salt (see magnesium sulphate).....lb.	.....	1.00 - 1.10
Ethyl Acetate Com. 85%.....gal.	.....	.40 - .42
Ethyl Acetate pure (acetic ether 98% to 100%).....lb.	.12 $\frac{1}{2}$ - .13	.13 $\frac{1}{2}$ - .15 $\frac{1}{2}$
Formaldehyde, 40 per cent.....gal.	.....	3.25 - 3.75
Fusel oil, ref.....gal.	.....	1.50 - 1.75
Fusel oil, crude.....gal.	.....	.....
Glauber's salt (see sodium sulphate).....lb.	.....	.14 $\frac{1}{2}$ - .15
Glycerine, C. P. drums extra.....lb.	.....	3.50 - 3.60
Iodine, resublimed.....lb.	.....	.10 - .20
Iron oxide, red.....lb.	19.00 - 20.00	21.00 - 22.00
Iron sulphate (copperas).....ton	.....	.10 $\frac{1}{2}$ - .12 $\frac{1}{2}$
Lead acetate.....lb.	.09 - .09 $\frac{1}{2}$	.10 - .11
Lead arsenate, paste.....lb.	.....	.15 - .20
Lead nitrate.....lb.	.07 $\frac{1}{2}$ - .07 $\frac{3}{4}$	.08 - .08 $\frac{1}{2}$
Litharge.....lb.	.....	1.30 - 1.40
Lithium carbonate.....lb.	.09 - .09 $\frac{1}{2}$	.10 - .11
Magnesium carbonate, technical.....lb.	2.40 - 2.75	.....
Magnesium sulphate, U. S. P. 100 lb.	.....	1.20 - 1.60
Magnesium sulphate, technical.....100 lb.	.....	.78 - .79
Methanol, 95%.....gal.	.....	.80 - .88
Methanol, 97%.....gal.	.....	.12 - .12 $\frac{1}{2}$
Nickel salt, double.....lb.	.....	.14 - .14 $\frac{1}{2}$
Nickel salt, single.....lb.	.....	.....
Phosgene (see carbonyl chloride).....lb.	.40 - .41	.42 - .45
Phosphorus, red.....lb.	.....	.30 - .35
Phosphorus, yellow.....lb.	.11 $\frac{1}{2}$ - .11 $\frac{3}{4}$	.12 - .12 $\frac{1}{2}$
Potassium bichromate.....lb.	.....	.....

	Carlots	Less Carlots
Potassium bitartrate (cream of tartar)..... lb.	\$ \$	\$0 28½ - \$0 29½
Potassium bromide, granular..... lb.		16 - 25
Potassium carbonate, U. S. P..... lb.	.35 - .40	45 - 50
Potassium carbonate, 80-85%..... lb.	.05 - .05½	06 - .06½
Potassium chlorate, crystals..... lb.	.08 - .08½	09 - 12
Potassium cyanide..... lb.		26 - 28
Potassium hydroxide (caustic potash)..... lb.	.04½ - .05	05½ - .06
Potassium muriate, 80% K.C.I..... ton	42.50 - 45.00	
Potassium iodide..... lb.		2 75 - 3 00
Potassium nitrate..... lb.	.09½ - .09½	10 - 12½
Potassium permanganate..... lb.	.25 - .26	26½ - 27
Potassium prussiate, red..... lb.	.28 - .29	29½ - 30
Potassium prussiate, yellow..... lb.	.21 - .22	22½ - 23
Potassium sulphate (powdered)..... per unit		1 35 - 1 35
Rochelle salts (see sodium potas tartrate)		
Salammoniac (see ammonium chloride)		
Sal soda (see sodium carbonate)		
Salt cake..... ton		22 00 - 25 00
Silver cyanide..... oz.		1 35 - 1 38
Silver nitrate..... oz.		41½ - 42
Soda ash, light..... 100 lb.	2.00 - 2.10	2 15 - 2 50
Soda ash, dense..... 100 lb.	2.35 - 2.40	2 45 - 2 70
Sodium acetate..... lb.	.04 - .04½	04½ - 05
Sodium bicarbonate..... 100 lb.	2.25 - 2.40	2 50 - 2 75
Sodium bichromate..... lb.	.08 - .08½	08½ - 09
Sodium bisulphate (nitre cake)..... ton	5.00 - 5.25	5 50 - 6 50
Sodium bisulphite powdered, U.S.P..... lb.	.04½ - .05	05½ - .06
Sodium borate (borax)..... lb.	.05 - .06	06½ - 06½
Sodium carbonate (sal soda)..... 100 lb.	1.90 - 2.00	2 10 - 2 40
Sodium chlorate..... lb.	.07½ - .07½	08 - 08½
Sodium cyanide..... lb.	.19½ - .21	22 - 30
Sodium fluoride..... lb.	.11 - .11½	12 - 13
Sodium hydroxide (caustic soda)..... 100 lb.	3.60 - 3 70	3 80 - 4 40
Sodium hyposulphite..... lb.		03½ - 03½
Sodium nitrate..... 100 lb.	2.10 -	2 30 -
Sodium nitrite..... lb.	.07 - .07½	07½ - 08
Sodium peroxide, powdered..... lb.	.25 - .26	27 - 30
Sodium phosphate, dibasic..... lb.	.04½ - .04½	05 - 05½
Sodium potassium tartrate (Rochelle salts) lb.		22 - 25
Sodium prussiate, yellow..... lb.	.11½ - .12	12½ - 13
Sodium silicate, solution (40 deg.)..... 100 lb.	1.00 - 1.15	1 25 - 1 40
Sodium silicate, solution (60 deg.)..... lb.	.02½ - .03	03½ - 03½
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	1.50 - 1 75	2 00 - 2 25
Sodium sulphide, fused, 60-62 per cent (conc.) lb.	.05 - .05½	05½ - 06½
Sodium sulphite, crystals..... lb.	.03½ - .04	04½ - 04½
Strontium nitrate, powdered..... lb.	.15 - .15½	16 - 17
Sulphur chloride, red..... lb.	.07 - .07½	07½ - 08
Sulphur, crude..... ton	20.00 - 22.00	
Sulphur dioxide, liquid, cylinders extra..... lb.	.08 - .08½	09 - 10
Sulphur (sublimed), flour..... 100 lb.		2 25 - 3 10
Sulphur, roll (brimstone)..... 100 lb.		2 00 - 2 75
Tin bichloride, 50 per cent..... lb.	.18 - .19	
Tin oxide..... lb.		38 - 40
Zinc carbonate, precipitate..... lb.	.15½ - .16	16½ - 17
Zinc chloride, gran..... lb.	.11 - .11½	11½ - 12
Zinc cyanide..... lb.	.42 - .44	45 - 47
Zinc dust..... lb.	.11½ - .11½	11½ - 12½
Zinc oxide, XX..... lb.	.07½ - .07½	08 - 09
Zinc sulphate..... 100 lb.	3.00 - 3 25	3 30 - 3 50

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude..... lb.	\$1.10 - \$1 15
Alpha-naphthol, refined..... lb.	1 25 - 1 30
Alpha-naphthylamine..... lb.	.35 - .40
Aniline oil, drums extra..... lb.	.18 - .21
Aniline salts..... lb.	.25 - .28
Anthracene, 80% in drums (100 lb.)..... lb.	.75 - 1 00
Benzaldehyde U.S.P..... lb.	1.00 - 1 25
Benidine, base..... lb.	.85 - 1 00
Benidine sulphate..... lb.	.75 - .85
Benzoic acid, U.S.P..... lb.	.60 - .65
Benzoate of soda, U.S.P..... lb.	.55 - .60
Benzene, pure, water-white, in drums (100 gal.)..... gal.	.27 - .32
Benzene, 90%, in drums (100 gal.)..... gal.	.25 - .28
Benzyl chloride, 95-97%, refined..... lb.	.25 - .27
Benzyl chloride, tech..... lb.	.20 - .23
Beta-naphthol benzoate..... lb.	3 50 - 4 00
Beta-naphthol, sublimed..... lb.	.70 - .75
Beta-naphthol, tech..... lb.	.32 - .35
Beta-naphthylamine, sublimed..... lb.	1 75 - 1 80
Cresol, U. S. P., in drums (100 lb.)..... lb.	.16 - .18
Ortho-cresol, in drums (100 lb.)..... lb.	.25 - .27
Cresylic acid, 97-99%, straw color, in drums..... gal.	.68 - .75
Cresylic acid, 35-97%, dark, in drums..... gal.	.65 - .70
Cresylic acid, 50%, first quality, drums..... gal.	.45 - .50
Dichlorobenzene..... lb.	.06 - .09
Diethylaniline..... lb.	1 20 - 1 25
Dimethylaniline..... lb.	.45 - .55
Dinitrobenzene..... lb.	.26 - .28
Dinitrochlorobenzene..... lb.	.20 - .30
Dinitronaphthalene..... lb.	.30 - .40
Dinitrophenol..... lb.	.35 - .40
Dinitrotoluene..... lb.	.27 - .30
Dip oil, 25%, ear lots, in drums..... gal.	.40 - .45
Diphenylamine..... lb.	.65 - .70
H-acid..... lb.	1 15 - 1 25
Meta-phenylenediamine..... lb.	1 15 - 1 20
Monochlorobenzene..... lb.	.12 - .14
Monoethylaniline..... lb.	1 75 - 1 85
Naphthalene crushed, in bbls..... lb.	.06½ - .07½
Naphthalene, flake..... lb.	.08½ - .09½
Naphthalene, balls..... lb.	.08 - .09½
Naphthionic acid, crude..... lb.	.70 - .75
Nitrobenzene..... lb.	.12 - .15
Nitro-naphthalene..... lb.	.30 - .35
Nitro-toluene..... lb.	.16 - .18
Ortho-amidophenol..... lb.	3 10 - 3 20
Ortho-dichlor-benzene..... lb.	.15 - .20
Ortho-nitro-phenol..... lb.	.80 - .85
Ortho-nitro-toluene..... lb.	.15 - .20
Ortho-toluidine..... lb.	.20 - .25
Para-amidophenol, base..... lb.	1 40 - 1 45
Para-amidophenol, HCl..... lb.	1 60 - 1 75

Para-dichlorobenzene..... lb.	15 - 20
Paranitroaniline..... lb.	75 - 80
Para-nitrotoluene..... lb.	85 - 95
Para-phenylenediamine..... lb.	1 70 - 1 95
Para-toluidine..... lb.	1 25 - 1 40
Phthalic anhydride..... lb.	50 - 60
Phenol, U. S. P., drums..... lb.	09 - 11
Pyridine..... gal.	2 00 - 3 50
Resorcinol, technical..... lb.	1 60 - 1 65
Resorcinol, pure..... lb.	2 25 - 2 30
Salicylic acid, tech., in bbls..... lb.	19 - 22
Salicylic acid, U. S. P..... lb.	20 - 25
Salol..... lb.	75 - 80
Solvent naphtha, water-white, in drums, 100 gal..... gal.	25 - 28
Solvent naphtha, crude, heavy, in drums, 100 gal..... gal.	14 - 16
Sulphanilic acid, crude..... lb.	27 - 30
Tolidine..... lb.	1 25 - 1 35
Toluidine, mixed..... lb.	40 - 45
Toluene, in tank cars..... gal.	25 - 28
Toluene, in drums..... gal.	28 - 31
Xylidines, drums, 100 gal..... lb.	40 - 45
Xylene, pure, in drums..... gal.	40 - 45
Xylene, pure, in tank cars..... gal.	45 - 45
Xylene, commercial, in drums, 100 gal..... gal.	33 - 35
Xylene, commercial, in tank cars..... gal.	30 -

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark..... lb.	\$0 24 - \$0 25
Beeswax, refined, light..... lb.	27 - 28
Beeswax, white pure..... lb.	40 - 45
Carnauba, Flora..... lb.	58 - 60
Carnauba, No. 2, North Country..... lb.	25 - 26
Carnauba, No. 3, North Country..... lb.	13½ - 14
Japan..... lb.	15½ - 16½
Montan, crude..... lb.	06½ - 06½
Paraffine waxes, crude match wax (white) 105-110 m.p..... lb.	.03 - 03½
Paraffine waxes, crude, scale 124-126 m.p..... lb.	.02 -
Paraffine waxes, refined, 118-120 m.p..... lb.	.03 - 03½
Paraffine waxes, refined, 125 m.p..... lb.	03½ - 03½
Paraffine waxes, refined, 128-130 m.p..... lb.	.04 - 04½
Paraffine waxes, refined, 133-135 m.p..... lb.	04½ - 05
Paraffine waxes, refined, 135-137 m.p..... lb.	05½ - 06
Stearic acid, single pressed..... lb.	.09 -
Stearic acid, double pressed..... lb.	09½ -
Stearic acid, triple pressed..... lb.	.10 - 10½

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl..... 280 lb.	\$4 95 -
Rosin E-I..... 280 lb.	5 05 - 5 30
Rosin K-N..... 280 lb.	5 40 - 5 85
Rosin W. G.-W. W..... 280 lb.	6 60 - 7 35
Wood rosin, bbl..... 280 lb.	6 25 -
Spirits of turpentine..... gal.	.66 -
Wood turpentine, steam dist..... gal.	.64 -
Wood turpentine, dest. dist..... gal.	.62 -
Pine tar pitch, bbl..... 200 lb.	 - 7 00
Tar, kila burned, bbl. (500 lb.)..... bbl.	 - 11 50
Retort tar, bbl..... 500 lb.	 - 11 50
Rosin oil, first run..... gal.	.35 -
Rosin oil, second run..... gal.	.37 -
Rosin oil, third run..... gal.	.41 -
Pine oil, steam dist., sp.gr. 0.930-0.940..... gal.	\$1 60 -
Pine oil, pure, dest. dist..... gal.	1 50 -
Pine tar oil, ref., sp.gr. 1.025-1.035..... gal.	.46 -
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla..... gal.	.35 -
Pine tar oil, double ref., sp.gr. 0.965-0.990..... gal.	.75 -
Pine tar, ref., thin, sp.gr. 1.080-1.960..... gal.	.35 -
Turpentine, crude, sp. gr., 0.900-0.970..... gal.	1 20 -
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990..... gal.	.35 -
Pinewood creosote, ref..... gal.	.52 -

Solvents

73-76 deg., steel bbls. (85 lb.)..... gal.	\$0.41 -
70-72 deg., steel bbls. (85 lb.)..... gal.	.39 -
68-70 deg., steel bbls. (85 lb.)..... gal.	.38 -
V. M. and P. naphtha, steel bbls. (85 lb.)..... gal.	.30 -

Crude Rubber

Para-Upriver fine..... lb.	\$0 16 - 17
Upriver coarse..... lb.	.09 - 09½
Upriver caucho ball..... lb.	.11½ - 12
Plantation—First latex crepe..... lb.	.14 -
Ribbed smoked sheets..... lb.	.12 - 12½
Brown crepe, thin, clean..... lb.	.15 -
Amber crepe No. 1..... lb.	.17 -

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls..... lb.	\$0 09½ - \$0 09½
Castor oil, AA, in bbls..... lb.	10½ - 11
China wood oil, in bbls. (f.o.b. Pac. coast)..... lb.	12 - 12½
Cocoonut oil, Ceylon grade, in bbls..... lb.	09½ - 10
Cocoonut oil, Cochín grade, in bbls..... lb.	10½ - 10½
Corn oil, crude, in bbls..... lb.	08½ - 08½
Cottonseed oil, crude (f. o. b. mill)..... lb.	07 - 07½
Cottonseed oil, summer yellow..... lb.	08½ - 09
Cottonseed oil, winter yellow..... lb.	09½ -
Linseed oil, raw, ear lots (domestic)..... gal.	.73 - .74
Linseed oil, raw, tank cars (domestic)..... gal.	.67 - .68
Linseed oil, in 5-bbl lots (domestic)..... gal.	.75 - .76

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

BIRMINGHAM—The Birmingham Flour Mills have plans under way for the construction of a new flour milling plant on a local site to be about 140 x 150 ft., and estimated to cost close to \$150,000.

GADSDEN—The Tri-City Gas Co. has completed plans for extensions in its generating plant to double the present capacity. Extensions will also be made in the distributing system. The work will be inaugurated at once.

California

MELROSE—The National Lead Co. of California has completed plans and will soon commence construction of a new unit at its plant for lead-refining operations. Headquarters of the company are at 485 California St., San Francisco.

TURLOCK—The Turlock Gas Co. will make improvements and additions in its plant on South Front St., to cost about \$50,000.

TRACY—Officials of the Chamber of Commerce are holding a series of meetings relative to the establishment of a municipal gas manufacturing plant. O. W. Smith is at the head of the project.

Connecticut

OAKVILLE—The Connecticut Rubber Co., Hartford, has acquired an existing factory building at Oakville, near Waterbury, for the establishment of a new plant for the manufacture of rubber tubes and other rubber specialties. A number of improvements will be made in the structure and equipment installed at an early date. It is expected to give employment to about 100 operatives for initial production. The company is now operating a similar plant at Yale, Okla.

NEW HAVEN—The Seamless Rubber Co., Inc., is adding to its working force for increased production. The company has recently taken on about 150 additional persons.

Florida

TAMPA—The Nu-Tex Brick Co., which has begun the construction of a local plant for the manufacture of brick and other burned clay products, has been incorporated under state laws as the Florida Nu-Tex Brick & Tile Co., with capital of \$200,000. It is expected to have the plant ready for operation early in the fall. W. B. Coarsey is president and general manager; and H. E. Lough, secretary and treasurer.

DADE CITY—The Florida Cane Syrup Co. has preliminary plans under way for the establishment of a new local works for the manufacture of cane sirups. The equipment installation, including grinding mill, conveyor apparatus, cooking vats, etc., is estimated to cost in excess of \$50,000. E. S. Slough is general manager.

Indiana

DUNKIRK—The Hart Mfg. Co., specializing in the manufacture of glass jars and containers, is completing the installation of new machinery for jar production. Present operations will be on a curtailed basis with full resumption expected in the near future.

Illinois

CHICAGO—E. F. Houghton & Co., Shields Ave., manufacturer of lubricating oils, etc., has awarded a contract to the Austin Co., 208 South LaSalle St., for the construction of a new 1-story building at 3524 Shields Ave., 37 x 100 ft.

CHICAGO—The Arabol Mfg. Co., 200 North Jefferson St., manufacturer of liquid glue, etc., is planning for the early occupancy of its new 1-story and basement plant on Fifty-fourth St., now nearing completion. It will be 60 x 100 ft., estimated to cost about \$25,000.

BLUE ISLAND—The American Wire Fabrics Co., 208 South LaSalle St., Chicago, has awarded a contract to A. and E. Anderson, 19 South LaSalle St., for the construction of its proposed new galvanizing plant at the Blue Island works to be 48 x 145 ft. With a warehouse building to be erected at the same time, the cost is estimated at about \$100,000.

Maine

GREENVILLE—The Great Northern Paper Co., Millinocket, Me., has awarded a contract to the H. P. Cummings Construction Co., Fidelity Bldg., Portland, Me., for the erection of its proposed new 1-story shop addition at Greenville, 100 x 218 ft.

Maryland

LUKE—The West Virginia Pulp & Paper Co. has commenced the erection of a new addition at its local mills.

BALTIMORE—The Co-operative Paper Box Co., recently organized, will install machinery in a local building for the manufacture of paper boxes and containers. It is proposed to develop an output of about 10,000 boxes per day. B. F. Garrett, 3502 Cottage Ave., Govans, Md., is president; A. W. Watson, 4916 Alhambra Ave., Baltimore, is manager.

Massachusetts

BOSTON—Tileston & Hollingsworth, 892 River St., Hyde Park, manufacturer of paper products, have awarded a contract to the Aberthaw Construction Co., 27 School St., for the construction of two additions to its plant, to the finishing department and machine building, respectively.

Michigan

KALAMAZOO—The Western Paper Makers' Chemical Co. will rebuild the portion of its plant destroyed by fire, July 21, with loss reported at about \$12,000.

PONTIAC—The American Forging & Socket Co., Branch St., has preliminary plans under way for the erection of a new 1-story foundry addition, 40 x 50 ft., estimated to cost about \$30,000.

New Jersey

GLOUCESTER CITY—Leroy A. Goodwin, P. A. Stewart and J. L. Blandy, members of the local board of directors of the Chamber of Commerce, are interested in the establishment of a local plant for the manufacture of newsprint paper, utilizing the former buildings of the Argo Mills, manufacturer of textile products. A company capitalized at \$1,000,000 is being formed by Frank Hummell, owner of the mill property, and associates. A list of machinery for installation at the plant has been arranged, and it is proposed to have the mill ready for service around the close of the year. The Chamber of Commerce has adopted resolutions approving the plans of the company and urging support.

New York

NEW YORK—The Tidal Osage Oil Co., a subsidiary of the Tidewater Oil Co., 11 Broadway, previously known as the Guffey-Gillespie Oil Co., operating oil refineries, etc., has arranged for a bond issue of \$3,500,000, the proceeds to be used for general operations, extensions, improvements, etc.

LONG ISLAND CITY—The Mirrorlike Mfg. Co., 203 Eighth St., manufacturer of polishes, has awarded a contract to Walter J. Bond, 333 Jackson Ave., Astoria, L. I., for the construction of its proposed new plant, 100 x 100 ft., on property recently acquired at Queens Blvd. and Buckley St.

NEW YORK—The United Oil Producers Corp., 347 Madison Ave., affiliated with the Middle States Oil Corp. and the Imperial Oil Corp., address as noted, has sold a bond issue aggregating \$4,000,000, to be used in part for extensions, improvements, general operations, etc., in connection with its oil refineries.

North Carolina

ROANOKE RAPIDS—The Armstrong Chaborn Co., manufacturer of pulp and paper products, is reported to be planning for the rebuilding of the portion of its mill recently destroyed by fire, with loss estimated in excess of \$100,000.

Ohio

CINCINNATI—The Piqua Straw Board Co., 515-19 Eggleston Ave. recently organized, has acquired the Piqua, O., division of the American Straw Board Co., including the plant at Tippecanoe City, O., and the subsidiary company of Cincinnati, known as the Queen City Paper Co. The new organization plans for extensive operations. C. H. Palmer is president.

Pennsylvania

UNIONTOWN—The du Pont Powder Co. is planning for the rebuilding of the press mill at its Oriental works, near Uniontown destroyed by fire, caused by an explosion Aug. 3.

Tennessee

BRISTOL—The Enterprise Foundry & Machine Works has acquired a local building for the establishment of a new plant. The structure will be remodeled and a large department equipped as foundry. The work, including equipment, is estimated to cost about \$45,000.

Texas

MEXIA—The Golden Star Refining Co. is reported to be planning for the erection of a new oil refinery on local site. The initial plant will have a daily capacity of about 6,000 bbl.

DALLAS—The City Council is having plans prepared for the installation of a new water-purification plant at the White Rock reservoir, to include chemical lines, chemical feed machines, filter equipment and auxiliary apparatus. A bond issue has been arranged to cover the cost. David Morey, Jr., 517 Prætorian Bldg., is engineer for the project. M. G. James is city secretary.

FORT WORTH—The Panther Machine Co., F. & M. Bank Bldg., has plans under way for the erection of a new local plant with extensive foundry department for the manufacture of brass, bronze, aluminum and other metal castings. The company recently increased its capital from \$25,000 to \$100,000 for expansion. S. Johnson is president and general manager.

Virginia

BRISTOL—The Enterprise Foundry Co. is planning for the early occupancy of its new local plant, comprising the former rolling mill of the Virginia Iron, Coal & Coke Co. Remodeling work is under way, estimated to cost about \$45,000, and the present works will be removed to the new site upon completion. Additional equipment will be installed.

Washington

ANACORTES—J. E. Jensen and associates have leased the local plant of the Washington Glass Mfg. Co. for the establishment of a new works for the manufacture of glass specialties. The plant will be remodeled and improved, and additional equipment installed.

West Virginia

MARTINSBURG—Spangler & Oyler, Gettysburg, Pa., manufacturers of fertilizer products, are planning for the rebuilding of their branch plant at Martinsburg, recently destroyed by fire.

HUNTINGTON—The West Virginia Foundry & Stove Works are completing plans for the erection of a new 1-story foundry at their plant, 50 x 120 ft. It is proposed to provide equipment to double the present casting output at the plant. Frank C. Roggess is manager.

Wisconsin

CASPER—The Midwest Refining Co. is planning for the rebuilding of the portion of its local plant, destroyed by fire, July 17, with loss estimated at about \$50,000.

CASPER—The Producers & Refiners Corp., Waterloo, Ia., operating the former plant of the Hawkeye Oil Co., is perfecting plans for the erection of a new oil refinery at Casper, with ultimate capacity of about 10,000 bbl. The first unit, ground for which will be broken at an early date, will have an output of about 3,000 bbl. per day. Continuous stills will be installed and all products taken from the crude oil with the

exception of lubricants and waxes. At a later date it is proposed to extend the works to include a wax manufacturing and lubricating oil plant. The entire project is estimated to cost about \$5,000,000, including site, recently secured, on the Yellowstone Highway, about 4 miles from Casper.

British Columbia

NEW WESTMINSTER—The Triangle Chemical Co. is planning for the establishment of a new local plant for the manufacture of muriatic acid, sulphuric acid, superphosphates and kindred products.

Capital Increases, etc.

THE GAYNER GLASS WORKS, Salem, N. J., has filed notice of increase in capital from \$150,000 to \$500,000.

THE WESTERN PAPER MAKERS' CHEMICAL CO., Kalamazoo, Mich., has increased its capital from \$200,000 to \$1,000,000.

THE SHAMOKIN POWDER CO., Shamokin, Pa., has filed notice of dissolution under state laws.

THE ILLINOIS TERRA COTTA LUMBER CO., Pullman, Ill., manufacturer of burned clay products, has filed notice of dissolution under state laws.

THE CHEMICAL PRODUCTS CO., Detroit, Mich., has filed notice of dissolution under state laws.

New Companies

THE MCKINNEY COTTON OIL CO., McKinney, Tex., has been incorporated with a capital of \$100,000, to manufacture oil products. The incorporators are J. S. Heard and F. B. Pope.

THE LEWES FERTILIZER CO., Lewes, Del., has been incorporated with a capital of \$1,700,000 to manufacture fertilizers, phosphates, etc. The incorporators are Charles D. Murphy, Harrington, Del., and James M. Tunnell, Lewes, Del.

THE DEALERS CO-OPERATIVE OIL CO., Haddonfield, N. J., has been incorporated with a capital of \$125,000 to manufacture oil products. The incorporators are Herman Schreiner, Jr., C. E. Brearley and Edward T. Catlett, Haddonfield.

THE TRINACHIA DRUG & CHEMICAL CORP., with a capital of \$25,000 to manufacture chemicals, chemical byproducts and kindred specialties. The incorporators are G. Porrazzo and C. Firestone, 299 Broadway, New York, N. Y., has been incorporated.

THE REGAL ASBESTOS MINES, INC., New York, N. Y., has been incorporated with a capital of \$100,000 to manufacture asbestos products. The incorporators are E. Hemming, E. A. Barth and A. Pettit. The company is represented by McCole & Reid, 80 Maiden Lane.

THE WARWICK CHEMICAL CO., East Greenwich, R. I., has been incorporated with a capital of \$50,000, to manufacture chemicals and chemical byproducts. The incorporators are Harry A. J. Clarke, Samuel A. Olevson and John J. Clarke, West Greenwich, R. I.

THE COLONIAL OIL CO., Room 734, 208 South LaSalle St., Chicago, Ill., has been incorporated with a capital of \$50,000, to manufacture oil products. The incorporators are William C. Blean, Raynald A. Whitehead and Furber I. Marshall.

THE KEARNEY FOUNDRY CO., Newark, N. J., has been incorporated with a capital of \$25,000, to manufacture iron and other metal castings. The incorporators are Robert Douglas, William Baskerville and Colin D. Matier. The company is represented by Clyde D. Souter, 31 Clinton St., Newark.

THE SILICA GEL CORP., Garrett Bldg., Baltimore, Md., has been incorporated with a capital of 600,000 shares of stock, no par value, to manufacture chemicals and chemical byproducts. The incorporators are Benjamin F. Lovelace, Ernest B. Miller and Walter A. Patrick.

THE ENDICOTT OIL CO., Endicott, N. Y., has been incorporated with a capital of \$150,000, to manufacture oil products. The incorporators are A. H. Burmont, R. B. Hoadley and W. J. Doyle, 78 Laurel Ave., Binghamton, N. Y.

THE FLASHITE CO., 208 South Clark St., Chicago, Ill., has been incorporated with a capital of \$10,000, to manufacture waterproofing compounds, insulating materials, etc. The incorporators are Andrew G. Burt, Jr., William F. Waugh, and Philip H. Newman.

THE TEXAS SHOPE BRICK CO., Dallas, Tex., has been incorporated with a capital of \$75,000, to manufacture brick, tile and

other burned clay products. The incorporators are E. H. Jones, B. K. Howard and J. G. Strawn.

THE LAKE CHAMPION PULP & PAPER CORP., Plattsburgh, N. Y., has been incorporated with a capital of \$200,000, to manufacture pulp and paper products. The principal incorporators are Thomson Douglas, 4 Elk St., Albany, N. Y.

THE PATERSON LEATHER CO., Paterson, N. J., has been incorporated with a capital of \$50,000, to manufacture leather products. The incorporators are Edward F. Murphy, Martin J. Fogarty and Jacob Van Hetloo, 32 Main St.

THE E. L. COOK BRICK CO., Bridgewater, Mass., has been incorporated with a capital of \$100,000, to manufacture brick and other burned clay products. Ernest L. Cook is president, and G. M. Cook, treasurer, both of Bridgewater.

THE BERING-KRAMMERER OIL CO., Long Beach, Cal., has been incorporated with a capital of \$500,000, by R. E. and L. H. Bering and William Krammerer, Long Beach, to manufacture petroleum products. The company is represented by Desmond & Larzelere, attorneys, Long Beach.

THE SPANISH AMERICAN CORK PRODUCTS CO., Westport, Md., has been incorporated with a capital of \$500,000, to manufacture cork specialties, insulation products and affiliated materials. The incorporators are Walter V. Harrison, C. J. Denhard and Philip S. Ball, Westport.

THE PADDOCK PAPER CO., Providence, R. I., has been incorporated with a capital of \$50,000, to manufacture paper products. The incorporators are Stephen D. and Louis N. Paddock and Edward J. Davis, Cranston, R. I.

THE SAN TONE OIL & REFINING CO., San Antonio, Tex., has been incorporated with a capital of \$2,500,000, to manufacture refined oil products. James Kepley is president; and M. A. Arnett, secretary and treasurer, San Antonio.

THE METAL CLEANER CO., Wilmington, N. C., has been incorporated with a capital of \$125,000, to manufacture cleaning compounds and other chemical specialties. Edward Sandlin is president and general manager; and F. B. Markey, secretary and treasurer, Wilmington.

THE PAN-AMERICAN PAPER PRODUCTS, Philadelphia, Pa., has been incorporated with a capital of \$150,000, to manufacture paper specialties. The incorporators are Wells H. Hall, Ira G. and E. H. Ross, Philadelphia. The company is represented by James A. Coady, 914 West St., Wilmington, Del.

THE ECONOMY OIL CO., Taunton, Mass., has been incorporated with a capital of \$25,000, to manufacture oil products. Samuel Cohen is president; and Alexander Glaser, 92 Summer St., treasurer.

THE BRICKSTILE CO., 500 Diversey Ave., Chicago, Ill., has been incorporated with a capital of \$25,000, to manufacture wax products, tile and other burned clay specialties, and cement materials. The incorporators are H. B. and H. H. Minnick and Ambrose J. Krier.

THE INTERNATIONAL VARNISH & COLOR WORKS, 495 Cortland St., Belleville, N. J., has filed notice of organization to manufacture paints, varnishes, etc. Joseph Bozzol, 312 North Fifteenth St., East Orange, N. J., heads the company.

THE ACME PAPER CO., INC., Boston, Mass., has been incorporated with a capital of 100 shares of stock, no par value, to manufacture paper products. William P. Yanes, is president; and Jacob A. Promboin, 156 Line St., Cambridge, Mass., treasurer.

THE CHATTANOOGA BRICK CO., Chattanooga, Tenn., has been incorporated with a capital of \$50,000, to manufacture brick and other burned clay products. The incorporators are Luze C. Hale, Sr., and Robert E. Winsett, Chattanooga.

THE RIDGEWOOD MFG. CO., Brooklyn, N. Y., has been incorporated with a capital of \$20,000, to manufacture chemicals and kindred products. The incorporators are E. Luca, C. Cavallino, and C. A. Winter, 507 Fifth Ave., New York.

THE PHILIPPINE REFINING CORP., New York, N. Y., has been incorporated with a capital of \$50,000, to manufacture refined oil products. The incorporators are C. W. Hamilton, O. C. Sanborn and A. C. Patterson. The company is represented by Larkin, Rathbone and Perry, 80 Broadway.

THE TONKIN FLAKE GRAPHITE CO., INC., New York, N. Y., has been incorporated with a capital of \$150,000, to manufacture graphite products. J. J. Tonkin, Highbridge, N. J., is the principal incorporator.

THE TAR HEEL OIL CO., Greensboro, N. C., has been incorporated with a capital of

\$350,000, to manufacture refined oil products. The incorporators are J. M. Hunt, and W. J. Jones, Greensboro; and W. L. Stamey, High Point, N. C.

THE LIFE SAVER SOAP WORKS OF AMERICA, 10 South LaSalle St., Chicago, Ill., has been chartered under state laws, to manufacture soaps and kindred products. The incorporators are Alexander Gibbons, M. Goodrich and Louis Kaplan.

THE ELITE CHEMICAL CO., 40 Frank St., Providence, R. I., has filed notice of organization to manufacture chemicals and chemical byproducts. John F. Aptt and Foster F. Hocking head the company.

THE DEFENDER OIL CO., Huntington, W. Va., has been incorporated with a capital of \$200,000, to manufacture oil products. The incorporators are C. C. Curtis and G. L. Bremmer, Huntington.

THE HERCULES CORRUGATED BOX CORP., New York, N. Y., has been incorporated with a capital of \$60,000, to manufacture corrugated paper products. The incorporators are J. Breem, B. W. Rod and M. London, 55 Liberty St.

THE BROOKLYN PACKERS BYPRODUCTS CORP., Brooklyn, N. Y., has been incorporated with a capital of \$10,000, to manufacture greases, oil compounds, fertilizers, etc. he incorporators are L. Weill, M. Lehman and N. D. Shapiro, 892 Broadway, Brooklyn.

Coming Meetings and Events

AMERICAN CERAMIC SOCIETY will hold its twenty-first annual meeting at St. Louis, Feb. 27 to March 2, 1922.

AMERICAN CHEMICAL SOCIETY, THE SOCIETY OF CHEMICAL INDUSTRY and the American Section of the latter society will hold a joint meeting in New York, Sept. 6 to 10.

AMERICAN GAS ASSOCIATION will hold its third annual convention in the Congress and Auditorium Hotels, Chicago, the week of Nov. 7.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in Lake Placid, N. Y., Sept. 29 and 30, and Oct. 1.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its annual winter meeting at Baltimore, Md., Dec. 6 to 9. Headquarters will be at the Southern Hotel and the sessions will be held in the Engineers' Club.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its fall meeting at Wilkes-Barre, Pa., Sept. 12 to 17.

AMERICAN MINING CONGRESS AND NATIONAL EXPOSITION OF MINES AND MINING EQUIPMENT will hold its twenty-fourth annual convention in the Coliseum, Chicago, Oct. 17 to 22.

AMERICAN PEAT SOCIETY will hold its fifteenth annual convention at the Hotel Commodore, New York City, Sept. 7, 8 and 9.

AMERICAN SOCIETY FOR STEEL TREATING will hold its third annual convention and exhibition Sept. 19 to 24 at Indianapolis.

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SEVENTH) will be held during the week of Sept. 12 in the Eighth Coast Artillery Armory, New York City.

NEW JERSEY CHEMICAL SOCIETY has discontinued meetings for the summer and will resume them in October.

SOCIETY OF CHEMICAL INDUSTRY (BRITISH) at the invitation of the Montreal section will hold its annual meeting in Montreal and other Canadian cities during the week of Aug. 29, 1921. Details will be printed in this magazine from time to time.

SOCIETY OF INDUSTRIAL ENGINEERS will hold its fall meeting at Springfield, Mass., Oct. 5 to 7.

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY will hold its fall convention with the American Pulp and Paper Mill Superintendents' Association, at Washington, Philadelphia, Spring Grove, York, York Haven, Pa., and Wilmington, Del. Oct. 18 to 20.

The following meetings are scheduled to be held in Rumford Hall, the Chemists' Club, New York: Oct. 7—American Chemical Society, regular meeting; Oct. 14—Société de Chimie Industrielle, regular meeting; Oct. 21—Society of Chemical Industry, Grasselli Medal; Nov. 11—American Chemical Society (in charge), Society of Chemical Industry, American Electrochemical Society, Société de Chimie Industrielle, joint meeting; Nov. 18—American Electrochemical Society, regular meeting; Dec. 2—Society of Chemical Industry, regular meeting; Dec. 9—American Chemical Society regular meeting.

CHEMICAL & METALLURGICAL ENGINEERING

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A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY and IRON & STEEL MAGAZINE

ALAN G. WIKOFF
B. S. McBRIDE
CHARLES N. HULBERT
Assistant Editor
CHESTER H. JONES
Industrial Editor
J. S. NEGRU
Managing Editor

Volume 25

New York, August 24, 1921

Number 8

Wisdom in Managing an Educational Institution

WHILE we continue to twit our California friends and to assure them that we have already heard of their far-famed climate, they seem to be doing things out there. In fact they have been doing things for several years. Some time ago in talking with one of the most illumined professors of chemistry in the country he expressed a desire to go to California and to visit Berkeley.

"Why?" we asked.

"I should like to observe how GILBERT LEWIS does it," he replied.

Now the school of chemistry at the University of California has so established itself that it needs no encomium from us; but here comes the announcement of the California Institute of Technology that Dr. ROBERT A. MILLIKAN, professor of physics at the University of Chicago, will go permanently to Pasadena to become director of the Norman Bridge Laboratory of Physics at the Institute and chairman of its Executive Council. The presidency of the Institute was offered to him, but—let us quote a few words of rare wisdom from a note on the subject in *Science* of August 12. "The trustees . . . were appreciative of his desire not to be burdened with the administrative duties usually attached to that office and have created a new administrative board to be called the Executive Council, which will combine the usual functions of the president and the executive committee of the board of trustees. It will consist of six members, three trustees and three members of the faculty, viz.: ROBERT A. MILLIKAN, chairman; ARTHUR H. FLEMING, president of the board of trustees; HENRY M. ROBINSON, first vice-president of the board (and president of the First National Bank of Los Angeles); GEORGE E. HALE, director of the Mt. Wilson Observatory; ARTHUR A. NOYES, director of the Gates Chemical Laboratory, and EDWARD C. BARRETT, secretary of the Institute."

How rare, and how sweet to the scientific ear it is to hear that the trustees themselves were mindful of the fact that a great teacher does not want to be burdened with administrative duties! And how reasonable it is, in an establishment that has no ambition to be big in the number of its students, to secure the advantage of his wisdom along with that of Dr. HALE and Dr. NOYES in conjunction with the president, the first vice-president and the secretary of the board to order the affairs of an institute of science!

Liberal provision has been made for the prosecution of research and a joint attack is to be made from the physical and chemical laboratories on "the most fundamental problem of physical science today: that of the constitution of matter and its relation to the phenomena of radiation."

In addition to the advantage of the occasional presence of Professor A. A. MICHELSON of Chicago, Professor H. A. LORENTZ of Leyden will be in residence as lecturer and research associate during two months of the coming winter and Dr. C. G. DARWIN of the University of Cambridge has been appointed professor of mathematical physics for the college year of 1922-23.

We do not want to appear before our readers as too radical or as iconoclastic. We recognize the value of traditions and the merit of maintaining them. But given a student with a mind open to mathematics and an unspoiled curiosity in regard to the unseen causes of things, we venture the opinion that there is more in it for him, somehow, to study among selected students with these masters of science than there would be if he were captain of a football team that is champion of the Pacific Coast, the Rocky Mountains, the Middle West and the Atlantic Seaboard all at once. There is more in it for him than there would be in making the Harvard Crimson fade away to a pale pink, the Yale Blue look almost white and in reducing the Princeton Tiger to a maltese cat on all the fields of sport. Shocking as this may sound, we venture to say it right here, in the open, on the irrevocable printed page.

Now bring along your University Clubs!

The Long, Long Road to Results

ARS longa, vita brevis est. And long, too, are the ways of industry, which is itself an application of the arts. We children of men are crude, very crude, and it takes generations to do what we know should be done and wish to see done. If we look at a railway locomotive with a scientific conscience, we recognize immediately that it is a wretched thief of the heritage of future generations in its voracious wastefulness. A blast furnace is also as much of a destructor as it is a producer. And why should we transport coal on expensive railroads, then on still more expensive trucks, then on trucks again only to get a little of the available energy out of it while we waste the precious lower hydrocarbons that it contains?

We know better but somehow we don't get around to it. On every side we see things done as they should not be done; but the inertia of tradition and the lack of competent leaders inhibit progress. Look at our methods of transporting freight by rail. For example, A wants to deliver to B, who lives a hundred miles away, two tons of a product which he makes. There are no standard containers, everybody uses what he can get. A 5-ton truck carries the two tons of merchandise to the freight shed. There it waits until a car comes along that is going in B's direction

or destined to the place where B wants the goods. Not once in ten thousand times is it possible to put it on the car with the mechanical economy provided by cranes and platform cars. Usually it is banged about by a lot of roustabouts and with innumerable strains and shouts it is shoved through the narrow door of a box car. Stevedore work is required after it is in the car. When the car is wholly or partly filled it is shunted off to wait a convenient train and then it is shunted on again. Arrived at its destination, there is more straining and grunting to get it out of the door, on a platform and under cover. B then receives a postal card that his goods have arrived and he sends a 5-ton truck that may not have to wait more than five or six hours and then it takes more grunts and strains to load it up and to unload it after the truck arrives at his place of business. The time is likely to be a week or ten days for shipment and nobody knows how many men have been banging it about with hooks and eating up its value with time-and-a-half or double for overtime.

Adequate terminals with cranes overhead depositing each parcel of freight from above on a flat car already part of a predestined train, and tarpaulin covers when needed, would take care of the loading and unloading in a small fraction of the time and expense now required. The railroads themselves or a single co-ordinated trucking concern could gather up and deliver freight with a fraction of the expense now involved. Why don't we do these things? Why are we so slow in making advances? The answer is very simple. We lack the men in place to see improvements through.

In many respects the world is bobbing around like a chicken with its head cut off simply because of a lack of leaders.

Mechanical Engineering In Chemical Production

TWO of the articles in this issue have been contributed by mechanical engineers. Although this in itself is not an unusual occurrence, it serves to emphasize the close relations existing between the different branches of the engineering profession. The chemical engineer must rely upon his older brother for much of the mechanics of chemical production. He must be able to draw from the other divisions of engineering as much of their specialized knowledge and experience as will serve to assist him in solving his problems. He must in turn contribute his own experience and expert advice so that all may derive benefit from the common fund of knowledge.

CHRISTIAN KRARUP, who gives us the article on potash recovery, is a mechanical engineer confronted with the thoroughly practical problem of putting the cement mill's byproduct industry on a paying basis. The cement dust must be separated from the volatilized salts as early as possible in the operation or else difficulties arise which prevent the proper application of the fundamental principle of the process. The raw material dust causes trouble for the electrical engineer in charge of the precipitation chamber and later on the separation of the gypsum from the mixture of dust and potash tests the skill of the chemist and chemical engineer. The problem was solved, however, by a combination of simple mechanical operations. Water sprays, which are used to cool the gases before they pass to the electrical

treater, were used to remove the bulk of the dust, and the remainder was separated by gravity precipitation. This simple modification of the process meant the difference between success and failure for the byproduct installation.

The second article is by THOMAS G. ESTEP. He deals with a problem of interest to the operating engineer who is concerned with the measurement of gases. He tells us that engineers are often apt to overlook the necessity for correcting their gas measurements for the water vapor contained in the saturated gases, even though large errors can thus be introduced into their determinations. In most cases the correction for the vapor is greater than the error due either to observation or to the accuracy of the measuring device. All of these devices, such as Pitot tubes, Venturi meters, orifices and throttle disks, measure the gases in terms of velocity as indicated by a measurable differential pressure. To calculate the volume of the gas from its velocity, however, requires a determination of density, and herein lies the difficulty. Since the gas is a mixture of gas and water vapor, either an accurate analytical determination is necessary or the operator must resort to a laborious mathematical process. Professor ESTEP, recognizing the delay that the tedious calculations and physical measurements usually involve, has prepared a set of curves which will materially assist in the calculation where a gas saturated with water vapor is being measured. Knowing the temperature and pressure of the gas at the point of measurement and the specific gravity of the dry gas, the specific gravity of the saturated gas can be read directly from the curves. This value can then be subtracted in the usual velocity formula, from which the volume of the gas can readily be calculated. The procedure for partly saturated gases is also simplified by these graphical determinations.

The mechanical problems referred to in these articles are similar to many which are met in chemical production, and therefore they lie distinctly within the field of chemical engineering. If the chemical engineer is to serve his industry to the fullest extent, he will do well to profit by the experiences of workers in other branches of the engineering profession.

Athletics And Chemistry

IT IS not our habit to discuss or to record intercollegiate or international sports, or sport of any kind except the queen of them all, which is the hunt for knowledge in science. But at the international meet in New York in July there was a sequel to an event which seems interesting from the standpoint of chemistry. The contestants in the one-mile run were STALLARD of Cambridge, IRISH of Cornell, McCULLOCH of Princeton and KENT-HUGHES of Oxford. Our interest is in the first named. He's a tall, lank Englishman, or looks like one, wherever he hails from. He saved his wind without falling behind until they had covered about three-quarters of the course and then with all his might and all his strength forged ahead and won the race by a considerable lead. He conserved his powers until they were needed and then he put everything he had into it.

Of course, there is nothing remarkable in that; every good athlete tries to do it, but it is pleasing to observe.

At about this time the captain of the Oxford-Cam-

bridge team came and took place beside a neighbor during some events in which he was not entered. "That STALLARD is a rum fellow," said he. "He is quiet and rather shy, but good company when you can get him. He has, however, a passion for chemistry, and you can't get him away from his chemistry books. On the way over he would take his exercise and then go back to them all the time. He spent from eight to ten hours a day at them, reading them with gusto like a boy with 'The Three Musketeers.' He lives in chemistry all the time."

This reminded us that Sir ERNEST RUTHERFORD is in Cambridge and so is Sir WILLIAM POPE, and other teachers of great repute and worth; that they have sound traditions in science and mathematics at that university, and that it might be worth while to make note of the name of the athletic student of chemistry: S-T-A-L-L-A-R-D.

Steadier Prices

Mean Business Expansion

THERE can be no doubt that the volume of business transacted will increase as a result of the fairly stable basis the commodity markets have reached, whereas last winter everyone was insisting that business was halted while men waited for prices to decline. It does not follow, of course, that business will resume the swing it appeared to have in 1920. The showing of that year was partly fictitious. Since we lack comprehensive statistics of the volume of business transacted from time to time, we naturally fall back on symptoms, particularly prices. We have since found that in the case of many commodities the high prices ruling in 1920 did not really prove that there was a heavy demand, and the stocks that represented frozen credits toward the close of the year showed that in some instances the supply had been really in excess of the demand, the holders having contrived to conceal the fact. We may indeed reach a stage in the near future of doing a larger volume of business than was done in 1920, while the outrageous prices of that year certainly will not be developed.

The volume of business that is being done now is larger than is commonly assumed. The last report of ton-mileage freight movement on the railroads, for the month of May, shows an increase over the rate in April, and a rate slightly in excess of the rate in the best railroad year before the war, that being the year ended June 30, 1913. The Federal Reserve Board reports that debits to individual accounts at banks in the week ended June 1 were only 17 per cent less than in the corresponding week of 1920, while the week ended June 22 showed a lag behind 1920 of only 14 per cent. These showings are quite different from the common appraisals of the volume of business being done. The reaction to them should be that new light is being thrown on the situation, not that they are things to be explained away. They are plainly of fundamental importance.

Reverting to the statement that commodity prices are now much steadier, the Bureau of Labor Statistics at Washington released its wholesale price statement for July on August 18. This showed an index number (1913 = 100) of 148 for July, the same as had been shown for June. Farm products and "food, etc." increased two points each from June to July, while the other items, which are not weighted as heavily in the total, declined various numbers of points.

The readjustment is either completed for the time being or has reached its final stages, indicated by the fact that no longer are all prices declining. Early in the readjustment a common feeling was that if commodity A had experienced a great decline or had approached its pre-war price, and commodity B had had only a small decline or was still far above its pre-war level, then it was up to commodity B to do a great deal more and it was necessary to wait for the slacker to do his duty. Dr. HURLIN's statistics, commented on in these columns under date of July 27, 1921 (page 135) showed that commodity prices in general declined for about thirty years after 1815 and after 1865. The point is that some commodities can get down easily while others have a hard time of it. The divergences now in advances over 1913 averages shown by different commodities are due largely to that fact. The prices that are high have to be accepted as likely to decline but little from month to month. A basis for doing business is afforded.

Price divergences now are due largely to differences in the character of the costs. Some high costs were shaken out readily. Others yield grudgingly. Such increases in costs as are due to freight rates have not been shaken out at all, for freight rates have not been reduced. We cannot take a fixed relation to 1913 prices and say that each commodity must conform to that relation or be left alone until it does. Indeed, the entire process of deflation may be stopped altogether, for there are some able economists who now argue that we are likely to have a "secondary inflation" for a time.

A Silk Purse

From a Sow's Ear

A FEATURE of the exhibit of Arthur D. Little, Inc., at the coming National Exposition of Chemical Industries, is a silk purse made out of a sow's ear. This hardly belongs to industry in the commercial sense, but it is at once an object lesson and a contribution to philosophy. First there was the sow which "passed on" as the saying is—but into provisions here present in accordance with her genus rather than into the less definitely known Great Beyond. The ears, instead of going into pickle, went into glue and the glue was softened in water, brought almost to the point of precipitation with acetone, then forced through a warm container into a spinneret and through this into a hardening solution of formaldehyde and acetone in a V-tube. It was picked out of the V-tube, reeled, dried, treated to a 40 per cent glycerine bath in which it was also dyed, then reeled and dried again, woven and sewed up—and there is as handsome a silk purse as ever was carried by the gentle abbess of whom CHAUCER sings and who never messed up her wineglass while engaged in the conviviality which now, alas, is denied to us.

As a chemical achievement it was play, mere play; an incident of minor research. Our interest in it is as a contribution to philosophy. This trinket, of which the silk is not even strong or of especially good quality, should serve as a mighty club in argument. The wretched old saw, "You can't make a silk purse out of a sow's ear," has been echoed down the ages, the Bourbon chortle of those who never learn and never forget. Let's hope that it may serve to refute the footless arguments of the ignorant and that it will help to lay those hoary ghosts of the past that jabber against progress. Science can do.

Readers' Views and Comments

Case Hardening and Oxidation of Steel

To the Editor of Chemical & Metallurgical Engineering

SIR:—Many events have prevented me from paying the necessary attention to the important paper by Mr. Matsubara on "Chemical Equilibrium Between Iron, Carbon and Oxygen" read before the February meeting of the American Institute of Mining and Metallurgical Engineers and briefly abstracted in your journal Feb. 23, 1921, page 331. I intend to study very carefully the data contained in this paper, and expect to resume my experimental researches in this very interesting field within a few months.

But in the meantime I must say that many points, both in the experimental part and in Mr. Matsubara's conclusions, seem worthy of a closer analysis, and—in some respects—to be open to some criticism.

His reaction chamber consisted of a glazed porcelain tube partly inclosed in an electric furnace, but whose ends projected into the open air. One end, in fact, was water-cooled. After introducing a certain amount of oxide, evacuating and bringing the furnace to the correct temperature, the gas to be charged was forced into the reaction chamber. After the reaction had proceeded "to equilibrium" the gas was drawn off and analyzed.

I will limit my observations to but two of the many points which could be discussed in connection with this experimental work. Mr. Matsubara does not sufficiently explain his manner of deducing equilibrium data in a vessel which is only partly heated to the reaction temperature to be studied and the balance (about one-quarter of its length) cooled by circulating water. Neither do I find any reference to the time required to withdraw the gas contained in the reaction chamber—which gas cannot be in a true physical and chemical equilibrium for the reason stated above.

These points and the many others that could be quoted perhaps have not been explained by the author for the sake of brevity. But in my opinion they require a complete discussion if the experimental results are to be taken as a sure basis of a new theory in open opposition to the results of previous investigators.

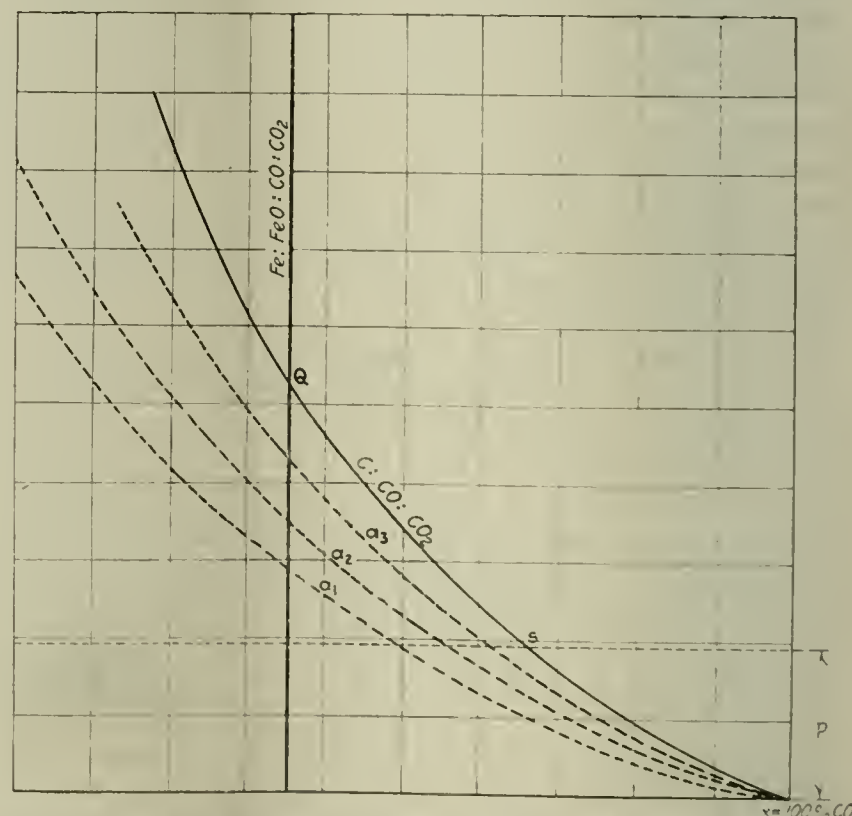
In any case, I am absolutely sure that the results of my experiments on the *simultaneous* oxidation and carbonization of iron by the system $C:CO:CO_2$ under sufficient pressure cannot be explained in the way suggested by Mr. Matsubara—namely, that the oxidation may have been caused by an excess of CO_2 being blown into the mass at too high velocity and reaching the metal before being converted by the hot surrounding charcoal into CO . I am fortified in this belief by the knowledge of many hundreds of carbonizations carried out under atmospheric pressure, but in all other respects under exactly identical conditions as those under higher pressure, not one of which has caused the slightest oxidation of the surface of steel imbedded in the charcoal. Neither did an increase in gas velocity twenty times higher cause any oxidation at atmospheric pressure.

Such simultaneous carbonization and oxidation I explained (and for that matter, still explain) on the basis of Schenck's investigations, easily summarized in

the attached diagram showing isothermals for the two systems in question. If conditions are as here represented, it is obvious that at some pressure p , less than Q , hot carbon will tend to hold the CO concentration at S , which will not only protect any iron from the formation of FeO but bring the carbon in austenite up through various stages represented by curves a_1, a_2, a_3 , etc., eventually arriving at a certain carbon concentration (Σ austenite) which is in equilibrium with the same CO concentration as that generated by carbon. On the other hand, any pressure greater than that represented by Q will cause simultaneous oxidation and carbonization.

Mr. Matsubara's diagram shows the iron oxide vertical displaced far to the left so that the two principal curves do not intersect. Therefore his diagram infers that the admitted phenomenon of combined oxidation and carbonization must accomplish itself alternately in two opposite directions. Thus for some time the $CO:CO_2$ mixture which bathes the surface of the iron would act as a carbonizing agent, but could not cause the least oxidation. In the next period of time the $CO:CO_2$ mixture—having in some unexplained manner changed its composition—should act as an oxidizing agent.

Accepting for the moment this situation, it must be clear that in the second period of time the gas, containing a higher percentage of CO_2 , cannot be in equilibrium



ISOTHERMALS SHOWING CONDITIONS EXISTING DURING CARBURIZATION BY CO AND CHARCOAL UNDER PRESSURE

with the carbonized zone produced previously. Necessarily, then, there must be some decarbonization of the outer layers of metal before the oxidation could occur. Such an intermittent process, no matter what the order or number of the alternate periods, would consequently leave an end product which is quite different from those I have observed without exception in pressure carbonizations.

In my own experience the finished samples always

possessed a thick layer, strongly and very uniformly carbonized, in which the carbon content reached its maximum value at the *outer* surface where the metal was in intimate contact with a thick solid crust of iron oxide. In this crust many pieces of charcoal were imbedded, so that the oxide was in close contact with free carbon, a proof that in my experimental conditions the gas mixture was in equilibrium *at the same identical time* with charcoal, iron oxide and the austenite of highest carbon content.

Aside from all these remarks, it must be constantly borne in mind that it has been experimentally proved, independently of any theory by Schenck or other scientist, that at certain temperatures the simultaneous carbonization and oxidation of iron can take place only when the pressure of the C:CO:CO₂ system exceeds a given value. Hence it follows with the same degree of certainty that the curves corresponding to the two reactions must cross each other at that pressure.

Turin, Italy.

FEDERICO GIOLITTI.

Slip Interference Theory of Hardening

To the Editor of Chemical & Metallurgical Engineering

SIR:—Dr. Jeffries and Mr. Archer must be congratulated on their very interesting and important contribution to the theory of hardening published in your issue for June 15, 1921. The authors have in "slip interference" found a lucky word, which when made comprehensive enough gives a nice and easily remembered explanation of the cause of hardness, especially after defining hardness as resistance to deformation (or slip). If their theory is correct, it should satisfactorily explain all phenomena connected with hardening, and it may be of interest to discuss a few points to see whether the theory will hold when considered from a few other angles.

The authors state in the beginning that metals owe their hardness and strength to interatomic bonds and, further on, that deformation is caused by slip. I cannot find it clearly so stated, but it must be assumed that such slip will occur between atoms and will take place most easily at right angles to the direction where the sum of interatomic bonds is the least.¹ When some outside force is applied which causes slip between the atoms, these take up new positions, each to each, with stronger bonds. They can then better resist an outside force against further displacement. When the temperature is low and the molecular motion is not lively enough, no rearrangement of disorganized atoms will take place and the phenomenon known as cold-working is the result. When the outside force exceeds a certain limit, the interatomic bonds will be broken.

It is generally conceded, as the authors state on page 1059, that a solid solution will be harder or more resistant to slip than the pure solvent. Anybody who has watched the steel melter forging test samples taken from a furnace bath before and after the addition of a small amount of chromium will know that the sample containing chromium will yield less under the same hammer blow. The interatomic bonds when chromium is present in the hot alloy must evidently be stronger than when chromium free. The question may be asked whether this is caused by a network of Cr atoms in a lattice independent of the lattice of Fe atoms and possibly of a different orientation, or whether there are

distinct bonds between Fe and Cr in one lattice in which Cr atoms have replaced Fe atoms.

To my mind, diffusion at high temperatures and in the molten state is readily explained by assuming the solute to be distributed in the molecular state, and there is good reason to believe that cementite dissolves in that way when taken up by iron. This is denied by Jeffries and Archer. When solids dissolve in liquids like water or alcohol, the solution is molecular. Association or disassociation of molecules may occur according to circumstances. When carbon separates from solution in gamma iron, it is in the form of cementite. Furthermore, hydrocarbons are formed when quenched steels are dissolved in acid. Cementite can apparently migrate even below the critical range, since it is known that the cementite particles of sorbite or granular pearlite decrease in number and increase in size, and that even lamellar pearlite can be converted into granular by prolonged heating at 650 deg. C. These are reasons for assuming that cementite dissolves as such and is not dissociated into carbon and iron. It would be interesting to know in detail the author's reasons for not assuming cementite to dissolve as molecules in γ iron.

Jeffries and Bain have found that cold γ iron has a face-centered lattice and that α iron has a body-centered lattice. In this they are in accord with Dr. Westgren.² Dr. Westgren has not yet been able to determine the space lattice for Fe₃C at elevated temperature and whether there is any change in space lattice when dissolving in γ iron.³ It would be most interesting if someone could succeed in doing this, because it might give an idea as to the form of cementite in γ iron. Most probably the space lattice of a crystalline solvent will have a directional influence on the space lattice of a crystalline solute, at least when the latter has some similar atoms, so that in the same crystal γ iron and cementite will have space lattices of the same general nature. The bonds between atoms in dissolved molecules will be stronger than between atoms in the solvent, thus the mass is made harder.

Like Dr. Westgren, they find that martensite consists mainly of alpha iron, which is in agreement with other known facts, but there is still the possibility that some γ iron is left in quantities insufficient to give interference lines in their photograms.

From remarks and the illustrations on page 1062 it appears that Jeffries and Archer consider it necessary that Fe₃C particles must have reached a relatively large critical size, greater than a molecule, to give greatest hardness to the steel. They state, on the other hand, on page 1065, quoting evidence, that cementite cannot be detected in martensite and, further on, that carbon must be in solution. If cementite should act as keys on cleavage planes in the way the authors apparently explain it, the cementite must have separated out of solution but might still exist as submicroscopic agglomerates of Fe₃C molecules.

The investigation of Andrews, Rippon, and Mills⁴ shows clearly that cementite has not separated from

³ Editor's Note: In a paper read before the British Iron and Steel Institute, May, 1921, meeting, Dr. Westgren gave results on hot and cold iron wires as follows:

Condition	Crystal Form	Length of Edge in Angstroms
Pure iron at room temperature	Body-centered cube	2.85
Pure iron at 815 deg. C. (beta)	Body-centered cube	2.92
Pure iron at 1,000 deg. C. (gamma)	Face-centered cube	3.60
Cold 25 per cent nickel steel	Face-centered cube	3.58
Cold 12 per cent manganese steel	Face-centered cube	3.61

²Jernkonteret Annaler, 1920.

⁴J. Iron and Steel Inst., 1920, p. 548.

¹Compare the cleavage in graphite.

martensite as such. Andrews shows also that there is an increase in volume of γ iron when Fe_3C goes into solution; further, that a dissociation of carbide molecules is probable in steels with higher carbon contents when heated to high temperatures. The carbide expansion found by Andrews is nearly equal to the increase in volume of martensite over annealed steel. Austenite, on the other hand, has a smaller specific volume, and we know that cold-worked steel has a larger volume than annealed steel. It seems to the writer that these facts, to which the authors have made no mention, are of importance in determining the condition of the carbon in heat-treated steel.

It would be interesting to know whether there is not some slight change of volume in the aging and in the annealing of duralumin.

The increase in volume of α cold-worked steel is evidently due to slips having taken place. Now when γ

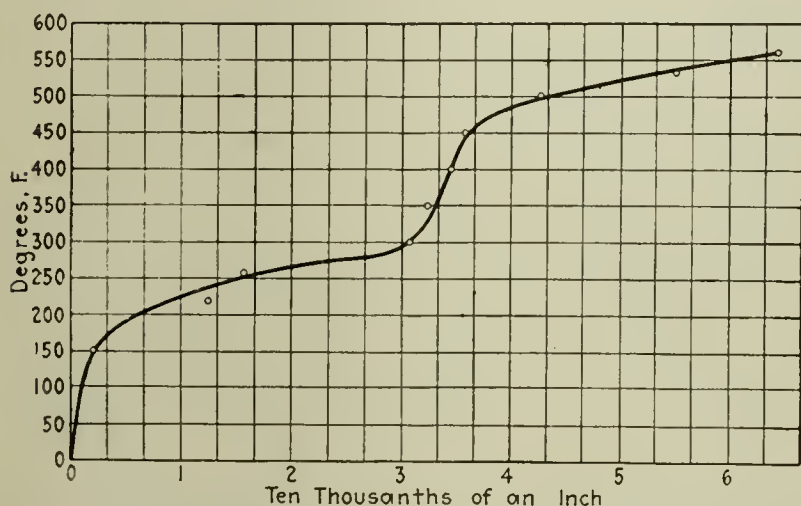


FIG. 1. DECREASE IN DIAMETER OF HARDENED STEEL BALLS WITH INCREASING DRAWING TEMPERATURES

iron transforms into α iron an increase in volume also takes place, but the transformation in cooling does not take place instantaneously throughout the whole mass. Crystallization of α iron starts on cleavage planes and grain boundaries of the γ grain and the first α iron formed will tend to rid itself of the cementite present, but like in any other rapid crystallization, it succeeds but imperfectly. At the same time the volume changes attending transformation will cause mechanical work to be done on the surrounding metal, causing slippage and further increase in volume.

Gradual change in carbon content of martensite needles is easily seen by etching, especially in highly drawn nickel steels.

Portevin⁵ showed that martensite forms below 300 deg. C. and that it takes time to form. An experience similar to the aging of duralumin can be cited. When hacksaw blades are hardened they can be straightened and set when they are no cooler than 100 deg. C. immediately after being withdrawn from the quenching bath, but if they have been cooled to room temperature and reheated 100 deg. C. or more, they cannot be straightened. Thus there is evidently some internal slipping going on in the steel immediately after quenching.

Andrews shows that on drawing hardened steels there is a cementite separation with decrease in volume at about 100 to 150 deg. C. and a transformation of γ to α iron at about 400 deg. (shown by change in electric and magnetic resistance), but with a further decrease in volume which must be explained by healing the slip

planes and closing of voids. The attached curve (Fig. 1) made by Mr. Wright of the Atlas Ball Works, showing decrease in diameter of hardened balls by drawing to different temperatures, may be of interest in this connection. We have also found that simple storage at room temperature for a considerable time is sufficient to decrease a ball-diameter measurably. Andrews' investigation seems to indicate the presence of a small amount of γ iron even after hardening straight carbon steel, where he (Andrews) does not believe it is present, and Dr. Westgren also believes that his photograms show presence of γ iron in hardened steel.

Is it not reasonable therefore to conclude that in hardened steel, cementite is in solution in the traces of gamma iron left after most of the α iron has formed. The Fe_3C molecules are still in solution, perhaps polymerized, and, with the γ iron, forming a kind of gel in the iron, but not separated as crystals of cementite. In such form the dissolved cementite molecules may well be considered as keys on the slippage planes of the iron.

Portevin showed that troostite forms at about 600 deg. C. and it is agreed that free cementite is then separated.

It seems clear that the crystallization power of ferrite and cementite, influenced in turn by the presence of other solutes in iron, will have some influence on the final product.

When martensite is formed from solid solution there is doubtless a grain refinement due to the formation of

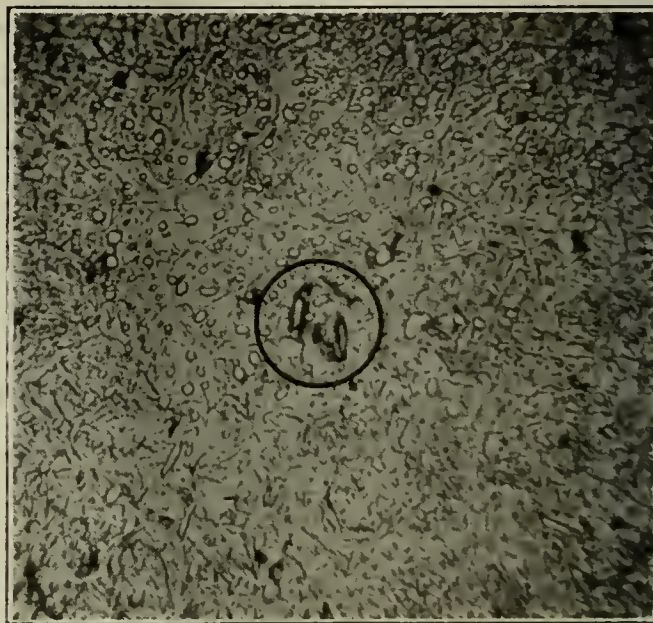


FIG. 2. SECONDARY FERRITE IN CHROMIUM STEEL. $\times 1,000$.

the many new particles of α iron, but it should not be concluded directly that the hardness of the mass will be in inverse proportion to the size of such particles (which latter probably will have some relation to the size of the γ grain from which they are formed). McCance⁶ shows little variation in Brinell hardness by increasing the quenching temperature, even though a coarser martensite is thereby produced.

How would the theory of Jeffries and Archer explain the formation of Hultgren's secondary ferrite in tungsten steel⁷ and a similar phenomenon illustrated in Fig. 2 found sometimes in chromium steel? How would they explain the presence of internal stresses in hardened steels?

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⁵J. Iron and Steel Inst., 1919.

⁶J. Iron and Steel Inst., 1914.

⁷Hultgren, "A Metallographic Study of Tungsten Steels," p. 14.

Italian Chemical Industries

FROM OUR SPECIAL CORRESPONDENT

GENOA, Italy, Aug. 1, 1921.

JULY was characterized by the return of orders on the Italian market, brought more through the fear of future increase in price, caused by a higher foreign exchange, than through the weak industrial demand. Such orders were principally for the commoner products and brought up prices of these, but they did not stop a further fall in price in the case of other products, despite the higher importation taxes arranged, the full force of which was felt the first of the month.

NEW IMPORTATION TARIFFS ON CHEMICALS

The new importation tariffs are as follows: Silicate of soda and silicate of potash, in solution, 10 lire gold per ton; silicate of soda, solid, 25 lire gold; hypochlorite of potash and hypochlorite of soda, 40 lire gold; hypochlorite of lime, 20 lire gold; bicarbonate of soda, 30 lire gold; beet-root ashes, exempted; vegetable ashes, exempted; crystallized carbonate of soda, 10 lire gold; calcined carbonate of soda, 30 lire gold; carbonate of potash, 20 lire gold; carbonate of lead, 80 lire gold; carbonate of ammonia, 120 lire gold; carbonate of barium, 40 lire gold; carbonate of magnesia, 25 lire gold; ammonia, compressed, 120 lire gold; ammonia in solution, 50 lire gold; solid caustic soda, 30 lire gold; liquid caustic soda, 20 lire gold; caustic potash, 30 lire gold.

REDUCTIONS IN IMPORTATIONS

The first four months of this year saw quite a general reduction in importations and exportations. The following were the values of some of the imported commodities: Benzine, 11,000,000 lire; petroleum, 12,000,000 lire; carbonate of soda, 13,000,000 lire; paraffine, 15,000,000 lire; explosives, 11,000,000 lire. The values of some of the exported products were: Citrate of lime, 30,000,000 lire; citric acid, 10,000,000 lire; sulphur, 15,000,000 lire; raw tartar, 7,000,000 lire; sumac, 7,000,000 lire.

SUGAR IMPORTATIONS

In the year 1920 the sugar importations reached only 11,374 tons in the case of the finer product, against 73,465 tons in 1919 and 29,713 tons in 1918; and only 1 ton in 1920 in the case of the second class product. The total importation of the first class sugar can be subdivided as follows: United States, 6,635 tons; Japan, 430 tons; Egypt, 326 tons; Argentina, 11 tons; Brazil, 241 tons; Cuba, 179 tons; Dutch East Indies, 1,575 tons; France, 1,523 tons.

HYDRO-ELECTRIC DEVELOPMENT IN ITALY

Italy developed with great energy its hydro-electric plants during the time of the war to meet as far as possible the demand for combustibles of all sorts, and at the end of 1915 as many as 329 plants were at work, with a total capacity of 835,000 hp. After 1915 fifty-eight other plants were constructed, producing additional 217,000 hp., and at present fifty-seven new plants, representing more than 599,000 hp., are under construction. For this reason Italy will soon have hydro-electric plants capable of producing about one million and a half horsepower. Fifty-nine mountain lakes will soon be completed for the above plants, having a capacity of 225,000,000 cu.m. Of these, seven have a total capacity of 10,000,000 to 40,000,000 cu.m. In addition

seventeen other reservoirs with a capacity of 701,000,000 cu.m. are now under construction. Among them is the enormous Tirso reservoir in the Isle of Sardinia, which will have a capacity when finished of more than 400,000,000 cu.m.

PRODUCTION, IMPORTATION AND EXPORTATION OF SUPERPHOSPHATES

The production of bone superphosphates was greatly reduced through the war, falling from 924,736 tons in 1914 to 911,190 tons in 1915, 867,690 tons in 1916, 489,000 tons in 1917 and 480,000 tons in 1918. The importation also showed a marked decrease, being reduced from 38,249 tons in 1914 to 13,765 tons in 1915, 2,040 tons in 1916, ceasing altogether in 1917, and again reaching only 164 tons in 1918 and little more in 1919. In 1920 the total imports of all fertilizers reached 5,353 tons (leaving out Thomas slag). The exportations of bone superphosphates were 19,981 tons in 1914, 12,925 tons in 1915, 4,482 tons in 1916, 895 tons in 1917 and 6 tons in 1918, being stopped altogether after this. In 1914, 943,004 tons of bone superphosphates were available for agricultural purposes as against 912,030 tons in 1915, 865,248 tons in 1916, 488,105 tons in 1917 and 480,158 tons in 1918.

Up to the end of 1918 no production of mineral superphosphates was recorded. The importation was 513,998 tons in 1914, 456,901 tons in 1915, 434,713 tons in 1916, 230,150 tons in 1917 and 231,679 tons in 1918. The exportations of mineral superphosphates reached 8,560 tons in 1914, 1,805 tons in 1916, being stopped after this altogether. The mineral superphosphates in stock were 505,429 tons in 1914, 455,096 tons in 1915, 434,712 tons in 1916, 230,159 tons in 1917, and 231,078 tons in 1918.

These great reductions in the available stock of superphosphates impoverished the Italian soil, and production was reduced considerably and has not yet reached the proportions realized before the war.

ESSENTIAL OILS AND CAMPHOR IN ITALY

Italy exports yearly about 30,000,000 lire of essence of flowers and aromatic plants. Among the essences produced in largest quantity is that of the flowers of the lavender plant, of which several million kilos are prepared yearly, and the price has risen during ten years from 20 to 150 lire per kilo. The essence of mint, which is produced in Piedmont and to a larger extent in the provinces of Turin and Cuneo, where the plant can be cultivated with a very high yield on account of the special nature of the ground, is exported to France and to England. Thyme oil has so far been produced principally in Sardinia, and more than 100,000 kilos of essence or oil of bergamot (which is largely employed in the preparation of eau de cologne) is produced, especially in the province of Reggio Calabria. The essences of rosemary, of anis, of orange flowers, etc., are also produced, but so far not in very large quantities.

Italy is in a position to produce natural camphor, as the camphor laurel is cultivated fairly easily at Naples and thereabout, at Caserta, at Rome, at Pisa, at Florence, on the Riviera and on Lake Maggiore. For the extraction of the camphor the green and dry leaves and the small branches of camphor laurel are employed. The yield in these portions of the plant is more than the yield of any foreign plant, but the yield in the roots, branches and trunk of the Italian laurel is much below that of foreign plants, especially the Japanese variety.

The Successful Recovery of Potash as a Byproduct From Cement Kilns

Difficulties Encountered in Placing Byproduct Industry on a Paying Financial Basis and a Description of a Successful Plant in Which the Cement Dust Is Separated From the Potash by Spray Washers Prior to the Electrical Precipitation

By CHRISTIAN KRARUP

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THE comparatively small quantity of potassium salts volatilized from the raw material in rotary cement kilns and subsequently discharged into the atmosphere with the dust in the waste gases, suddenly came into prominence at the time the recent war cut off the usual supplies of this valuable material. The recovery of potash from the waste gases was undertaken by several cement companies throughout the United States, but in view of the fact that many of these attempts have met with failure, it is believed that the following account of a successful plant will be of interest. Rather than to give a detailed description of the plant, however, which admittedly may be considerably simplified and improved upon, it is the purpose of this article to point out the various problems encountered and to state the line of reasoning and the assumptions forming the basis for the design of the plant. It is believed that the information it is intended to convey will in that form be made more useful as an aid in the design and construction of future plants.

The quantity of potash available for collection varies at the different plants according to the raw materials used in the manufacture of the cement. It is stated that the average quantity volatilized at the plants in the United States is somewhat in excess of 2 lb. of actual potash (K_2O) per barrel of cement manufactured, although at several plants as much as 4 lb. is volatilized. The recovered salts, consisting mostly of potassium sulphate, with some sodium sulphate, have been used principally as an ingredient in mixed fertilizers, but as these are made up according to definite specifications, the low and irregular potash content in the recovered product makes it somewhat undesirable for this purpose. Valuable as potash is as a fertilizer, it has, of course, no value whatever as a commodity unless placed on the market in a satisfactory commercial form. To realize better financial returns from the recovered potash, several companies therefore undertook to refine the product by leaching the salt from the dust and evaporating the solution to obtain the salt in a concentrated form. This process, however, had considerable trouble and expense attached to it and also resulted in some loss of potash, which made still more pertinent the question as to whether the industry would be able to survive at all, should the price of potash fall to the pre-war level.

GYPSUM CAUSES DIFFICULTIES

That such a simple refining process should present any unusual difficulties may not be immediately apparent to the reader, but the elimination of gypsum has proved to be a serious stumbling block in connection with the recovery of potash from cement kilns. Many schemes, proposed and tried, would in practice have

worked perfectly, if gypsum had not the apparent habit of always crystallizing out where it is not wanted. The gypsum is formed in abundance, because an excess of SO_2 , over that required to form potassium sulphate and sodium sulphate, is generally present in the gases, and if this excess has not all been combined with the lime in the dust to form gypsum, that remaining may be relied upon to expend itself in corroding metals or doing some other equal damage. Aside from the fact that to remove gypsum from the interior of pumps, pipe lines and filters involves considerable expense, the main objectionable feature in connection with gypsum is that it will combine with the potassium sulphate to form a "double salt," which is soluble only in very dilute solution. To separate any appreciable portion of this salt from the dust, it is necessary to use a large quantity of wash water, and this in turn increases the evaporation cost. Under certain conditions a very considerable portion of the potash is tied up in the dust in the form of this double salt and is therefore lost, unless it can be returned to the kiln to be re-volatilized. However, this procedure invariably results in a portion of the salt being crowded into the cement clinker or lost through other channels.

These are the principal reasons why the potash byproduct industry in connection with cement manufacture did not materialize as rapidly as might have been expected. The difficulties met with in connection with gypsum, no doubt, directly or indirectly, are responsible for the fact that the recovery has been abandoned by several companies that were already established in the business. The nature of the difficulties are such that no remedy apparently is possible as long as water is used in the process of separating the salt from the dust and on the other hand, no other course would seem to be left open, once the two are collected together in the mixed condition.

CLASSIFICATION OF DUST AND FUME PARTICLES

Obviously the aim should be to collect each separately, as far as it is possible to do so. The dust and the salt are both present in the gases in the form of minute particles in suspension and are already apparently hopelessly mixed before leaving the kiln, but as the individual particles do not touch one another while in suspension in the gas, it is still possible, if the proper means are employed, to effect a classification of the particles before the collection is made.

It is, of course, essential that this classification should be carried out while the particles are still in suspension, because, if they are collected first and therefore brought in actual contact with one another, no mechanical means are then available for separating them to a

sufficient degree to permit a proper classification being made. This may be explained as being due to the fact that the power of cohesion, and that of adhesion as well, of particles of such extreme fineness is much greater than the weight of the particles themselves, which condition makes it impractical by mechanical means to dislodge individual particles, after they have attached themselves to other particles or objects.

It is of course necessary that the means employed for classifying the particles should recognize the difference in the physical characteristics of the dust and the salt. As the specific gravity of both substances is nearly the same, a difference in the size of the particles must be relied upon to accomplish the desired results. That there is a decided difference in the size of the dust and salt fume particles can readily be detected in a strong light, even with the naked eye. Individual dust particles may be distinguished floating in the gas, while individual fume particles cannot be singled out in the same manner, and their presence can only be recognized by the foggy appearance of the gas.

This difference in their physical characteristics is not surprising, when it is remembered how each is produced. The salt, being volatilized in the kiln, passes through the vapor state, in which condition it becomes diffused into a large quantity of gas; this vapor is condensed into a fog consisting of minute particles of salt in the liquid state, which subsequently change to the solid state, as soon as the temperature becomes low enough. Particles produced in that manner should naturally be expected to be very much smaller in size than the raw material dust particles, which have been produced by a grinding process.

The salt fog behaves very much like the ordinary fog, produced by water vapor in the atmosphere, which does not exhibit any tendency to settle due to the force of gravity, or at least, if such a tendency is present, it is so small as to be negligible; nor do the individual particles of their own accord tend to agglomerate to form bodies of such size that would be expected to settle. The dust on the other hand, it has been found, is acted upon sufficiently by the force of gravity to cause it to precipitate, if it is given the proper opportunity.

DETERMINING THE METHOD OF CLASSIFYING

It is not within the scope of this article to discuss the nature of the forces that cause the fume to act in a manner similar to that of a vapor, although it is composed of solid particles instead, but it is the purpose to bring out clearly that a difference between the dust and the fume does actually exist. While the fume will not settle appreciably by the force of gravity, it will, on the other hand, not stay indefinitely suspended in the gas, but must eventually precipitate upon any surface with which the gas is brought in contact. It is possible to carry out the classification in such a manner that practically no dust will be carried over into the salt, but it is not possible to prevent a certain quantity of the salt from being precipitated with the dust, because the dust particles originating in that part of the kiln where the potash salt is volatilized are surrounded by the salt vapor while suspended in the gas and some of this vapor is condensed upon the dust particles as a nucleus and is therefore firmly attached thereto.

The quantity of salt thus adhering to the dust is probably further increased in amount by the collection of solid fume particles on the surface. As the salt collected with the dust can not be made available for the

market except by bringing it into solution or by returning it to the kiln to be re-volatilized, it is desirable that the quantity, thus caught with the dust, should be held at a minimum. For that reason, the dust should be removed from the gas at the earliest possible moment, and it is necessary to use discrimination in the selection of the method to be used for the purpose.

The method employed must be efficient enough to prevent any large quantity of the dust from being carried over into the salt, and yet, at the same time, not precipitate an excessive amount of the salt into the dust. A solution to this problem has been successfully worked out at the plant of the Santa Cruz Portland Cement Co. at Davenport, California. This company is operating a potash-recovery plant that is of a high efficiency and simple in operation. A high grade product is recovered, containing about 33 per cent of K_2O as potassium sulphate, and the recovered salt is remarkably uniform in quality, seldom varying more than 1 or 2 per cent in its potash content. Each kiln is provided with a separate recovery unit and 10 such units are at present in operation. The daily production of potassium salts is 10 to 12 tons.

SEPARATING THE DUST BEFORE RECOVERING THE SALTS

For the recovery of the salts, the gases are first cooled with water sprays, which also incidentally remove the greater part of the dust; the portion not removed in that manner is then subjected to gravity precipitation and finally the salts are collected by electrical precipitation. The dust precipitated by gravity is returned to the kiln, but that caught by the sprays and therefore contained in water in the form of a thin slurry is conveyed by gravity to a Dorr thickener, where the solids are settled to the bottom and drawn off as a thick slurry. This slurry is filtered on Oliver continuous filters and the cake formed by this operation is dried in a rotary drier. The dried cake or dust is returned to the kiln along with the regular feed of raw material, of which it forms a part. The benefit derived from the return of this dust to the kiln is due partly to its value as raw material, but mostly to the fact that it contains a much higher percentage of potash than the original raw material. The quantity of dust collected in 24 hr. per kiln is about 6 tons and in this dust is the salt which is unavoidably caught along with the dust. This amounts to about 15 per cent of all that is volatilized. The clear liquor from the Dorr thickener is re-circulated through the sprays by a single stage centrifugal pump, which supplies a pressure of about 30 lb. per sq.in. at the spray nozzles.

As the chief interest in the recovery process is centered in the treatment of the gases for the collection of the salts, a detailed description of the auxiliary equipment is not attempted, inasmuch as this part of the plant has no direct bearing upon the results obtained in the recovery of the salts.

The recovery plant was originally designed for the recovery of the salts by the wet process and was operated successfully as such up to the latter part of the year 1919, at which time it was remodeled to meet the requirements for the collection of the dry salts direct from the gases. In remodeling the plant, many desired features in connection with the dry process have not as yet been applied. It is contemplated to eliminate the expense connected with the filtering and drying process by feeding the thick slurry from the Dorr thickener direct to the individual kilns. In no case, however, have

these deficiencies interfered with the proper application of the fundamental principle of the process, which had already been recognized and incorporated in the original installation, namely: "that of separating the raw material dust from the gases before the collection for the salts is made."

COOLING THE GASES

As the dry process of cement manufacture is in use at the Santa Cruz plant, the temperature of the waste gases is high, being about 750 deg. C. This makes it imperative to cool the gases as the first operation, because such a high temperature could not be handled through the recovery plant, on account of the deteriorating effect on the structures, which are of reinforced concrete and steel. It is also advantageous to cool the gases to a low temperature, as it greatly improves the efficiency of collection in the electrical treater.

Water sprays are used to cool the gases. As it is not desired to put the salt fume into solution, the spraying is limited to such an amount as will not completely saturate the gas with water vapor. The temperature may safely be lowered to 100 deg. C., which leaves a sufficient margin over the saturation temperature to insure that the salt fume will remain in the dry state in which it left the kiln. About 75 gal. of water is sprayed per minute and of this about 20 gal. is evaporated and carried off with the gas.

The gases from the kiln are taken from the top of the stack, which is cut off at a point about 40 ft. above the base. In taking the gas at the top, instead of near the base, an advantage is derived from the fact that no dampers are required to control the flow of the gases, which may, at will, be discharged directly to the atmosphere or be drawn through the recovery plant by simply applying the suction of a fan. This arrangement leaves the kiln and its stack a complete unit independent of the recovery plant and permits of its operation with the least interference. The arrangement also tends to increase the safety in operation, as the stack is always open and ready to discharge the gas to the atmosphere in any emergency.

SPRAY WASH TOWER

About 35,000 cu.ft. per min. of gas enters a spray wash tower at the top, at which point the water sprays are also located. The tower is 6 ft. by 10 ft. inside in plan and 21 ft. high. At each 7-ft. level, a shelf projects part way across, leaving openings 4 ft. by 6 ft. at alternate sides of the tower for the gases to pass through.

The efficiency of the water sprays in gathering up these extremely fine dust particles would seem to depend entirely upon to what extent the water sprays are forced to take a different path from the gas and upon the velocity with which the drops of water are made to plow their way through the gas, it being assumed that the dust particle is caught by reason of the fact that it has appreciable size and weight and can not, therefore, get out of the path of the water drops fast enough, whereas the fume particles would veer off with the gas, due to their insignificant size and weight. For the same reason it would seem that fine atomization of the water is not desirable for the purpose of removing the dust, as the fine water particles would travel along with the gases, the same as the dust, and could not be thrown out by any zig-zag arrangement. The high efficiency as a dust collector obtained by this tower, considering the

large volume of gas handled and the comparatively small quantity of water used by the sprays, must be attributed to its small size, with the consequent high velocity of the gas through the tower, combined with the particular arrangement as outlined.

The gypsum crystallizing out on the walls of this tower must be removed at intervals of about 6 weeks. To facilitate this work, the floors, installed primarily for the purpose of giving the gas a zig-zag course, answer admirably as working platforms. Gypsum also crystallizes out in the pump and pipe lines as well as in the spray nozzles of the circulating spray system. The nozzles are removed daily and sand-blasted clean; the pump and pipe line require cleaning about every 6 to 8 weeks. The circulating spray system is installed in duplicate in order to allow time to remove the gypsum without interruption in the operation of the recovery plant.

DUST SETTLING CHAMBER

The efficiency of collection by the sprays can not be depended upon to remain constant at all times, on account of the variable condition of the nozzles, and therefore a supplemental gravity precipitation of the dust is resorted to, in order to control the quantity of dust escaping to the electrical treater. With the sprays in proper working order, about 95 per cent of the dust is removed from the gases in the spray tower, which leaves only a small quantity to be precipitated by gravity; the important object is not so much to remove this small amount of dust as it is to insure uniformity in the quality of the recovered product.

The chamber in which the dust is precipitated is 13 ft. wide by 30 ft. long by 7 ft. high and is located directly beneath the electrical treater chamber, from which it is separated by a floor having openings along the outer walls for the passage of the gas. The openings are of such size as to insure uniform distribution of the gas over the entire chamber. The gases from the spray tower enter this chamber through a large opening in one end, and as they enter they are passed toward the center of the chamber and from there divided and drawn to each side through the openings communicating with the treater chamber. The velocity of the gases is in that manner reduced without turbulence, thus affording excellent opportunity for the small amount of dust still present in the gases to precipitate to the floor. It has been demonstrated by the operation of this chamber that it is possible to settle out the very light and flocculent dust, without resorting to the use of dust-settling flues of prohibitive length and cross sectional area.

ELECTRICAL PRECIPITATION CHAMBER

The electrical treater is of chief interest in the entire installation inasmuch as it is the apparatus by which the salt fume is collected, but it is also of particular interest on account of its many unusual features. In the design of this treater, several distinct departures have been made from the usual types, described from time to time in the various publications. It will be observed from Fig. 1 that the treater is of the plate type, although the plates can not be directly seen, as they are covered with precipitated salts. The treater chamber is 13 ft. wide by about 34 ft. long. On each side of the chamber are benches or shelves above the floor; these are for the purpose of preventing the collected salt, as it drops from the treater to the floor, from passing through the openings into the dust settling



FIG. 1. INTERIOR VIEW OF PRECIPITATION CHAMBER SHOWING THE ELECTRICAL TREATER OVERHEAD

chamber below. The rectangular openings through which the gases enter this chamber are located immediately beneath the shelves. The gases in passing through the treater are distributed uniformly over the entire area by reason of the control obtained through the restricted openings left between the angle irons, which are riveted to the upper edge of the treater plates. These angle irons also serve to stiffen the plates and to keep them in alignment. The plates are suspended from cross beams on top of the treater and are bolted to these through the angle irons.

The outstanding feature of this treater is the large area employed in the collecting field for the gases to pass through. The velocity of the gas is therefore very low, less than 1 ft. per sec.; this permits of the salts, which have been precipitated by the treater, to drop to the floor against the gas current. In the customary types of pipe or plate treaters, it has usually been one of the objects to economize in the floor space occupied. As a result of this, the gas velocity through the precipitating field has been correspondingly high, which necessitated using long pipes or wide plates, as the case may be, in order to obtain good efficiency of collection.

A treater of this type, with pipes 13 ft. long, was experimented with, but did not prove entirely satisfactory, mostly because severe arcing interfered with precipitation and required too much attention on the part of the operator. It was found that these arcs were usually started by some of the deposited salt breaking away from the collecting surface, and as this salt was falling down through the pipe, an electrical disturbance was created that frequently resulted in the circuit-breaker "kicking out." This trouble was aggravated by the comparatively high velocity of the gas up through the pipes, and by the height of the pipe treater, which unduly delayed the salts in falling clear of the electrical field. To overcome these difficulties, the treater now in use at the plant was developed.

The plates in this treater are only 18 in. wide in

the direction of the flow of the gases, which therefore gives a rather narrow field for precipitation, but this is made up for by the large area employed. The treater is 12 ft. wide by 30 ft. long over the plates, and the plates are spaced 6 in. apart. Instead of suspending the electrode wires in the usual vertical position with the necessary weights at the lower end to keep them tight, the wires in this treater are suspended horizontally. By this arrangement the space underneath the treater is left entirely clear, with no obstructions on which the salts can accumulate and thereby invite trouble. The wires, which are two high and spaced 8 in. apart vertically, are strung from bus-bars, rigidly supported by insulators at each end of the chamber. No special provisions are made to take up any slack in the wires due to the expansion from heat, as the elasticity in the wire is sufficient to allow for this. In the middle of the span of the wires is suspended a light grid, which serves



FIG. 2. VIEW OF POWERHOUSE SHOWING CONTROL OF MOTOR-GENERATOR SETS AND TREATERS

to steady the wires and is for that purpose prevented from swinging by diagonal wires running to the bus-bars. This arrangement is plainly seen in the view in Fig. 1.

An iron pipe frame may also be seen directly underneath the grid. This frame supports a small air hammer of a very simple construction, which is used for the purpose of stripping off any salts, that have been precipitated on the wires, by delivering a succession of light blows on the grid. The air hammer automatically withdraws, when not in use, so as to leave the necessary air gap, to avoid arcing from the grid. The air hammer, or some other similar device for vibrating the wires, is an essential part of the treater, since, without adequate cleaning, the wires become unevenly coated with salts, which will form in lumps the size of a fist. These distort the electrical field around the wire with a consequent falling off in the efficiency, besides making operation difficult on account of arcing. The wires are cleaned once an hour by the simple operation of turning on compressed air for a few seconds, which is done by the operator in the power house. (See Fig. 2.) No rapping device is used on the plates, as the salts precipitated on these, of their own accord, drop off during operation, when a certain thickness of deposit is reached. The voltage used on the treater is from 40,000 to 45,000 volts. The efficiency of collection is 75 to 80 per cent.

The salts, dropping to the floor in the treater chamber, are conveyed by a scraper conveyor to one end, where they are discharged through a set of slow moving rolls, directly into sacks. These rolls reduce the salts in bulk to about one-quarter. The salts as collected on the floor are very light, weighing only about 10 lb. to the cu.ft., but after they have been pressed into flakes by these rolls, the weight per cu.ft. is increased to about 40 lb., which makes it possible in shipping to load the cars to capacity weight. These rolls answer the double purpose of compressing the salts and at the same time discharge them to the outside of the chamber against a static pressure of the atmosphere of about $1\frac{1}{4}$ in. of water over the gas pressure in the chamber. This difference in pressure is due to the suction produced by the fan drawing the gases through the plant.

The total power consumption for the recovery plant is about 40 hp. per unit, of which one half is consumed by the motor generator set for the electrical treater. The labor required on each shift to operate the plant consists of: one man to operate the 10 motor-generator sets and treaters; one man to operate the fans and circulating spray system (this man is assisted by another on the day shift only, in miscellaneous routine work) and one man to attend to the rolls and to weigh and tie the sacks of salts. Other labor used periodically to clean out the spray tower is about equivalent to one man employed continuously. The men engaged in filtering and drying the cake or dust are not included in this, as these operations should, without difficulty, be eliminated. It is of course possible to make even greater economy in the labor required by making the necessary provisions. This is a most encouraging feature—viz., that the limit of possibilities in economy have not been reached.

The use of waste-heat boilers to cool the gases instead of sprays would no doubt work in to good advantage, although the sprays should not be entirely eliminated, on account of the better results obtained on the treater by their use, and also because they tend to increase the safety in operation, by forming a barrier through which the flame from the kiln can not propagate to ignite com-

bustible gas, that may be present in the large chambers. The electrical equipment for supplying the high voltage current for the treaters is standard apparatus supplied by the Westinghouse Electric and Manufacturing Co., according to specifications furnished by the Western Precipitation Co. of Los Angeles, California. The treater and all other features in connection with the plant have been worked out at the works.

The responsibility for carrying the problems through to a successful solution rests with: George T. Cameron, president of the company; F. H. Davis, works manager; Fred Davis, superintendent; L. T. Bachman, chief chemist; E. W. Rice, chemist; and the writer, as mechanical engineer.

The Electrolytic Reproduction of Engraved Printing Plates*

BY WILLIAM BLUM† AND THOMAS F. SLATTERY‡

IN 1918 and 1919 the printing requirements of the Bureau of Engraving and Printing increased greatly owing to the large issues of bonds and other securities and to the increased demand for currency. In consequence it was found difficult to prepare the required number of printing plates by the mechanical transfer process, which was previously used entirely for this purpose. When electrolytic methods of reproducing these plates were first investigated it was found that although accurate reproductions could be thus obtained, plates which were similar to the ordinary electrotypes or even plates consisting entirely of electrodeposited copper did not possess sufficient strength to withstand the pressures used in plate printing. While conducting experiments in this connection, George U. Rose, Jr., chief of the engraving division of the Bureau of Engraving and Printing, discovered that by the deposition of alternate layers of nickel and copper it was possible to produce plates having the strength necessary for the purpose. This process of depositing alternate layers of copper and nickel, which has been patented by Mr. Rose, is the basis of the method now used in the new electrolytic plant of the Bureau of Engraving and Printing.

The more rigid requirements of plates to be used in "plate" or "intaglio" printing arise from the fact that in this process the designs (which are all below the plane surface of the plate) are filled with ink, and in order to cause the paper to pick up this ink considerable pressure is required. On the other hand, in using ordinary printing plates (upon which the characters are in relief) the lightest possible pressure is used between the paper and the type. Because of the greater pressure required in using engraved plates there is a tendency for these plates to curve in use unless they are sufficiently rigid to retain their form. Another special requirement for plate printing is that the surface shall have the greatest possible resistance to abrasion, as after each impression the plate is inked, rubbed with a mechanical wiper, and polished by hand, all of which operations exert more wear upon the plate than does the actual printing process.

The experimental work conducted at the Bureau of Standards toward the development of this process

*Abstract of address delivered before the American Electroplaters' Society, July 1, 1921.

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upon a commercial scale consisted therefore in the determination of the best methods for securing (a) accurate reproduction, (b) a durable printing surface, and (c) the necessary rigidity.

ELECTRODEPOSITION OF MOLD OR ALTO PLATE

For the accurate reproduction of engraved printing plates it was found to be most satisfactory to prepare by electrodeposition a metal mold or negative of the original plate, rather than to attempt to take an impression in lead or wax, as in the ordinary electrotyping process. As upon this metal mold the designs are in relief, this plate has been designated as an "alto." One advantage of producing the altos by electrodeposition is that any change in dimensions such as might occur in wax or lead molding is avoided.

For the production of such an alto from a steel plate the latter is first thoroughly cleaned and is then brushed with graphite in order to permit subsequent separation. Nickel is then deposited directly upon this surface, after which alternate layers of copper and nickel are deposited until any desired thickness is obtained, which thickness is merely sufficient to insure reasonable rigidity when handling the alto in subsequent operations. This alto then serves as a form upon which to deposit the actual printing plate, known as the "basso," which is an exact duplicate of the original plate. Needless to say every precaution must be taken in these operations to avoid the presence of bubbles or foreign particles upon the surfaces during the initial deposition.

For the production of a durable printing surface the most promising metals are probably nickel, cobalt and iron. A few experiments were made upon cobalt deposition which, while by no means exhaustive, indicated that at least with our present knowledge satisfactory deposits can be more uniformly obtained from the nickel baths than from cobalt. A few experiments have been carried out by us upon the possible application of iron, but it was concluded that this method could not be considered for immediate adoption. As opportunity offers, further work will be done with cobalt, iron and other metals.

NICKEL DEPOSITED IN PRESENCE OF FLUORIDES

It is not difficult to obtain nickel deposits of great hardness, but unfortunately this hardness is usually associated with brittleness and with consequent curling and cracking of the deposit. It was found that by the addition of hydrofluoric acid or fluorides to the nickel solutions, as recommended some time ago by E. G. Lovering of Detroit, it is possible to employ higher current densities and to obtain deposits of greater tensile strength than in corresponding solutions containing chlorides instead of fluorides.¹ Satisfactory results have been obtained by using either nickel fluoride (prepared by the solution of nickel carbonate in hydrofluoric acid) or sodium fluoride. Operating at a current density of about 20 amp. per sq.ft. it is possible to obtain deposits of nickel up to a thickness of 0.02 in. or more with a tensile strength considerably over 100,000 lb. per sq.in. Some deposits have proved very satisfactory upon the printing surface. Up to this time no reliable means of measuring the "abrasion hardness" of thin layers of

metal has been developed, but as a first approximation it has been assumed to be proportional to the ultimate tensile strength.

As above noted, the use of alternate layers of copper and nickel leads to the production of plates of very much greater tensile strength than can be obtained with copper alone. Microscopic examinations of deposits thus produced shows that the beneficial effect of the nickel is not due alone or principally to the greater tensile strength of the nickel, but rather to the effect upon the structure of the deposited copper produced by the interdeposition of layers of nickel. The presence of each layer of nickel prevents further growth of the copper crystals and thereby causes the layer of deposited copper to have a higher tensile strength than it would if it consisted of coarse crystals. The use of nickel layers is also a great advantage in reducing the tendency to form trees, a tendency which is particularly objectionable in the production of thick deposits of copper at relatively high current densities. Except for the presence of the nickel layers it would be impossible to use the current densities here employed for copper deposition without producing very rough and badly treed deposits, which would require an excessive amount of labor for finishing and would represent a considerable waste of material.

PREPARATION OF THE BASSOS, OR PRINTING PLATES

In the actual production of the bassos, or printing plates, an initial coat of nickel is deposited at 10 to 20 amp. per sq.ft. for 6 hours and which has therefore a thickness of about 0.005 in. Alternate deposition of nickel and copper for periods of one hour each is then continued for about six days. The current density used for nickel is about 20 amp. per sq. ft. and for copper about 50 amp. per sq.ft. so that the relative thicknesses are approximately in the ratio of 1 to 3—in other words, the plates contain about 25 per cent of nickel. A final layer of copper is deposited for one or two days. This latter material is largely removed in the subsequent machining operations. Its principal purpose is to fill up any small depressions that may exist at the end of the alternate deposition.

After separation the plates are machined and ground by means of appropriate equipment to a thickness of 0.25 in. and to the desired size. Plates prepared in this way are now being used successfully for the printing of securities and are yielding impressions fully equal in appearance and accuracy to those prepared from steel plates. The present average service of the plates is about 40,000 impressions. It is believed, however, that by further improvements and by increased experience in the methods of using such plates this service may be appreciably increased.

Numerous details of the process are still under investigation. When these studies are completed it is expected to publish as a technologic paper of the Bureau of Standards a detailed description of the plant and equipment used for this purpose. The experimental work upon this process was conducted largely by W. E. Bailey, L. D. Hammond and H. E. Haring of the Bureau of Standards. Valuable suggestions and advice were received from George B. Hogaboom, electroplating adviser of this Bureau, and Charles Barbour, assistant superintendent of the electrolytic plant at the Bureau of Engraving and Printing.

¹William Blum, "The Use of Fluoride in Solutions for Nickel Deposition," *Trans. Am. Electrochem. Soc.*, vol. 39, p. 227 (1921). *CHEM. & MET. ENG.*, vol. 24, p. 1109 (1921).

Note on Notched Bar Impact Tests and Toughness of Monel Metal

BY R. G. WALTENBERG*

THE notched bar impact test occupies probably the unique position of being at the same time the oldest mechanical test known and one of the youngest in point of development with modern mechanical apparatus and measuring devices. The first one to apply this test was unquestionably the smith who used it first to break his bars and later to test roughly their quality. It was not until 1884 (Tetmajer), however, that the test was brought into a quantitative form by the measurement of the energy required to fracture a notched bar by a single blow. Since that time many prominent investigators have been associated with its development—Barba, Fremont, Vanderhey, Charpy, Guillery, Martens, Heyn—and one can scarcely fail to be impressed today at its growing usefulness and importance in the testing and investigation of materials. Particularly in the field of alloy steels has the growth of its application been most rapid during the past few years, until it has been included in many commercial and government specifications for these materials.

THE CHARPY AND IZOD TESTS

The test is now so well known that only the briefest mention of two of its more common forms is warranted in this place. In the Charpy impact testing machine the test-bar is supported horizontally at both ends on a double anvil and struck at the center by a weight swinging as a pendulum in a plane perpendicular to its axis. From the known height from which the center of gravity of the pendulum bob was dropped and the vertical distance to which it rises as it swings through after bending or fracturing the specimen, the energy may be computed which was absorbed in the deformation or fracture of the specimen, and this energy, expressed in foot-pounds or kilogram-meters, is the result as usually expressed of the test.

In the Izod, or the Olsen, machine one end of the specimen is clamped vertically in a vise and the pendulum bob swings down over the vise and strikes the specimen at a specified distance above the vise; the same method is used of measuring and expressing the energy absorbed in fracturing the specimen. The notch in the specimen for the Charpy machine is in the middle of the beam and is on the opposite side from that which the hammer strikes, and in the Izod, the specimen is clamped with the notch even with the ends of the clamps and on the side on which the hammer strikes. In each case the notch is at the point in the beam where the value of the shear passes through zero and the fiber stress is maximum and in tension.

The relations between the size and shape of specimen, design of testing machine and of foot-pounds of energy absorbed in the test are at present so little known that it has been necessary to standardize carefully both the specimen and the machine in order that different experimenters may obtain concordant results. Thus the energy absorbed in fracturing a specimen is not proportional to its cross-section, as are tensile and compressive properties. In this country the usual specimen for these machines is 10 mm. square in section

with a 45-deg. V-notch, 2 mm. deep, with root fillet of 0.25 mm. radius, although some use a specimen of the same size but with slightly different type of notch.

VALUE OF THE NOTCHED BAR IMPACT TEST

It has been generally recognized that the notched bar impact test reveals properties and defects which are not usually shown in the results of the more common static tests such as the tensile, the torsion or the transverse bending test. In particular the result of this test expressed in terms of energy required to rupture seems to be the best single indication we have to date of the toughness, or conversely, the brittleness, of a material. It has therefore achieved perhaps its principal popularity with the users of alloy steels for automobile and aircraft construction, since the materials in these classes of service are subjected to rapidly applied stresses on parts with abrupt changes in cross-section.

In the non-ferrous field the impact test has been used chiefly up to the present time in the testing of light aluminum alloys,¹ but it appears that in this field also its usefulness and importance are growing rapidly. It has appeared worth while to carry out a brief series of impact tests on another prominent non-ferrous alloy, Monel metal, in order both to obtain additional data from which we might judge of the usefulness of the test in the non-ferrous field and to see what light the test would throw on the toughness property of this alloy.

TESTS ON HOT-ROLLED MONEL METAL RODS

At the suggestion, therefore, of Dr. Paul D. Merica of the International Nickel Co., tests were carried out, both with the Charpy and with the Izod machines at

TABLE I. SOME MECHANICAL PROPERTIES OF HOT-ROLLED MONEL METAL

Rod No.	Material, In.	—Hardness—							
		Prop. Limit, Lb. per Sq. In.	Yield Point, Lb. per Sq. In.	Breaking Strength, Lb. per Sq. In.	Elongation in 2 In., per Cent	Red. of Area, per Cent	Brinell, 500 Kg.	Brinell, 3,000 Kg.	Scleroscope
1	1 round	40,000	42,000	93,000	48	68	119	137	22
2	1 round	42,500	47,500	95,500	45	63	119	143	22
3	1 round	35,000	40,000	86,500	49	78	109	137	23
4	1 round	40,000	45,000	93,000	45	59	119	126	22
5	1 round	37,500	42,500	88,000	43	68	143	127	23
Ave.	1 round	39,000	43,400	91,200	46	67	122	136	22
6	3/4 round	37,500	42,500	87,500	43	68	109	131	19
7	round	42,500	47,500	97,000	45	61	119	149	23
8	round	42,500	45,000	89,500	46	68	119	137	20
9	round	47,500	50,000	93,500	43	59	143	149	22
10	4 round	42,500	47,500	98,500	45	61	119	137	23
Ave.	3/4 round	42,500	46,500	93,200	44	63	122	141	21

* None of the specimens fractured in the Izod machine. In some cases the specimens bent enough to allow the hammer to pass and cracked less than one-fourth their thickness.

† Hammer did not pass specimen.

the Bureau of Standards on specimens cut from stock, hot-rolled Monel metal rods 1 in. and 3/4 in. in diameter. These tests were carried out on specimens of the type mentioned above; the Izod machine was of 120 ft.-lb. capacity, built by F. H. Bultman, and the Charpy machine of 224 ft.-lb. capacity, built by Sauveur & Boylston. The dimensions of these machines with a discussion of the effect of variations in the dimensions

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¹See article by E. H. Dix, "Charpy Impact Test as Applied to Aluminum Alloys," *Mining and Metallurgy*, No. 160, April, 1920.

TABLE II. IMPACT AND OTHER MECHANICAL PROPERTIES OF SOME METALS

No.	Material	Tensile Properties			Impact Test		
		Tensile Strength, lb. Sq. In.	Yield Point, lb. Sq. In.	Elong. in 2 In., Per Cent	Brinell Hardness	Kind	Impact Work, Ft.-lb.
1	Copper bars.....					Charpy	35
2	Semi-hard carbon steel.....					Charpy	54
3	Semi-hard nickel steel.....					Charpy	46
5	Commercial aluminum, cast.....	13,500		20	24	Charpy	9
4	8 per cent copper-aluminum alloy, cast.....	22,900		2	72*	Charpy	1
6	$\frac{1}{2}$ -in. nickel chromium steel rod, heat-treated C 0.39, Cr 0.73, Ni 3.54.....	126,600	108,600	16.4	260	Charpy	24
7	$\frac{3}{4}$ per cent nickel steel (C 0.36), heat-treated.....	185,000	171,000	14.5	342	Izod	22
8	Chromium-nickel steel (Ni 3.99, Cr 1.62, C 0.11):					Charpy	80
	Annealed.....	124,500	52,500	23	198	Charpy	83
	Heat-treated.....	191,500	168,500	13	302	Charpy	86
9	Chromium-nickel steel (Ni 3.62, Cr 0.48, C 0.44), heat-treated.....	132,000	113,000	17		Charpy	46
10	Various copper alloys with small amounts of Ni, P, Sn, Zn, As, etc.....					Charpy	35-70
11	Carbon steel, forged (C 0.60).....					Izod	4-2
12	Nickel steel, heat-treated.....					Charpy	87
13	Nickel-chromium steel, heat-treated.....					Izod	62
14	Usual minimum specified value for heat-treated aircraft alloy steels.....					Izod	40
15	1-in. hot-rolled Monel rod (average of 5 tests).....	91,200	43,400	46		Charpy	166
16	$\frac{3}{4}$ -in. hot-rolled Monel rod (average of 5 tests).....	93,200	46,500	44		Charpy	153

* 500 kg. pressure.

of the machine and specimens are given by E. H. Dix. *Proceedings, A.S.T.M.*, vol. 19, p. 720, 1919.

The results of these tests are shown in Table I. The average of five impact tests with the Charpy machine on specimens cut from 1-in. hot-rolled Monel metal rods was 166 ft.-lb., and on specimens cut from $\frac{3}{4}$ -in. rods the average was 153 ft.-lb. The tests with the Izod machine were not satisfactory, as none of the specimens fractured and in some cases the hammer failed to pass the specimens. Attention may be called to the fact that in the Izod test the angle of bend is about 60 deg., while in the Charpy tests it is about 120 deg. The values of the impact energy absorbed in these tests are extraordinarily high and may usefully be compared with values which have been obtained on essentially similar specimens of other materials by other investigators and of which a compilation is given in Table II. It is most interesting that the energy absorbed in fracturing Monel metal in impact is much

TABLE III. AVERAGE TENSILE PROPERTIES AND TOUGHNESS FACTORS OF MONEL METAL AND OTHER MATERIALS

	Tensile Strength, Lb./Sq. In.	Elongation in 2 In., per Cent	Quality Factor*
Hot-rolled Monel rod 1-in. in diameter			
International Nickel Co. booklet.....	94,600	40	1,580
Heat-treated carbon steel (SAE 1045) drawn to 1,000 deg. F.....	106,000	19	920
Heat-treated $\frac{3}{4}$ per cent nickel steel (SAE 2335) drawn to 1200 deg. F.....	186,000	15	1,160
Heat-treated nickel-chromium steel (SAE 3320) drawn to 500 deg. F.....	150,000	23	1,440
Annealed wrought copper.....	35,000	50	730
Wrought manganese bronze.....	70,000	30	870
Wrought aluminum bronze.....	70,000	30	870
Wrought aluminum.....	13,000	30	170

* Product of tensile strength and elongation divided by $2 \times 100 \times 12$.

greater than that required to fracture any other materials of which the author has seen the record of tests, including even heat-treated alloy steels. This would indicate a very uncommon degree of toughness, surpassing that of the steels.

A little consideration will show, however, that this fact is not entirely unexpected. Until the advent of the impact test, engineers had been in the habit of combining those tensile values—tensile strength or yield point—which are indicative of strength with those—elongation or reduction of area—which are indicative of ductility in some manner to give a single expression as an indication of toughness. Thus a simple manner of doing this was to integrate the area under the stress-strain diagram of the tensile test of a material, which is the energy required to rupture the specimen in static tension. Still simpler is the method of multiplying the elongation in per cent by the ultimate

tensile strength, which is also of the dimensions of energy and not greatly different from the value obtained by integration of the stress-strain diagram. In Table III are shown average values of these quantities for some materials together with their product in each case expressed in foot-pounds per square inch of cross-section. This quality factor of toughness for Monel metal is again seen to be greater than that of any other material.

For the benefit of those who might wish to compare this property of Monel metal with any of its other physical and mechanical properties the following summary is given of the approximate average physical and mechanical properties of Monel metal in the hot-rolled condition as determined by various observers:

Tensile strength (1-in. hot-rolled rod), lb. per sq.in.....	94,600
Yield point (tension), (1-in. hot-rolled rod), lb. per sq.in.....	63,100
Proportional limit (tension), (1-in. hot-rolled rod), lb. per sq.in.....	40,000
Elongation in 2-in. (1-in. hot-rolled rod), per cent.....	40
Young's modulus, lb. per sq.in.....	23,000,000
Brinell hardness (3,000 kg.).....	160
Specific gravity of rolled Monel.....	8.97
Electrical resistivity, microhms per c.c.....	42
Electrical resistivity, ohms per mil-ft.....	256
Thermal conductivity, cal. per deg. C. per sec. per c.c.....	0.06
Thermal expansivity, per deg. C.....	14.0×10^{-6}
Melting range, deg. C.....	1310-1350
True specific heat, cal. per g. per deg. C.....	0.104
Optical reflectivity, per cent.....	60
Magnetic induction for $H = 100$, gauss.....	1,500

Coconut Oil Export From the Philippines

The total export of coconut oil from the Philippines during the first quarter of 1921 amounted to \$4,854,985, which was \$264,196 more than the export for the same period in 1918, but \$2,816,551 and \$3,562,952 less than the exports for the corresponding periods of 1920 and 1919, respectively. The highest single monthly exportation during the four years mentioned was in January, 1919, when the shipments of oil from the Philippines totaled \$6,098,069, at an invoice value of 30c. per kilo. The United States and the Netherlands were the only countries that absorbed the exports for the first quarter of 1921, while in previous years Great Britain, Spain and France shared a good portion of the Philippine output. Of the total export for this period \$3,190,407, or approximately 66 per cent, went to the United States; \$1,661,668, or about 34 per cent, to the Netherlands; and \$2,910, or less than 1 per cent, to all other countries.

The copra exported for the first quarter of 1921 was valued at \$1,912,133. That the copra trade is becoming active is shown by the fact that for the first quarter of 1920 the total export was \$10,148 only. In 1918 and 1919 the total exports of copra for the first quarters were \$122,219, and \$3,036,871, respectively, states the *Bulletin* of the Philippine Government Commercial Agency.

Legal Notes

BY WELLINGTON GUSTIN

George Patent for Cooling Bed Held an Advance in Art and Valid.

The United States District Court, in the case of the Morgan Construction Co. vs. the Donner Steel Co., held the George patent, No. 863,841, valid as making an advance in the art in which it is used. This patent relates to improvement in conveyors for metal rods used in rolling mills, and commonly called cooling beds.

The object of the inventor was to make the supporting and lifting bars of such shape and form that, when acting in combination, they would serve to hold the heated metal in contact and automatically straighten it while being moved step by step or by intermittent movements from one end of the cooling bed to the other. The specification stated that the inventor does not wish to confine himself to the curved form of the supporting surfaces of the lifting bars, as the desired result was achievable by other forms.

The steel company defended the suit on the grounds of lack of novelty and invention and non-infringement. The evidence showed that in making steel ingots, billets, bars, etc., of varying lengths, the heated metal as it emerges from the run-out of the mill is ordinarily cooled on a conveyor or cooling bed before it is handled. A large number of separate pieces of hot metal are usually placed on the cooling bed, arranged side by side and moved intermittently across it. It is desirable that the metal bars or billets should not in their heated condition come in contact with one another, as experience has shown that by contact they are often bent or distorted; and hence it is necessary that they should be moved on supporting surfaces, which help to prevent or correct any curves or bends in them. To accomplish this the supporting members of the device in suit are notched, and the notches aligned with corresponding wave-shaped depressions in the lifting member, so that the lowest part of the notches upon which the heated metal rests comes in the same plane with the depressions on the lifting member.

INVENTION NOT A GENERIC ONE

The court says the invention was not in any sense a generic one. The separate elements of the combination of the claims in suit were old, but the inventor was the first to combine in a single apparatus the step by step arrangement present in the known straight-edged bar device and in old devices with serrated edges on bars or skids aligned for carrying the hot rods by a rocking or oscillating mechanism of the skids or bars.

The prior patents issued to Johnston, to McDonald and McKee for so-called shuffle bar conveyors, to Edwards, to Kellogg for gravity notched cooling beds, to Geer, the so-called Illinois and Republic and Austrian cooling beds, disclose types of known devices. Such structure the patentee designed to improve, since the hot rods were bent in their travel in the shuffle bar conveyors, while the rocking and gravity devices operated on a different principle.

The court found in none of these the elements combined as in the patent in suit. By his new combination of old parts or elements separately shown in prior de-

vices the court thought the patentee advanced the art a little, producing a new and useful result, one operating upon a somewhat different idea from prior patents. The law is that a combination of old elements, if they have been combined to operate in a new way or to accomplish a new and useful result, is patentable.

The defendant company in its cooling bed adapted a similar combination to plaintiff's patent without having any prior actual knowledge of this patent. And since the serrations on the surface of the lifting support are of different shape, defendant claimed that a departure from the patent in suit resulted by its adoption, that a new use eventuated, in that the hot bars, after being lifted by the sides of the serrations, are allowed to slide or tumble to the bottom as they are carried over the edged surfaces of the stationary support. The court thought that the tumbling or sliding action of the hot rods after the lifting began was due in the main to lateral adjustment of the serrated bars and to the form of the serrations. And the changes in the serrations were changes of form only, and any improvements resulting therefrom were such as a skilled mechanic could make.

Finally, it was contended that plaintiff's device is impracticable since only one cooling bed had actually been constructed, its construction being under the broad claim only. But the court held that the utility of the invention is established by the fact that defendants have persisted in infringing it. (*Cf. Rumfort Chemical Works vs. New York Baking Powder Co.*, 134 Fed., 385.)

The court further says that under our laws a patentee is not obliged to manufacture the apparatus described in the patent. Its non-use does not deprive him of the protection of the patent laws.

Quality of Motor Gasoline

That the quality of gasoline has been maintained despite the fact that the stocks on hand at the refineries have been the greatest on record and that retail prices have been materially reduced is indicated by preliminary data obtained from the examination of samples collected in Washington, D. C., by the United States Bureau of Mines in its fourth semi-annual survey of the motor gasoline sold commercially throughout the country. While the average quality of gasoline now being sold is very similar to that sold a year ago, there is a noticeable difference in the shape of the distillation curve, due presumably to the increasing use of benzene blends in the eastern part of the country. The preliminary figures also confirm the deductions of previous surveys that there is a decided difference between the gasoline sold in summer and that sold in winter.

The average boiling point of gasoline sold in Washington a year ago was 279 deg. F. Today it is 278 deg., a negligible difference. Last winter the boiling point averaged 270 deg., and the winter before 267 deg.

Below are given the average distillation figures for the samples so far collected in Washington. While there is little change in the average boiling point as compared with a year ago, the difference in the actual character of the fuel, indicating increased use of benzene blends, is particularly noticeable at the 50 per cent point:

	First Drop	20%	50%	90%	End Point
July, 1920.....	131	200	273	396	449
July, 1921.....	128	202	259	390	445

Chicago's Relation to the Future American Steel Industry

An Analysis of the Economic Location of a Steel Industry in View of Modern Practice in Coal Economy, Diminishing Ore Tenor, Increasing Amount of Scrap Used, and the Greater Influence of Freight on Finished Product

By GERARD DE GEER
Nyhammar Steel Works, Sweden

"THE ore comes to the fuel," says a well-known rule in reference to the location of a steel plant. The past history of the steel industry over the whole world has proved the correctness of this expression. The center of gravity of the steel industry in the United States is consequently placed near the large coal and oil fields, and the ore is transported from other places. The German steel industry has been developed around the coal fields of Westphalia and Silesia, with the ore imported chiefly from France and Sweden. England is so fortunate as to have the coal and ore supply in common; at several places the ore and coal are even brought up from the same mine shaft.

In a natural way the location of the steel industry was determined by transportation facilities. If we go back half a century, when modern steel industry on a large scale began to develop, we find that it required about 2.3 tons of ore to produce 1 ton of manufactured steel with a consumption of 3 to 4 tons of coal. Under such circumstances it was considerably cheaper to transport the ore to the coal than *vice versa*.

DIMINISHING FUEL REQUIREMENTS

The question, however, is often raised whether these relations between ore and coal are fixed once for all and are unchangeable. It may be answered immediately. Certainly not. They are governed by the laws of progress. We find that the consumption of coal per ton of iron during the last decades has been gradually reduced, by a better utilization of the fuel combined with new metallurgical and thermotechnical methods. Formerly the gas from coke ovens and blast furnaces was allowed to waste into the atmosphere; nowadays this gas is very carefully collected and forms quite an important source for the production of heat and power. Formerly the steel was allowed to cool off between the different metallurgical processes. Now the pig iron is taken in a molten state from the blast furnaces to the steel-making departments, and the hot ingots are taken directly to the mills. The consumption of coal per ton of manufactured steel has accordingly during the last few years been reduced to about one-half the amount used fifty years ago, and it is safe to assume that the bottom level has not as yet been reached. Up-to-date modern steel mills need at the present time an insignificant amount of fuel in addition to the coke consumed in the blast furnaces. All other demands for heat and power are covered by the use of gas and tar from coke ovens and blast furnaces. Sometimes even an excess supply of gas or power is available which can be used outside the plant and which partly compensates for the quantities of coal that may be

necessary for certain purposes over and above the amount of coal for coking. Under such circumstances the coal supply is reduced to 2 tons or less per ton of manufactured steel.

DECREASING ORE TENOR

If we turn to the ore we will find the development to be in the opposite direction. A saving of ore in the same sense as that of coal is not possible. At all times practically all the iron has been recovered from ore smelted in the blast furnace. Small losses in slag and dusty gases are unavoidable, and even if they could be eliminated their importance would be insignificant. On the other hand, the consumption of ore per ton of pig iron is being gradually increased, due to a lower percentage of iron in the ore.

The best and richest ore is already mined and it becomes gradually necessary to use poorer ore. The average percentage of iron in the ore being used at the present time in the United States hardly reaches over 50 per cent, while a few years ago it was about 55 per cent. In Germany this retrogression is still more striking; there the average percentage of iron in ore has decreased from 54 to 41 per cent in forty years. A continued diminution of the percentage of iron in the ore is most likely to occur, even though it is partly counterbalanced by an increased number of ores which are concentrated.

One may readily ask the question whether or not the same condition prevails with regard to the deposits of coal—viz., that the best grade of coal has been consumed and that its quality decreases as mining continues. Such is not the case. When the upper coal strata have been mined it will be necessary to go deeper into the earth for further mining; the price of coal will be higher, but its quality, on the other hand, will be better rather than worse. The higher cost of mining leaves the question of transportation between mine and mill unchanged. Besides, the total supplies of coal are so enormously greater than the visible supply of what we now know as iron ore that shortage of the latter will ensue far sooner than of the former.

A table showing the relative distribution of the amount of transportation between manufactured products and the two most important raw materials, coal and iron, is given below, using the assumption that 1.25 tons of pig iron is required for 1 ton of ingots and 1.5 tons of coal for 1 ton of coke:

	1870	1920
Ore.....	2.3 tons, or 34.0%	2.5 tons, or 45.4%
Coal.....	3.5 tons, or 51.3%	2.0 tons, or 36.3%
Manufactured product...	1.0 tons, or 14.7%	1.0 tons, or 18.3%

From this table it is seen that the reasons for the location of the iron industry, judging from the transportation point of view, have been changed quite considerably. Ore and coal have almost changed places and the importance of transportation of manufactured steel in relation to the raw materials has increased. It is to be noted particularly that these changes have been accentuated in a considerable degree during the last two decades. Its consequences already show themselves in certain tendencies in the development of the steel industry. The rule mentioned at the beginning of this article, that the ore comes to the fuel, is nowadays a truth only with modification.

If one considers the steel industry of the United States he finds that an unquestioned movement has taken place in direction *from* the coal *to* the ore. Branches have reached out from the Pittsburgh steel center toward the north and met the Lake Superior ore, and toward the east to the imported ores. At present there is a steel district of considerable size at the south shore of Lake Michigan with Chicago as the center. A rapidly growing steel industry has also been developed near the earliest location of the American industry, the Atlantic coast around Boston, Baltimore and Philadelphia. It is shown by production statistics that these steel districts have grown considerably more rapidly than the original ones. For instance, the production of pig iron, in accordance with the official statistics of the United States, has progressed in the following manner during 1900 to 1918 in the two districts as given below:

Year	Pennsylvania, Tons	Illinois and Indiana, Tons
1900.....	6,365,935	1,527,095
1910.....	11,272,328	3,925,749
1918.....	15,198,271	6,513,906

Pennsylvania is the home of the original steel industry of the United States and maintains still a predominant position in comparison with other states. The two other states as given in the above table represent a new steel district, which has grown up in the last thirty years at the south end of Lake Michigan. The percentage of increase within the latter district from 1900 to 1918 has been 326 per cent, while the corresponding figure for Pennsylvania is 140 per cent.

In judging the question of ore versus coal it will be necessary to give some attention to the fact that not all kinds of coal are suitable for the steel industry. For example, in order to obtain good coke for the blast furnaces a special brand of coal is required. It is true that there are enormous supplies of coal in Indiana and Illinois, and on that ground it seems absurd to talk about a movement toward the Mesabi ores *from* the coal which is to be used for the steel industry that has been located in that district. These coal supplies are, however, of such a quality that they are not, as a rule, suitable for production of coke without mixing. The largest part of coal used for coking by the Chicago industries is consequently taken from the coal fields in Pennsylvania and Kentucky.

ILLUSTRATIONS FROM EUROPE

Movement of the steel industry toward the ore can be shown more distinctly in Germany. About thirty years ago there was hardly any steel manufactured in Lorraine (now French). At the present time the coal comes from Westphalia and the Saar district and to a

large extent is transported to the western part of the country, where a rapidly growing steel industry has been developed around the large ore fields of Lorraine. The more important steel and iron districts of Germany proper also show the same tendencies of evolution. Thus, the steel interests in Upper Silesia have sent branches to the Baltic Sea, where a couple of large steel mills have grown up, using Swedish ore and Silesian and Westphalian coal.

INFLUENCE OF SCRAP

In judging the influence of transportation on the steel industry due consideration must also be given another factor of rapidly growing importance. An investigation of the statistics of production in the United States shows that a replacement has occurred in the relations between the tonnage of pig iron and of steel. Up to 1910 the former was greater than the latter, but since 1911 steel has outdistanced pig iron, as is shown in the following table:

Year	Pig Iron, Tons	Steel, Tons
1890.....	9,202,703	4,277,071
1895.....	9,446,308	6,117,834
1900.....	13,789,242	10,188,329
1905.....	22,992,380	20,023,947
1910.....	27,303,567	26,094,919
1911.....	23,649,547	23,676,106
1915.....	29,916,213	32,151,036
1917.....	38,647,397	45,060,007

The thing which has caused this reversal is the use of scrap iron in the manufacture of steel. Scrap iron has therefore become a third standard raw material for the steel industry, competing in importance with the older two, ore and coal.

Daily experience tells us that only an insignificant part of the enormous quantities of iron which are being discharged into the world's markets is destroyed in the true sense of the word. Much the largest part of it is saved from the destroying elements and sooner or later it is returned to the steel mills in the form of scrap iron. Through this cycle the loss of ore and coal as well as of labor will become less in spite of the growing demand for iron.

The period required for this circulation of iron is naturally quite variable. Steel from which tools and machines are fabricated can be used only for a few years; in rails and ship plates it lasts 10 to 40 years, but when steel is used as building material and reinforcement for concrete construction its life may be hundreds of years. The transposition of a steel product into scrap iron is in a large measure dependent upon other factors than the real wear and tear or the disintegration of the iron. The many technical advancements and the ever-continued progress in every line of business have become a factor of enormous importance in producing scrap iron. All kinds of machinery are being scrapped because they are not modern and up to date; rails are being exchanged, not because they are worn out but for the reason that increased train speed requires heavier locomotives and stronger rails; perfectly good buildings are torn down and replaced with new ones because they no longer correspond to the increasing demand for hygiene and comfort. The real disintegration of iron is less than is generally conceded. It is reduced chiefly to such objects as shoe tacks, horseshoe nails, rims on wagon wheels, etc., or is caused by accidents, such as shipwrecks and fires. In a machine that weighs about 10 tons only a few pounds

of its metallic contents are subjected to real wear—as for example the edge of a tool. Worn-out rails have in many cases lost only a few per cent of their original weight; in fact the formation of rust is usually a more dangerous enemy to iron than mechanical wear.

IRON CIRCULATING IN FABRICATION PROCESSES

The time has not yet arrived when the effects of the circulation of iron have become felt to the full extent. We must realize that the production of iron on a large scale commenced only with the introduction of the bessemer and open-hearth processes during the latter half of the last century. Before that the world's production could without difficulty be produced at the present time in a couple of the larger steel mills in the United States. We are now living in a period when the return flow of used-up iron to the steel mills has just started. There can be no doubt that this flow will grow in size.

As late as at the beginning of this century practically all the steel was produced from pig iron—that is, directly from ore. The older metallurgical methods did not permit of anything but a very limited use of scrap iron. Conditions are entirely different now. It is hardly possible to say exactly how large a part of the steel comes from pig iron and how large a part from the addition of scrap, as this figure cannot be obtained directly from the statistics. Consideration must be given to the fact that not all of the scrap iron used is material which has been returned to the steel mills as an actual increase of the raw materials, but that part of it is a waste product in the mills themselves, formed during the process of fabrication, defectives, crop ends and trimmings. Because the statistics usually show the production of steel in form of raw ingots the iron that comes from this continuous circulation within the mill will be included in the figures for the total production.

SCRAP WITHIN THE MILL

Were it possible to count the production in manufactured goods, then the condition would be different, but this cannot be done for the reason that the line between partly manufactured goods and completely finished products is very changeable. It is true that the largest part of the products of the steel mills is shipped direct without further treatment—such as, for example, rails, structural shapes and pipes. A considerable portion, however, undergoes additional processes of fabrication, resulting in a certain amount of scrap—for example, all iron which is delivered to machine shops. Scrap iron from these industries must be counted in the same class with that of the steel mills. It is not an actual addition to the supply, but must rather be considered as part of the unavoidable circulation; the time cycle involved is hardly longer than for the scrap iron produced within the mill itself.

A calculation which cannot necessarily claim to be exact but which in all probability comes pretty near reality will show that the iron that comes from this circulation during its production and further fabricating processes corresponds to 20 per cent of the weight of the produced ingots. In order to conceive the importance of the real circulation of iron—that is, the quantity of iron which has actually been in use, worn out or scrapped for any other reason and then returned to the steel mills—it will be necessary first to reduce the statistical figures for production of ingots

by 20 per cent and then to calculate how much of the remaining portion comes from the pig iron and the scrap iron respectively.

STEEL FROM BONA FIDE SCRAP

If the American production of ingots during 1917 is used as a basis for the calculation, it will be shown that about 82.5 per cent of the weight of iron comes directly from the ore and the remaining 17.5 per cent from the real scrap. The calculation has been made as follows: The production of ingots during 1917 in the United States was 45 million tons. From this is deducted 20 per cent, that portion derived from iron circulating in the manufacturing processes, leaving 36 million tons. The production of pig iron during the same year was 38.6 million tons. In order to determine how much of this pig iron was finally obtained as steel it will be necessary to reduce the above figure not only by the production of iron castings (about 14 per cent) but also by the iron losses which follow the change of pig iron to steel (about 9 per cent). Final figures are thus: The

portion of pig iron $38.6 - \frac{23}{100} \times 38.6 = 29.7$ million tons. The amount of scrap iron entering into the ingots must then be $36 - 29.7 = 6.3$ million tons, or 17.5 per cent.

Considering the effect of scrap iron on the relation between transportation and the production of iron in accordance with the above the following tabulation may be made for the year 1917:

Ore.....	2.05 tons, or 41.0 per cent
Coal.....	1.75 tons, or 35.0 per cent
Scrap.....	0.2 tons, or 4.0 per cent
Manufactured product.....	1.0 tons, or 20.0 per cent

It must be stated that these figures do not pretend to be fully exact, because they are partly based on deductions and assumptions. The object of this article is, however, to give a picture of the general trend of progress and not to show complete statistical calculations. It is further assumed that the errors which eventually may be found in the above figures are not great enough to affect perceptibly the final conclusions.

From this tabulation it is shown that the third great class of raw materials has not as yet affected the question of transportation as related to the steel industry to any extent. The conclusions drawn when consideration was confined to the ore and coal are in a broad sense unchanged. The relative importance of transportation to the disposal of the manufactured goods has, however, increased somewhat.

I repeat that the movement of the steel industry from the coal toward the ore, the beginning of which is already distinctly noticeable, will with all probability be more and more accentuated in the future. Of course we can never expect any complete move in this direction, as a certain equilibrium will be established under the influence of the possibilities for return freight among other factors. Market for manufactured steel and the increasing importance of the scrap supply will in the future exert a greater influence upon the choice of new locations for a steel plant. The question of railroad accommodations will be decisive in relation to both factors. It is necessary to have good transportation facilities to already established markets, as well as, and particularly, to the new fields which the future will probably open for the consumption of iron. An effec-

tive utilization of the scrap iron is altogether dependent upon the transportation facilities. The supply of scrap is not concentrated; it is made up from a multitude of smaller supplies located at places far apart. A net of transportation lines is required in order to collect the scrap and transport it to the place where it is to be used. The railroads themselves are, for that matter, big iron users as well as scrap producers.

ECONOMIC ADVANTAGE OF CHICAGO DISTRICT

It must be admitted that hardly any steel-manufacturing district in the United States has such favorable future possibilities as the Chicago district when judged according to above-given viewpoints. Its location corresponds to the economical equilibrium between the coal and the ore. It is situated in the focus of the greatest outbranching network of railroads in the world, with the gate open toward west and north, where new and great market possibilities are waiting. Its shores are washed by an inland sea offering favorable means for supply and distribution, a lake which may become a bay of the Atlantic when the plans for new connecting canals are realized. The leading position of Chicago in trade and communication will reach out to include also the most important of all industrial products—steel.

Exports of Chemicals During the Past Fiscal Year

ACCORDING to the Bureau of Foreign and Domestic Commerce reports, the fall in value of our exports of chemical products during the present industrial depression has not been much during the last four months of the fiscal year, ended June 30. As compared with the figures for the corresponding months of 1920, this group of exports showed a decrease of 54 per cent in February, 72 per cent in March, 70.6 per cent in April, 75.3 per cent in May, 73.3 per cent in June. The total value of the shipments during the latter month was \$4,178,685, as compared with \$15,685,322 in June, 1920, and \$4,366,119 in May, 1921. Three items only show an increase in 1921 over the export total for June, 1920; glycerine advanced in amount from 44 short tons to 52 short tons; its value, however, fell from \$21,638 to \$18,740. Calcium acetate increased from 13 tons (\$6,714) to 898 tons (\$29,212). Benzene, as during the preceding months, registered a notable upward movement from 590 tons (\$79,728) to 2,920 tons (\$187,237).

ARTICLES SHOWING LARGEST FALLING OFF

The articles which suffered most seriously in this fall were the following:

Nitric acid, 44 tons to 4 tons; miscellaneous coal-tar crudes, \$890,530 to \$35,163; copper sulphate, 193 to 28 tons; coal-tar dyes, \$2,389,515 to \$444,273; formaldehyde, \$212,925 to \$33,360; bleaching powder, 2,199 tons to 449 tons; petrolatum, \$322,431 to \$63,153; potassium chlorate, 255 to 16 tons; miscellaneous potassium compounds, \$304,616 to \$34,067; borax, 865 to 83 tons; caustic soda, 11,514 to 1,620 tons; soda ash, 7,341 to 2,130 tons.

COMPARISON WITH TWO PRECEDING YEARS

Far less serious was the shrinkage in the amount and value of our chemical exports for the fiscal year, ended with June 30, as compared with the two preceding years.

In 1919 the total value of such exports was \$148,053,531; in 1920 it was \$158,691,918; in 1921 it fell to \$110,284,401. This is a decrease of 30.5 per cent as compared with 1920, and 25.5 per cent as compared with the total for 1919. Increase over the 1920 figures is registered for four products. Bleaching powder advanced from 15,616 short tons (\$840,092) to 18,713 short tons (\$1,146,378); sodium bicarbonate, 5,999 to 6,672 tons; benzene, 8,627 to 33,311 tons; miscellaneous coal-tar crudes, \$3,618,424 to \$4,101,129. Soda ash fell from 58,727 to 56,741 tons, but the value rose from \$2,804,130 to \$3,308,783. The most noteworthy decreases in our exports of chemicals during the past fiscal year were as follows:

Baking powder and glycerine, 38 per cent; formaldehyde, 40 per cent; miscellaneous chemicals, 42 per cent; sulphuric and miscellaneous acids, 43 per cent; miscellaneous dyes, 47 per cent; roots, herbs and barks, 54 per cent; caustic soda, 56 per cent; borax, 57 per cent; all potassium compounds and calcium acetate, 61 per cent; nitric acid, 67 per cent; carbolic acid, 71 per cent.

HOLDING OUR SHARE OF FOREIGN MARKET

In view of the lowered prices of numerous chemicals it is evident that we are holding a fair share of the foreign market for these products, gained by our unceasing efforts during the war period. It is equally evident that only by a similar strenuous effort can the market over there be held in the face of the determined resolution of the German chemical trade to win back as much as possible of its control in this branch of commerce. The accompanying table furnishes comparative details of the movement into the world's consuming markets of our American chemicals and allied products during the fiscal years ending with January, 1920 and 1921:

EXPORTS OF CHEMICALS AND ALLIED PRODUCTS FOR THE FISCAL YEAR ENDING JUNE 30, 1920 AND 1921

(Quantities in Pounds Unless Otherwise Stated)

Acids:	1920	1921
Carbolic.....	\$2,223,305	\$659,890
Nitric.....	820,517	267,119
Picric.....	8,073	3,730
Sulphuric.....	32,334,393	18,600,704
All other acids.....	5,292,987	3,029,332
Total acids.....	\$6,600,687	\$3,612,703
Alcohol, wood, gal.....	687,008	467,763
Baking powder.....	5,595,126	3,491,666
Bleaching powder.....	31,232,379	37,425,093
Calcium acetate.....	32,885,132	12,845,700
Calcium carbide.....	21,164,404	20,147,753
Coal-tar distillates:		
Benzene.....	17,253,314	66,622,862
All others.....	3,618,424	4,101,129
Copper sulphate.....	4,511,284	4,297,378
Dyes and Dyestuffs:		
Coal-tar colors.....	17,190,397	13,577,788
Logwood extract.....	1,832,231	1,471,040
All other dyes.....	6,829,937	3,571,309
Total dyes.....	\$25,852,565	\$18,620,137
Extracts for tanning.....	6,016,438	1,732,198
Formaldehyde.....	2,289,217	1,376,281
Glycerine.....	2,257,623	1,388,194
Potassium Compounds:		
Chlorate.....	2,845,858	1,130,771
All others.....	3,362,827	1,309,852
Roots, Herbs and Barks:		
Ginseng.....	220,970	157,351
All others.....	1,793,064	836,320
Sodium Compounds:		
Bicarbonate.....	11,988,510	13,353,769
Borax.....	10,943,110	4,368,880
Caustic.....	229,146,363	101,021,827
Sal soda.....	12,763,399	10,376,424
Silicate.....	33,692,535	23,099,660
Soda ash.....	116,555,500	113,481,062
All other sodium salts.....	7,485,008	5,353,600
Total sodium compounds.....	\$21,499,421	\$15,470,235
Sulphur, long tons.....	393,404	375,826
Washing powder.....	6,114,816	4,021,497
All other chemicals, drugs, etc.....	42,179,732	24,458,956
Total chemicals, drugs, etc.....	\$158,691,918	\$110,284,401

Measuring Gases Containing Water Vapor

Accurate Measurement of Gases Saturated With Water Vapor Requires a Determination of Density—
Velocity Formulas Modified to Use Specific Gravity Values Determined
Graphically—Procedure for Partially Saturated Gases

By THOMAS G. ESTEP*

IN THE various industries where devices are used for measuring large volumes of gases it is found that practically all such gases contain a certain amount of water-vapor. Byproduct coke-oven, producer and blast-furnace gases are nearly always saturated with water vapor at the moderate temperatures, while atmospheric air is usually only partially saturated.

The necessity for correcting gas measurement for water vapor is often overlooked by engineers with the result that large errors obtain. The extent of such errors may be more appreciated by pointing out that in a particular problem which is referred to later in this paper, if the gas had been considered as dry instead of saturated, the error in the volume under standard conditions would have been 5.3 per cent. When it is considered that with the devices for measuring gases, if carefully handled, will give results correct within one per cent, it is apparent that the error due to neglecting the water vapor is much larger than the errors due to observation.

FORMULAS FOR VELOCITY

Of the various methods employed for measuring gases—Pitot tubes, Venturi meters, orifices and throttle disks—all produce a measurable differential pressure which bears some relation to the velocity of the gas. In the case of the Pitot tube, this differential pressure or head is directly proportional to the square of the velocity but in the case of the other devices mentioned, this head only represents change in velocity. Expressed in the form of equations: For Pitot tubes,

$$V_1^2 = 2gh$$

For Venturi meters, orifices and throttle disks where the differential pressure is small enough so that changes in specific volume of the gas may be neglected,

$$V_2^2 - V_1^2 = 2gh$$

Where

V_1 = velocity of gas in main pipe, feet per second.

V_2 = velocity of gas at smallest section, feet per second.

g = acceleration due to gravity, feet per second per second.

h = differential pressure expressed in feet of the gas at the pressure and temperature at the point of measurement.

The differential pressure h is usually measured in inches of water, oil or mercury. To convert it into equivalent feet of gas it is only necessary to divide by 12 and multiply by the ratio of the density of the water, oil or mercury to the density of the gas under the conditions at the point of measurement. This sounds comparatively simple but the labor lies in the determination of the density of the gas at the point of measurement

because it is the density of a mixture of gas and water vapor. This can be determined by chemical analysis, but the process, while not difficult, is very laborious. The density can, however, be calculated from more easily determined data.

CALCULATION OF DENSITY OF A MIXED GAS

To illustrate this method of finding the density of a gas when saturated with water vapor and the determination of the velocity of the mixture in the pipe, a concrete problem will be solved. Assume that the average velocity head of a certain gas has been determined by the Pitot tube and is 3 in. of water. The gas at the point of measurement has a temperature of 85 deg. F. and an absolute pressure of 34 in. Hg and is saturated with water vapor. The chemist reports that this gas, when dry at a temperature of 62 deg. F. and an absolute pressure of 30 in. Hg, has a specific gravity of 0.4 referred to air at the same temperature and pressure as unity. It is first necessary to determine the density of air at a temperature of 62 deg. F. and an absolute pressure of 30 in. Hg. This can be done by using the characteristic equation of a perfect gas.

$$d = \frac{P}{RT}$$

Where

d = density, pounds per cubic foot.

P = absolute pressure in pounds per square foot.

R = gas constant, foot pounds per degree F.

T = absolute temperature of the gas, degrees F.

Substituting,

$$d = \frac{144 \times .49117 \times 30}{53.34 \times (62 + 459.6)} = .07627 \text{ lb. per cu.ft.}$$

The density of the dry gas at 62 deg. F. and 30 in. Hg = $.07627 \times 0.4 = .03051$. By consulting the steam tables, it is found that at a temperature of 85 deg. F., the vapor pressure is 1.209 in. Hg. and the vapor density is 0.001832 lb. per cu.ft. If the total pressure of the mixture of gas and water vapor is 34 in. Hg and the partial pressure of the vapor is 1.209 in. Hg, then according to Dalton's law, the partial pressure of the gas in the mixture is $34.000 - 1.209 = 32.791$ in. Hg. In one cubic foot of the mixture there is one cubic foot of gas at a temperature of 85 deg. F. and an absolute pressure of 32.791 in. Hg and one cubic foot of saturated water vapor at an absolute pressure of 1.209 in. Hg. The weight of the one cubic foot of gas at a temperature of 85 deg. F. and an absolute pressure of 32.791 in. Hg is,

$$\text{weight, lb. per cu.ft.} = .03051 \times \frac{62 + 459.6}{85 + 459.6} \times \frac{32.791}{30.000} = .031940$$

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The weight of the mixture of gas and water vapor per cubic foot is

weight of mixture, lb. per cu.ft. =

$$.031940 + .001832 = .033772.$$

This is the density of the mixture at the point of measurement.

The specific gravity of the mixture at the point of measurement, referred to air at a temperature of 62 deg. F. and an absolute pressure of 30 in. Hg as unity is,

$$\text{Specific gravity of mixture} = \frac{.033772}{.076270} = .4428.$$

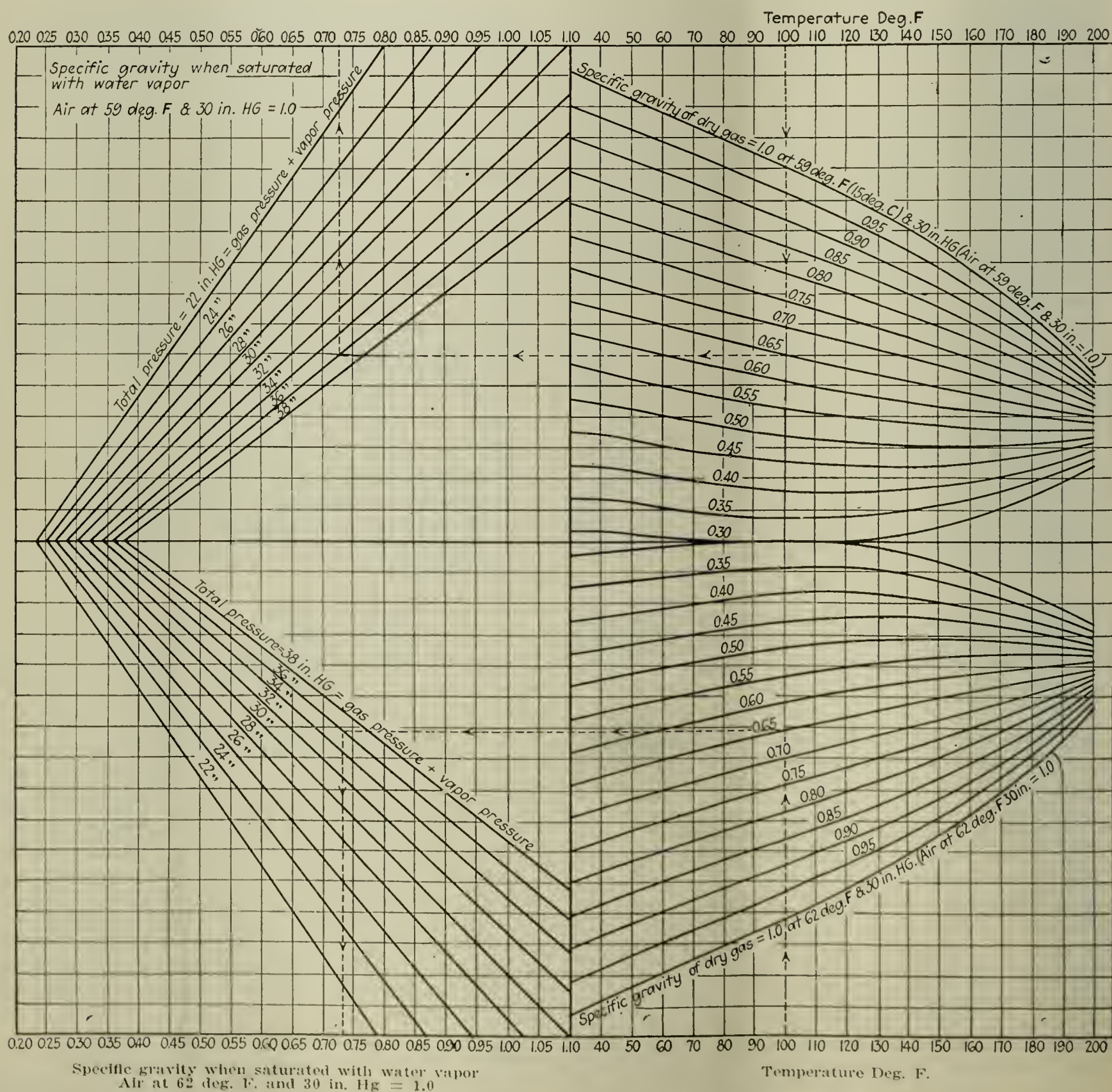
The equivalent feet of gas corresponding to the 3-in. water velocity head is,

$$\text{Feet of gas} = \frac{3 \times 62.4}{12 \times .033772} = 461.92.$$

The velocity of the gas in the pipe is then,

$$\text{Velocity, ft. per sec.} = \sqrt{2 \times 32.16 \times 461.92} = 172.37.$$

It can be readily seen from the above that the determination of the density of the mixture at the point of measurement is rather laborious, hence a set of curves has been prepared from which the specific gravity of the gas when saturated with water vapor at various temperatures and pressures can be read directly, thus avoiding the tedious calculation. Two families of curves are given in the accompanying figure, one for a base of 62 deg. F. and 30 in. Hg and the other for 59 deg. F. (15 deg. C.) and 30 in. Hg. The abscissa of the curves at the right of the diagram is the temperature of the mixture at the point of measurement. The curves above are the specific gravities of the dry gas referred to air at the base temperature and pressure as unity. The straight lines to the left are lines of constant pressure of the mixture at the point of measurement while the abscissa for this set is the specific gravity of the gas when saturated with water vapor at the given temperature and pressure, referred to air at a temperature and



CURVES SHOWING VARIATION IN SPECIFIC GRAVITY OF GASES WHEN SATURATED WITH WATER VAPOR AT DIFFERENT TEMPERATURES

pressure corresponding to the base as unity. The dotted line shows how to use the curves for any condition.

Since these curves give the specific gravity of the mixture at the point of measurement the equations for velocity will be modified so that the values from the curves can be substituted directly. When air at 62 deg. F. and 30 in. Hg is taken as a base, for Pitot tubes the velocity is

Velocity, ft. per sec. =

$$\sqrt{\frac{2 \times 32.16 \times 62.4 \times H}{12 \times .07627 \times S}} = 66.22 \sqrt{\frac{H}{S}}$$

Where

H = velocity head, inches of water.

S = specific gravity of the mixture at the point of measurement referred to air at a temperature of 62 deg. F. and an absolute pressure of 30 in. Hg as unity.

When air at 59 deg. F. and 30 in. Hg is taken as the base; for Pitot tubes the velocity is,

$$\text{Velocity, ft. per sec.} = 66.02 \sqrt{\frac{H}{S}}$$

Where

H = velocity head, inches of water.

S = specific gravity of the mixture at the point of measurement referred to air at a temperature of 59 deg. F. and an absolute pressure of 30 in. Hg as unity.

For Venturi meters, orifices and throttle disks where the differential pressure is small enough so that changes in specific volume of the gas can be neglected, the equation for velocity becomes,

Velocity at smallest section, ft. per sec. =

$$K \times C \sqrt{\frac{H}{S \left[1 - \left(\frac{A_2}{A_1} \right)^2 \right]}}$$

Where

K = a constant = 66.22 or 66.02 depending upon what condition of air is taken as a base.

A_1 = inside area of main pipe where upstream pressure is measured.

A_2 = area of smallest cross section.

(Both these areas must be in the same units.)

C = orifice coefficient.

This coefficient for Venturi meters is usually taken as unity. For well-rounded or so-called standard orifices it varies from .95 to .99 depending largely upon the size of the orifice. For throttle disks, the coefficient varies greatly for different conditions and should be determined experimentally.

Where the differential pressure is great enough to cause an appreciable change in the specific volume of the gas as it passes through the device, then the above equation will not hold and the general equation for frictionless adiabatic flow must be used.

VOLUME DETERMINED FROM VELOCITY

After the velocity of the gas has been determined, if this velocity in feet per second is multiplied by the area of the section in square feet, the result is the volume of the mixture of gas and water vapor flowing, in cubic feet per second at the pressure and temperature at the point of measurement.

Very often the volume of dry gas at some standard condition, such as a temperature of 62 deg. F. and an

absolute pressure of 30 in. Hg, is wanted instead of the volume of wet gas. To find this, multiply the volume of the mixture by the ratio of the absolute gas pressure in the mixture to the absolute pressure at the standard condition and further, by the ratio of the absolute temperature at the standard condition to the absolute temperature of the mixture at the point of measurement.

For example; suppose that the area of the section in the problem already solved is such that when the velocity of 172.37 is multiplied by this area the result is, for convenience, 100 cu.ft. per sec. This means that there are flowing 100 cu.ft. per sec. of a mixture of gas and water vapor at a temperature of 85 deg. F. and a total absolute pressure of 34 in. Hg. The equivalent volume of dry gas at a temperature of 62 deg. F. and an absolute pressure of 30 in. Hg is,

$$\text{Vol. dry gas} = 100 \times \frac{32.791}{30.000} \times \frac{62 + 459.6}{85 + 459.6} = 104.5 \text{ cu. ft.}$$

In some cases it is desired to know the equivalent volume of gas when saturated with water vapor at some other condition of pressure and temperature as a standard. To illustrate; suppose that it is desired to know the equivalent volume of gas when saturated with water vapor at a temperature of 62 deg. F. and an absolute pressure of 30 in. Hg. From the steam tables, the vapor pressure at a temperature of 62 deg. F. is .560 in. Hg. The absolute gas pressure under the new conditions will then be 30.00 — .56 = 29.44 in. Hg and the equivalent volume at 62 deg. F. and 30 in. Hg is,

Volume saturated gas at 62 deg. F. =

$$100 \times \frac{32.791}{29.44} \times \frac{62 + 459.6}{85 + 459.6} = 106.7$$

PARTIALLY SATURATED GASES

So far, only the case where the gas is completely saturated with water vapor has been considered. When it is desired to determine the volume of air delivered by fan, compressors or turbo blowers and the measurements are made with sufficient accuracy to justify making a correction for water vapor, the problem becomes more involved due to the fact that in practically all cases the air is only partially saturated. In such cases the procedure would be as follows: Determine the wet and dry bulb temperatures of the gas at the point of measurement. From a psychrometric chart find the dew point temperature for this condition. Then from the steam tables find the vapor pressure and density corresponding to the dew point temperature and proceed as in the previous problem. This method is correct only when the total pressure is 30 in. Hg, for practically all psychrometric charts are based on this pressure and for any great variation in the total pressure from the above the relative humidity or the dew point should be calculated from the original equations. In nearly all cases in actual practice the total pressure of the gas at the point of measurement is nearly atmospheric so that the error from the procedure mentioned will be small.

TNT for Road Building

TNT, in the opinion of Thomas H. MacDonald, chief of the Bureau of Public Roads, is an ideal explosive for use in road construction. Through his bureau 26,000,000 lb. has been distributed for that purpose without an accident. As TNT does not freeze and the fumes do not produce headaches it is popular with road contractors.

The Training of the Glass-Works Chemist

BY ALEXANDER SILVERMAN

IN AN article which appeared recently in the *Pottery and Glass Record* and was reprinted in an American journal¹ Dr. W. E. S. Turner of the Department of Glass Technology of Sheffield University called attention to the lack of a course in Glass Technology in the curricula of our institutions of learning. The writer outlines the following course of study to "start the ball rolling," and invites discussion. Numbers indicate the actual hours per week scheduled for classes, the first figure signifying lecture and recitation hours, the second, laboratory.

FIRST YEAR

- First term.—General inorganic chemistry (4-6)
General physics (3-3)
Advanced algebra (5)
German (3)
English (3)
- Second term.—General inorganic chemistry (4-6)
General physics (3-3)
Trigonometry (5)
German (3)
English (3)
- Third term.—General inorganic chemistry (4-6)
General physics (3-3)
Analytical geometry (5)
German (3)
English (3)
- Fourth term.—Such general work in a glass factory as requires no special technical training.

SECOND YEAR

- First term.—Advanced inorganic chemistry (2)
Qualitative analysis (1-9)
Advanced physics (light) (2-6)
German or French² (3)
Analytical geometry (5)
- Second term.—Advanced inorganic chemistry (2)
Qualitative analysis (1-9)
Advanced physics (Heat) (2-6)
German or French (3)
Calculus (5)
- Third term.—Advanced inorganic chemistry (2)
Quantitative analysis (1-9)
Advanced physics (Study and determination of physical properties of glass) (2-6)
German or French (3)
Calculus (5)
Graphics (3 practice)
- Fourth term.—General work in a glass factory.

THIRD YEAR

- First term.—Physical chemistry (3-3)
Quantitative analysis (1-9)
Mineralogy (2-6)
Gas and fuel analysis (2-6)
French (3)
- Second term.—Physical chemistry (3-3)
Quantitative analysis (Raw materials for glass) (1-9)
Geology (5)
Fuel values. Pyrometry. (3)
French (3)
- Third term.—Physical chemistry (3-3)
Quantitative analysis (Glass) (1-9)
Microscopy (1-6)
Organic chemistry (2-6)
French (3)
- Fourth term.—Analytical laboratory practice in a glass factory.

FOURTH YEAR

- First term.—Clays and refractories (2-6)
Glass technology (2-6)
Ceramic calculations (2)
Engineering laboratory (2-6)
General economics (3)
Library work (5)
- Second term.—Glass technology (3-9)
Ceramic calculations (2)
Electrical engineering (2-6)
Economics (Factory management) (3)
Library work (5)
- Third term.—Glass technology (3-12)
Electrical engineering (2-6)
Economics (Labor and costs) (3)
Library work (5)

The writer considers it necessary to discuss only a few of the courses in detail, as most of those listed are familiar to all engaged in teaching. In the short courses in mineralogy and geology special attention must naturally be given to raw materials used in the glass industry. The course in microscopy should cover both microchemical and petrographic methods.

Under glass technology one should include furnace and lehr design; fuels; raw materials; preparation of batches; melting and refining; furnace control; glass manipulation; annealing; physical and chemical properties of glasses; manufacture of plate, window, bottle, illuminating, chemical, optical, water glass, table ware and fused quartz; etching, silvering, enameling and decorative processes; glass substitutes. The laboratory work should include the preparation of various glasses and the study of their properties. The course in ceramic calculations supplements that in glass technology and affords the student practice in the handling of mathematical problems encountered from time to time.

Some may think that the glass chemist is so specialized a being that there will be but little demand for him in the industry. The writer feels that with the training prescribed he will, with practical experience in the industry, develop into a very important factor.

As stated in the introduction the paper was presented to arouse discussion. This is earnestly invited.

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Statement of Austrian Iron and Steel Concern for 1920

The net profits of the Alpine Montan Gesellschaft, which comprises nearly all of the Austrian iron and steel industry, for 1920 were 28,564,704 crowns as compared with 10,697,928 crowns during the preceding year, according to a report received from C. H. Foster, with the American Mission, Vienna. The volume of annual sales for 1920 was 1,930,000,000 crowns against 246,000,000 crowns for 1919. On April 20, 1921, the company decided to pay on May 10 a dividend of 25 per cent, or 50 crowns, per share. Last year the dividend was 10 per cent, or 20 crowns, per share; in 1916 it was 50 crowns; and in 1912 it was 52 crowns per share.

The year seems to have been very prosperous, but the higher figures were really caused more by higher prices and a depreciated currency than by a greater quantity of production and economy of operation. In general, production at the end of the year was about 22 per cent of capacity. In comparison with the company's best year—1916—iron ore was produced at the rate of 18 per cent; pig iron, 14.5 per cent; rolled iron, 27.5 per cent; and steel, 24.5 per cent.

¹Glass Industry, vol. 2, 1921, p. 10.

²Students who have had three years of German should begin French.

Carbon Black From Natural Gas in 1920

BY E. G. SIEVERS

THE total quantity of carbon black produced from natural gas in the United States in 1920 was 51,321,892 lb. and 43,500,000 lb. in 1918. In 1919 the plants were still operating at or near full capacity on account of the war, but since normal conditions have been restored the production has decreased.

The output in 1920 was made by thirty-nine plants, operated by nineteen producers, whereas in 1919 only thirty-six plants were operated by sixteen producers. The total value as computed from the prices received by the producers was \$4,032,286 for 1920 and \$3,816,000 for 1919. The prices ranged from 4c. to 27c. a lb. in 1920 and from 3c. to 27c. in 1919. The average daily production in 1918 was 120,830 lb.; in 1919, 144,600 lb.; and in 1920, 140,608 lb.

About 40,600,000 cu.ft. of natural gas was consumed in the manufacture of carbon black in 1920, as compared with 49,896,200,000 cu.ft. in 1919 and 45,000,000,000 cu.ft. in 1918. In 1920 the production of carbon black per thousand cubic feet of gas consumed ranged from 0.45 to 2 lb., but the average production during the year for all states was about 1.26 lb., as compared with 1.04 lb. during 1919. Table I gives the range in production of carbon black at plants in the United States in 1919 and 1920.

TABLE I. RANGE OF PRODUCTION OF CARBON BLACK IN 1919 AND 1920

Production	Plants	
	1919	1920
Less than 1 lb.	6	6
From 1 to 1.2 lb.	17	19
From 1.3 to 1.6 lb.	11	6
From 1.7 to 2.0 lb.	2	8
	36	39

The daily capacity of the plants in volume of gas treated ranged from 172,000 to 20,350,000 cu.ft. as against 72,000 to 18,360,000 cu.ft. in 1919; the quantity of carbon black produced was from 90 to 23,250 lb. as against 90 to 22,900 lb. in 1919.

Tables II and III give the production by states for 1919 and 1920. West Virginia remained the leading producing state in 1920, although its output decreased 11 per cent. The annual decrease in production in West Virginia and in Pennsylvania is due in part to the diminishing supply of gas, which has made it possible to sell for fuel at higher prices large volumes of gas that would otherwise be used in making carbon black.

Louisiana, which has made rapid growth in the carbon black industry during the last few years and was second in rank, increased its production by 32 per cent

TABLE II. CARBON BLACK PRODUCED FROM NATURAL GAS IN THE UNITED STATES IN 1919

State	Number of Plants	Carbon Black Produced		Gas Used		
		Quantity, Lb.	Value	Average Price, c.	Quantity M. Cu.Ft.	Average Yield per M. Cu.Ft. Lb.
West Virginia...	23	29,925,614	\$2,358,119	7.8	23,117,332	1.3
Louisiana.....	7	14,024,606	933,334	6.6	20,291,021	0.7
Wyoming.....	1	4,868,947	231,747	4.7	4,306,153	1.1
Montana.....	1					
Oklahoma.....	2	2,922,274	244,726	8.3	1,954,129	1.4
Kentucky.....	1					
Pennsylvania...	2	315,500	48,114	15.0	227,700	1.3
	36	52,056,941	\$3,816,040	7.3	49,896,235	1.04

in 1920. The great supply of gas in the Monroe field accounts for this marked increase in production. Louisiana will continue to be a large producer of carbon black unless prevented by legislation.

Oklahoma produced no carbon black in 1920. The combined output of Wyoming, Montana and Kentucky decreased 4 per cent, so that Louisiana was the only state showing a substantial increase. The producing states, named in order of production and the percentage of the output they produced, are West Virginia, 52 per cent of the total output; Louisiana, 36 per cent; Wyoming, Montana and Kentucky combined, 11 per cent; and Pennsylvania, 1 per cent.

TABLE III. CARBON BLACK PRODUCED FROM NATURAL GAS IN THE UNITED STATES IN 1920

State	Number of Plants	Carbon Black Produced			Gas Used	
		Quantity, Lb.	Value	Average Price	Quantity M. Cu.Ft.	Average Yield per M. Cu.Ft.
West Virginia...	19	26,659,469	\$2,221,674	8.2	18,628,780	1.35
Louisiana.....	15	18,565,498	1,455,764	7.8	18,099,800	1.0
Wyoming.....	1					
Montana.....	1	5,850,313	326,424	5.6	3,673,108	1.6
Kentucky.....	1					
Pennsylvania...	2	246,612	28,424	11.5	197,290	1.2
	39	51,321,892	\$4,032,285	7.8	40,598,978	1.26

The carbon black industry migrates according to the available supplies of natural gas. West Virginia has always been the center of manufacture, but Louisiana and Wyoming have made rapid growth. As natural gas is an ideal domestic fuel, the consumers demand that it be reserved for domestic uses, and the carbon black industry has, therefore, migrated to localities where there are abundant supplies of natural gas for which there is only a small market or no market at all. The Monroe gas field, in Louisiana, one of the largest in this country, has been a favorable location for carbon black plants, for it is remote from large cities and towns and supplies but little gas for domestic uses, and the gas is sold at a fairly low rate, so that the carbon black industry has there become well established. The producers are now installing plants that remove the gasoline from the gas before it is consumed in the manufacture of carbon black, which is another means of conservation.

In Wyoming the conditions are somewhat similar to those in Louisiana. The general market for the gas produced there is small, so that the carbon black industry has been developed until Wyoming has surpassed Oklahoma and assumed third rank among the producing states.

A cubic inch of carbon black contains approximately 1,905,000 sq.in. of surface, whereas a cubic inch of lampblack contains only 1,524,000 sq.in. Carbon black therefore consists of finer particles and is superior to lampblack for use in both the printing and rubber industries.

Carbon black is an amorphous form of soft carbon produced by the incomplete combustion of natural gas. It is sometimes confused with lampblack, which is made by burning oil or some other raw material and which differs from carbon black in molecular structure and tinctorial strength as well as in quality and in use. Its lightness and fineness, freedom from gritty particles, miscibility with oil, intensity of color and remarkable covering power when mixed with other materials are among its essential qualities.

Carbon black was first made commercially in this country about 1864, when it was first used in making

printing ink. The growth of the industry has been stimulated by the rapid increase in the publication of books and newspapers, which demand a constantly increasing supply of carbon black for the manufacture of printing inks adapted to fast press work. The modern rotary printing presses now used by daily newspapers and printing establishments require an ink that will dry rapidly and yet permit the presses to be operated at a high speed—an ink that will flow freely, possess great covering power and make an instantaneous and legible impression—and an ink having all these qualities

TABLE IV. SUMMARIZES THE APPROXIMATE DISTRIBUTION BY USES OF CARBON BLACK IN 1918, 1919 AND 1920

Use	1918 ^a		1919		1920	
	Per Cent	Quantity, Lb.	Per Cent	Quantity, Lb.	Per Cent	Quantity, Lb.
Rubber.....	45	20,000,000	40	20,822,400	40	19,947,000
Printer's ink...	23	10,000,000	35	18,219,600	35	17,454,000
Export.....	18	8,000,000	15	7,808,400	15	7,480,000
Miscellaneous..	14	8,500,000	10	5,205,600	10	4,986,000
	100	43,500,000	100	52,056,000	100	51,321,892

^a Estimated by Bureau of Mines.

^b Exact total obtained from producers.

can be made by using carbon black. One pound of carbon black mixed with 8 lb. of oil and other chemicals will produce enough ink to print 2,250 copies of a sixteen-page newspaper of ordinary size or 90 copies of a 300-page octavo book. Prior to 1864 lampblack was used in making printing ink, but as carbon black proved to be superior for this use it rapidly displaced lampblack. About 35 per cent of the total annual output of carbon black is now incorporated in printing ink.

CARBON BLACK IN THE RUBBER TIRE INDUSTRY

The introduction of carbon black in the manufacture of rubber tires has been of considerable consequence in the rubber tire industry. The addition of carbon black, which is a reinforcing agent, has given the rubber greater toughness and resiliency, better traction and a longer mileage. It has increased the tensile strength and the elasticity of the tire about 25 per cent and 10 per cent, respectively. During 1920 a number of rubber tire manufacturers who formerly manufactured white tires have changed to the manufacture of "black tread tires," and are using considerable quantities of carbon black—indicating the increasing use of this product in the rubber industry, which consumes about 40 per cent of the output. The advantages of carbon black in making rubber tires have been established, but whether it is irreplaceable is still a matter of opinion among chemists.

About 10 per cent of the carbon black produced is used in the manufacture of stove polish, about 1 per cent in phonograph records, and about 2 per cent is distributed among miscellaneous uses, including black leather, black and gray paper, bookbinder's board, buttons, carbon paper, carriage cloth, celluloid, electric composition insulators, cement colorings, crayons, glazed paper, Chinese and India inks, marking and stenciling inks, artificial stone and black tile, paint, shoe polish, tarpaulins, type ribbon, varnish, etc.

Between 15 and 20 per cent of the output is exported. Before the war about one-third of the output was exported, but owing to unstable conditions the export trade has not resumed its normal proportions. Owing to the increased use of carbon black in the manufacture of rubber tires in this country, however, less of the product will probably be available for export.

Macroscopic Examination of Iron and Steel

A COMMITTEE on metallography, appointed by the American Society for Testing Materials, has proposed the following tentative methods for testing iron and steel. Criticism of the methods is invited; it should preferably be addressed to G. F. Comstock, Titanium Alloy Manufacturing Co., Niagara Falls, N. Y.

In order to show up both chemical and crystalline heterogeneity, sections of iron and steel are more or less deeply etched in order to bring out their macrostructure. In this way the persistence of the dendritic structure of castings even after much heat-treatment and mechanical working, physical unsoundness such as blowholes, gas cavities, porosity, fine internal cracks and flakes, discontinuities of structure such as found in welding, flow of metal as in pressing and forging, are brought out.

Suitable sections are cut, smoothed and then ground on various grades of emery paper in order to obtain a smooth flat surface. In some cases it is necessary to continue polishing through No. 0 and No. 00 French emery papers. Other similar papers of domestic manufacture are also available and suitable for this purpose. The sample ought to have a surface free from grease and dirt; if necessary it is then freed from all grease by cleaning with gasoline and then alcohol when it is ready for immersion in the solution.¹

SOLUTIONS USED IN ETCHING

Macroscopic etching of iron and steel was used as early as 1783 by Bergman. Many different solutions have been used and many of them are given by Campbell,² and more recently by Rawdon.³

Of the following, 1 (a) and 2 are recommended.

1. To show segregation and the like:

(a) Hot concentrated hydrochloric acid used at about 100 deg. C. A deep etched specimen may be printed with printer's ink.

(b) Etching for four to five hours with 5 per cent picric acid in alcohol.

2. To show variations in crystalline structure as well as segregation:

One to 2 g. of ammonium persulphate in 10 c.c. of water. This is probably the best reagent for developing this phase of the structure in iron and steel.⁴

3. To show the distribution of phosphorus.⁵

Various reagents containing copper chloride are used. The copper coats those portions which are low in phosphorus and leaves the high-phosphorus areas bright. It has recently been shown that nickel and other alloys give similar effects, also that oxide of iron acts in the same way. The accompanying list shows the various solutions which have been recommended:

Heyn:⁶ Copper-ammonium chloride, 10 g., water, 100 c.c. A somewhat weaker solution is better, the specimen being etched two or three times in fresh solution if necessary. The liquid is gently agitated. The coating of spongy copper forming on the face of the specimen is easily removed with a swab of wet cotton. Portions high in carbon, sulphur and phosphorus will have darkened. If the copper

¹For large sections various methods have been devised depending on the material. Surface grinding when carefully done gives excellent results.

²*Proceedings, Am. Soc. Tes. Mat.*, vol. 25, Part II, p. 96 (1915).

³The Structure and Related Properties of Metals. Bureau of Standards Circular. (In the press.)

⁴Rawdon, "Macro-etching with Ammonium Persulphate," *Scientific Paper* 402, Bureau of Standards (1920).

⁵Howe, "Metallography of Steel and Cast Iron," p. 601. Charpy and Bonnerot, *Compt. rend.*, 1914, vol. 165, p. 536.

⁶Heyn and Bauer, *Metallographic*, 1909, vol. 1, p. 21.

film adheres, a 0.5 per cent solution of ammonium persulphate will facilitate its removal.

Stead:⁷ CuCl_2 , 10 g.; MgCl_2 , 40 g.; HCl , 10 c.c.; H_2O , 20 c.c.; alcohol to 1,000 c.c. Dissolve salts in smallest possible amount of hot water and make up to 1,000 c.c. with absolute alcohol. For small specimens the reagent is applied drop by drop until structure is developed. The specimen is then washed with boiling water and then alcohol. Another method is to wash off the deposited copper with ammonia and so increase the contrast.

Le Chatelier and Lemoine:⁸ CuCl_2 , 10 g.; MgCl_2 , 40 g.; HCl , 20 c.c.; H_2O , 180 c.c.; alcohol, 1,000 c.c. Applied like Stead's reagent. Contrast can be increased by electrolysis, using a single battery cell, keeping the current below 50 milliamperes.

Rosenhain and Haughton:⁹ Fe_2Cl_6 , 30 g.; HCl , 100 c.c.; CuCl_2 , 10 g.; SnCl_2 , 0.5 g.; H_2O , 1,000 c.c. The copper adheres firmly. Pearlite areas remain bright. Ferrite darkened by deposited copper, the purest parts darkening the fastest. Pitting can be avoided by diluting the reagent.

LeChatelier and Dupuy:¹⁰ Ethyl alcohol, 100 c.c.; H_2O , 10 c.c.; CuCl_2 , 1 g.; picric acid, 0.5 g.; HCl (concentrated), 1.3 to 2.5 c.c., varying with material.

Oberhoffer:¹¹ Ethyl alcohol, 500 c.c.; H_2O , 500 c.c.; SnCl_2 , 0.5 g.; CuCl_2 , 1.0 g.; Fe_2Cl_6 , 30 g.; HCl , 50 c.c.

Humfrey:¹² Emery paper finish may be used for specimen. Copper ammonium chloride, 120 g.; HCl (concentrated), 50 c.c., more or less, H_2O , 1,000 c.c. The addition of HCl causes the copper deposit to adhere. Etching is therefore started with the neutral solution and continued until all traces of the scratches have disappeared. Then in successive applications the acidity of this solution is gradually increased up to the maximum. Alloy steels etch better with solutions of weaker acidity. After wiping away the deposited copper and drying, the surface is lightly rubbed with fine emery paper and the relief portions brought out in strong contrast. The selection may be printed with ordinary printer's ink applied to the surface by means of a roller.

Dickenson:¹³ First etch with 10 per cent HNO_3 . Then re-etch with Fe_2Cl_6 , 40 g.; CuCl_2 , 3 g.; HCl , 40 c.c.; H_2O , 500 c.c.

METHODS FOR INDICATING DISTRIBUTION OF SULPHUR

The distribution of sulphur is usually shown by the sulphur print method.¹⁴ A solution of 2 to 3 c.c. of concentrated H_2SO_4 in 100 c.c. of water is used to moisten a sheet of matt-finish photographic paper. The specimen with its surface smoothed either with a fine file or grinding wheel is pressed firmly on the paper on which a brown mark indicates the sulphur-rich areas. About sixty seconds is usually sufficient. The paper is then washed and fixed in hyposulphite solution.

With larger sections the paper is placed on their polished surface with care so that no air pockets occur. If a very dilute solution is used and a longer "etch" several prints can be obtained. Fresh solution can be added with absorbent cotton should the paper tend to become dry.

Considerable differences of opinion have arisen as to the meaning of the results obtained by deep etching in transversely fissured rails, etc., because the presence of cracks in the material previous to etching had not been demonstrated. The following method, however, can be used to locate them. The sample after careful polishing is magnetized and then immersed in kerosene or a

similar liquid containing very fine iron dust in suspension. The particles of iron dust collect upon the face of the specimen and orient themselves to correspond to the shape of the cracks because of discontinuity in the metal which causes a change in the density of the magnetic flux. The samples are then washed in clean kerosene to remove as much as possible of the excess iron dust which clings to the surface.¹⁵

According to several authorities their existence has been proved by annealing the specimens prior to etching, because a pronounced decarburized area then occurs around these cracks.

The camera should be arranged so that the specimen is illuminated by vertical light. After certain kinds of etching, e.g., ammonium persulphate, the surface should be immersed in water, alcohol or light oil. Large specimens may be covered with oil or glycerin.

The surface obtained by deep etching may be printed with printer's ink applied with a roller. The printing can be done on a glossy paper in a letter press. For small samples of wrought iron deeply etched a reproduction can be made using an ordinary ink pad and applying the specimen as in block printing.

The Condensation of Water Solutions of Furfural With Aniline

BY JACK P. MONTGOMERY AND E. S. ERNST

In a recent paper by Mains and Phillips¹ a resin, "furfur-aniline," was described and the optimum conditions for its production and application as a varnish stain were given. They used equal weights of furfural and aniline heated for one hour at 200 deg. C. in an open flask, or for three hours at 170 deg. C. in a flask attached to a reflex condenser. A gum which was hard and brittle at 25 deg. C., insoluble in water, soluble in benzene and in furfural was obtained. The saturated benzene solution gave a light brown stain on white oak and the saturated furfural solution a dark brown stain.

We have found that water solutions of furfural as dilute as 2 per cent, mixed with aniline and heated to 125 deg. C. in an autoclave for fifteen minutes, give a gum very similar to that described by Mains and Phillips, the chief difference being that the gum made by us gives a darker shade than that described by them.

When an excess of aniline is used with the solutions of furfural, the residue is oily and not brittle at 25 deg. C., but when the mixture is steam-distilled the excess aniline is separated and the residue is hard and brittle at 25 deg. C.

The preparation of water solutions of furfural is very easy, but the fractionation of the furfural is somewhat difficult² and there is always a considerable percentage, frequently up to 8 and 10 per cent, of furfural in the rejected water, according to our experience. If the furfural production is being carried on with a view to subsequent condensation with aniline, it would seem useless first to prepare pure furfural. If furfural is being prepared for other purposes, the rejected water from the fractionating process has enough furfural present to make its recovery as furfur-aniline profitable.

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¹Rawdon and Epstein, Technologic Paper 165, Bureau of Standards, 1920.

²CH. & MET. ENG., vol. 24, p. 661, (1921).

³J. Ind. Eng. Chem., vol. 13, p. 133 (1921).

⁷Stead, *Journal, Iron and Steel Inst.*, 1915, vol. 1, p. 173, 1918, vol. 1, p. 408.

⁸Le Chatelier and Lemoine, *Compt rend.*, 1915, vol. 161, p. 373.

⁹Rosenhain and Haughton, *Journal, Iron and Steel Inst.*, 1914, vol. 1, p. 505.

¹⁰Le Chatelier and Dupuy, *Revue de Metallurgie*, vol. 15, p. 127.

¹¹Oberhoffer, *Stahl und Eisen*, 1916, vol. 36, p. 798.

¹²Humfrey, *Journal, Iron and Steel Inst.*, 1919, vol. 1, p. 273.

¹³Dickenson, *idem*, p. 294.

¹⁴R. Baumann, *Metallurgie*, 1906, p. 416. Stead, "Sulphur and Iron," Staffordshire Iron and Steel Institute, March, 1908. Hatfield, "Cast Iron," p. 71, shows sulphur prints of pig iron.

Effect of Lightning Striking an Acid Tank

BY PHILIP DE WOLF

AT 3:45 p.m. June 1, 1920, during a terrific rain storm, at the Old Hickory Powder Plant, now being developed by the Nashville Industrial Corporation, a 20 x 12 ft. vertical acid tank, containing about 200 tons of 89 per cent H_2SO_4 , was struck by lightning.

The 20 x 12 ft. tanks are arranged in pairs, 60 ft. from the nearest building, high enough above the

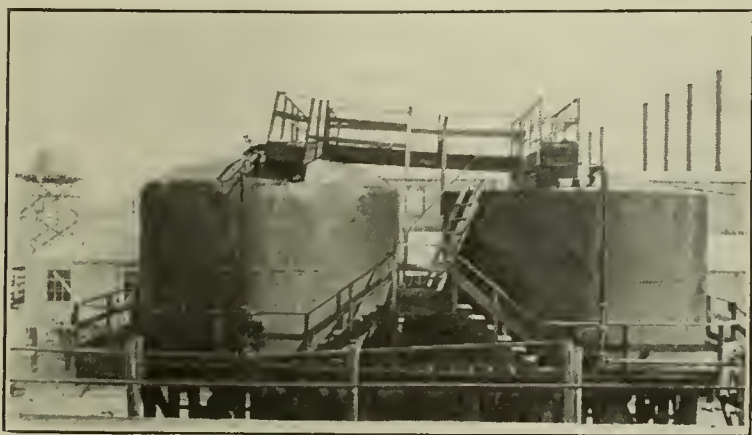


FIG. 1. ACID TANK STRUCK BY LIGHTNING

ground to feed by gravity to the circulation and storage tanks of the adjoining O. V. lines. At their closest point the tanks are only 3½ ft. apart. They are connected by overhead lines into the general acid system of the plant.

After the lightning stroke the acid began to pour out, and the fire department was called. Its activity was confined to flushing back the acid and confining it to the relatively small area about the tanks, where it was partly removed by the sewerage system, and partly absorbed by the sandy soil.

The tank had bulged at the top, wrecking the platform, and smashing some of the timbers in the main deck. The platform under the valves on the pipe line a hundred feet away was also wrecked, but no harm was done to the columns or foundations of the tank, outside of a little blackening of the wood due to carbonizing with acid.

The lightning naturally struck the tank at the top, but it was bulged out, not in, showing internal pres-

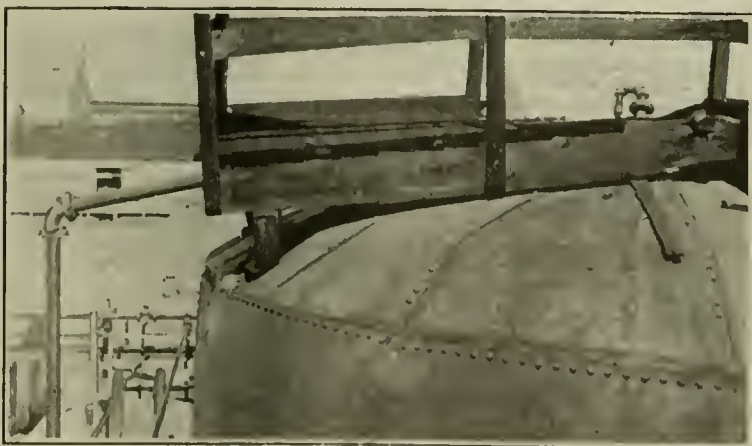


FIG. 2. TOP OF TANK, SHOWING DISTORTION

sure of considerable magnitude. This must have come from an accumulation of hydrogen inside, due to the action of the acid upon the iron, and this, with the air inside, exploded to water. Or possibly the heat vaporized enough of the acid to produce this pressure. While no temperature measurements were taken, the condition of the top of the tank, which is now coated with

a smooth oxide, apparently impervious to weather, shows that there was sufficient heat to start an explosion.

The top of the tank was bulged out 9 in. and all cast-iron fittings broken, but not a rivet was started, nor apparently a seam opened. The illustration shows the curious distortion of the top, how much more the plates were expanded than the single riveted lap joints.

The acid ran out only through the broken fittings.

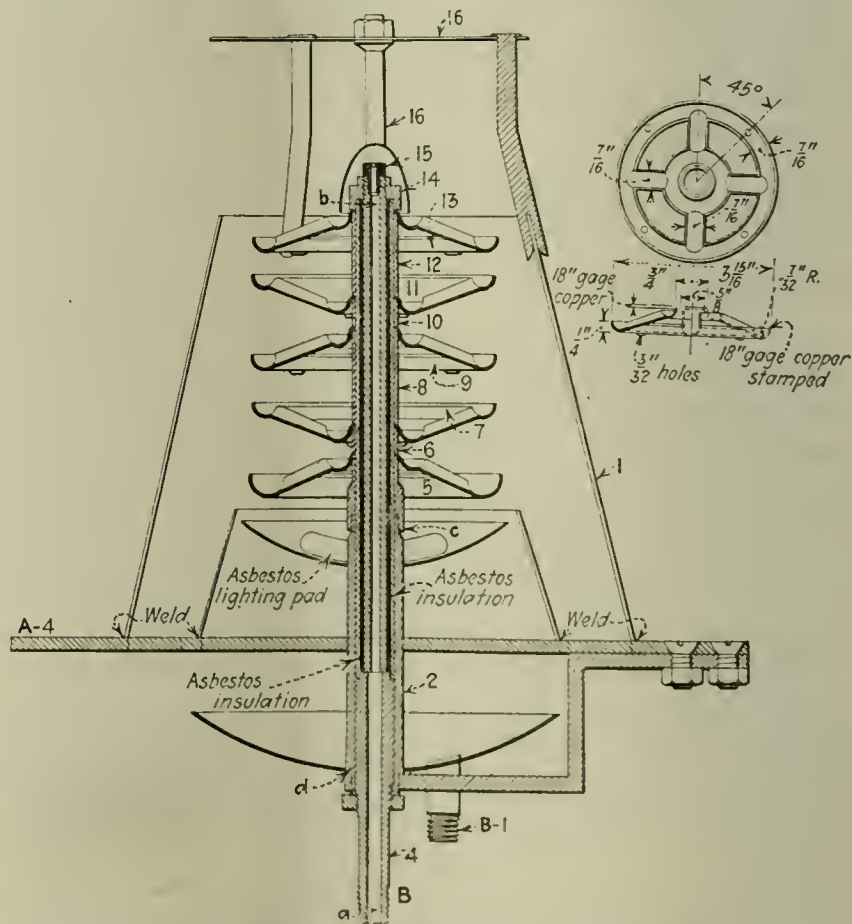
The lower half of the tank still retains its original coat of paint, all around, showing that the high temperatures did not get down that far; presumably the plates cooled very fast on account of the rain and the large body of acid inside.

But the course of the lightning was not the shortest way to the ground, over the tank and down the wet wooden columns, but along a horizontal 3-in. pipe line for a hundred feet, where instead of following the line any further it jumped 12 ft. to the ground, wrecking the platform there.

Why it did not touch the big tank only 3½ ft. away is a mystery, as is also the fact that several acid pipe lines, paralleling the one it chose for a path, and as near as 4 in. to it, were not touched.

A New Development in Oil Burners

The early types of vaporization oil burners have been designed on the principle of boiling the oil indirectly and mixing the hydrocarbon vapors with air in the combustion zone. Carbon has always formed



troublesome deposits which were conducive of bad burner adjustment and incomplete combustion. Recently Dr. J. B. Garner, J. B. Anderson, G. A. Shaner and the staff of the National Gas Fellowship at the Mellon Institute of Industrial Research, Pittsburgh, have perfected a burner of novel design which gives promise of making 30 to 40 deg. Bé. distillate a first-class fuel at a price equivalent to 35c. gas.

The Peoples National Gas Co., the local branch of the donor of the fellowship, plans to exploit the burner, being influenced by the need of the conservation of its natural gas resources.

The essential feature of the design may be seen from

the cross-section of the burner given herewith. The oil is boiled by direct partial combustion during flow in the channel rings, producing a very hot vapor which is mixed with air under 0.5-oz. pressure in the combustion zone and completely burned. A very efficient flame results, an actual heat absorption of 56 per cent being obtained in commercial operation during a rise from 60 to 300 deg. F. The burner is lighted at an asbestos wick placed in the drip pan in the cone base.

The past year has been spent in demonstrating the practicability of this apparatus. When all serious imperfections in the apparatus had been removed by the inventors, it was submitted to the Underwriters' Laboratories, Inc., of Chicago, for inspection and test. These investigations were begun in July, 1920, and continued until January, 1921, when the approval and indorsement of the Fire Council of the National Board of Fire Underwriters was given.

The Jennings Steam-Turbine-Driven Return-Line Heating Pump

THE satisfactory performance of the Jennings Hytor vacuum heating pumps, operated by electric motors, has led the Nash Engineering Co. of South Norwalk, Conn., to develop a novel type of steam-turbine-driven return-line heating pump. The cross-section (Fig. 1) shows the general design of this unit, which consists of an air pump that exhausts the air from the system, a centrifugal pump to remove the hot condensate and return it to a feed-water heater or hot well, and a steam turbine to drive the unit; all mounted on one shaft and assembled in the same casing.

The Jennings turbine-driven unit is especially designed for use in connection with heating or drying systems where the pump is called upon both to maintain a vacuum on the heating system and to return the hot water and condensation against a pressure.

The unit consists of two independent turbine pumps built in one casing—one pump handling the air, the other the condensation, the air and condensation being separated in a receiver under vacuum before entering the unit. This arrangement makes possible the large saving in horsepower, because the condensation, which is only one-eighth of the volume handled, is alone delivered against discharge pressure, the air being delivered free to the atmosphere. Also the air is handled in a

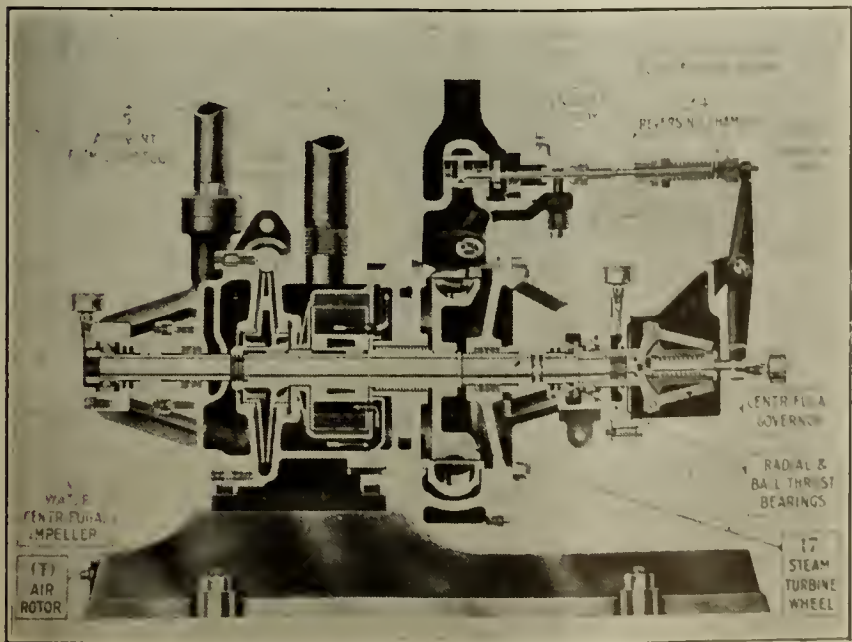


FIG. 1. CROSS-SECTION OF JENNINGS TURBINE-DRIVEN UNIT

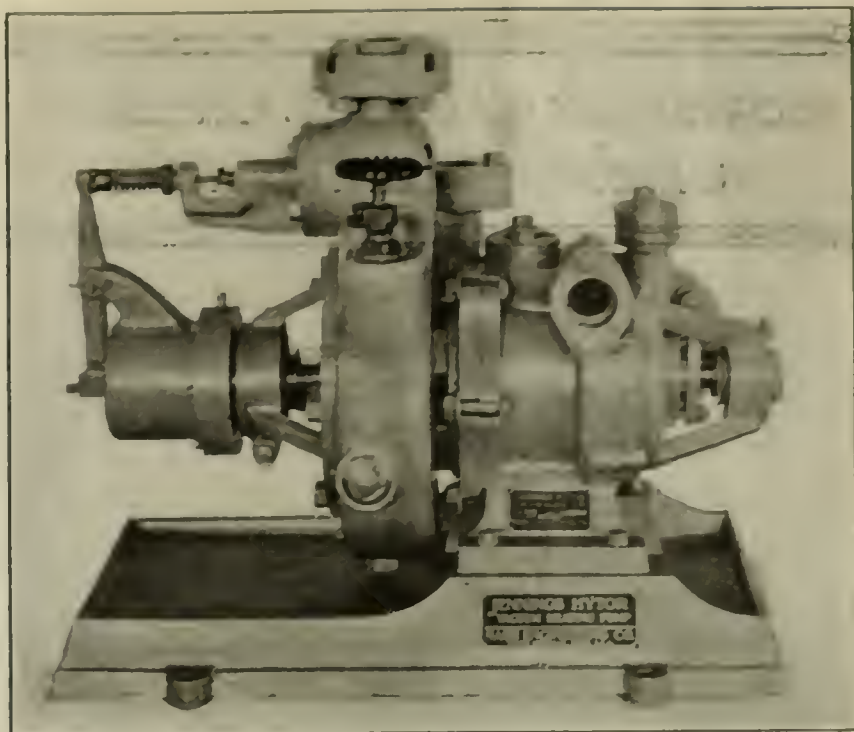


FIG. 2. STEAM-TURBINE-DRIVEN RETURN-LINE HEATING PUMP

pump designed for air, while the water is handled in a pump designed for water. This permits a much higher efficiency than in one pump handling both air and water.

The air end of the new turbine-driven unit is a development of the well-known Hytor vacuum pump, in which the rotor, the only moving part, revolves in an elliptical casing filled with water. The water turns with the rotor, but follows the casing, due to centrifugal force.

The water end of the machine is a centrifugal pump with an inclosed type impeller designed to give high efficiency when handling hot water. It has the very desirable characteristic of unloading when not handling condensation, and at the same time will require very little increased power when delivering against low heads. Provision has been made by special construction to vent the centrifugal inlet back to the receiving tank, which is under vacuum, precluding air binding.

All interior parts of the pump are constructed of bronze with the exception of the steam turbine rotor. No lubricant is required in the interior of the pump. No oil or grease can be introduced by the pump into the condensate. As the condensate is usually returned to a hot well, tank or feed-water heater for boiler feed purposes, this feature is very desirable.

The shaft upon which the impeller, rotor and steam turbine wheel are mounted is supported by the highest grade annular ball bearings mounted outside of the casing, in an adjustable housing. These bearings, if properly lubricated, will wear indefinitely.

The steam turbine rotating element consists of a solid steel forging with blades milled out off the rim.

A centrifugal throttling governor is furnished assembled as regular equipment to maintain a constant steam turbine speed. This governor automatically shuts off steam if the steam pressure rises or if the pump unloads when not handling condensation, preventing all increase in speed.

The turbines are designed to operate at 75 lb. steam pressure, although the turbine casing is suitable for steam pressures up to 200 lb. If it is desirable to operate at pressures lower than 75 lb., a satisfactory operation can be secured on pressures as low as 40 lb.

These pumps are ready for delivery in sizes up to 300,000 sq.ft. of equivalent direct radiation.

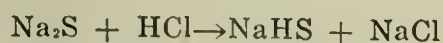
Synopsis of Recent Chemical & Metallurgical Literature

Chemical Research in India.—Dr. E. R. Watson, in charge of the Government Research Institute at Cawnpore, India, discusses chemical research for the development of industries in India in the *Journal of Indian Industries and Labour* for May, 1921. He points out a number of important manufactured articles which are not made at present in that country, notwithstanding the fact that the natural raw materials are present in abundance. Among such materials and articles are mentioned: zinc, copper, tungsten and other ingredients of high-speed steels, chromium, graphite, thorium salts for gas mantles, caustic soda, benzene and related products, rubber goods, tin plate, paper, drugs, dyes and essential oils. It is remarked that "in the absence of any means for production from purely Indian sources of sulphuric, nitric and hydrochloric acids and the alkalis, our manufactures, actual or prospective, of paper, drugs, matches, oils, explosives, disinfectants, dyes and textiles are dependent upon imports, which under war conditions might be cut off, yet sources of raw materials for heavy chemicals are not deficient."

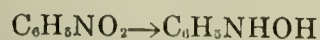
The quantity of coal tar available at present in India is not sufficient to supply a large byproducts industry; about 500,000 tons of coke and 8,000 tons of tar are produced annually. Her production of coal is now 20,000,000 tons, which would indicate that the output of coke can be increased materially.

The Indian Government is interesting itself in a proposal to erect zinc-smelting works at Jamshedpur to handle zinc concentrates from Burma. The plant under consideration will deal with 25,000 tons of concentrate annually, producing 10,000 tons of spelter and 32,000 tons of sulphuric acid. This is practically equal to the consumption of sulphuric acid, practically all of which at present is imported.

Reduction By Sodium Hydrosulphide.—In two papers in the June number of the *Journal of the Chemical Society* ("Reduction of Emulsified Nitro-Compounds, Part I. Phenylhydroxylamine From Nitrobenzene," by Arthur Lapworth and Lenore Kletz Pearson; pp. 765-768; "Part II. Some Extensions of the Method," by Robert Downs Haworth and Arthur Lapworth, pp. 768-777) is described a method of reduction of nitro-compounds of great theoretical interest and of probable commercial value. The active reagent is sodium hydrosulphide (NaHS) in aqueous solution, prepared by acidifying sodium sulphide with the requisite quantity of hydrochloric acid.



The reduced compounds desired are the substituted hydroxylamines.



The sodium hydrosulphide acts as the reducing agent. As practically all nitro-compounds are insoluble in water, it was deemed necessary to emulsify the nitro-compound (liquid) or to dissolve it in a solvent like benzene or toluene (solid compounds) and emulsify the solution. Calcium chloride proved a very satisfactory emulsifying agent, as its addition caused the precipitation of a finely-divided precipitate of calcium hydroxide or "basic" calcium sulphides, in the presence of which emulsification readily occurred. Furthermore, the concentration of hydroxyl ions was probably regulated by the calcium ions present, so that the reduction proceeded chiefly in the direction desired. By regulating the concentration of the solutions it was possible to obtain the phenylhydroxylamine crystallized out from the solution at the end of the reaction. The crystals were contaminated by the precipitate of calcium compounds which catalyzed the oxidation of phenylhydroxylamine (to nitroso-benzene) by the air when filtered. This was minimized by adding ammonium chloride at the end of the reaction to dissolve the calcium compounds and filtering

off the relatively pure phenylhydroxylamine. On a large scale the ammonia could be recovered from the mother liquors, or probably better still, hydrochloric acid could be used to dissolve the calcium precipitate. As the reaction mixture absorbs oxygen from the air rather rapidly, the reaction would best be carried out in a closed vessel to reduce this oxidation.

Yields of 72 to 74 per cent of β -phenylhydroxylamine from the nitrobenzene used were obtained without counting what was left in the mother liquors and might be recovered in a continuous commercial operation. The raw materials, nitrobenzene, calcium chloride or hydrochloric acid, are sufficiently cheap to be used as commercial raw materials for the process if sufficient use for phenylhydroxylamine could be found.

p-chloronitrobenzene gave 68 per cent of the theoretically possible *p*-chlorophenylhydroxylamine.

p-bromonitrobenzene gave 65 per cent of the theoretically possible *p*-bromophenylhydroxylamine.

p-iodonitrobenzene gave 64 per cent of the theoretically possible *p*-iodophenylhydroxylamine.

p-nitrotoluene in benzene gave 53 per cent of the theoretically possible *p*-tolylhydroxylamine and a further 5 per cent could be extracted from the mother liquors.

o-nitrotoluene gave 15 per cent of the theoretically possible *o*-tolylhydroxylamine, which, however, did not separate out as such, but was estimated by oxidation to *o*-nitrosotoluene.

o-chloronitrobenzene gave 62 per cent of the theoretically possible *o*-chlorophenylhydroxylamine, which was not isolated as such, but was oxidized to *o*-chloronitrosobenzene, a new compound.

m-bromonitrobenzene gave 55 per cent of the theoretically possible *m*-bromophenylhydroxylamine.

m-chloronitrobenzene gave 57 per cent of the theoretically possible *m*-chlorophenylhydroxylamine.

α -nitronaphthalene gave close to 80 per cent of α -naphthylhydroxylamine. By using an excess of sodium hydrosulphide, and kieselguhr instead of calcium chloride (as calcium chloride emulsions break down on heating) and heating on water bath for eight hours, 73 per cent of theory of α -naphthylamine was obtained. At lower temperature with calcium chloride not a trace of α -naphthylamine was obtained.

α -nitroanthraquinone yields more than 80 per cent of theory of α -aminoanthraquinone or 73 per cent of theory of α -hydroxylaminoanthraquinone, depending on conditions of experiment.

m-dinitrobenzene gave 3:3' dinitroazoxybenzene and 2:4 dinitrotoluene gave 3:3'-dinitro-4:4'-dimethylazoxybenzene as the partial reduction products.

Nitroanilines reduced by this method do not stop at the hydroxylamine stage, but reduce completely to the diamine stage.

p-nitrophenol gave no reduction products by this method.

(The abstractor may record that it is his experience that calcium chloride is a useful catalyst in reductions of nitro-compounds. Thus, *p*-nitraniline is almost quantitatively smoothly reduced to *p*-phenylenediamine by zinc dust in the presence of calcium chloride in aqueous solution. The application of sodium hydrosulphide to reductions is by no means new, although its application to emulsified insoluble nitro-compounds is original and useful. Hundreds of thousands of pounds of *m*-dinitrobenzene have been reduced to *m*-nitraniline by means of sodium hydrosulphide, but, as shown in the paper quoted, the intermediate reduction to the hydroxylamine is impossible in this case under the given conditions.)

Proof Loads.—After remarking upon the fact that many engineering materials do not possess any "yield point" when testing in tension and that the determination of the elastic limit, proportional limit or fatigue limit is not now a practicable operation in routine testing, an editorial writer in the *Engineer* for July 8, 1921 (p. 42), goes on to say:

"Fortunately, a fairly satisfactory alternative exists and has been incorporated in some of the recent specifications of the British Engineering Standards Association. It is the specification of a 'proof load.' There may be some doubt as to the appropriateness of this particular term, but the idea itself appears to be entirely sound. It is based upon

the principle that, instead of endeavoring to ascertain in the course of a rapid tensile test at what particular stress permanent deformation occurs to a measurable extent, it is better to decide beforehand, as the result of accurate tests made by means of extensometers or otherwise, what stress satisfactory material of that particular type should be well able to bear without undergoing any extension more than a small specified amount, such as $\frac{1}{2}$ per cent. If the figure thus arrived at is specified as the 'proof load,' it is a very simple matter to test any given specimen. All that need be done is to mark the test-piece accurately with two fine lines whose distance apart is the standard specified gage length; the specified 'proof load' is then applied to it for a specified short time and the load is then removed and the test-piece remeasured. If the lines marked on it have not moved apart by more than the specified amount— $\frac{1}{2}$ per cent—the test has been passed, and the breaking or ultimate stress, extension, etc., can then be determined by a further test on the same test-piece. It is all very simple and quick; measuring appliances, such as small microscopes, can easily be mounted so that the measurement can be made in a few seconds without removing the test-piece from the machine. Above all, however, is the great advantage that the manufacturer, the inspector and the engineer all obtain a definite determination which bears some relation to the properties of the material, instead of a vague estimate of a non-existent yield point."

Recent Chemical & Metallurgical Patents

American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Acid-Resisting Alloy.—Foster Milliken, of Lawrence, N. Y., has prepared an alloy with a high resistance to corrosion by acids and capable of withstanding high temperatures. It is claimed to be serviceable for use in the manufacture of plugs and other still fittings. Its approximate composition is as follows: Copper, 45-55 per cent; nickel, 29-35 per cent; lead, 1-3 per cent; zinc, 5-9 per cent; iron, 4-8 per cent; and silicon-copper (approximately 10 per cent) 1-3 per cent. (1,377,089; assigned to Foster Milliken, S. F. Deaver, and James M. Repplier, trustees; May 3, 1921.)

Manganese-Magnesium Alloy.—Magnesium and manganese, when heated together, do not ordinarily alloy to an appreciable extent except at temperatures above the boiling point of magnesium. If, however, there is an inter-fusing of a limited amount of a manganese compound, such as manganous oxide or chloride, with an excess of magnesium, it is possible to obtain an alloy of manganese with magnesium in the proportion varying from 0.5 to 8.0 per cent. These alloys, with specific gravity of less than 2, have an ultimate strength of more than 20,000 lb. per sq.in. when in the form of castings. (1,377,374; WILLIAM R. VEAZNEY, assignor to the DOW CHEMICAL CO., of Midland, Mich.; May 10, 1921.)

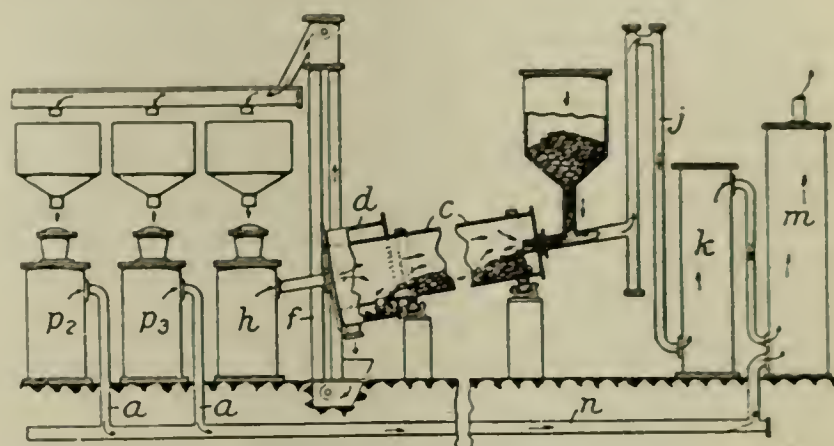
Refining Sulphur.—In the mining of sulphur in Louisiana and Texas, the melted sulphur is brought to the surface and diverted to wells or sumps, where it is permitted to cool and solidify. The solidified sulphur is then removed and broken into fragments of suitable size for shipment. The process is long and there is a considerable production of fines which are more or less undesirable. Raymond F. Bacon and Calvin H. Wenrich of Pittsburgh, Pa., have patented a substitute process by which the molten sulphur is converted into pellets and similar pieces of size and weight which may be uniformly controlled by the operator. This is accomplished by supplying the sulphur, at a temperature of 115 to 130 deg. C. in the form of drops into a solution of a salt, such as calcium chloride, in water. The solution contains sufficient salt to give it the required

specific gravity as well as a sufficiently high boiling point. (1,378,084; assigned to TEXAS GULF SULPHUR CO., Bay City, Tex.; May 17, 1921.)

British Patents

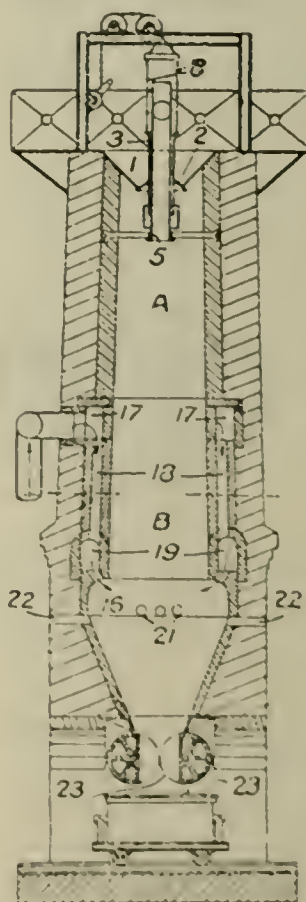
For complete specifications of any British patent apply to the Superintendent, British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Gas Manufacture.—In a plant for the distillation of carbonaceous material by contact with hot producer gas, a number of producers are used to consume the whole of the coke obtained, and only one producer delivers gas to the retort so as to avoid undue dilution of the coal gas prior



to the separation of tar oil. The coal is fed into a rotary retort *c*, and the coke is discharged through an annular casing *d* to a conveyor *f* feeding the producers *p₂*, *p₃*, *h*. The gas from the producer *h* passes through the retort to a condenser *j* and oil washer *k* and thence to an ammonia washer *m*, to which the gas from the auxiliary producers *p₂*, *p₃* is led directly by a main *n*. (Br. Pat. 162,459. H. Nielsen and J. R. Garrow, both of London; June 22, 1921.)

Refuse-Consuming Furnace.—A vertical shaft refuse destructor comprises a device for collecting the noxious fumes, etc., means for heating air for combustion, and improved discharging means. The hopper 1 is closed by a cone-valve 2 mounted on a movable sleeve 3 operated by chains 8. Concentric with the sleeve 3 is a tube 5 serving as an escape flue for fumes and distillation products. Refuse is distilled and dried in the upper zone *A* and is then consumed in the lower zone *B* with air which is heated in two annular passages 17, 19 and vertical ducts 18 and downwardly discharged by orifices 16 into an enlarged cone-shaped lower portion of the shaft. The residue is discharged by segmental drums 23 consisting of hollow air-cooled disks mounted on horizontal rotatable shafts. Orifices 21, 22 admit steam jets or other means for disintegrating the clinker. Flames escape by a suitable duct and may be used for steam generation etc. (Br. Pat. 162,597. H. Breuille, Paris; June 22, 1921.)

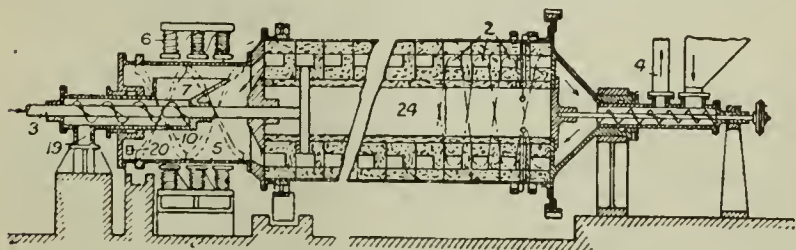


Arsenical Compounds.—Salts of thioarsenic acids, possessing the general formulae $RA_3O_3 \cdot xS_x$ and $R_3AsO_4 \cdot xS_x$ in which R represents an alkali metal, ammonium or an organic ammonium radicle, are prepared by passing sulphuretted hydrogen into a solution of an arsenate, or by treating arsenious oxide or arsenic trisulphide with an alkali or ammonium polysulphide, or by treating arsenic pentasulphide with an alkali or ammonium monosulphide, followed by double decomposition in the case of the organic compounds. Examples are given of the preparation of $Na_3AsO_3 \cdot 12H_2O$, $Na_3AsO_3 \cdot 10H_2O$, $Na_2AsO_3 \cdot 10H_2O$, $Na_3AsS_4 \cdot 8H_2O$, $NaAsS_4$, and of the analogous salts of methyl-

amine and ethylamine. The substances are of use for the destruction of parasites externally. (Br. Pat. 162,747. K. B. Edwards, London; June 29, 1921.)

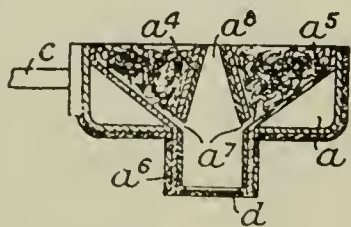
Casein Composition.—Casein is treated with formaldehyde, dried and shaped under heat and pressure. The casein may be coarsely or finely ground and moistened with a solution of formaldehyde, or the unground casein may be soaked in the solution. The drying is preferably continued until no trace of free aldehyde remains. The material is moulded at a temperature above 90 deg. C. and a pressure exceeding 100 atmospheres. (Br. Pat. 162,657; not yet accepted. E. Krause, Berlin, and H. Blücher, Leipzig; June 22, 1921.)

Treating Poor Iron Ores.—In the treatment of poor iron ore containing weakly magnetic or non-magnetic oxygen compounds of iron by subjection to a reducing roast at about 400 deg. C. to facilitate magnetic separation, the concentration is effected while the material is still in the reducing atmosphere. The ore is fed to helical channels 2 in a rotary furnace having a central heating-passage 24. Hydrogen is supplied to the channels through a pipe 3, and the gaseous products escape through a pipe 4 to a condenser. The magnetic separator comprises a cylinder 5 which rotates with the furnace, and is partly surrounded by a system of magnets 6. Helical ribs 10 convey the material into the magnetic field, and the particles attracted to the surface are



carried to the top, fall into a stationary pocket 7, and are conveyed to an outlet 19; non-magnetic particles are discharged through an opening 20. In a modification, the separation is effected in the furnace itself, and the magnetic and non-magnetic particles after separation are conveyed automatically into one or other of the two helical channels. The reduction of the magnetic material may be completed, and the product melted in an electric or other furnace. (Br. Pat. 162,718. R. Stören and R. Johanson, both in Norway; June 29, 1921.)

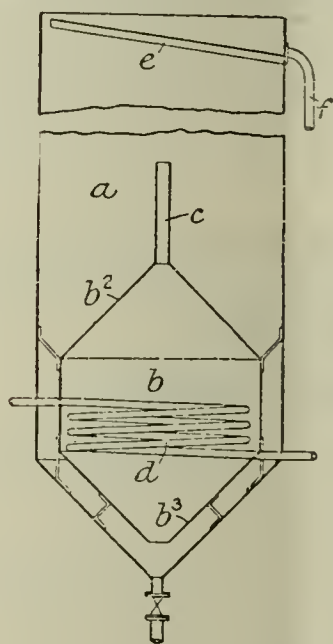
Recarburizing Steel.—A means for recarburizing molten steel in an open-hearth furnace consists of a box *a* which is carried on a ram *c* and fitted with hopper-like plates *a*⁴, *a*⁵, to contain the carbonaceous material, and provided with an extension *a*⁶ to pass through the slag. The extension is temporarily closed by a cover, such as a wooden plug *d*, adapted to be melted or consumed in the molten steel. The openings *a*⁷ between the plates and the extension are temporarily closed with paper stoppers, and a vent *a*⁸ is provided to allow the escape of gas generated during the operation. (Br. Pat. 162,994. J. N. Kilby, Rotherham, and N. H. Bacon, Sheffield; June 29, 1921.)



Making Tungsten Wire.—In making tungsten wire, particularly for electric-lamp filaments, a blank consisting of rods which contain or are bound together to produce in their cross-section zones differing from one another as regards their composition in physical properties is drawn and then submitted to a heat-treatment so that the crystals form uniformly along the length of the wire. The length of the crystals in the direction of the axis of the wire exceeds the diameter of the wire several times. The blank may differ in composition from the axis to the circumference or from side to side, or may contain different sectors. The blank may consist of a casing into which circular, rectangular or other structures of desired composition are inserted, the casing or core consisting of pure tungsten, tungsten and thorium oxide, or tungsten alloyed with metals or metalloids such as molybdenum, manium, thorium, tantalum, vanadium,

chromium, carbon or phosphorus or mixtures or compounds thereof or with other elements dissolved or admixed therewith. As examples, the casing may consist of pure tungsten and the core of tungsten containing thorium dioxide, or the casing may be of tungsten containing thorium dioxide and the core of pure tungsten or tungsten containing a small quantity of thorium dioxide. The thorium oxide, etc., may be introduced into the blank by superposing or imbedding or introducing into holes in the blank layers of powder, by inserting sintered or mechanically worked bodies or by saturating with solutions. The wire may be regularly heated throughout its whole length or may be heated by passing the wire through a hot zone. The latter method may be effected by heating sections of the wire in turn by an electric current or by surrounding with a hot cylinder or ring. (Br. Pat. 163,014; not yet accepted. Patent Treuhand Ges. für Elektrische Glühlampen, Berlin; June 29, 1921.)

Separating Water From Coal Tar.—Water is separated from coal tar by projecting the tar upwardly against a



separating surface to which the water adheres and from which it is collected. A vessel *a* is provided with a container *b* having conical ends *b*², *b*³, the end *b*² preferably having a tube *c* and the end *b*³ being open to the vessel *a*. The vessel *a* is filled with tar which enters and is heated by a coil *d* in the container *b*, and the tar is projected upwardly against an inclined separating plate *e*, the water adhering to the under surface of the plate and traversing along until it creeps over the upper edge. A drain pipe *f* is provided above the lower end of the plate *e*. (Br. Pat. 163,011; not yet accepted. Bismarckhütte, at Bismarckhütte, Upper Silesia; June 29, 1921.)

Cellulose and Other Carbohydrate Ethers.—In the production of ethers of cellulose, starch, dextrine, etc., their conversion products and derivatives, the cellulose, etc., is before reaction with the alkylating, aralkylating or arylating agents, treated with solid caustic alkali either in the dry state or in the presence of so little water or caustic alkali solution that at least a part of the caustic alkali remains undissolved; the products—films, celluloid, artificial filaments and insulating materials—prepared from the ethers eventually obtained, are distinguished by their water-resisting properties. The incorporation of the cellulose, etc., with the caustic alkali may be conducted in the presence of air or inert gas, or in vacuo, and at ordinary temperatures, or with heating or cooling; and the treated cellulose may before etherification be freed wholly or partly from the water contained therein, and may be immediately treated with the alkylating, etc., agent, or after standing. The etherification may be conducted so as first to form a lower ether, which may be converted into a higher ether by treatment with further quantities of caustic alkali and alkylating etc. agent. (Br. Pat. 163,018; not yet accepted.—See also 163,016 and 163,017.—L. Lilienfeld, Vienna; June 29, 1921.)

Calcium Nitrate.—Calcium nitrate is obtained from nitric acid obtained from atmospheric nitrogen by concentrating the acid to about 48 deg. Bé. and supplying ground calcium carbonate (limestone) and the concentrated acid continuously to an apparatus in which the temperature is not allowed to rise above the boiling point of the acid, 60 to 80 deg. C. being mentioned. The apparatus may consist of a horizontal tube having a conveying screw which discharges the calcium nitrate in a pasty condition. The carbonic acid is withdrawn under reduced pressure at the end at which the reagents are supplied. (Br. Pat. 163,330; not yet accepted. Aluminum Industrie Akt. Ges., Neuhausen, Switzerland; July 6, 1921.)

Current Events

in the Chemical and Metallurgical Industries

Chemical Schedule Considered

After closing the public hearings on the dye embargo, the Finance Committee of the Senate began listening to testimony in regard to the various items in the chemical schedule and items on the free list which would fall within that schedule if made dutiable.

Producers of salt told the committee that after many years, during which no efforts were made to import salt, large quantities now are arriving at north Atlantic ports from Germany. Due to lower producing costs and to low ocean rates, salt from Germany is being offered at Atlantic ports at 29c. per 100 lb., it was testified. This is less than the average freight rate from the mines in New York State. The Fordney bill carries a duty of 7c. per 100 lb. This is held by the domestic producers of salt to be entirely inadequate. They ask for a duty of 15c. per 100 lb., plus an ad valorem rate of 20 per cent. The ad valorem rate is contingent upon American valuation.

The National Association of Glue and Gelatin Manufacturers appeared to ask for a segregation of glue and gelatin. It was pointed out that gelatin is a much higher-grade product than glue and should not be grouped with it under one bracketing and rate. The association of glue and gelatin manufacturers has asked that paragraph 39 of the bill be corrected so as to read:

Glue, and glue size, 20 per cent ad valorem and 1½c. per lb.; manufactures, wholly or in chief value of glue, cascin glue, isinglass and other fish sounds, cleaned, split or otherwise prepared, and agar agar, 25 per cent ad valorem. Gelatin conforming to United States pure food laws specifications, 20 per cent ad valorem and 7c. per lb. Technical gelatin, gelatin in sheets, or otherwise, with physical qualities to show a solidified jelly in mixture of 1.8 g. of gelatin to 100 c.c. of water at 42 deg. F., for six hours, valued above 30c. per lb., 20 per cent ad valorem and 15c. per lb. Manufactures, wholly or in chief value of gelatin, 35 per cent ad valorem.

August Kochs, president of the Victor Chemical Works of Chicago, addressed the committee with regard to oxalic and formic acids, asking that a specific duty of 5c. per lb. be allowed in addition to the 25 per cent ad valorem rate contained in the bill passed by the House. He said the American industry has been struggling to live for fifteen or eighteen years and that the rate of duty asked is necessary for the continuation of the industry.

Don D. McCloud, representing the Gas Products Association, which is composed of forty manufacturers of oxygen, appeared to protest against a duty of \$20 a ton on calcium carbide.

Matthew Adgate, representing the Naugatuck Chemical Co., of Naugatuck, Conn., protested against a rate of 6c. per lb., and 30 per cent ad valorem on acetaldehyde and paracetaldehyde. He pointed out that these chemicals are not manufactured in the United States and are important in the rubber industry.

R. L. Hoguet, president of the Antimony Compounds Co., of New Brunswick, N. J., told the committee that the Fordney bill rates of 2c. on antimony oxide and 1½c. on antimony are inadequate. He suggested that a duty of 4c. on each would be necessary in order to equalize the lower labor costs in China.

John H. Keusel, of Tenaflly, N. J., president of the Meadows Oil & Chemical Co., asked that the Fordney bill be revised so as to protect American manufacturers against synthetic ammonium ichthyolate.

J. G. Timolate, representing the Oakland Chemical Co., New York, urged the committee to remove the duty on crude barytes or at least not to allow it to exceed \$2 per ton.

A representative of the Commercial Solvents Corporation presented an argument in behalf of a duty of 20c. per lb. on amyl, butyl and isopropyl alcohols and fusel oil. These alcohols are made dutiable at 6c. per lb. in the bill passed by the House.

Nine manufacturers of epsom salts presented a brief and oral argument asking that 35 per cent ad valorem be added to the ½c. duty on epsom salts allowed in the Fordney bill.

Charles B. Grimes, representing importers of bone black, appeared in opposition to the 20 per cent duty contained in the House bill. He said it would prohibit all importations.

A representative of the Diamond Match Co. urged that phosphorus be put on the free list. The rate in the Fordney bill of 10c. per lb. will put the domestic match industry at the mercy of a company controlled in England, he said.

The committee on magnesite consumers, a representative of the American Refractories Co., of Pittsburgh, and a representative of an American company engaged in magnesite mining in Venezuela, presented arguments intended to convince the committee that crude magnesite should be put on the free list.

Bill to Stimulate Production of Mineral Raw Materials for Chemical Industry

With Congress prescribing particularly high rates of duty to foster the chemical industry, Representative Rhodes, chairman of the House Committee on Mines and Mining, believes the Government should undertake a comprehensive program looking to the stimulation of the production of non-metallic minerals from which the chemical industry draws much of its raw material. It is Mr. Rhodes' intention to concentrate his efforts toward getting such action. He is assured of the unanimous support of the Committee on Mines and Mining.

As the first step of this program, Mr. Rhodes has introduced the following bill:

That the United States Bureau of Mines be authorized and directed to carry on investigations as follows:

(1) To conduct inquiries and scientific and technical investigations in the United States and its territories concerning the mining, treatment and utilization of non-metallic minerals, such as sulphur, phosphate rock, feldspar, potash, mica, graphite, talc, barytes, limestone, and so forth, with the main object of elimination of waste both in their production and utilization.

(2) To conduct investigations for the purpose of aiding in the efficient production of the non-metallic and other mineral raw materials for the chemical industry, and to investigate and obtain fundamental data needed for the efficient production of chemical products from mineral sources.

Mr. Rhodes points out that no other industry was developed during the war to the same extent as was the chemical industry. A natural complement of tariff protection for the industry is the stimulation of the production of such domestic raw materials as that industry can utilize, Mr. Rhodes believes. He contends that the development of the non-metals has lagged far behind that of the metalliferous minerals. As evidence of that contention, Mr. Rhodes points to the action of Congress during the war in authorizing an appropriation of \$50,000,000 in an effort to stimulate the prompt production of a number of minerals then urgently needed for war purposes. Among them were about forty non-metals.

"Now that the war is over," he says, "we are content to settle back comfortably and allow ourselves to follow the line of least resistance and continue to buy our non-metals from foreigners. When the country needed these minerals most, we found that they were undeveloped. We have had our lesson. Now there is no excuse for our failure to achieve economic independence in practically all of the non-metals."

The Muscle Shoals Situation

Since the defeat of the appropriation for continuation of the work on the Wilson dam there has been a feeling on the part of some of the friends of that project that the Muscle Shoals development is enmeshed hopelessly in politics and misunderstandings. There is a growing impression, however, that Henry Ford's proposition offers a way out. While several propositions were submitted in response to the request of the Chief of Engineers, there was but one practical proposal—that of Mr. Ford. The other propositions were indefinite and unaccompanied by any evidence that the persons submitting them commanded financial resources necessary to carry on the work.

J. B. Duke, president of the Southern Power Co., is understood to have expressed the opinion that the Government cannot complete the Wilson dam and the hydro-electric plant and obtain a reasonable return on the investment. His opinion, which is subscribed to by all the Southeastern hydro-electric companies except the Alabama Power Co., is understood to have been based on a report made by W. S. Lee, chief engineer of the Southern Power Co.

The Alabama Power Co. is not in a position to submit a bid at this time. Thomas W. Martin, president of the company, in reply to an inquiry by General Beach, Chief of Engineers, has explained the position of that company in a detailed statement.

It is believed that the business depression prevented some interests from submitting bids. Had times been better, much more interest would have been shown in General Beach's inquiry, it is believed. The inquiry was sent out widely to interests likely to be able to make use of this power. Some interests, it is stated, entered upon a systematic effort, when the appropriation failed of passage, to belittle the whole Muscle Shoals proposition. As a result, they were not in a position to reverse themselves by submitting bids.

Considerable criticism is reaching Washington as a result of the action of the Secretary of War in making public the Ford proposal. This gives an unfair advantage to other bidders, it is declared, and is contrary to the long-established policy of the War Department.

There can be no doubting of the widespread and growing public demand that the Ford offer be accepted unless some one else is willing to submit a better proposition at once. This is evidenced by the large number of letters which are being received from all sections of the country by Senators and Representatives. The publicity the matter has received has also had the effect of arousing new demands that the Government itself undertake the operation. Senator Underwood continues to insist that the operation of the project by the Government is the only way in which the public will receive the maximum benefit from this natural resource. It is believed that he will support legislation looking to the carrying out of the Ford proposal, or any other private proposal, only when he is convinced that the opposition has the votes to defeat Government operation.

Some letters are being received on Capitol Hill alleging that Mr. Ford is seeking this resource as a part of his plan to monopolize the farm tractor and cheap automobile fields. This charge, it may be said, is not regarded seriously by legislators, as it is generally recognized that such monopoly as Mr. Ford's products may enjoy has not been obtained by absorbing competitors, but by attaining costs so low that competitors are not able to compete.

Byproduct Coke Oven Company Formed

The Belgian-American Coke Ovens Corporation, New York, has been formed with a capital of \$10,000,000, to construct and install Piette byproduct coke ovens and carbonization equipment for fuel saving. Olivier Piette, of Belgium, holds the patent rights to the coke ovens and appliances, and will be on the board of directors of the new organization, which is headed by Thomas F. Ryan and F. S. Landstreet, both of New York. The latter has been elected president of the company and offices have been established at 25 Broad St. The American corporation will have the assistance of technical experts from Belgium. The European organization is known as the Franco-Belgian Coke Ovens Corp.

Salesmen's Association of American Chemical Industry

One hundred representative salesmen and sales executives connected with American manufacturers and their recognized sales agents in all branches of the chemical industry will be invited to become charter members of the Salesmen's Association of American Chemical Industry, after plans of the organization committee have been formed.

This committee, which consists of Fred E. Signer of Butterworth-Judson, chairman, Charles F. Abbott of National Aniline, John A. Chew of Warner Chemical Co., P. S. Tilden of du Pont, A. H. Pierce of Grasselli, E. J. Barber of The Barrett Co., E. C. Scott of Wing & Evans, and Williams Haynes of Drug & Chemical Markets, secretary, held a meeting Monday, Aug. 8, at which a constitution was drawn up. This constitution provides that the membership shall be open to any American citizen connected with the sales or advertising staff of an American chemical manufacturer, or his recognized sales agent, and vests the active control of the association in an executive committee, consisting of the officers and six members, two of whom shall be elected every year to serve three years and who shall be ineligible for re-election at the expiration of their term. The committee is considering plans for the promotion of local associations in the various large cities.

According to the present plans, invitations will be extended to one hundred thoroughly representative salesmen to join as charter members. Details are being considered for a meeting and dinner to be held at the time of the Chemical Exposition.

Salesmen interested in this organization, the object of which is to be the fostering and promotion of the commercial interests of the sales staffs and of the broader interests of the chemical industry as a whole, are requested to communicate with the secretary, 3 Park Place, New York City.

Wants Organic Chemistry Encouraged

Senator Ladd, of North Dakota, appeared before the Senate Finance Committee as a witness to make a special plea for an American organic chemical industry. He classed the making of dyes as a master-key industry and declared that he would rather see a monopoly than to take any chances on destroying the start which the United States has made in the manufacture of dyes. Senator Ladd's statement to the committee follows:

I simply desire to come before the committee and record my interest in American organic chemistry and the chemical industry in this country. For nearly forty years I have been engaged as a researcher and chemist, and in chemical laboratories as a teacher. I have seen in the past the need of building up organic chemistry, which has not been made possible because of the fact that the Germans had apparently complete control of the manufacturing.

I feel that if England and France and Italy and Japan found it necessary to place an embargo on dyes for a certain length of time, those that are made in those countries, and to afford protection to those that are needed to build up, the United States ought to do the same thing. I do not feel that it is likely that a tariff, however high it may be placed, will enable the organic chemical industry of the country to develop as we hope for.

I have heard considerable and read considerable on the question of a monopoly in the dye industry. I doubt very much that that is true in any true sense of the word, but if there is to be a dye monopoly I would rather see it in the hands of American manufacturers, where they can be controlled by Congress and the American people, rather than in the hands of foreigners. I think we can render a distinct service at this time to chemistry and to the industries of this country by protecting the organic chemical industry and the dye industry, to furnish means of training our young men who are graduates of educational institutions in chemistry for work along the lines and in the lines necessary for development in this country. If we are to be drawn into another war at any time it seems to me that we will be in a very poor condition unless our organic chemistry and our institutions for manufacturing organic materials of all classes are well protected.

Chemical Exposition Notes

PUMPS AND CONDENSERS

Air pumps and condensers have not been overlooked at the chemical exposition this year. A most comprehensive exhibit has been planned as part of the annual show, which will be held in the Eighth Coast Artillery Armory, New York, Sept. 12 to 17. One company will display besides a double effect evaporator with circulating pumps and piping, a barometric ejector condenser, a centrifugal pump, Edwards air pump, and two steam jet air pumps, a model cooling tower tube exhibit.

Pumps for air, industrial gas or acid gas will be exhibited. A pump or compressor where no valves, gears, pistons, piston packing, sliding vanes or interior lubrication is necessary will be entered in one of the displays on this subject. Tank pumping installations, pumping systems, vacuum apparatus for all chemical purposes, dry vacuum, centrifugal, air compressors, acid, and hydraulic pressure pumps and deep well engines will be shown. Hard rubber pumps, pipe, fittings, tanks and utensils will form part of this most complete exhibition.

International Conference at A. C. S. Meeting

The fall convention of the American Chemical Society will be opened by a general meeting to be held in the gymnasium of Columbia University, Wednesday, Sept. 7, at 10 a. m. Sir William J. Pope will speak and Herbert Hoover has promised to address the gathering provided public duties do not interfere.

On Thursday, Sept. 8, a joint international meeting will be held in the Great Hall of the College of the City of New York. Dr. Edgar F. Smith will preside. The following addresses have been announced:

"Science and Civilization; the Rôle of Chemistry," by Prof. Charles Baskerville.

"Energy; Its Sources and Future Possibilities," by Dr. Arthur D. Little.

"The Engineer; Human and Superior Direction of Power," by Dr. Leo H. Baekeland.

"Chemistry and Life," by Sir William J. Pope.

"Theories and Their Development," by Dr. Willis R. Whitney.

"Research Applied to the World's Work," by Dr. C. E. K. Mees.

"Problem of Diffusion and Its Bearing on Civilization," by Prof. Ernst Cohen, of the University of Utrecht.

"Catalysis; The New Economic Factor," by Prof. Wilder D. Bancroft.

Prof. Samuel A. Baldwin, head of the department of music of the College of the City of New York, will give an organ recital in honor of the delegates.

Following the sessions at Columbia University the chemists will attend the National Exposition of Chemical Industries, which is to be held from Sept. 12 to 17, inclusive, in the Eighth Coast Artillery Armory in the Bronx. At this exposition will be shown many new types of chemical apparatus and of machinery used in the large-scale manufacture of the products of industrial chemistry.

Optical Society to Meet in Rochester

The Optical Society of America will meet in Rochester, N. Y., Oct. 24, 25 and 26 at the Hotel Rochester. Members and others desiring to communicate results in optical research are invited to submit titles any time before Sept. 25 to the secretary, Irwin G. Priest, Bureau of Standards, Washington, D. C. Because of the optical industries in Rochester it is expected that this will be a particularly interesting meeting. The local committee is arranging for visits to Bausch & Lomb and the Eastman Kodak Co.

British Chemical Workers to Strike

According to a recent cable despatch from London, the executive committee of the Federation of Chemical Workers has rejected the employers' proposal to reduce wages 2d. per hour. The men propose to strike on Aug. 27. The Brunner Mond Co. threatens to close down its Winnington works unless sufficient men accept the reduced wage and agree to continue under the new scale.

Alcohol Fumes Explode at Abbott Laboratories

The Abbott Laboratories, large manufacturer of synthetic pharmaceuticals, had a serious explosion in the process plant at 4753 Ravenswood Ave., Chicago, on Monday, Aug. 8. One of the operations involves the production of high proof alcohol in an apparatus consisting of a Stokes rotary vacuum drier, a dust trap and distillation column. The horizontal drier, 15 ft. long by 3½ ft. diameter, with steam jacket and horizontal agitating mechanism, receives the mixture of slaked lime and low proof alcohol through an opening on top. The gasketed cover is clamped down and steam introduced in the annular space about the mixing chamber. No vacuum was used at the time of explosion and the steam is introduced at such rate that no pressure registers on the gage.

Alcohol vapor passes over through the dust trap, which is a horizontal steel cylinder about 2 ft. in diameter by 4 ft. long equipped with baffles for catching any lime dust which may be mechanically carried in the vapor. From this point the vapor is carried upward through a pipe bend (about 8-in. pipe) into the top of the column. The agitating shaft is driven by a 15-hp. four-pole direct-current back-gearred open electric motor, in turn controlled through an inclosed "Square D" knife switch and exposed starting box with release coil. All this apparatus is mounted on the frame at the end of the drier.

As near as can be determined the pipe bend between trap and column became clogged near the top of the still with lime dust, the dust trap having ceased to function. Pressure of entrapped alcohol and water vapor built up immediately in the inner chamber of the drier and began to leak into the room around the gasket at the feed opening. The operator, noting something was amiss, first shut off the steam supply leading to the jacket. By this time a considerable quantity of alcohol fume and water vapor had filled the room. He next pulled the electric knife switch and the explosion immediately occurred. Fire doors on the nearby elevator shaft and at the other side of the room about 50 ft. away were blown down and the windows were shattered. None of the woodwork was scorched and the rack of time cards a few feet from the switch had only one or two cards browned at the edges. Six operators were injured, three of them seriously burned. William Copeland, who pulled the switch, and Elmer Groskopf, standing near by at the time, both died in the hospital two days later.

It is apparent from the testimony of witnesses that the fumes were ignited by an electric spark incidental to the shutting down of the motor. This spark may have been furnished by the brushes on the motor commutator, by an arc on the knife switch or by the starter contact arcing as it passed over the segments. While the "Square D" knife switch is totally inclosed by a sheet iron case, the cover was not gasketed to prevent the permeation of explosive fumes.

Total gas-tight inclosure of all electrical apparatus in chemical plants handling flammable or explosive gases would do much to obviate such accidents, for it is not always possible to control fumes. The new process plant being erected by the Abbott Laboratories at North Chicago will have fireproof compartments and the electrical apparatus will be in separate chambers from the process machinery.

Ceramic Society to Visit England Next Year

At a recent meeting of the Glass Division of the American Ceramic Society a letter was received from Dr. Turner, head of the Society of Glass Technology of England, inviting the entire membership of the American Ceramic Society to attend the joint conference in England in 1922.

The American Ceramic Society is now soliciting its membership to ascertain how many members contemplate making this trip. They plan to leave the United States about Aug. 15 and remain in England about one month, visiting glass- and clay-working plants of the British Empire.

The itinerary covers a three weeks trip, including visits not only to glass works in different cities in England and Scotland but the china works and other industries at Derby and Stokes and the fireclay and material works at Stourbridge.

Brussels Meeting, International Union of Pure and Applied Chemistry

The 1921 meeting of the International Union of Pure and Applied Chemistry was held in Brussels from June 25 to 30, under the presidency of Prof. Charles Moureau, member of the Institut de France. At a preliminary meeting, the Council, composed of representatives of countries already admitted (see CHEM. & MET., vol. 23, p. 210), unanimously approved the admission to the Union of Argentina, Japan, Monaco, Norway, Portugal, Rumania, Switzerland, Uruguay and Jugoslavia. Eighty-two delegates from eighteen countries were present. Dr. F. C. Cottrell, Prof. C. Mackall and Prof. J. B. Conant represented the United States, while Great Britain sent Sir William Pope, Dr. S. Miall and Prof. T. M. Lowry. France had 26 delegates, Belgium 15, Italy 12, Netherlands 4 and Switzerland 4.

Further Council meetings and the general assembly were devoted largely to a discussion of the reports of committees appointed last year at the meeting in Rome.

COMMITTEE ON ATOMIC WEIGHTS

The existing International Committee on Atomic Weights is to be reorganized as the International Committee on Chemical Elements. It will consist of twelve members, divided into three sub-committees to deal with atomic weights, the compilation of a table of isotopes, and the constants of radioactive elements.

NOMENCLATURE

The report of the committee on nomenclature, adopted unanimously, recommends: (a) The formation of three international committees on nomenclature to deal with organic chemistry, inorganic chemistry and biological chemistry respectively. (b) The formation of three working sub-committees, of six members each, elected by the international committees, each member being intrusted with the task of forming, with the aid of his national federation, a national committee to discuss questions of nomenclature; the proposals put forward by a national committee to be embodied in a report for circulation among chemists of other nationalities.

CHEMICAL ABSTRACTS

The following recommendations relating to the unification of abstracts, put forward by the National Council of the Netherlands, were accepted: (1) That the Bureau of the International Union take the initiative in bringing together representatives of chemical journals that publish abstracts with a view to discussing the eventual formation of a central publication and its probable cost. (2) That the possibility of conducting an international chemical card index be investigated together with the approximate costs of establishing and maintaining it.

INTERNATIONAL INSTITUTE OF CHEMICAL STANDARDS

In order to avoid confusion, M. Timmermans recommended that the three sections of the International Institute of Chemical Standards be named as follows: Bureau of Physicochemical standards (headquarters at Brussels); Research Chemicals (headquarters in England); Department of Publications Concerning Industrial and Technical Products (headquarters in Paris).

CERAMIC PRODUCTS AND FUELS

The establishment of national and international laboratories for the study of ceramic products and fuels was approved. Laboratories for the investigation of refractories will be attached to the fuel laboratories as special sections.

INTERNATIONAL PATENTS

The committee on international patents was re-appointed for another year. A resolution was passed by the assembly to the effect that the institution of international patents is highly desirable and that the Union should take the initiative by calling a conference to consider the question.

Reports on bibliographical contractions, the mechanical standards, tables of constants, analyses of foodstuffs, and international hygiene were also considered. It was resolved that the next meeting of the Union be held in France.

Conditions in the Brass Industry

A recent survey of conditions in the brass industry, taking Waterbury, Conn., one of the largest centers of this character in the country, as a barometer, shows that the trend is upward, with greater plant activity and larger number of operatives engaged. The reports of the different important companies in this district, show the following:

The American Brass Co. is now giving employment to as many men as in 1914 and 1915, working on a basis of forty hours a week, instead of regular time of fifty-five hours, as obtained in the two previous years noted.

Scovill Mfg. Co., manufacturing both brass and copper products, is employing the same working force as in 1914, with curtailed running time making about 60 per cent of normal pre-war capacity.

The Chase Metal Works and the Chase Rolling Mills are giving employment to about one-third of the number of operatives as compared with a year ago.

The Waterbury Mfg. Co. is operating at about 50 per cent of normal at the present time.

The American Ring Co. is employing about 75 per cent of its normal working force, with curtailed time approximating thirty-two hours a week. One department at the mills is operating on a 45-hour weekly schedule.

The Randolph-Clowes Co. is giving employment to about two-thirds of its regular force under a 32-hour week, instead of normal 55-hour running time.

The Mattatuck Mfg. Co. is using 80 per cent of its normal number of employees, with running time from 60 to 70 per cent of the regular schedule.

The Waterbury Buckle Co. is operating on a full-time basis.

The Novelty Mfg. Co. is employing two-thirds of its regular working force on a 45-hour weekly running time basis.

Blake & Johnson, brass and iron hardware, are operating with about 75 per cent of the normal working force, four days a week.

Status of Japanese Chemical Industry

It is necessary to establish a large government laboratory where the necessary experts can be trained, says Dr. Takamatsu, Director of the Tokyo Industrial Laboratory, in an official bulletin, if Japan is to hold her own in developing her chemical industry.

Before the war, he writes, Japan had to import most of her dyes and chemicals, especially from Germany. During the war the law for the encouragement of the dyeing and chemical industries was passed and in 1916 the Japan Dye-stuff Manufacturing Co. was established. Though this company has done its best, lack of funds and of expert workers has hampered its activities and even last year the imports of dyes were very large. They are likely to be much larger this year, judging from prevailing conditions.

During the war numbers of dye works were started in various parts of Japan, but nearly all of them have disappeared since the depression set in. Those that still hold on are working on a very small scale, have no permanent plans of business, but are looking only to immediate profits. The chemical industry, which is of so much importance to Japan, cannot be developed on such narrow lines, and the assistance of the government in the direction already indicated is urgently necessary.

The Japan Dyestuff Co., it is reported, is contemplating the engagement of dye experts from Germany. Such a plan may also be adopted by other chemical works in the country, which feel the necessity of a thoroughgoing reform of the industry.

Joint Dye Committee Named

In an effort to work out some compromise in the dye embargo controversy, a joint committee representing the Finance Committee of the Senate and the Ways and Means Committee of the House has been designated to study the existing situation. The Finance Committee will await the recommendations of the joint committee before deciding whether or not it will replace the dye embargo in the tariff bill. Included in the joint committee's membership are members of the committees representing each side of the controversy.

Bureau of Soils to Continue Phosphoric Acid Experiments

Investigations by the Bureau of Soils in the matter of extracting phosphoric acid from phosphate rock by the application of heat are to be continued. The bureau has issued the following official notice in that connection:

With the installation of a new high-temperature oil-burning furnace at the experimental farm at Arlington, Va., the Bureau of Soils, United States Department of Agriculture, will continue investigations into the extraction of phosphoric acid for fertilizer from phosphate rock by the application of heat.

Experimental runs with an old furnace several months ago apparently demonstrated the practicability of the new method developed by department scientists of separating the phosphoric acid. The present commercial method is by the application of sulphuric acid to ground phosphate rock. It is not practicable for low-grade rocks and makes necessary the shipment of a large proportion of inert material with the phosphate. Early experiments in separation by heat were made with electric furnaces, but the expense seemed a serious obstacle to the introduction of the new method. It was found, however, that the petroleum-burning furnace could be made to do the work at much less expense. Experiments will be continued to establish methods which will permit the use of much phosphate rock which now goes to waste, and also to a material reduction in freight rates on commercial fertilizers.

Transportation of Poisonous Articles

The Interstate Commerce Commission has acted favorably upon the petition of the American Smelting & Refining Co. and has amended one of the paragraphs of the regulations covering the transportation of dangerous articles, as follows:

"Arsenic, paris green, arsenate of lead, calcium arsenate and all other strongly poisonous articles must not be offered nor accepted for shipment in bulk, but must be packed in strong and tight containers which will prevent sifting or escape of contents in transit, provided that sintered arsenical flue dust may also be shipped between plants in steel gondola cars equipped with suitable covers."

Complete Utilization of Southern Pine Waste

An invitation has been extended by Joseph H. Wallace & Co. to the chemists who attend the fall meeting of the American Chemical Society and others who may be interested, to visit the company's research laboratory at Stamford, Conn., where much work has been done on the complete utilization of Southern pine waste. The laboratory will be open to visitors on Sunday, Sept. 11. Stamford is one hour from New York on the New Haven road and the laboratory is ideally situated on Webb's Hill, about five miles north of the station.

New Brick to Be Tested

A new cinder cement brick, manufactured under a process invented by Sigurd Bo, at the plant of the Farmingdale Cement Brick Co., Farmingdale, L. I., will be subjected to a series of tests at Columbia University, commencing Aug. 29. It is claimed that the new brick is stronger, lighter and cheaper than any other kind now in use. It has been tested by the New York Bureau of Buildings, and its approval by the department depends upon the results of the tests at the University.

Extension of Temporary Dye Control

With the increasing possibilities that the permanent tariff bill will not become a law much before Jan. 1, the Senate Committee on Finance amended the bill which passed the House in the matter of extending the temporary control over dyes and chemicals so as to continue the present procedure until Jan. 1, 1922.

Officials of German Potash Syndicate to Visit U. S.

A recent cable from Berlin states that several delegates of the Kalisyndikat will sail from Germany for the United States in September. They will make a careful survey of the potash market in America.

Personal

GERALD C. BAKER, who is on the sanitary chemistry staff of the State University of Iowa, is working during the summer on the problem of water softening with the Barromite Co. of America, in Chicago.

NEIL C. BOWMAN, president of the Pocono Rubber Cloth Co., Trenton, N. J., gave an interesting address at a luncheon and meeting of the local Rotary Club, Aug. 10, on the subject of "Rubber Cloth." The talk covered features of manufacture, and dealt particularly with rubber cloth for the automobile industry.

Dr. ALFRED S. BURDICK has been elected by the board of directors of the Abbott Laboratories, Chicago, as president, to fill the vacancy caused by the recent death of Dr. W. C. Abbott.

E. DANA DURAND has been appointed chief of the newly created eastern European division of the Bureau of Foreign and Domestic Commerce. Mr. Durand was director of the Bureau of the Census from 1909 to 1913, and from 1903 to 1909 was connected with the Bureau of Corporations of the Department of Commerce and Labor, first as economic expert and later as deputy commissioner.

OTTO EISENSCHIML sailed on July 26 for a two months' visit to Austria, where he will attend to personal matters.

Dr. HERBERT E. FOOTE, of Dover, N. J., experimental chemist at the Picatinny Arsenal of the Government, near Dover, was hurt seriously while engaged at his work Aug. 12, covering certain experiments with the nitration of benzene. He was removed to the Dover General Hospital, and the fear is expressed that he will suffer the loss of one of his eyes. The explosion in the laboratory slightly injured Dr. Foote's assistant, Frank McPeck, but with no serious consequences.

A. P. GLOECKLER has resigned as chief chemist of the Tropical Paint & Oil Co., Cleveland, Ohio, and has accepted the position of superintendent of the paint department of the Acorn Refining Co., Cleveland, Ohio.

O. C. JOHNSON is leaving the employ of Swift & Co. to become instructor in chemistry at the Ewing Christian College in India. He sailed from New York on July 30, and will spend at least three years in India.

Dr. IRVING LANGMUIR, assistant director of the research laboratory of the General Electric Co., sailed for Europe Aug. 13 to attend the annual meeting of the British Association for the Advancement of Science to be held in Edinburgh, Scotland, Sept. 7 to 14. He will also attend a meeting of the Faraday Society in London on Sept. 28 and will be awarded the honorary degree of Doctor of Laws by the University of Edinburgh on Sept. 13. Dr. Langmuir will open the discussion on Molecular Structure at the British Association meeting. He will read a paper before the Faraday Society on "Chemical Reactions on Surfaces," and open discussion on that subject. During his stay he will visit a number of European countries on business. He is expected to be absent from the United States between two and three months.

Dr. R. B. MOORE of the U. S. Bureau of Mines is visiting the Western stations of the bureau.

WILLIAM N. PORTER, of the Chemical Warfare Service, has been promoted to the rank of major.

J. LEONARD REPLOGLE, president of the Vanadium Corporation of America and chairman of the Replogle Steel Co., recently returned from a trip to Europe, where he has been studying business conditions.

EARLE E. RICHARDSON, who has been instructing in analytical chemistry and physics for the past four years at the Massachusetts Institute of Technology, has been appointed to the position of research physicist under L. A. Jones at the research laboratories of Eastman Kodak Co., Kodak Park, Rochester, N. Y.

Lithopone Sales in 1920

The quantity of lithopone marketed during 1920 showed an increase of 14 per cent over the figure for the preceding year, according to the compilation of reports from the manufacturers which has recently been completed by the Geological Survey. Quantity, value and average selling price of lithopone marketed during 1919 and 1920 are shown in the following table. It will be noted that the figures for 1919 differ from those previously published by the Survey, but the explanation is that the earlier statistics were for the quantity of lithopone manufactured and not that which was marketed:

LITHOPONE MARKETING IN 1919-1920

	Quantity, Short Tons	Value	Average Selling Price
1919.....	78,365	\$10,218,850	\$130.40
1920.....	89,373	12,484,925	139.69
Increase.....	11,008	2,266,075	9.29
Percentage.....	14.0	22.2	7.1

Current Market Reports

Chemical and Allied Industrial Chemical Markets

NEW YORK, Aug. 22, 1921.

Some improvement in the demand has been noted in the heavy chemical field, although business is still limited to comparatively small lots. Prices all around are firmer, with a less pronounced tendency to shade except in instances where unusually heavy orders are in prospect. Advices from Germany that prices are somewhat firmer, especially in the alum group, have probably caused some stiffening in the New York market. Throughout the trade the feeling is decidedly better and all leading factors are looking forward to greatly improved business in the fall or early winter.

CHEMICALS

Buyers of *acetic acid* are not showing any inclination to come into the market and prices remain unchanged with makers' quotations ruling. The price basis is \$2.50@\$2.75 per 100 lb. for the 28 per cent and 10@10½c. per lb. for the glacial, although occasional small lots may be located in resale hands at lower figures. Buyers of *muriatic acid* are showing very little interest, and makers are unable to reduce prices to any further levels. Stocks are not excessive and producers are holding them down as low as possible. Quotations for the 20 deg. range from \$1.25@\$1.75 per 100 lb. in carload quantities. In spite of the recent sharp declines in nitrate of soda prices, *nitric acid* held steady at recently quoted figures. The demand has been of only a limited nature. Prices are quoted on a basis of 6½@7c. per lb. in carboys for the 40 deg. test in carlot quantities. Prices on *ammonia alum* are based on 3½@4c. per lb. for the lump, with imported and domestic goods competitive. *Potash alum* is offered by importers on a basis of 3¼c. per lb. for lump, against a domestic price of 5¼c. Cable advices from Germany state that an advance of 50 per cent has been made on alum prices. The announcement has not affected any spot prices, partly on account of the recent decline in the exchange. Quotations on *ammonium carbonate* are given at 7@9c. per lb. according to seller, with lower prices named by importers. It is stated that the lower figure may be shaded on business of a large nature. Importers of *barium chloride* offer prime white crystals at \$48 per ton on the spot and \$46 per ton for arrival. Prices on *barium peroxide* around 24c. per lb. are named for the 86@90 per cent by makers. Offers as low as 17c. per lb. are heard in the spot market, but this material is off grade and it is doubtful if better than 20c. per lb. could be done for good grades.

Small lots of spot *bichromate of soda* are moving at 8c. per lb. and the market appears quite steady on this basis. It is admitted that a few odd lots might be purchased at a slight concession, but dealers are inclined to hold steady at former levels and in some directions higher prices are

named. Transactions are chiefly of a jobbing character, involving only small tonnages. Solid *caustic soda* is higher than noted a week ago, and \$3.90 per 100 lb. was the general quotation for standard brand goods ex-store. Moderate trading was reported at this figure and the tone of the market looked much steadier. Producers are holding contract prices at 3¼c. per lb. f.o.b. works, basis 60 per cent, in carload quantities. Manufacturers of *hyposulphite of soda* are accepting business at slightly lower figures, and sales are reported on a basis of \$3.40 per 100 lb. in car lots and 3¼c. per lb. in less than carload quantities. The absence of important business in *nitrite of soda* has left the market in a dormant condition. The general quotation is 7@7¼c. per lb. according to seller and quantity. A slight reduction might be granted on a firm order for a round lot. Spot sales of *prussiate of soda* are reported at 11¼@12c. per lb. and the market was quoted firm at the inside figure. In some quarters it was stated that inquiries were a little freer, although it was admitted that the call was chiefly for small lots. Light *soda ash* on spot is holding quite steady with sales reported at \$2.15@\$2.20 per 100 lb. in single bags. Barrels are selling at \$2.40@\$2.50 per 100 lb. ex-store. The inquiry for small quantities in barrels is reported fairly active. Producers continue to name \$1.60 for single bags and \$1.95 for barrels, basis 48 per cent, f.o.b. works. Special prices are being named on contracts to the consuming trade, the price depending upon the quantity involved. Imported ash is offered at \$1.60 per 100 lb., prompt shipment from abroad. Consumers of *bleaching powder* are showing an interest, and sales f.o.b. works are reported from 2@2¼c. per lb. in large drums. A few small drum sales occasionally go through at 2¼@2½c. per lb. f.o.b. works. Spot material is quite scarce, with prices about ¼c. above those named at the works for prime fresh material. Dealers of *formaldehyde* are quoting spot material in barrels at 13c. per lb. Some of the larger sellers have accepted less than this figure and state that they have placed business down to 12c. per lb. The low price, however, is confined to large lot quantities. Spot *oxalic acid* is quoted at 16c. per lb. and upward, depending upon the seller and quantity. It is stated that imported material is becoming scarce and that most of the business is on domestic stock. The extreme range of prices is 16@18c. per lb. Prices on white *sal ammoniac* vary considerably and the market at present is governed by the views of individual sellers. The range is from 6@7½c. per lb. The gray material is moving at 7@7½c. per lb., according to quantity, producers naming the inside price f.o.b. works. Importers of fused *sodium sulphide*, 60 per cent, are offering goods at 4½c. per lb., against a domestic price of 5@6c. per lb. Importers of *chlorate of potash* are offering lower at 7½@8c. per lb. Domestic prices are still held at 12@13c. per lb., although subject to shading. Very little interest has been noted from consumers of *caustic potash*, and prices are very soft, although quoted values remain unchanged. Quotations of 4¼@4½c. per lb. are heard from importers, but it is probable that shading of these figures could be done for firm business of a large nature. Domestic makers are still unable to compete.

COAL-TAR PRODUCTS

During the past week buying has been light and consumers show little disposition to change their hand-to-mouth methods. The decision of the tariff question is expected to improve feeling, although there is little reason to believe at present that any pronounced revival can come before some decision is reached. Interest, in the meantime, is centered around Washington and the ultimate fate of the licensing feature is anxiously awaited. There are some in the trade who are of the opinion that even the decision of this question will have little effect until general business is better. This is not the general belief, however, in chemical circles. In the absence of any market demand, prices are only secondary and it seems probable that any figures quoted can be materially shaded for firm business. Occasional orders are coming in, but the general tone is dull. Benzene still continues scarce and high in second hands where supplies are only to be had. Beta naphthol continues weak, with makers showing signs of further

weakness. *Paranitraniline* in resale hands is scarce, and makers are firm in their ideas. Producers of *benzene* are firm at 27@33c. per gal. Supplies are limited and export business is being turned down. Resale goods are hard to get, with some odd lots selling at 34@36c. per gal. Sales of *phenol* at prices ranging from 7@9c. per lb. have been made, but it is believed that the quality of these low-priced goods is not up to standard. Offers of prime goods at 9½c. per lb. have been heard. Better prices could undoubtedly be had on firm business, as there is a great amount of surplus stocks in practically every direction. Producers ask 15@16c. per lb. Prices on *H acid* are named at \$1.15@\$1.25 per lb., according to maker. A few small orders have come in, but few consumers are interested. The market on *aniline oil* continues dull, with makers willing to compete for business near the 20c. level. Resale lots are said to be available in moderate quantities as low as 18c. per lb. Makers are pretty well in line at 20c. per lb., although higher figures are quoted in some quarters. Some improvement has been noted in the demand from the rubber trade. Offers of low-priced *benzidine base* are very scarce and it seems probable that no first quality material can be had below \$1@\$1.10 per lb., quoted according to maker. Consumers are not showing much interest and it seems that even lower prices would not induce them to buy at present. Makers of *dimethylaniline* are quoting down to 45c. per lb., while others hold for prices up to 60@64c. per lb. The resale market is practically bare of supplies. The demand, in general, is rather slow. Makers' prices on *diphenylamine* rule at 65@70c. per lb. according to quantity. Business in this commodity is somewhat slow. Manufacturers of *paranitraniline* are holding their prices at 79@82c. per lb., merely to feel out prospective buyers. There is unquestionably a tendency to shade these figures rather than lose any passing business.

VEGETABLE OILS

Some importers of *chinawood oil* reported the spot situation as slightly easier, but with actual offerings scanty, the market was merely nominal where prices were concerned. Recent business in spot oil went through at 17c. per lb., but it was said that scattered lots could have been picked up at concessions. One operator thought that 12c. could be done. Early September arrivals were offered at 12½c. per lb., with buyers backward. September-October shipment from the Orient closed at 10¾@11c. per lb., c.i.f. New York. The market for *coconut oil* was less active, but prices for Manila oil on the Coast ruled firm. One sale was recently noted of 500 tons, sold on the bulk basis of 7½c. per lb., c.i.f. San Francisco. Scattered lots of tank cars were reported at 8½c. per lb., f.o.b. Coast, September-October shipment. Some holders on the Coast were asking 8½c. per lb. for prompt and nearby oil. Receipts of *olive oil* from Italy and Spain continue on a liberal scale and the market has shown no signs of improvement. Prices for edible oil were unsettled, ranging from \$1.80@\$2.20 per gal. Denatured oil closed nominally at \$1.10 per gal. Both soapmakers and tin plate mills have been showing more buying interest in *palm oils* and importers report that a good volume of business has been placed during the past week. *Lagos oil* is offered sparingly on spot in small lots as high as 7½c. per lb. On shipment goods, 7c. was asked. *Niger oil* closed at 5¾c. per lb. to arrive, with sales noted around this level. There was a quiet but steady market for domestic crude *peanut oil*. At the close holders were asking 7½c. per lb., buyers' tanks, f.o.b. mills for the prime quality.

The St. Louis Market

ST. LOUIS, Aug. 19, 1921.

There is evidence of a broadening of business in many localities, with more frequent spot orders, increased quantities and wider range of material which has stimulated the market quite a bit. Furthermore it is apparent that more confidence and optimism exist for the future. It is the opinion of most of the factors that the disturbing element which existed has been practically eliminated, which they hold as indicative of sounder and more stable business for the coming season. The general trend of the

market continues to be downward and many commodities undoubtedly have reached a minimum.

ALKALIS

Sal soda is very dull. *Soda ash* remains at manufacturers' schedule with slight increase in demand and movement. *Sodium bicarbonate* demand is quiet with prices from \$2.60 to \$2.75 per 100 lb. in less than carlots. *Caustic soda* continues to enjoy good demand. Contract buyers continue to consume their allotments and the price has stiffened to \$4 per 100 lb., basis 73-75 per cent solid, f.o.b. point of production.

CHEMICALS, DRUGS AND PHARMACEUTICALS

Acetanilid and *acetphenetidin* are not moving, due to the fact that these are unseasonable products. *Bismuth subnitrate* continues to move in large volume and manufacturers are in position to keep abreast with the demand. *Caffeine alkaloid* shows no exceptional activity and makers recently reduced their price. *Carbon bisulphide* is still among the active articles, with a demand for substantial quantities. Business in *chloral hydrate* is not very brisk and shading in prices has been heard of but without confirmation. *Cream of tartar* commands a fair demand. Manufacturers report a good volume of business on *cumarin*. *Glycerine* has declined no further and was quoted for spot and contract at 14½c. per lb. Little effort was being made by the producers to book contracts, as they consider the present price too low. *Soda glycerophosphate* has recently been reduced. *Hydrogen peroxide* continues to move steadily, but is still below past sales. *Iodides*, particularly potash, have shown an encouraging increase during the past two weeks. Now is the time to prepare for the winter season and wholesalers and consumers should not overlook their stocks on *salicylates*, *guaiacols*, *creosote* and *acetyl-salicylic*, as these articles will certainly be in demand with the first cold period. *Sulphur* continues in routine demand with advance in price of \$2.10 per 100 lb. for commercial in bags. *Zinc oxides* remain the same in price and demand is much below routine. *Zinc sulphate* is being offered at 3½c. per lb., f.o.b. St. Louis, with few inquiries.

ACIDS

Producers report a very appreciable increase in inquiry and demand for heavy acids, especially *sulphuric acid*, which is now moving in good volumes, and the manufacturers are very optimistic regarding the future. In some localities the demand for *citric acid* has improved, but the general demand is still below normal. *Acid pyrogalllic* continues to increase. *Tartaric acid* is favorable with a routine business.

VEGETABLE OILS

Linseed oil declined to 75c. basis raw in barrels from warehouse and has recently advanced again and holds very firm at 78c., with further advances expected. *Castor oil* continues in good demand, with price firm at 11½c. per lb. for No. 1 U.S.P. in returnable drums. *Turpentine* has advanced from its position of two weeks ago, and today is quoted at 60½c. in 5-bbl. lots. The demand is also better.

PAINT MATERIALS

Lithopone remains same in price with slight increase in demand. Many inquiries are being received on *dry earth colors* for the purpose of revising costs for the expected fall demand.

The Iron and Steel Market

PITTSBURGH, Aug. 19, 1921.

It requires very close analysis to show any change in the steel market situation in the week under review. There is a slight increase in demand upon the mills, in the aggregate, but the increase is probably smaller than in recent weeks, the trend toward heavier demand having begun about the middle of July. The character of demand is unchanged, orders being widely distributed geographically and by classes of buyers, while orders are, as formerly, chiefly for single carloads.

Steel prices likewise show little if any change. The regular or openly quoted prices are unchanged, there having indeed been no material change since the beginning of the

month. As for some time past, concessions can be obtained from these prices in the case of particularly desirable orders, whether in point of tonnage or of specifications. It is a question whether the concessions average more or less than a fortnight ago, but a change either way would not prove the market to be either better or worse. A larger concession might be quoted because a larger order was offered, or concessions might be less because less desirable business is going.

Much of the comment on the steel market is along the line that there is no forward buying, hence the market is still in very poor shape. This scarcely seems like a practical view. Steel mill operations dropped to below 20 per cent of capacity at the middle of July, and it ought not to be difficult to arrive at the conclusion that the mills needed prompt buying first. It is true that forward buying is essential in order that prices may be advanced, but the first objective of the steel mills necessarily is more business.

Steel mill operations have probably attained an average close to 25 per cent of capacity, against an average of about 21 per cent in July and a low point of less than 20 per cent at the middle of that month. This is on the basis of ingot production. Shipments of finished steel products have increased somewhat more, as there has been drawing upon the small remaining stocks of finished steel at mills, as well as a little rolling of semi-finished steel that had accumulated.

On the whole, the proportion of demand that comes from jobbers as compared with the demand from manufacturing consumers seems to be above the normal. This would tend to confirm the general analysis of the situation given in previous reports, that demand has suffered on account of the existence of stocks of steel and of manufactured goods, which have to be liquidated. The jobbing demand, which is for material to be distributed at once to small users, would naturally not be affected so much by stocks. It is noted that jobbers in the South, catering to agricultural trade, are particularly active.

There is heavy demand for galvanized sheets for making and repairing box car roofs, against the requirements of the fall movement of agricultural products. The automobile trade is somewhat more active than a month or two ago and while production of automobiles is below the best rate in the late spring the demand for steel is greater because at that time stocks of steel were being used. There is only a little demand from the oil fields, nothing at all comparable to a normal demand.

PRICES

As to openly quoted prices for steel products, against inquiries for carloads to 100 tons, prices of the leading products are unchanged since about the first of the month, except that blue annealed sheets are now commonly quoted at 2.25c. for orders at all attractive, against 2.40c. quoted a week ago. Concessions from regular prices, when named on attractive inquiries, are generally \$1 or \$2 a ton, occasionally reaching \$3 a ton, and this applies to most commodities except wire products and standard steel pipe, concessions on which are relatively small.

Pig iron has begun to show signs of an advancing tendency, this being a natural reaction, since in many cases prices done in the open market had passed below the cost of replacement, and were due to a desire to liquidate stocks. While buying has appeared to be very light right along, it appears that there really has been considerable liquidation. Some Chicago furnaces had sold foundry iron at \$18 furnace, while quotations are now advanced to \$20. Whether there will be any buying at the new price remains to be seen. In the valley market there is the interesting development that many if not all the producers have marked up basic iron from \$18 to \$20. Even in the latter part of last week there were sales on the \$18 basis. The valley market remains quotable at \$20 for bessemer, \$18 for basic and \$19.50 for foundry, f.o.b. furnace, on the basis that the market is quotable at last sales made.

Connellsville furnace coke remains at \$3 as the common asking price, with concessions frequently possible of about 10c. on standard coke. Standard foundry coke remains at \$4@4.50.

General Chemicals CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots		Less Carlots	
Acetic anhydride.....lb.	\$0.12½	\$0.12½	\$0.40	\$0.45
Acetone.....lb.	12½	13	.13	.13½
Acid, acetic, 28 per cent.....100 lbs.	2.50	2.75	3.00	3.25
Acetic, 56 per cent.....100 lbs.	5.00	5.25	5.50	6.00
Acetic, glacial, 99½ per cent, carboys, 100 lbs.	10.00	10.25	10.50	10.75
Boric, crystals.....lb.	.12½	.13	.13½	.14
Boric, powder.....lb.	.13	.13½	.14	.14½
Citric.....lb.	—	—	.44½	.45
Hydrochloric.....100 lb.	1.25	1.50	1.60	1.75
Hydrofluoric, 52 per cent.....lb.	.11½	.11½	.12	.12½
Lactic, 44 per cent tech.....lb.	.10	.11	.11½	.12
Lactic, 22 per cent tech.....lb.	.04½	.05½	.06	.07
Molybdic, C. P.....lb.	4.00	4.50	4.50	5.00
Muriatic, 20 deg. (see hydrochloric).....lb.	.06½	.06½	.07	.07½
Nitric, 40 deg.....lb.	.07	.07½	.07½	.07½
Nitric, 42 deg.....lb.	.16	.16½	.17	.18
Oxalic, crystals.....lb.	.13	.13½	.14	.18
Phosphoric, 50 per cent solution.....lb.	.20	.25	.27	.35
Picric.....lb.	—	—	1.75	1.90
Pyrogallol, resublimed.....lb.	—	—	11.00	13.00
Sulphuric, 60 deg., tank cars.....ton	—	—	13.00	15.00
Sulphuric, 60 deg., drums.....ton	—	—	—	—
Sulphuric, 66 deg., tank cars.....ton	18.00	20.00	—	—
Sulphuric, 66 deg., drums.....ton	21.00	22.00	22.50	23.00
Sulphuric, 66 deg., carboys.....ton	—	—	—	—
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	21.00	22.00	—	—
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	23.00	23.50	24.00	24.50
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	31.00	32.00	33.00	34.00
Tannic, U. S. P.....lb.	—	—	.75	.85
Tannic (tech.).....lb.	.45	.48	.50	.55
Tartaric, crystals.....lb.	—	—	.26½	.28
Tungstic, per lb. of WO.....lb.	—	—	1.30	1.40
Alcohol, Ethyl.....gal.	—	—	4.65	4.75
Alcohol, Methyl (see methanol).....gal.	—	—	—	—
Alcohol, denatured, 188 proof.....gal.	—	—	.35	.36
Alcohol, denatured, 190 proof.....gal.	—	—	.37	.38
Alum, ammonia lump.....lb.	.03½	.03½	.04	.04½
Alum, potash lump.....lb.	.03½	.04	.04½	.04½
Alum, chrome lump.....lb.	.10	.11	.11	.12
Aluminum sulphate, commercial.....lb.	.02	.02½	.02½	.02½
Aluminum sulphate, iron free.....lb.	.03	.03½	.03½	.04
Aqua ammonia, 26 deg., drums (750 lb.).....lb.	.07½	.07½	.08	.08½
Ammonia, anhydrous, cyl. (100-150 lb.).....lb.	.30	.32	.33	.35
Ammonium carbonate, powder.....lb.	.07	.07½	.08	.09
Ammonium chloride, granular (white sal-amoniac).....lb.	.06	.06½	.06½	.07½
Ammonium chloride, granular (gray sal-amoniac).....lb.	.07	.07½	.07½	.08
Ammonium nitrate.....lb.	.07	.07½	.07½	.08½
Ammonium sulphate.....100 lb.	2.20	2.25	2.30	2.40
Amylacetate.....gal.	—	—	3.25	3.50
Amylacetate tech.....gal.	—	—	2.50	3.00
Arsenic oxide, (white arsenic) powdered lb.....lb.	.06½	.06½	.07	.07½
Arsenic, sulphide, powdered (red arsenic) lb.....lb.	.11	.11½	.12	.13
Barium chloride.....ton	48.00	50.00	51.00	53.00
Barium dioxide (peroxide).....lb.	.20	.21	.22	.23
Barium nitrate.....lb.	.08	.08½	.08½	.09½
Barium sulphate (precip.) (blanc fixe).....lb.	.04½	.04½	.04½	.05½
Bleaching powder (see calc. hypochlorite).....lb.	—	—	—	—
Blue vitriol (see copper sulphate).....lb.	—	—	—	—
Borax (see sodium borate).....lb.	—	—	—	—
Brimstone (see sulphur, roll).....lb.	.27	.28	.28½	.30
Bromine.....lb.	—	—	—	—
Calcium acetate.....100 lbs.	2.00	2.05	—	—
Calcium carbide.....lb.	.04½	.04½	.05	.05½
Calcium chloride, fused, lump.....ton	23.50	24.00	24.50	25.50
Calcium chloride, granulated.....lb.	.01½	.02	.02½	.02½
Calcium hypochlorite (bleach'g powder) 100 lb.....lb.	2.65	2.75	3.00	3.50
Calcium peroxide.....lb.	—	—	1.40	1.50
Calcium phosphate, tribasic.....lb.	—	—	.15	.16
Camphor.....lb.	—	—	.68	.70
Carbon bisulphide.....lb.	.06	.06½	.06½	.07½
Carbon tetrachloride, drums.....lb.	.10½	.10½	.11	.12
Carbonyl chloride (phosgene).....lb.	—	—	.60	.75
Caustic potash (see potassium hydroxide).....lb.	—	—	—	—
Caustic soda (see sodium hydroxide).....lb.	—	—	—	—
Chlorine, gas, liquid-cylinders (100 lb.).....lb.	.08	.09	.09½	.10
Chloroform.....lb.	—	—	.38	.43
Cobalt oxide.....lb.	—	—	2.35	2.40
Copperas (see iron sulphate).....lb.	—	—	—	—
Copper carbonate, green precipitate.....lb.	.19	.19½	.20	.21
Copper cyanide.....lb.	—	—	.50	.62
Copper sulphate, crystals.....lb.	.05½	.05½	.06	.06½
Cream of tartar (see potassium bitartrate).....lb.	—	—	—	—
Epsom salt (see magnesium sulphate).....lb.	—	—	—	—
Ethyl Acetate (pure) (acetic ether 98% to 100%).....lb.	—	—	1.00	1.10
Formaldehyde, 40 per cent.....lb.	.12	.12½	.12½	.13½
Fusel oil, ref.....gal.	—	—	3.25	3.75
Fusel oil, crude.....gal.	—	—	1.50	1.75
Glauber's salt (see sodium sulphate).....lb.	—	—	—	—
Glycerine, C. P. drums extra.....lb.	—	—	.14½	.15
Iodine, resublimed.....lb.	—	—	3.50	3.60
Iron oxide, red.....lb.	—	—	.10	.20
Iron sulphate (copperas).....ton	19.00	20.00	21.00	22.00
Lead acetate.....lb.	—	—	.10½	.12½
Lead arsenate, paste.....lb.	.09	.09½	.10	.11
Lead nitrate.....lb.	—	—	.15	.20
Litharge.....lb.	.07½	.07½	.08	.08½
Lithium carbonate.....lb.	—	—	1.30	1.40
Magnesium carbonate, technical.....lb.	.09	.09½	.10	.11
Magnesium sulphate, U. S. P.....100 lb.	2.40	2.75	—	—
Magnesium sulphate, technical.....100 lb.	—	—	1.15	1.65
Methanol, 95%.....gal.	—	—	.66	.68
Methanol, 97%.....gal.	—	—	.70	.72
Nickel salt, double.....lb.	—	—	.12	.12½
Nickel salt, single.....lb.	—	—	.14	.14½
Phosgene (see carbonyl chloride).....lb.	—	—	.42	.45
Phosphorus, red.....lb.	.40	.41	.42	.45
Phosphorus, yellow.....lb.	—	—	.30	.35
Potassium bichromate.....lb.	.11½	.11½	.12	.12½

	Carlots	Less Carlots
Potassium bitartrate (cream of tartar)..... lb.	\$. . . - \$. . .	\$0.28 1/2 - \$0.29 1/2
Potassium bromide, granular..... lb.		.16 - .25
Potassium carbonate, U. S. P..... lb.	.35 - .40	.45 - .50
Potassium carbonate, 80-85%..... lb.	.05 - .05 1/2	.06 - .06 1/2
Potassium chlorate, crystals..... lb.	.07 1/2 - .08	.08 1/2 - .10
Potassium cyanide..... lb.		.26 - .28
Potassium hydroxide (caustic potash)..... lb.	.04 1/2 - .05	.05 1/2 - .06
Potassium muriate, 80% K.C.L..... ton	42.50 - 45.00	
Potassium iodide..... lb.		2.75 - 3.00
Potassium nitrate..... lb.	.09 1/2 - .09 1/2	.10 - .12 1/2
Potassium permanganate..... lb.	.25 - .26	.26 1/2 - .27
Potassium prussiate, red..... lb.	.28 - .29	.29 1/2 - .30
Potassium prussiate, yellow..... lb.	.21 - .22	.22 1/2 - .23
Potassium sulphate (powdered)..... per unit		1.25 - 1.30
Rochelle salts (see sodium potas tartrate)		
Salammoniac (see ammonium chloride)		
Sal soda (see sodium carbonate)		
Salt cake..... ton		22.00 - 25.00
Silver cyanide..... oz.		1.35 - 1.38
Silver nitrate..... oz.		.41 1/2 - .42
Soda ash light..... 100 lb.	2.15 - 2.20	2.25 - 2.75
Soda ash, dense..... 100 lb.	2.35 - 2.40	2.45 - 2.70
Sodium acetate..... lb.	.04 - .04 1/2	.04 1/2 - .05
Sodium bicarbonate..... 100 lb.	2.25 - 2.40	2.50 - 2.75
Sodium bichromate..... lb.	.08 - .08 1/2	.08 1/2 - .09
Sodium bisulphate (nitre cake)..... ton	5.00 - 5.25	5.50 - 6.50
Sodium bisulphate powdered, U.S.P..... lb.	.04 1/2 - .05	.05 1/2 - .06
Sodium borate (borax)..... lb.	.05 1/2 - .06	.06 1/2 - .06 3/4
Sodium carbonate (sal soda)..... 100 lb.	1.90 - 2.00	2.10 - 2.40
Sodium chl rate..... lb.	.07 1/2 - .07 3/4	.08 - .08 1/2
Sodium cyanide..... lb.	.19 1/2 - .21	.22 - .30
Sodium fluoride..... lb.	.11 - .11 1/2	.12 - .13
Sodium hydroxide (caustic soda)..... 100 lb.	3.90 - 3.95	4.00 - 4.60
Sodium hyposulphite..... lb.		.03 1/2 - .03 3/4
Sodium nitrate..... 100 lb.	2.10 -	2.30 -
Sodium nitrite..... lb.	.07 - .07 1/2	.07 1/2 - .08
Sodium peroxide, powdered..... lb.	.25 - .26	.27 - .30
Sodium phosphate, dibasic..... lb.	.04 1/2 - .04 3/4	.05 - .05 1/2
Sodium potassium tartrate (Rochelle salts) lb.		.22 - .25
Sodium prussiate, yellow..... lb.	.11 1/2 - .12	.12 1/2 - .13
Sodium silicate, solution (40 deg.)..... 100 lb.	1.00 - 1.15	1.25 - 1.40
Sodium silicate, solution (60 deg.)..... lb.	.02 1/2 - .03	.03 1/2 - .03 3/4
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	1.50 - 1.75	2.00 - 2.25
Sodium sulphide, fused, 60-62 per cent (conc.) lb.	.04 1/2 - .05	.05 1/2 - .06
Sodium sulphite, crystals..... lb.	.03 1/2 - .04	.04 1/2 - .04 3/4
Strontium nitrate, powdered..... lb.	.15 - .15 1/2	.16 - .17
Sulphur chl ride, red..... lb.	.07 - .07 1/2	.07 1/2 - .08
Sulphur, crude..... ton	20.00 - 22.00	
Sulphur dioxide, liquid, cylinders extra..... lb.	.08 - .08 1/2	.09 - .10
Sulphur (sublimed), flour..... 100 lb.		2.25 - 3.10
Sulphur, roll (brimstone)..... 100 lb.		2.00 - 2.75
Tin bichloride, 50 per cent..... lb.	.18 - .19	
Tin oxide..... lb.		.38 - .40
Zinc carbonate, precipitate..... lb.	.15 1/2 - .16	.16 1/2 - .17
Zinc chloride, gran..... lb.	.11 - .11 1/2	.11 1/2 - .12
Zinc cyanide..... lb.	.42 - .44	.45 - .47
Zinc dust..... lb.	.11 1/2 - .11 3/4	.11 3/4 - .12 1/2
Zinc oxide, XX..... lb.	.07 1/2 - .07 3/4	.08 - .09
Zinc sulphate..... 100 lb.	3.00 - 3.25	3.30 - 3.50

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude..... lb.	\$1.10 - \$1.15
Alpha-naphthol, refined..... lb.	1.25 - 1.30
Alpha-naphthylamine..... lb.	.35 - .40
Aniline oil, drums extra..... lb.	.18 - .21
Aniline salts..... lb.	.25 - .28
Anthracene, 80% in drums (100 lb.)..... lb.	.75 - 1.00
Benzaldehyde U.S.P..... lb.	1.00 - 1.25
Benzidine, base..... lb.	1.00 - 1.10
Benzidine sulphate..... lb.	.75 - .85
Benzoic acid, U.S.P..... lb.	.60 - .65
Benzoate of soda, U.S.P..... lb.	.55 - .60
Benzene, pure, water-white, in drums (100 gal.) gal.	.27 - .32
Benzene, 90%, in drums (100 gal.) gal.	.25 - .28
Benzyl chloride, 95-97%, refined..... lb.	.25 - .27
Benzyl chloride, tech..... lb.	.20 - .23
Beta-naphthol benzoate..... lb.	3.50 - 4.00
Beta-naphthol, sublimed..... lb.	.70 - .75
Beta-naphthol, tech..... lb.	.32 - .35
Beta-naphthylamine, sublimed..... lb.	1.75 - 1.80
Cresol, U. S. P., in drums (100 lb.)..... lb.	.16 - .18
Ortho-cresol, in drums (100 lb.)..... lb.	.25 - .27
Cresylic acid, 97-99%, straw color, in drums..... gal.	.68 - .75
Cresylic acid, 35-97%, dark, in drums..... gal.	.65 - .70
Cresylic acid, 50%, first quality, drums..... gal.	.45 - .50
Dichlorobenzene..... lb.	.06 - .09
Diethylaniline..... lb.	1.20 - 1.25
Dimethylaniline..... lb.	.45 - .55
Dinitrobenzene..... lb.	.26 - .28
Dinitrochlorobenzene..... lb.	.20 - .30
Dinitronaphthalene..... lb.	.30 - .40
Dinitrophenol..... lb.	.35 - .40
Dinitrotoluene..... lb.	.27 - .30
Dip oil, 25%, car lots, in drums..... gal.	.40 - .45
Diphenylamine..... lb.	.65 - .70
II-acid..... lb.	1.15 - 1.25
Meta-phenylenediamine..... lb.	1.15 - 1.20
Monochlorobenzene..... lb.	.12 - .14
Monoethylaniline..... lb.	1.75 - 1.85
Naphthalene crushed, in bbls..... lb.	.06 1/2 - .07 1/2
Naphthalene, flake..... lb.	.06 1/2 - .08
Naphthalene, balls..... lb.	.08 - .09 1/2
Naphthionic acid, crude..... lb.	.70 - .75
Nitrobenzene..... lb.	.12 - .15
Nitro-naphthalene..... lb.	.30 - .35
Nitro-toluene..... lb.	.16 - .18
Ortho-amidophenol..... lb.	3.10 - 3.20
Ortho-dichlor-benzene..... lb.	.15 - .20
Ortho-nitro-phenol..... lb.	.80 - .85
Ortho-nitro-toluene..... lb.	.15 - .20
Ortho-toluidine..... lb.	.20 - .25
Para-amidophenol, base..... lb.	1.40 - 1.45
Para-amidophenol, HCl..... lb.	1.60 - 1.75

Para-dichlorobenzene..... lb.	15 - 20
Paranitroaniline..... lb.	75 - 80
Para-nitrotoluene..... lb.	85 - 95
Para-phenylenediamine..... lb.	1.70 - 1.75
Para-toluidine..... lb.	1.25 - 1.40
Phthalic anhydride..... lb.	50 - 60
Phenol, U. S. P., drums..... lb.	.09 1/2 - .11
Pyridine..... gal.	2.00 - 3.50
Resorcinol, technical..... lb.	1.60 - 1.65
Resorcinol, pure..... lb.	2.25 - 2.30
Salicylic acid, tech., in bbls..... lb.	.19 - .22
Salicylic acid, U. S. P..... lb.	.20 - .25
Salol..... lb.	.60 - .75
Solvent naphtha, water-white, in drums, 100 gal. gal.	.25 - .28
Solvent naphtha, crude, heavy, in drums, 100 gal. gal.	.14 - .16
Sulphanilic acid, crude..... lb.	.27 - .30
Tolidine..... lb.	1.25 - 1.35
Toluidine, mixed..... lb.	.40 - .45
Toluene, in tank cars..... gal.	.25 - .28
Toluene, in drums..... gal.	.28 - .31
Xylidines, drums, 100 gal..... lb.	.40 - .45
Xylene, pure, in drums..... gal.	.40 - .45
Xylene, pure, in tank cars..... gal.	.45 - .45
Xylene, commercial, in drums, 100 gal..... gal.	.33 - .35
Xylene, commercial, in tank cars..... gal.	.30 - .35

Waxes

Prices based on original packages in large quantities

Beeswax, refined, dark..... lb.	\$0.24 - \$0.25
Beeswax, refined, light..... lb.	.28 - .30
Beeswax, white pure..... lb.	.36 - .42
Carnauba, Florida..... lb.	.48 - .50
Carnauba, No. 2, North Country..... lb.	.25 - .26
Carnauba, No. 3, North Country..... lb.	.15 - .16
Japan..... lb.	.18 1/2 - .20
Montan, crude..... lb.	.06 1/2 - .06 3/4
Paraffine waxes, crude match wax (white) 105-110 m.p..... lb.	.03 1/2 - .03 3/4
Paraffine waxes, crude, scale 124-126 m.p..... lb.	.02 1/2 - .03
Paraffine waxes, refined, 118-120 m.p..... lb.	.03 - .03 1/2
Paraffine waxes, refined, 125 m.p..... lb.	.03 1/2 - .03 3/4
Paraffine waxes, refined, 128-130 m.p..... lb.	.04 - .04 1/2
Paraffine waxes, refined, 133-135 m.p..... lb.	.04 1/2 - .05
Paraffine waxes, refined, 135-137 m.p..... lb.	.05 1/2 - .06
Stearic acid, single pressed..... lb.	.09 - .09 1/2
Stearic acid, double pressed..... lb.	.09 1/2 - .10
Stearic acid, triple pressed..... lb.	.10 - .10 1/2

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl..... 280 lb.	\$4.90 -
Rosin E-I..... 280 lb.	5.00 - 5.25
Rosin K-N..... 280 lb.	5.35 - 5.80
Rosin W. G.-W. W..... 280 lb.	6.60 - 7.35
Wood rosin, bbl..... 280 lb.	6.25 -
Spirits of turpentine..... gal.	.62 -
Wood turpentine, steam dist..... gal.	.60 -
Wood turpentine, dest. dist..... gal.	.58 -
Pine tar pitch, bbl..... 200 lb.	 - 7.00
Tar, kila burned, bbl. (500 lb.)..... bbl.	 - 11.50
Retort tar, bbl..... 500 lb.	 - 11.50
Rosin oil, first run..... gal.	.35 -
Rosin oil, second run..... gal.	.37 -
Rosin oil, third run..... gal.	.41 -
Pine oil, steam dist., sp.gr. 0.930-0.940..... gal.	\$1.80 -
Pine oil, pure, dest. dist..... gal.	1.50 -
Pine tar oil, ref., sp.gr. 1.025-1.035..... gal.	.46 -
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla..... gal.	.35 -
Pine tar oil, double ref., sp.gr. 0.965-0.990..... gal.	.75 -
Pine tar, ref., thin, sp.gr. 1.080-1.960..... gal.	.35 -
Turpentine, crude, sp. gr., 0.900-0.970..... gal.	1.20 -
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990..... gal.	.35 -
Pine wood creosote, ref..... gal.	.52 -

Solvents

73-76 deg., steel bbls. (85 lb.)..... gal.	\$0.37 -
70-72 deg., steel bbls. (85 lb.)..... gal.	.35 -
68-70 deg., steel bbls. (85 lb.)..... gal.	.34 -
V. M. and P. naphtha, steel bbls. (85 lb.)..... gal.	.23 -

Crude Rubber

Para-Upriver fine..... lb.	\$0.16 - .17
Upriver coarse..... lb.	.09 - .09 1/2
Upriver caucho ball..... lb.	.11 - .12
Plantation—First latex crepe..... lb.	.14 -
Ribbed smoked sheets..... lb.	.12 - .12 1/2
Brown crepe, thin, clean..... lb.	.15 -
Amber crepe No. 1..... lb.	.17 -

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls..... lb.	\$0.09 - \$0.09 1/2
Castor oil, AA, in bbls..... lb.	.10 - .11
China wood oil, in bbls. (f.o.b. Pac. coast)..... lb.	.12 - .12 1/2
Cocunut oil, Ceylon grade, in bbls..... lb.	.09 - .10
Cocunut oil, Cochia grade, in bbls..... lb.	.10 - .11
Corn oil, cru le, in bbls..... lb.	.08 1/2 - .08 3/4
Cottonseed oil, crude (f. o. b. mill)..... lb.	.06 1/2 - .07
Cottonseed oil, summer yellow..... lb.	.08 1/2 - .09
Cottonseed oil, winter yellow..... lb.	.09 1/2 -
Linseed oil, raw, car lots (domestic)..... gal.	.75 - .76
Linseed oil, raw, tank cars (domestic)..... gal.	.69 - .70
Linseed oil, in 5-bbl lots (domestic)..... gal.	.77 - .78

Olive oil, Denatured.....	gal.	\$1.10	—	\$1.20
Palm, Lagos.....	lb.	.07	—	.07½
Palm, Niger.....	lb.	.05½	—	.06
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.07½	—	.07½
Peanut oil, refined, in bbls.....	lb.	.10½	—	.10½
Rapeseed oil, refined in bbls.....	gal.	.88	—	.90
Rapeseed oil, blown, in bbls.....	gal.	.92	—	.94
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.08½	—	.....
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.06½	—	.....

FISH

Light pressed menhaden.....	gal.	\$0.40	—	.....
Yellow bleached menhaden.....	gal.	.42	—	.....
White bleached menhaden.....	gal.	.44	—	.....
Blown menhaden.....	gal.	.48	—	.....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$24.00	—	30.00
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	22.00	—	26.00
Barytes, crude, 88% @ 94% ba., Kings Creek.....	net ton	10.00	—	12.00
Barytes, floated, f.o.b. St. Louis.....	net ton	26.50	—	28.00
Barytes, crude, first grade, Missouri.....	net ton	7.00	—	.....
Blanc fixe, dry.....	lb.	.04½	—	.04½
Blanc fixe, pulp.....	net ton	45.00	—	55.00
Casein.....	lb.	.06½	—	.07½
Chalk, domestic, extra light.....	lb.	.04½	—	.05
Chalk, domestic, light.....	lb.	.04	—	.04½
Chalk, domestic, heavy.....	lb.	.03½	—	.04
Chalk, English, extra light.....	lb.	.04½	—	.05
Chalk, English, light.....	lb.	.04½	—	.05
Chalk, English, dense.....	lb.	.04	—	.04½
China clay (kaolin) crude, f.o.b. mines, Georgia.....	net ton	6.50	—	8.50
China clay (kaolin) washed, f.o.b. Georgia.....	net ton	9.00	—	10.00
China clay (kaolin) powdered, f.o.b. Georgia.....	net ton	13.00	—	20.00
China clay (kaolin) crude f.o.b. Virginia points.....	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points.....	net ton	13.00	—	20.00
China clay (kaolin), imported, lump.....	net ton	12.00	—	20.00
China clay (kaolin), imported, powdered.....	net ton	25.00	—	30.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	net ton	5.00	—	7.50
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27.00	—	30.00
Fullers earth, f.o.b. Mir es.....	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Pa.....	net ton	15.00	—	18.00
Fullers earth, powdered, f.o.b. Fla.....	net ton	18.00	—	.....
Fullers earth, imported, powdered.....	net ton	24.00	—	27.00
Graphite, Ceylon lump, first quality.....	lb.	.06	—	.07
Graphite, Ceylon chip.....	lb.	.04½	—	.05
Graphite, high grade amorphous crude.....	lb.	.00½	—	.02½
Magnesite, calcined.....	per ton	66.00	—	70.00
Pumice stone, imported, lump.....	lb.	.03	—	.40
Pumice stone, domestic lump.....	lb.	.05	—	.05½
Pumice stone, ground.....	lb.	.06	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore.....	net ton	.....	—	10.00
Quartz (acid tower) 1½ @ 2 in., f.o.b. Baltimore.....	net ton	.....	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	.....	—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange fine.....	lb.	.52	—	.53
Shellac, orange superfine.....	lb.	.55	—	.56
Shellac, A. C. garnet.....	lb.	.44	—	.45
Shellac, T. N.....	lb.	.45	—	.46
Soapstone.....	ton	12.00	—	15.00
Sodium chloride.....	long ton	12.50	—	13.00
Talc, paper-making grades, f.o.b. Vermont.....	ton	11.00	—	20.00
Talc, roofing grades, f.o.b. Vermont.....	ton	8.50	—	13.00
Talc, rubber grades, f.o.b. Vermont.....	ton	11.00	—	18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	10.00	—	14.00
Talc, imported.....	ton	30.00	—	40.00
Talc, California talcum powder grade.....	ton	18.00	—	40.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	per ton	\$37.50—40.00
Carborundum refractory brick, 9-in.	1,000	1250.00
Chrome brick, f.o.b. Eastern shipping points.....	net ton	60
Chrome cement, 40-45% Cr ₂ O ₃	net ton	30-32
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in car lots, f.o.b. Eastern shipping points.....	net ton	33-35
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	36-40
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	30-35
Magnesite brick, 9-in. straight.....	net ton	70
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	77
Magnesite brick, soaps and splits.....	net ton	98
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	42-45
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	46-50
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	35-38

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00 — \$225.00
Ferrochrome per lb. of Cr. contained, 6-8% carbon, carlots.....	lb.	.14 —
Ferrochrome, per lb. of Cr. contained, 4-6% carbon, carlots.....	lb.	.15 —
Ferromanganese, 76-80% Mn, domestic.....	net ton	65.00 — 68.00
Ferromanganese, 76-80% Mn, English.....	net ton	65.00 — 68.00
Spiegeleisen, 18-22% Mn.....	net ton	26.00 — 27.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.50 —
Ferrosilicon, 10-15%.....	net ton	40.00 — 42.00
Ferrosilicon, 50%.....	net ton	65.00 — 68.00
Ferrosilicon, 75%.....	net ton	135.00 — 138.00
Ferrotungsten, 70-80%, per lb. of contained W.....	lb.	.45 — .50
Ferrouanium, 35-50% of U, per lb. of U content.....	lb.	6.00 —
Ferrovandium, 30-40% per lb. of contained V.....	lb.	4.25 — 4.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content.....	net ton	\$8.00 — \$10.00
Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃	unit	30 — .33
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard.....	unit	30 — .33
Coke, foundry, f.o.b. ovens.....	net ton	4.00 — 4.50
Coke, furnace, f.o.b. ovens.....	net ton	2.75 — 3.00
Coke, petroleum, refinery, Atlantic seaboard.....	net ton	14.00 — 15.00
Fluorspar, lump, f.o.b. mines, New Mexico.....	net ton	12.50 —
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	20.00 —
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01½ — .01½
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	22 —
Manganese ore, chemical (MnO ₂).....	net ton	50.00 — 55.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.55 — .60
Monazite, per unit of ThO ₂ , c.i.f., Atlantic seaport.....	unit	30.00 —
Pyrites, Spanish, fines, c.i.f., Atlantic seaport.....	unit	12 — 12
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	12 — 12
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	11 — 12
Rutile, 95% TiO ₂ per lb. ore.....	lb.	15 —
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	2.75 — 3.00
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	3.00 — 3.25
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	1.50 — 2.50
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.25 — 2.50
Vanadium pentoxide, 99%.....	lb.	12.00 — 14.00
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1.00 —
Zircon, washed, iron free.....	lb.	.03 —

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic.....	11.75 @ 12.00
Aluminum, 98 to 99 per cent.....	24.5 @ 25
Antimony, wholesale lots, Chinese and Japanese.....	4½
Nickel, ordinary (ingot).....	41.00
Nickel, electrolytic.....	44.00
Monel metal, spot and blocks.....	35.00
Monel metal ingots.....	38.00
Monel metal, sheet bars.....	40.00
Tin, 5-ton lots, Straits.....	26.125
Lead, New York, spot.....	4.40
Lead, E. St. Louis, spot.....	4.20 @ 4.25
Zinc, spot, New York.....	4.55
Zinc, spot, E. St. Louis.....	4.20

OTHER METALS

Silver (commercial).....	oz.	\$0.60½
Cadmium.....	lb.	1.00—1.25
Bismuth (500 lb. lots).....	lb.	1.50 @ 1.55
Cobalt.....	lb.	3.00 @ 3.25
Magnesium (f.o.b. Philadelphia).....	lb.	1.25
Platinum.....	oz.	72.00 @ 75.00
Iridium.....	oz.	160.00 @ 170.00
Palladium.....	oz.	53.00—55.00
Mercury.....	.75 lb.	43.50—45.00

FINISHED METAL PRODUCTS

Warehouse Price
Cents per lb.

Copper sheets, hot rolled.....	19.75 @ 20.00
Copper bottoms.....	27.25 @ 27.50
Copper rods.....	18.50 @ 19.00
High brass wire.....	16.75
High brass rods.....	13.75
Low brass wire.....	18.25
Low brass rods.....	18.25
Brazed brass tubing.....	27.00
Brazed bronze tubing.....	31.75
Seamless copper tubing.....	20.00
Seamless high brass tubing.....	18.50

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current	Cleveland	Chicago
Copper, heavy and crucible.....	9.00 @ 9.25	9.25	9.50
Copper, heavy and wire.....	8.25 @ 8.50	8.50	8.50
Copper, light and bottoms.....	7.00 @ 7.25	7.50	7.25
Lead, heavy.....	3.00 @ 3.25	3.25	3.25
Lead, tea.....	2.25 @ 2.35	2.25	2.25
Brass, heavy.....	4.00 @ 4.25	4.50	5.00
Brass, light.....	3.00 @ 3.25	3.25	3.50
No. 1 yellow brass turnings.....	3.75 @ 4.00	4.25	4.50
Zinc.....	2.00 @ 2.25	2.00	2.25

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ½ in. and larger, and plates ½ in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes.....	\$2.18	\$3.00	\$3.00
8 ft steel bars.....	2.18	2.80	2.80
Soft steel bar shapes.....	2.18	2.90	2.90
Soft steel bands.....	2.50	3.20	3.20
Plates, ½ to 1 in. thick.....	2.18	3.00	3.00

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Arkansas

EL DORADO—The Arkansas Royalty Co., Little Rock, is planning for the construction of a new gasoline-refining plant at El Dorado, with initial capacity of about 5,000 gal. per day. Lee Miles is president.

California

PASADENA—The Pasadena Military Academy, Oak Knoll, has preliminary plans under way for the installation of a complete chemical and scientific laboratory at the institution.

MONTEREY—R. F. Angulo, Santa Barbara, Cal., manufacturer of ceramic tile products, is planning for the construction of a new plant in the vicinity of Monterey. Clay properties suitable for tile production have been acquired in this section.

LOS ANGELES—The California Gypsum Corp., 731 Pacific Finance Bldg., is planning for the erection of a new plant at Coyote Wells, Imperial County, for the manufacture of gypsum products. The plant is estimated to cost about \$650,000 with machinery, and will consist of a crushing plant, with mining machinery, to cost approximately \$100,000; plaster mill and auxiliary buildings costing \$350,000; and railroad line construction to make connection with the San Diego & Arizona R.R., estimated to cost \$200,000. R. W. Waterman is construction engineer.

Connecticut

STAMFORD—The Yale & Towne Mfg. Co., manufacturer of locks, builders' hardware, etc., has commenced the installation of a new annealing department at its plant, to be used for truck bearing production and other construction. The plant, comprising an arched tunnel, will be electrically operated. A new 2-ton electric furnace has been installed for the manufacture of steel and malleable iron castings, heretofore purchased from outside sources. It is proposed to operate the furnace under 4 heats a day, or with total output of eight tons of material for the period.

Florida

TAMPA—The Peninsula Tire & Rubber Co. is perfecting plans for the erection of its new local plant for the manufacture of tires and other rubber products. The main building will be two-story, 100 x 300 ft., with two smaller structures, each about 60 x 60 ft. The plant will be equipped for an initial output of about 300 tires per day, and is estimated to cost approximately \$200,000. The company was incorporated recently with a capital of \$1,000,000. A. H. Van Auken is general manager.

Illinois

CHICAGO—The G. A. Ball Bearing Co., 3051 West Lake St., manufacturer of steel ball bearings, will take bids at once for the erection of its proposed one-story addition, 208 x 230 ft., at West Lake St., and Albany Ave., estimated to cost about \$65,000. Burrett H. Stephens, 37 West Van Buren St., is architect.

Indiana

INDIANA HARBOR—The Inland Steel Co. has commenced surveys of its property in Portage Township, Porter County, where recent purchases totaling about 640 acres of land have been made. The site will be used for the construction of a new steel works. No announcement has been made as to when construction will be inaugurated.

JASPER—Louis Mehringer, receiver for the Jasper Tire & Rubber Co., has arranged for the sale of the company's property.

Kentucky

PADUCAH—The Ohio-Kentucky Fluorspar & Lead Corp., City National Bank Bldg., recently formed with a capital of

\$1,000,000, has leased the properties of the North American Fluorspar & Lead Corp., at Smithland, Ky., and plans extensive development of the site, aggregating about 1,000 acres. A plant will be established to develop a daily production of about 100 tons of lead and fluorspar. T. J. Clay is president and F. B. Moodle, vice-president and general manager.

Louisiana

BASTROP—The Bastrop Pulp & Paper Co. is planning to begin operations at its new local pulp and paper mill, now in course of erection, early in October, and work is being pushed for the completion of the plant. The mill will have an initial output of about 60 tons of pulp, dry weight every twenty-four hours, and will represent an investment in excess of \$600,000. The company is affiliated with the Kansas City Packing Box Co. and the Kansas City Fiber Box Co., both of Kansas City, Mo., with L. H. Fox heading all three organizations. The entire output of the new pulp and paper mill will be utilized at the Kansas City mills.

LEESVILLE—The Louisiana Oil Refining Co. and the Caddo-Central Oil & Refining Co. will rebuild the portions of their local plants, recently damaged by fire, with loss reported at \$22,000.

Massachusetts

LOWELL—The Wamesit Chemical Co. recently incorporated with a capital of \$100,000, has acquired the entire plant and business of the Avery Chemical Co., and operations in the future will be conducted by the new organization. George Stevens is president, and John H. Murphy, 8 Shattuck St., treasurer.

GARDNER—Otto W. Siebert, until recently connected with the Bay State Metal Wheel Co. and the Children's Vehicle Corp., both of East Templeton, Mass., has leased the Wright property on Main St., and a building in the vicinity on Logan St., for the establishment of a new plant for the manufacture of fiber vehicles for children, and other fiber specialties. The structures will be remodeled and improved, and machinery installed at an early date. It is proposed to have the new works ready for service during the fall. At a later date, within the coming year, it is planned to construct an entirely new plant in this section for the same character of production.

Maryland

BALTIMORE—The American Sugar Refining Co., 117 Wall St., New York, is arranging for the operation of its new sugar mill in the Locust Point district, Baltimore, early in the coming year. Construction work is being pushed and machinery will be installed as soon as the buildings are ready. The plant will represent an investment of about \$8,000,000 and give employment to more than 2,000 operatives.

Michigan

NILES—The Hercules Steel Post Co., is having plans prepared for a new local plant, to be one-story, 50 x 250 ft., and estimated to cost about \$25,000. Erection will be commenced at an early date. G. J. Pammel, secretary of the local Chamber of Commerce, is handling the details of the project.

Minnesota

DULUTH—The Minneapolis Steel Co., a subsidiary of the United States Steel Corp., has acquired a tract of land totalling about 330 acres in the vicinity of its plant in the Morgan Park section. The acquisition gives the company control of the waterfrontage along the St. Louis River, between New Duluth and the present works. It is said that the site will be used for additions to the steel plant, with cost estimated in excess of \$5,000,000.

Missouri

JOPLIN—The Nichols Wire & Sheet Metal Co. Tenth and Missouri Sts., has plans under way for the erection of a 1-story works building, 50 x 200 ft., at 513 East Fifth St.

Montana

BUTTE—The Anaconda Copper Mining Co. is said to be planning for the erection of a new wire insulating plant at Great Falls, to be used in connection with its copper wire and rod mill here.

Nevada

MINA—The Mina Mercury Co. has construction under way on two new retorts at its plant to increase the output to four flasks of quicksilver daily.

Newfoundland

ST. JOHN'S—The A. E. Rex Co. is considering the rebuilding of its pulp mill at Bishop's Falls, destroyed by fire, July 27, with heavy loss.

New York

BUFFALO—The Iroquois Natural Gas Co., Iroquois Bldg., has tentative plans under way for the construction of a new artificial gas plant, estimated to cost about \$4,000,000. The proposed plant will be operated in conjunction with the company's natural gas system. Application is now before the Public Service Commission for the acquisition of the local gas properties of W. J. Judge, Buffalo Gas Co., by the Iroquois company.

Ohio

TOLEDO—The Spitzer Paper Box Co., 3051 Monroe St., is taking bids for the construction of a 3-story addition, 30 x 50 ft., estimated to cost about \$50,000. George B. Rheinfrank, Gardner Bldg., is architect and engineer. Lyman Spitzer is president.

TOLEDO—The Libbey Glass Co. will increase its working force by about 400 operatives, effective at once. Former employees at the plant will comprise the majority of the greater working force.

CLEVELAND—The International Steel Tire Co., 15702 Waterloo Rd., is considering tentative plans for the erection of a new plant on Waterloo Rd. It is proposed to commence construction during the coming fall. W. P. Day is president and T. J. Lavan, company address, engineer.

SHELBY—The Shelby Sales Book Co., manufacturer of paper specialties, has awarded a contract to the D. Mohler Construction Co., West First St., Mansfield, O., for the erection of a 1- and 2-story addition to its plant. Construction will be commenced at once.

Oklahoma

LAWTON—A. L. Lund, Lawton, and associates are planning for the immediate establishment of a new paint manufacturing plant, with initial daily output of about 1,000 gal. of material.

Pennsylvania

BROWNSVILLE—The Brownsville Window Glass Co. is planning for the rebuilding of its plant, destroyed by fire Aug. 6, with loss estimated at about \$300,000, including machinery. W. S. Phillips is general manager.

Texas

MEXIA—O. H. Foster, Breckrenridge, Tex., and associates are organizing a new company to construct and operate an oil refinery at Mexia. A tract of about fifty acres of land has been secured in the northern section of the borough, and plans are under way for a refinery to cost about \$400,000.

TEXAS CITY—The Swiftsure Petroleum Co., Houston, Tex., is planning for the construction of a new topping plant at its works at Texas City, comprising the former plant of the Bennett Petroleum Co., recently acquired. Mills Bennett is president.

Virginia

RICHMOND—The Richmond Pressed Metal Works are planning for the rebuilding of the portion of their plant recently destroyed by fire.

West Virginia

WHEELING—The Bonita Art Glass Co., recently organized with a capital of \$100,000, has plans under way for the erection of a new local plant, consisting of two buildings, each about 60 x 80 ft. George E. House is president, and Otto Jaeger, secretary-treasurer and manager.

MORGANTOWN—The United States Window Glass Co. is arranging for a resumption of operations at its local plant, known as the Seneca Works, on Aug. 25. It is proposed to develop capacity output in about a month.

Capital Increases, etc.

THE SCOBEL-MILLER CHEMICAL Co., Rochester, N. Y., has filed notice of increase in capital from \$20,000 to \$60,000.

THE NATIONAL INDEPENDENT OIL Co., York, Pa., a Delaware corporation, has filed notice of increase in capital from \$200,000 to \$500,000.

THE COLUMBUS FOUNDRY Co., Columbus, Ind., has filed notice of increase in capital to \$25,000.

THE SOUTHERN ELECTRO STEEL Co., Lynchburg, Va., has increased its capital to \$100,000. Joseph Keyser is president.

THE IMPERIAL WALL PAPER Co., Queensbury, N. Y., manufacturer of paper products, has increased its capital from \$750,000 to \$900,000.

THE KEINER-WILLIAMS STAMPING Co., Vine St., Brooklyn, N. Y., manufacturer of stamped metal products, has filed notice of increase in capital from \$300,000 to \$500,000.

THE GIBSON-ZAHNISHER OIL CORP., a Delaware corporation, has filed notice of organization to operate in New York, with capital of \$300,000, for the manufacture of oil products. J. F. James, 501 Fifth Ave., represents the company.

New Companies

THE RICHDALE OIL CORP., Boston, Mass., has been incorporated with a capital of \$100,000 to manufacture oil products. William G. Todd is president; and John F. Ryan, 18 Tremont St., treasurer.

THE INDEPENDENT PAPER MILLS, INC., Brooklyn, N. Y., has been incorporated with a capital of \$50,000 to manufacture paper products. The incorporators are P. W. Horwitt, L. Laveck and D. E. Latham, 280 Broadway, New York.

THE KANE CHEMICAL Co., Chicago, Ill., has been chartered under state laws to manufacture chemicals and chemical by-products. The incorporators are J. E. S. Teal, Louis Salinger and Charles E. Heckler, Room 1515, 111 West Monroe St.

THE REZNOIR CORP., Alden (Erie Co.), N. Y., has been incorporated with a capital of \$30,000, to manufacture molded and composition products. The incorporators are H. M. Dent, C. E. Leffel and F. J. Moore, Alden. The company is represented by A. W. Plumley, Mutual Life Bldg., Buffalo, N. Y.

THE PANHANDLE BRICK & TILE Co., Amarillo, Tex., has been incorporated with a capital of \$80,000 to manufacture brick, tile and other burned clay products. The incorporators are W. C. Pope, A. S. Stinnett and H. B. Boyle, Amarillo.

THE EXCEL ALL PUNCTURE-PROOF TUBE Co., Jersey City, N. J., has been incorporated with a capital of \$125,000 to manufacture rubber tubes for automobile tire use, and other rubber products. The incorporators are David A. Farrington, E. L. Williams and Frank G. Schafer, 673 Summit Ave.

THE PURE ALUMINUM Co. OF AMERICA, INC., New York, has been incorporated with a capital of \$100,000 to manufacture aluminum products. The incorporators are H. P. Armstrong, B. L. Shaw and E. E. Grabo. The company is represented by J. M. Coleman, 29 Broadway.

THE MATTSON WIRE & MFG. Co., Market and Lucas Sts., Joliet, Ill., has been chartered under state laws to manufacture wire and other steel products. The incorporators are Jesse A. Tune, C. N. and Elmer L. Crouch, F. A. Hill, 314 Barber Bldg., Joliet, represents the company.

THE INTERNATIONAL COTTON PROTECTING Co., Dallas, Tex., has been incorporated with a capital of \$25,000 to manufacture paste, compounds and other protective solutions for cotton service. The incorporators are S. Van deMark, and Edgar G. Macley, both of Houston, Tex.; and Charles J. Hinkley, Dallas.

H. J. STEIN & Co., INC., Boston, Mass., has been incorporated with a capital of \$25,000 to manufacture chemicals and affiliated products. Henry J. Stein, Holborn Street, Roxbury, Mass., is president and treasurer.

THE PETRONIO CHEMICAL Co., Newark, N. J., has been incorporated with a capital of \$10,000 to manufacture chemicals and chemical byproducts. The incorporators are Muzio Petroni and Frank A. Rizzolo, 510 Broad St.

THE D. & C. SPECIALTY Co., New York, N. Y., has been incorporated with a nominal

capital of \$5,000 to manufacture soaps, chemicals and affiliated products. The incorporators are D. T. Clavin, C. Curtis and M. Lieberman. The company is represented by M. E. Seiling, 358 Fifth Ave.

THE IROQUOIS MFG. Co. OF PENNSYLVANIA, Scranton, Pa., has been incorporated with a capital of \$10,000 to manufacture paints, varnishes, etc. W. E. Woehrman, 6408 Euclid Ave., Cleveland, O., is treasurer.

THE COCHRANE CHEMICAL INDUSTRIES, INC., Augusta, Me., has been incorporated with a capital of \$10,000 to manufacture chemicals and chemical byproducts. E. M. Leavitt is president and treasurer; and S. L. Fogg, director, both of Augusta.

THE CULBERSON COUNTY SULPHUR & DEVELOPMENT Co., Austin, Tex., has been incorporated with a capital of \$30,000 to manufacture sulphur products and operate properties of this and kindred character. The incorporators are J. Miles Hall, H. C. Morrow, Sr. and Jr., all of Austin.

THE GROVE Co., Philadelphia, Pa., has been incorporated with a capital of \$10,000 to manufacture chemicals and chemical byproducts. M. A. Sherman, 1220 Herbert St., Frankford, Philadelphia, is treasurer.

THE VICTOR LENS MFG. Co., Camden, N. J., has been incorporated with a capital of \$125,000 to manufacture lenses and other precision glass products. The incorporators are Clifford A. Baldwin, George D. Rothermel and Albert E. Burling, 520 Market St.

THE MARL LIME & FERTILIZER Co., 1030 Citizens' National Bank Bldg., Los Angeles, Cal., has filed notice of organization to manufacture fertilizer products. A. J. and L. E. Robinson head the company.

THE RYAN OIL Co., Spencer, W. Va., has been incorporated with a capital of \$50,000 to manufacture refined oil products. The incorporators are Thomas P. Ryan, Spencer; Charles E. and William E. Hogg, Point Pleasant, W. Va.

THE LUCINDA REFINING Co., Lucinda, Pa., has been incorporated with a capital of \$200,000 to manufacture refined oil products. J. F. Eisworth, Lucinda, is treasurer.

THE NEW ERA CONCRETE TILE Co., Camden, N. J., has been incorporated with a capital of 2,500 shares of stock, no par value, to manufacture tile, blocks and other molded products. The incorporators are Charles A. and M. M. Smith, and George C. Rogers. The company is represented by David R. Rose, 522 Market St.

THE PENN-OLEAN Co., Olean, N. Y., has been incorporated with a capital of \$50,000 to manufacture refined oil products. The incorporators are H. C. and M. G. Fleming, and G. Forbes. The company is represented by A. J. Hastings, Olean.

THE CAMARILLO-DOME OIL Co., Ocean Park, Santa Monica, Cal., has been incorporated with a capital of \$50,000 to manufacture petroleum products. The incorporators are S. H. Bailey, George L. Adams and R. R. Robbin, Santa Monica. The company is represented by Tanner, Odell & Taft, attorneys, Santa Monica.

THE CENTRAL MAINE BRICK & STONE CORP., Fairfield, Me., has been incorporated with a capital of \$50,000 to manufacture brick and other burned clay products. Desire Baker is president; and William Seltzer, treasurer, both of Fairfield.

THE CHOCTAW COTTON OIL Co., New York, N. Y., has been incorporated under Delaware laws with capital of \$1,500,000 to manufacture cottonseed oil and other vegetable oils. The company is represented by A. W. Britton, 65 Cedar St.

THE NORTH METAL & CHEMICAL Co., York, Pa., has been incorporated with a capital of \$50,000 to manufacture chemicals and other products. H. B. North, York, is treasurer.

F. SCHOFIELD, INC., New York, N. Y., has been incorporated with a capital of \$100,000 to manufacture petroleum products. The incorporators are F. Schofield, G. Reda and H. S. Leman. The company is represented by H. N. Wessel, 45 Cedar St.

THE INTERBOROUGH OIL Co., New York, N. Y., has been incorporated with a capital of \$25,000 to manufacture refined oil products. The incorporators are H. L. Schwartz, L. M. and M. Block. The company is represented by S. Brandt, 347 Fifth Ave.

THE RED RIVER OIL SHALE Co., Clay City, Ky., has been incorporated with a capital of \$250,000 to construct and operate a new oil-distillation plant in this section. J. W. Lee, Clay City, is president.

THE CO-OPERATIVE PAINT Co., 1315 Dalsey Ave., Long Beach, Cal., has filed notice of organization to manufacture paints, varnishes, etc. The company is headed by E. A. Smith, W. H. McLean and George H. Evans, all of Long Beach.

Industrial Notes

THE ANTI-HYDRO WATERPROOFING Co., New York, has developed an applied hardener or flush-on, known as Armortop, for use on old floors or floors that are laid truly monolithic. Armortop is a liquid chemical compound that is diluted with equal parts of water and is applied with a brush.

E. S. CROSBY, sales and advertising manager for the United States & Cuban Allied Works Engineering Corp., has resigned to become manager of the Eastern district of the Celite Products Co., 11 Broadway, New York City.

THE BARRETT Co. announces that since Aug. 1 its offices have been in its new building, 40 Rector St., New York City.

THE GEORGE J. HAGAN Co., Pittsburgh, Pa., has just completed the erection of a modern steel factory building adjacent to its foundry at Orrville, Ohio. This building is to be used for construction and development work on all types of furnaces and furnace equipments.

THE AMERICAN BOSCH MAGNETO CORP., Springfield, Mass., announces that Roy Davey, who has been manager of the Detroit branch, is now acting as manager of the manufacturers' trade department.

Coming Meetings and Events

AMERICAN CERAMIC SOCIETY will hold its twenty-first annual meeting at St. Louis, Feb. 27 to March 2, 1922.

AMERICAN CHEMICAL SOCIETY, THE SOCIETY OF CHEMICAL INDUSTRY and the American Section of the latter society will hold a joint meeting in New York, Sept. 6 to 10.

AMERICAN GAS ASSOCIATION will hold its third annual convention in the Congress and Auditorium Hotels, Chicago, the week of Nov. 7.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in Lake Placid, N. Y., Sept. 29 and 30, and Oct. 1.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its annual winter meeting at Baltimore, Md., Dec. 6 to 9. Headquarters will be at the Southern Hotel and the sessions will be held in the Engineers' Club.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its fall meeting at Wilkes-Barre, Pa., Sept. 12 to 17.

AMERICAN MINING CONGRESS AND NATIONAL EXPOSITION OF MINES AND MINING EQUIPMENT will hold its twenty-fourth annual convention in the Coliseum, Chicago, Oct. 17 to 22.

AMERICAN PEAT SOCIETY will hold its fifteenth annual convention at the Hotel Commodore, New York City, Sept. 7, 8 and 9.

AMERICAN SOCIETY FOR STEEL TREATING will hold its third annual convention and exhibition Sept. 19 to 24 at Indianapolis.

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SEVENTH) will be held during the week of Sept. 12 in the Eighth Coast Artillery Armory, New York City.

NEW JERSEY CHEMICAL SOCIETY has discontinued meetings for the summer and will resume them in October.

SOCIETY OF CHEMICAL INDUSTRY (BRITISH) at the invitation of the Montreal section will hold its annual meeting in Montreal and other Canadian cities during the week of Aug. 29, 1921.

SOCIETY OF INDUSTRIAL ENGINEERS will hold its fall meeting at Springfield, Mass., Oct. 5 to 7.

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY will hold its fall convention with the American Pulp and Paper Mill Superintendents' Association, at Washington, Philadelphia, Spring Grove, York, York Haven, Pa., and Wilmington, Del., Oct. 18 to 20.

The following meetings are scheduled to be held in Rumford Hall, the Chemists' Club, New York: Oct. 7—American Chemical Society, regular meeting; Oct. 14—Société de Chimie Industrielle, regular meeting; Oct. 21—Society of Chemical Industry, Grasselli Medal; Nov. 11—American Chemical Society (in charge), Society of Chemical Industry, American Electrochemical Society, Société de Chimie Industrielle, joint meeting; Nov. 18—American Electrochemical Society, regular meeting; Dec. 2—Society of Chemical Industry, regular meeting; Dec. 9—American Chemical Society, regular meeting.

CHEMICAL & METALLURGICAL ENGINEERING

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A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY and IRON & STEEL MAGAZINE

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R. S. M. BRIDGE
CHARLES N. HULBERT
Assistant Editors
CHESTER H. JONES
Industrial Editor
J. S. NEGRO
Managing Editor

Volume 25

New York, August 31, 1921

Number 9

The Cover Of This Number

MANY minds have collaborated in the production of this number of CHEMICAL & METALLURGICAL ENGINEERING. Author, manufacturer, editor, printer, artist—each has contributed out of the abundance of his knowledge and resources to produce for the reader a work of exceptional utility. It is altogether fitting, therefore, that the cover should foreshadow the excellence of the contents. The reader will at once be struck with the keynote which Mr. HOOVER has contributed specially for this occasion. With clear vision he sees the loss to the human race “in goods and services” due to waste and inefficiency in our industrial processes; and though he addresses a profession characterized by inventive genius that has been responsible for much of the marvelous progress of our time, he nevertheless asserts that greater good will result from the elimination of waste in industry than from great inventions.

Typical of the improvements in technology that have increased efficiency and reduced waste are the illustrations of the methods of making nitric acid in AGRICOLA's time and today. The illustration of the crude firebox with its retorts and condensers, reproduced from the Hoover translation of AGRICOLA's *De Re Metallica*, is in sharp contrast to the modern plant shown in part in the adjoining picture.

For the border design the artist has appropriately adapted a decoration from old German pottery of the time when AGRICOLA flourished.

Elimination of Waste in Industry

WASTE and inefficiency are the twin evils that today threaten American industry from within. They are dangerous characteristics because of their insidious nature, and they are reprehensible because generally they are remediable. Blameworthy at all times, they are especially so when avoidable waste and increased efficiency offer the quickest and surest opportunities for reducing losses or increasing profits. The elimination of waste is something that is within our control if we but give thought to it, in contradistinction to those fundamental economic forces that work inexorably and against which it is useless for us to strive.

In casting about for an editorial theme for this annual number of CHEMICAL & METALLURGICAL ENGINEERING, it seemed both wise and appropriate to make a contribution to the elimination of industrial waste. The whole world is recovering from an orgy of economic waste followed by a revel in extravagance such as we have never seen. Heedless of warnings and forgetful of the lessons of other wars and periods of reconstruction, we have approached the very brink of industrial disaster. In some cases it was necessary to meet ruin face to face in order to recognize it. And much of this distress

occurred in the very presence of industrial wastes the removal of which would have alleviated conditions, if indeed it would not have remedied them. Mr. HOOVER was right when, through American Engineering Council, he directed a survey of industrial waste as the most important investigation engineers could undertake.

Our readers will find the theme treated editorially in a variety of phases. It is reflected throughout the advertising pages as well, because it lends itself to the message of progressive manufacturers. If waste should be at a minimum anywhere, it is in the technologic industries that are founded on science and engineering. And yet, as will be shown later, there are vast opportunities for improvement even in those that are best regulated.

The contents of this number will fall naturally into two classes—a series of major articles on topics of broad interest and application, and a collection of brief surveys of the outstanding causes of waste and inefficiency in more than a score of industries. The major symposium opens with a study of human waste—that intangible charge against industry which is gradually being reduced to definite terms. Human effort is the foundation of industry, and accordingly the problems of health, food, housing, sanitation and recreation become the problems of industry; and the factors of contentment, loyalty and confidence assume a hitherto unrecognized degree of importance. Dr. MOCK finds that we have been as prodigal of human life and limb as of natural resources, and his solution of the problem is found in co-operation between engineers and physicians. Dean KIMBALL of Cornell contributes a thoughtful article on waste due to poor engineering and management, discussing the waste of materials and labor and the elusive waste due to idle equipment. Lost time due to poor planning, and depreciation of material due to poor storage or unwise purchasing are direct charges against poor management.

It will be recalled that the report of American Engineering Council charged management with responsibility for 50 per cent of present industrial waste. In discussing in this number the educational waste in industry Dr. HOLLIS GODFREY boldly lays responsibility for this condition back upon our educational institutions, believing as he does that the waste due to management “never could exist had there been proper co-operation between colleges and industry in the past.” In his judgment “education is the salvation of industry,” and the college man, properly trained, is badly needed. The rôle of scientific research in waste elimination is ably presented by HARRISON E. HOWE, who shows the great need for fundamental research in pure science in order to lay the groundwork for industrial research. The fallacy of curtailing or abandoning research in times of industrial depression and the tremendous cost of this policy are strikingly elucidated.

Doubtless we shall have to talk about standardization of chemicals and trade specifications for some time before they are accomplished facts. Two phases of the waste due to lack of these things are ably presented in this number. WALLACE P. COHOE stresses the losses in raw materials and finished products which result from lack of careful standardization, and WELLINGTON GUSTIN lays bare the appalling waste in litigation arising from the same cause. Litigation seems to be an inevitable consequence of doing business, but it is the height of folly to invite it by failing to know in advance the basis on which business is being done. Without standardization and trade specifications, buyer and seller not only have no common ground on which to initiate business but they have no accepted authority to which they can turn in case of dispute. The consequence is a waste in litigation that is a considerable charge against industry.

Are you wasting time and production in your industry due to lack of personnel selection and training? If such a problem confronts you, you will find food for thought in the article by L. B. HOPKINS. Improper selection of personnel is responsible for the waste inherent in high labor turnover, and failure to recognize the value of training, transfer and promotion of deserving employees adds another unnecessary burden to industry. Of the same order of magnitude is the waste due to lack of efficient cost-accounting methods, as set forth by ERNEST J. WESSEN. In this connection it is refreshing to read that in devising an efficient system of cost-finding "a knowledge of engineering practice is indispensable." Familiarity with bookkeeping and clerical methods will not suffice.

Building construction is likely to be more active in the near future than it has been for some years past, and accordingly we may give thought profitably to the elimination of construction wastes. Mr. BURPEE gives us a comprehensive analysis of the preventable wastes in this important industry, reducing to dollars and cents the cost of such items as abnormal risk, accidents, labor turnover, restriction of output and manner of letting contracts. Having built our factories after much planning and effort, we are apparently lax in protecting the structures against fire hazard. Our country has an annual fire waste amounting to about a quarter of a billion dollars, according to figures given in the article by NICHOLAS RICHARDSON. His review of fire hazards should prove specially valuable to the chemical industry. A related cause of waste and loss, and one that has not received the consideration it needs, is the location of industrial plants. Out of a large experience V. V. KELSEY discusses the influence which a proposed industry will have on the community, and the accessibility of raw materials, transportation, labor and power.

Closely related to other phases of the human problem in industry is that of accident prevention. Mr. DEBLOIS shows how attention to this factor can reduce waste and increase efficiency. The industrial accidents of the chemical industry should be carefully studied and analyzed as a basis for future precautionary measures. Some accidents are due to poor lighting, as WARD HARRISON points out in his article on the waste due to poor illumination. But there are other wastes chargeable to this neglected factor: time, materials and production are lost for want of enough light properly distributed throughout the factory.

The importance of machinery—automatic machinery

—in modern industry has been emphasized of late by the scarcity of labor and the tendency toward restriction of output. Mr. HIRES makes an excellent case for automatic machinery as a substitute for hand labor, showing that it is at once more efficient and economical as well as superior in its product. Closely related to mechanical operations are the production and use of power. There is a double interest in the subject for the chemical industries, because they usually want heat as well as power, and the question will arise whether to purchase from a central station or install an individual power plant. DAVID MOFFAT MYERS answers this question in his article on elimination of waste in power plants.

The problem of distributing and marketing the products of manufacturers is ably discussed by WILLIAM R. BASSET, who shows that faulty marketing represents a waste that is an unnecessary deduction from profit. It frequently happens that the manufacturer is weakest in his knowledge of marketing methods. He may know how to buy raw materials, and we may assume that he manufactures his product efficiently and economically, but there is ample evidence that he fails woefully at times to adopt the best selling policy. Mr. BASSET's article discusses the subject from the point of view of the manufacturer.

The economic waste and nuisance inherent in the smoke, fume and gas discharged from industrial plants is a charge against industry that has been reiterated by investigators until it is pretty well understood by even the man on the street. A great deal is constantly being done to eliminate this waste, but a vast amount remains to be accomplished. For this reason Mr. LANDOLT's article is a welcome contribution to the symposium. His analysis of methods for reducing this economic waste will be helpful to many industries.

The relation of the patent situation to industrial waste may not be apparent at first glance, but when one stops to think of the needless delays, the interferences and the litigation which industry incurs due to a poorly manned Patent Office, no excuse need be made for including Mr. PRINDLE's forceful article in our treatment of this theme.

The series of short articles featuring the outstanding causes of waste and inefficiency in the industries will have a fascination for the reader because of their frankness, if for no other quality. We regard them, however, as valuable contributions on the part of men who are fully cognizant of technical and economic conditions internal to their respective industries. Some of the contributions are anonymous or offered under *noms de plume* for the reason that the authors felt they could thus speak more frankly. The value of their criticism, however, is not diminished, but rather enhanced, by failure to disclose their identity. On the whole we regard the symposium as a notable contribution of its kind.

The contents of this number will not be digested at one sitting, nor in a week or a month. The contributors are specialists and authorities, and have written out of a large experience. The magazine thus acquires a reference value out of the ordinary. Nor does this apply to the text pages alone; equally careful attention has been given to the preparation of the advertisements so that they form a very practical guide to the industry. The entire number will be worthy of preservation intact regardless of the reader's practice with respect to binding volumes.

Chemical Exposition for 1921 To Excel Its Predecessors

IT has been characteristic of the National Exposition of Chemical Industries that each annual exhibit surpassed the preceding one, both as to the number of exhibitors and amount of floor space covered. To this general rule the 1921 show will be no exception. The space occupied by exhibits will be considerably larger than in 1920 and the number of exhibitors will exceed those of a year ago by a small number. Various interpretations might be put on this record, but in view of prevailing industrial conditions we think it is a tribute to the stability of American chemical industries and to the inherent optimism of their executives. A year ago, in the face of impending business depression, exhibitors gladly committed themselves to participation in this year's exposition. There have been some additions to and some subtractions from the list since that time, but on the whole, preparation for this year's show has been carried out in the face of obstacles that would daunt a less courageous industry.

Many conditions this year will contribute to make the exposition more satisfactory to the visitor than in past years. In the first place, the use of the Eighth Coast Artillery Armory will make it possible to present the entire exposition on one floor. This is not only a great physical advantage, but it will have a tremendous psychological value in enabling the visitor to get a better conception of the magnitude of the show and the industry it represents. For the first time appropriate provision will be made for the technical sessions and display of industrial motion pictures. Hitherto speakers and audience at these sessions have been disturbed by the noise of moving machinery and the crowds, but this year they can enjoy the programs in a room well apart from the main exhibition floor. The technical sessions are growing in favor and improving in value and are coming to be recognized as an important feature of the exposition. This year there will be a number of interesting symposia on industrial subjects and some of the papers will be preprinted. Taken all together, the exposition this year will excel its predecessors and will be far more satisfactory from the point of view of the visitor.

Five Years of Legislative Waste

WASTE in government is as old as government itself and many methods have been proposed for its elimination. The investigations of congressional committees, the reorganization schemes of the Bureau of Efficiency and the Director of the Budget, the work of the joint commission on reclassification—all are steps in this direction which may be expected to accomplish many worth-while savings. As long, however, as the lion's share of our appropriations continues to be spent for the upkeep of the Government's fixed establishments of Army and Navy, the economies effected by these agencies must necessarily be limited.

There is a source of waste in government which we hear less about but which cannot have escaped the attention of those who have followed the efforts to obtain protective legislation for the dye industry. The first genuine attempt on the part of the chemists of the country to obtain recognition for this important industry was in 1916 and the history of what has transpired since that time is a record of disappointing delays and

discouraging wastes of time and effort. Progress has been extremely slow and the occasional successes accomplished have been only temporary. For five years the industry has had to keep up a continuous battle. It has been necessary to tell its story many times and in many places. Its case has been argued before the Ways and Means Committee on at least four separate occasions and each time the case has been retried before the Senate Finance Committee. Many volumes of testimony have been recorded and printed by each committee notwithstanding the fact that few if any new arguments were advanced at the subsequent hearings.

For the benefit of those who have not followed the details of these legislative activities, let us review them briefly. The measure previously referred to was passed by Congress on September 8, 1916. It had been sponsored by a committee of the American Chemical Society and in its final form it provided slightly increased duties on dyes and intermediates for a period of five years. It was soon evident, however, that the new law was unsatisfactory in many ways and in December, 1918, the Tariff Commission officially called attention to the urgent need for its revision. In May, 1919, President WILSON in his annual message to Congress declared that "special consideration should be given to the manufacture of dyestuffs and related chemicals." A few days later the original Longworth bill was introduced and was referred to the Ways and Means Committee and extended hearings were held. At that time Army and Navy representatives testified to the importance of the industry from the standpoint of national preparedness. Shortly afterward a second bill was reported and referred to the committee for hearings. Finally, in September, 1919, the Longworth dye-licensing bill was passed by the House and, following the usual procedure, was sent to the Senate Finance Committee, which devoted several months to hearings on the subject. In the meantime the President's message to the Sixty-sixth Congress had repeated the earlier appeal for special dye legislation. In February, 1920, the modified selective embargo was reported to the Senate, but three months later it was defeated without a vote principally because of the persistent filibuster by Senators THOMAS and MOSES. Early in the present year the Ways and Means Committee held hearings on the general tariff revision and on June 29 reported the Fordney tariff. Before this measure was passed, on July 21, it will be recalled, the House eliminated the dye embargo, due largely to Congressman FREAR's insistence that a monopoly was being fostered. And now the Senate Finance Committee has just concluded another series of open hearings and, although the chemists have again made a strong appeal for the industry, the embargo question, still unsettled, has been referred to a joint sub-committee.

Such is the story of the dye bill—a measure which has been recognized as essential to the national defense, a non-political question supported by free trader and protectionist alike. Five years has elapsed and nothing permanent has been accomplished. Hearings have followed hearings, licenses and embargoes have been discussed and discarded, wartime control of imports has been extended and re-extended, and we now find ourselves just about where we started. It is obvious that our law-making processes are truly wasteful.

After such a condemnation of our legislative system, we should like to suggest a practical remedy. We hesitate, however, to approve the theoretical solution which

is so often proposed—viz.: Take the tariff out of politics; put it into the hands of a non-partisan tariff commission and give that body complete authority to deal with all tariff matters. If the tariff were more of an economic problem and less of a political factor, such a change might perhaps be accomplished. A compromise solution which appears to us to have some advantages over the present system would be to let the Tariff Commission take over all of the investigational work of the tariff and conduct all tariff hearings. The facts presented to Congress by this impartial body would then be used as the basis for our tariff legislation. The wasteful duplication of hearings and needless political debate would thus be eliminated and with this much accomplished we could look forward to more radical changes in our legislative processes.

The Man on The Firing Line

IN THE preparation of that part of this number which tells of the outstanding causes of waste and inefficiency in a score or more of industries we have naturally had a great deal of correspondence. Our effort has been to select the man available who is best equipped in each case and then to give him a free rein. It has seemed to us that this would be of greater value to our subscribers and more profitable to them than to wind ourselves up in rhetoric over the bigness, the grandeur—over what LAFCADIO HEARN once called “the ahness” of American chemical enterprise.

We wrote, among others, to a leading technologist who replied as follows:

Please excuse me from writing on the causes of waste and inefficiency in the — industry. A man on the firing line cannot comprehensively report a battle. He is too close and his vision is too limited. For that very reason I shall all the more appreciate the articles of those who have a broader vision or who can view the scene at a better perspective.

There would seem to be an anomaly in this, that the man on the job every day should fail to see that which is obvious to the stranger or the more casual observer. But we appreciate his point of view. It is not alone with distant forests that we cannot see the trees for the woods. We suffer a similar inhibition among familiar things that are right before our eyes. When a thing is settled, a problem solved and things are working smoothly, we naturally close our minds to further worry over the subject and address our attention to those things which we believe need it. The single-track mind is the usual mind, and we know well that our best method is to do one thing at a time and to strive to do it well. Then it is likely to happen that certain features which have had attention and have been adjusted in times past suffer from neglect because in the march of progress they have been overlooked. That which two years ago seemed excellent is not good enough for today. And the man responsible does not realize it. There is not a person alive who is up to date in every respect.

It is therefore very profitable for men on the firing line to have their work looked over occasionally. A critical audit of a plant is as important as an audit of books. There is no establishment so well run as to be beyond criticism or incapable of improvement from it. Whoever thinks that he has achieved perfection or that his work is above criticism is, by that very token, a back number. He has lost his scientific spectacles if he thinks so.

Chemical Supremacy With English-Speaking People

A HEARTY welcome is extended to British and Canadian chemists representing the Society of Chemical Industry who expect to spend the next two weeks in the United States. This will afford an opportunity for exchange of views and opinions and for a more intimate knowledge of chemical and industrial conditions on the part of hosts and visitors. These international visits are better guarantees of peace and amity than are treaties concluded by statesmen and diplomats.

But there is a deeper significance in the conclave of British, Canadian and American chemists in New York next week than will appear in the mere fraternizing of men who are already more or less well known to each other by reputation or through correspondence. True, the British have crossed the water, which is in itself no mean undertaking in these piping times of peace and reconstruction. And Canada is putting her best chemical foot forward, as befits a hostess who would honor eminent guests that have journeyed far in the name of the Society of Chemical Industry. And finally, British and Canadians will converge upon New York to meet with the American Chemical Society and visit the Chemical Exposition. The bare incidents are noteworthy, but in our judgment they mark an epoch. This international meeting of chemists lays the foundation for the recognition of chemical supremacy in the English-speaking people.

We might almost speak of the restoration of chemical leadership to the Anglo-Saxon race, for the early history of the science abounds in names of English rather than of Gallic or Teutonic investigators. Curiously enough, the diligence and industry of the Teuton in applying the fundamental discoveries and developments of his neighbors earned for him the reputation of being the repository of all chemical knowledge. And he capitalized on this reputation through his literature and universities, until it required a great war to disillusion the rest of the world and awaken a sense of equality and independence in science, particularly chemistry.

Signs are not lacking that the old order changeth, one of which is the fact that no longer are we dependent on German chemical literature for knowledge of what is being done by, say, Russian or Japanese investigators. As DR. BENJAMIN T. BROOKS points out in private correspondence, an increasing proportion of research and investigation done in foreign countries is being published in English, whereas formerly the German language was the medium through which most of us acquainted ourselves with the work originally published in Russian, Scandinavian, Dutch or Italian. German has been the accepted language of international chemistry, much as French has served in international diplomacy. Our own *Chemical Abstracts*, however, now presents abstracts directly from Russian and Japanese publications, and doubtless the work will be extended to the point where former dependence on *Chemisches Centralblatt* will be a vanishing quantity.

This is but one of the factors contributing to English-speaking leadership in chemistry, which is a consummation that, in our judgment, will come in due course. The international gathering of chemists in New York should be another powerful impetus toward the same end, and we express the hope that these benign forces may continue to act until English merits the distinction of being the international language of chemistry.



OFFICERS AND SOME OF THE VISITORS AT THE MONTREAL MEETING, WEEK OF AUG. 29, 1921, OF THE SOCIETY OF CHEMICAL INDUSTRY (BRITISH) AND AT THE NEW YORK CITY JOINT MEETING, WEEK OF SEPT. 6, 1921, OF THE AMERICAN CHEMICAL SOCIETY AND OF THE SOCIETY OF CHEMICAL INDUSTRY

1—Sir William J. Pope, president of the Society of Chemical Industry.
 2—R. F. Ruttan of Montreal, president-elect of the Society of Chemical Industry.
 3—S. R. Church of New York City, member of the co-ordinate committee for the joint meeting at New York of the American Chemical Society and of the Society of Chemical Industry.
 4—J. P. Longstaff, Secretary of the Society of Chemical Industry.
 5—E. V. Evans, honorary treasurer of the Society of Chemical Industry.

6—F. W. Atack, Editor of Chemists' Year Book.
 7—R. H. Clayton of the Manchester Oxide Co.
 8—F. W. Gamble, of Allen & Hamburg, Ltd.
 9—C. S. Garland, chairman of Lighting Trades, Ltd.
 10—Captain C. J. Goodwin, honorary treasurer of the Chemical Industry Club of London.
 11—L. A. Jordan of the British Nylonite Co., Ltd.

12—J. D. McBain, professor of physical chemistry at the University of Bristol.
 13—J. MacWilliam, consulting metallurgist, of Sheffield.
 14—H. W. Matheson, vice-president of the Canadian Electric Products, Ltd.
 15—J. Reid of the Caldercruix Paper Mills, Airdrie, Scotland.
 16—Andrew Smith, managing director of Leech, Neal & Co., Ltd.
 17—T. H. Wardleworth, of Canada, member of the General Council of the Society of Chemical Industry.

Program of the Exposition

Symposia Prepared by the Management on Crushing, Grinding and Pulverizing, Evaporating and Drying, Paint and Varnish, Power Plant in the Chemical Industries, and American Dyes—
Motion Pictures of a Wide Variety of Industrial Operations

FOLLOWING is the program of the Seventh National Exposition of Chemical Industries, to be held at the Eighth Coast Artillery Armory, Kingsbridge Rd. and Jerome Av., New York City, Sept. 12 to 17. The program as given here is subject to changes and additions:

MONDAY, SEPT. 12

2 p.m. Exposition opens.

7 p.m. Motion pictures (in Auditorium).

1. "Iron Mining Operations" (4 reels), courtesy U.S.B.M.*
 - a. Stripping.
 - b. Exploration and stripping.
 - c. Underground mining.
 - d. Logging operations.
2. "The Story of Abrasives" (4 reels), courtesy the Carborundum Co. and U.S.B.M.
 - a. Creating power from water.
 - b. Within the power plant at Niagara.
 - c. In and about the City of Niagara Falls.
 - d. Power at work in the Carborundum Plant.
 - e. Making the crystal masses in the electric furnace
 - f. and making them into stones, grinding wheels, paper and cloth.
 - g. Unusual and usual uses for abrasives in fifty industries.

8 p.m. Opening addresses.

Dr. Charles H. Herty, opening address.

Hon. Irvine L. Lenroot, United States Senator.

General Amos A. Fries, Chief, Chemical Warfare Service.

TUESDAY, SEPT. 13

2:30 p.m. Crushing, grinding and pulverizing symposium.
Chairman, Harry J. Wolf.

- H. F. Kleinfeldt, Abbe Engineering Co., "Ball and Pebble Milling for Pulverizing and Mixing."
S. B. Kanowitz, Raymond Bros. Impact Pulverizer Co., "Grinding and Pulverizing With Air Separation."
L. H. Sturtevant, Sturtevant Mill Co., "Crushing, Storing and Pulverizing."
M. I. Dorfan, Allis-Chalmers Manufacturing Co., "Dust Collection as Applied to Grinding and Pulverizing Problems."

H. Schifflin, Allis-Chalmers Manufacturing Co., "The Development of Compound Grinding Mills."

G. W. Repetti, the Dorr Co., "Mechanical Handling of Finely Ground Wet Material."

Industrial Problems:

H. Austin, Ernest Scott & Co., "Solvent Extraction of Edible Fats and Oils."

R. H. McLain, General Electric Co., "Materials Handling in Industrial Plants."

W. H. Dickerson, Industrial Products Co., "Utilization of Industrial Waste; Its Economic Importance."

To be followed by motion pictures upon the subject of the handling of materials if time permits. See the first four titles upon the evening program.

7 p.m. Motion pictures.

1. "Transportation and Storage of Iron Ore" (1 reel), courtesy U.S.B.M.
2. "The Story of Asbestos" (4 reels), courtesy U.S.B.M.
3. "Dredging Anthracite Coal" (1 reel), courtesy U.S.B.M.

4. "Saving Wasted Millions Through Material Handling Equipment" (2 reels), courtesy Economy Engineering Co.

5. "The Story of Sulphur" (2 reels), courtesy Texas Gulf Sulphur Co.

6. "Mining and Extraction of Radium From Carnotite Ore" (2 reels), courtesy U.S.B.M.

7. "DuPont Dyes," showing their manufacture (2 reels), courtesy du Pont de Nemours & Co.

8. "Making Soap" (1 reel), courtesy Baumer Films.

9. "Mine Explosion and Rescue" (1 reel), courtesy U.S.B.M.

8 p.m. Address, Hon. Fred S. Purnell, Representative from Indiana.

WEDNESDAY, SEPT. 14

2:30 p.m. Evaporating and drying symposium.
Chairman, Wallace Savage.

E. G. Rippel, Buffalo Foundry & Machine Co.

A. E. Stacy, Jr., Carrier Engineering Corporation, "The Relation of Atmospheric Conditions to Chemical Processes."

H. S. Landell, Proctor & Schwartz, "Drying and Dying Problems."

Max Donauer, Elyria Enameled Products Co., "Special Problems for Enameled Evaporators."

Arthur B. Stonex, Hunter Dry Kiln Co., "Drying With Moist Air."

A. W. Lissauer, W. L. Fleisher & Co., Inc., "Drying as an Air-Conditioning Problem."

J. D. Stein, Grinnell Co., Drier Division, "Atmospheric Drying by Means of Compartment, Tunnel and Continuous Belt Conveyor Driers With Some Practical Applications."

W. H. Dickerson, Industrial Waste Products Co., "Spray Drying."

H. Austin, Ernest Scott & So., "Evaporation."

Robert V. Cook, Chemical Equipment Co., "The Criss-Cross Evaporator: Why It Was Designed, What It Is, and What It Does."

J. S. Chen, J. P. Devine Co., "Vacuum as Applied to Industry."

7 p.m. Motion pictures.

1. "The Manufacture of Dry Sausage" (2 reels), courtesy Armour & Co.

2. "The Making of Oleomargarine" (1 reel), courtesy Armour & Co.

3. "The Electric Heart—The Dry Cell" (1 reel), courtesy Baumer Films.

4. "Canning Electricity—The Wet Cell" (1 reel), courtesy Baumer Films.

5. "The Manufacture of Pyrex Glassware" (3 reels), courtesy Corning Glass Co.

6. "The Manufacture of Portland Cement" (2 reels), courtesy U.S.B.M.

7. "The Manufacture of Dynamite" (1 reel), courtesy U.S.B.M.

8. "Exterminate the Mosquito" (1 reel), courtesy U.S.B.M.

THURSDAY, SEPT. 15, PAINT AND VARNISH DAY

2 p.m. Paint and Varnish Symposium.

Chairman, R. S. Perry, Perry & Webster, Inc., "Paint and Varnish Waste Control."

H. A. Gardner, Institute of Paint and Varnish Research, "Reflection Factors on Industrial Paints."

*NOTE: "U.S.B.M." on this program refers to United States Bureau of Mines.

SATURDAY, SEPT 17

L. P. Nemzek, du Pont de Nemours & Co., "Laboratory Control."

Maximilian Toch, Toch Bros., "Rust: Its Cause and Prevention."

Frank G. Breyer, New Jersey Zinc Co., "Physical Testing of Paints and Paint Materials."

F. P. Ingalls, John W. Masury & Co., "The Ideal Paint and Varnish Specifications."

D. A. Kohr, Lowe Bros. Co., "Limitations of Standardization of Paint and Varnish Manufacture."

7 p.m. Save the surface; paint and varnish speakers and motion pictures.

Ernest T. Trigg, chairman, "Save the Surface" Committee, Paint Manufacturers Association of the U. S., "Save the Surface and You Save All With Paint and Varnish."

G. P. Heckel, secretary, Paint Manufacturers Association of the U. S., "What Is Paint?"

To be followed by motion pictures.

1. "Making White Lead" (2 reels), courtesy Bureau of Commercial Economics and National Lead Co.
2. "Making of Varnish" (1 reel), courtesy Bureau of Commercial Economics and Murphy Varnish Co.
3. "Making of Paint and Varnish" (2 reels), courtesy Bureau of Commercial Economics and Sherwin-Williams Co.
4. "Making of Paint" (1 reel), courtesy Bureau of Commercial Economics and Lowe Bros.
5. "Making of Paint" (1 reel), courtesy Bureau of Commercial Economics and Mathews & Co.
6. "Making of Varnish" (1 reel), courtesy Bureau of Commercial Economics and Taylor, Tregent & Co.
7. "The Manufacture of Pyrex Glassware" (3 reels), courtesy Corning Glass Co.
8. "The Manufacture of Portland Cement" (2 reels), courtesy U.S.B.M.

FRIDAY, SEPT. 16

2:30 p.m. The Power Plant in the Chemical Industries Symposium.

Chairman, R. C. Beadle, Editor, *Combustion*.

R. M. Gordon, the Solvay Process Co., "Modern Boiler House Arrangement and Equipment" (illustrated).

John Primrose, Power Specialty Co., "Suggestions for Reducing Heat Losses in Chemical Plants."

E. C. Bashore, Rice & Bashore, "Boiler Feed Water Treatment and Treatment Control."

A. R. Stevenson, Jr., General Electric Co., "Compressed Air Installations in Industrial Plants."

D. B. Rushmore, J. A. Seede and E. Pragst, General Electric Co., "The Application of Electric Power in Chemical Industry."

F. G. Anderson, Morse Chain Co., "The Limitation of Silent Chain Drive."

D. S. Chamberlain, Distillation Industries, Inc., "A New Method for Coking Coal as Required for Industrial Fuel."

H. S. Savage, Combustion Engineering Co., "The Application of Pulverized Fuel."

Perry West, Anti-Corrosion Engineering Co., "The Prevention of Internal Corrosion in Pipes, Tanks and Other Iron and Steel Equipment."

7 p.m. Motion pictures.

1. "The Cost of Careless Firing" (2 reels), courtesy U.S.B.M.
2. "Getting the Most Out of Coal" (1 reel), courtesy U.S.B.M.
3. "Conserving Coal and Saving Heat Values by Insulating Steam Pipes and Boilers" (1 reel), courtesy Magnesia Association of America.
4. "Modern Byproduct Coking" (2 reels), courtesy the Koppers Co.
5. "The Story of Rock Drilling" (4 reels), courtesy Sullivan Machinery Co., and U.S.B.M.
6. "The Story of Armco Ingot Iron" (3 reels), courtesy American Rolling Mill Co.

2:30 p.m. American Dyes Symposium.

Chairman, Justin B. Weddell, Nat'l Aniline & Chem. Co.

"Early History of the Dye Industry."

"Marvels of Modern Chemistry."

"Practical Dyeing Problems."

"Color Harmony in Textiles."

"The Relation of Color to the Theater."

"World Disarmament and the Necessity of an Independent American Dye and Chemical Industry."

"Is There an American Dye Monopoly?"

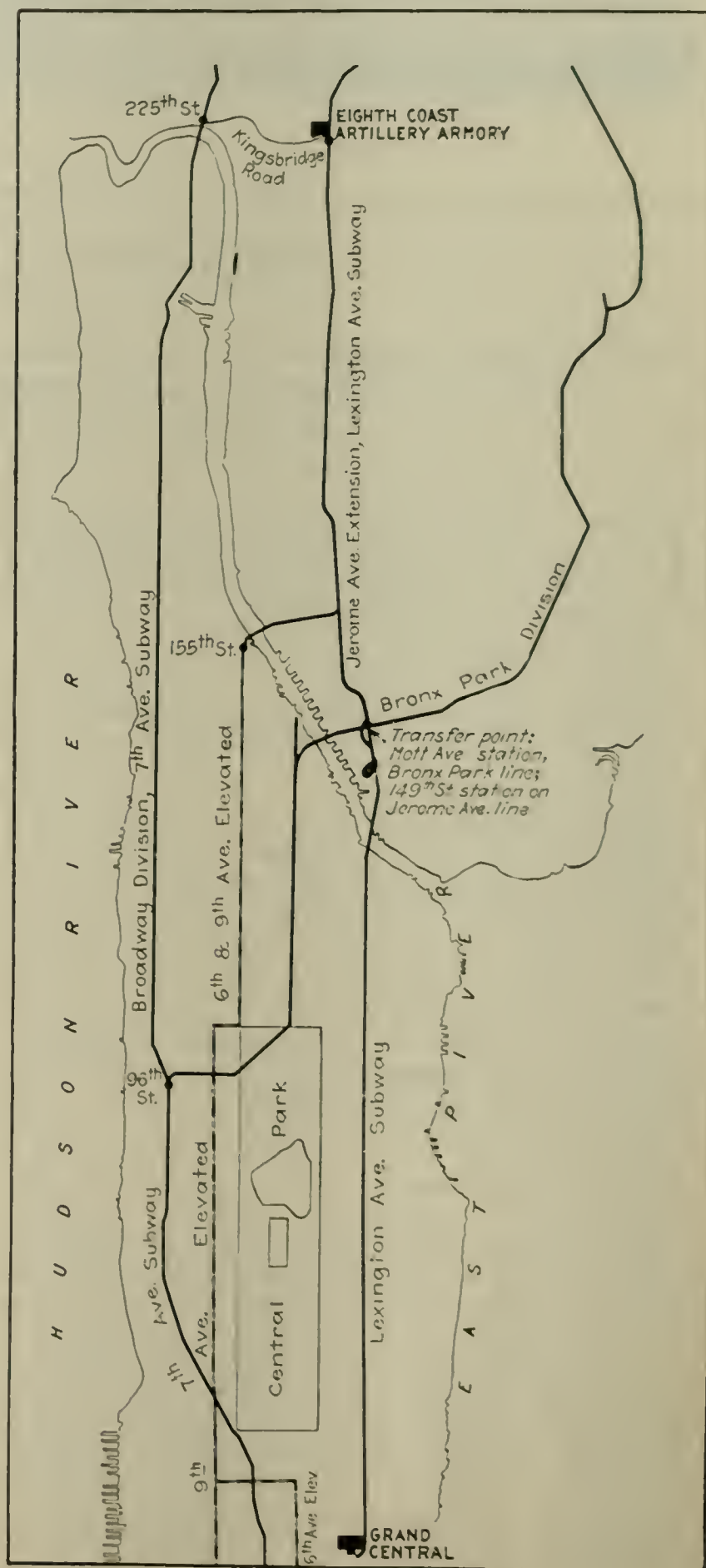
7 p.m. Motion pictures (subject to change).

1. "Manufacture of Newsprint Paper" (5 reels), courtesy Spanish River Pulp & Paper Mills.

2. "Making du Pont Dyes" (2 reels), courtesy du Pont Co.

3. "Manufacture of Dynamite" (1 reel), courtesy U.S.B.M.

4. "Mining Magnetic Iron Ore" (2 reels), U.S.B.M.





EIGHTH COAST ARTILLERY ARMORY, KINGSBRIDGE ROAD AND JEROME AVENUE

Exhibitors at the Exhibition

A Brief Catalogue of the Products and Equipment to Be Exhibited at the Seventh National Exposition of Chemical Industries, Together With the Names of the Four Hundred Exhibitors and the Representatives in Charge of Their Exhibits

THE following scientific societies and publications have reserved booths for the Seventh National Exposition of Chemical Industries, where they will be glad to receive their friends.

AMERICAN CERAMIC SOCIETY.
 AMERICAN CHEMICAL SOCIETY.
 AMERICAN DYESTUFF REPORTER.
 AMERICAN PERFUMER AND ESSENTIAL OIL REVIEW.
 CANADIAN CHEMISTRY AND METALLURGY.
 CANADIAN MINING JOURNAL.
 CHEMICAL AGE.
 CANADIAN TEXTILE JOURNAL.
 CHEMICAL CATALOG.
 CHEMICAL COLOR AND OIL RECORD.
 CHEMICAL & METALLURGICAL ENGINEERING.
 COLOR TRADE JOURNAL.
 COMBUSTION.
 DRUG & CHEMICAL MARKETS.
 INDUSTRIAL AND EDUCATIONAL PRESS.
 IRON & STEEL OF CANADA.
 JOURNAL OF COMMERCE.
 JOURNAL OF INDUSTRIAL AND ENGINEERING CHEMISTRY.
 MANUFACTURERS RECORD.
 OIL, PAINT AND DRUG REPORTER.
 PAPER MILL AND WOOD PULP NEWS.
 PULP & PAPER MAGAZINE OF CANADA.
 TEXTILE COLORIST.
 TEXTILE WORLD JOURNAL.
 TEXTILES.

The following list of exhibitors at the Exposition, together with a brief statement of their exhibits and the names of their representatives, will be of special value to those who expect to attend the Exposition. It is published well in advance in order to enable prospective visitors to conserve their time and to give their attention to those matters in which they are particularly interested. The list is practically complete. Where no description of exhibit is given, the information requested was not furnished or arrived too late for publication. No attempt has been made to give booth numbers or location in the Armory, because these will

be more easily obtained from the handbook and guide which will be distributed at the Exposition with the compliments of CHEMICAL & METALLURGICAL ENGINEERING.

ABBÉ, PAUL O., INC.—Pulverizing, grinding, crushing, and cutting machinery. Represented by Henry Sellman and John Buckley.

ABBÉ ENGINEERING Co.—Grinding and pulverizing machinery. Represented by H. F. Kleinfeldt and A. T. Beach, Jr.

ABERNETHY, JOHN F.—Lead burning, lead-lined tanks, acid containers made of lead, lead condensing coils, and various other chemical equipment of lead. Represented by John F. Abernethy and John J. Kiernan.

ACID-PROOF CLAY PRODUCTS Co.—Acid-proof chemical stoneware, including storage vessels, tower sections, faucets and piping in the various designs. Represented by N. E. Hansen and J. E. Cooper.

AINSWORTH, WILLIAM, & SONS.—Analytical balances with improved rider and weight carriers of the latest types, and an assay balance with reflection reading device sensitive to 1/1000 mg. Represented by W. H. Smith.

ALBANY CHEMICAL Co.—Solvent specialties and pharmaceutical products. Represented by K. E. Schoeneman and Edward S. Wright.

ALBERENE STONE Co.—Standard fixtures and equipment for research and educational laboratories, including a complete line of Alberene stone chemical hoods, sinks, drain boards, table tops, gutters and reagent shelves. Represented by A. Y. Meeker, F. E. Healy, W. K. Fields, E. C. Collins, Wesley Heins, R. G. Grothe, F. R. Nichols and N. N. Moneypenny, Jr.

ALBERGER CHEMICAL MACHINERY Co., INC.

ALLIS-CHALMERS MFG. Co., INC.—Operating models of dust collector, pulverator, motor-driven bronze pump, rubber-lined pump, direct current and induction motors, and air compressors. Represented by A. F. Rolf, W. E. Keine, M. I. Dorfan, T. Pilger, H. W. Dennison, A. J. Cooper, F. J. Geiger, O. H. Hentz, W. C. MacEwen, C. H. Paine, George Baiz, W. O. Taylor and W. H. Wolf.

AMERICAN CHEMICAL & MFG. Co.

AMERICAN COAL CHUTE Co.

AMERICAN CYANAMID Co.—Cyanamide, cyanide, liquid hydrocyanic acid, ferrocyanides, urea, dicyandiamide, am-

monia, ammonium phosphate, ammonium sulphate, ammonium nitrate, and nitric acid. Represented by E. J. Pranke, R. R. Stewart, F. S. Washburn, Jr., G. Thorn and A. E. Downes.

AMERICAN HARD RUBBER Co.—Chemical handling and conveyance equipment of hard rubber, including pumps, pipe fittings, tanks and utensils. Represented by A. M. Ackerman and D. W. Wilkins.

AMERICAN LAFRANCE FIRE ENGINE Co., INC.—Industrial safety devices, including the latest developments in breathing and eye protection for workers in chemical factories. Represented by James W. Knoblock, Arthur B. Crossman, R. C. Engels and J. E. Egan.

AMERICAN MANGANESE BRONZE Co.—The exhibit will show results of acid tests on various kinds of bronze castings and forgings used in the chemical trade, particularly those for centrifugals, valves and special castings made for sugar machinery. Represented by C. H. Spare, C. J. Bower and T. H. Addie.

AMERICAN METAL PRODUCTS Co.—A line of acid-resisting valves and fittings, rolled sheet and forged bronze, and bronze castings. Represented by C. J. Zaizer and A. S. Knowlton.

AMERICAN STEAM PUMP Co.

AMERICAN STEEL & WIRE Co.

AMERICAN WATER SOFTENER Co.—Model of pressure type filter and Decalso Zeolite type water softener; also a complete line of lime and soda water softeners. Represented by A. S. Garrett, W. T. Runcie, G. M. Graybill, J. B. Price and George F. Hodgkinson.

ANACONDA COPPER MINING Co.—An exhibit to illustrate the smelting and refining of copper, starting with ore and following through the various processes to the refined article. The various valuable byproducts, metals and chemicals obtained in the electrolytic refining of copper are shown. Other features of the exhibit will show the various applications of copper, and display Anaconda white lead made by the electrolytic process, and Anaconda fertilizer, the treble superphosphate, containing 48 per cent P_2O_5 . The products of the following subsidiaries will also be shown: Anaconda Lead Products Co., Anaconda Rolling Mills Dept., International Smelting Co., Raritan Copper Works and United Metals Selling Co. Represented by S. Skowronski and J. A. Dowdy.

ANGEL, H. REEVES, & Co.

ANTI-CORROSION ENGINEERING Co., INC.—Apparatus for treating water so as to make it non-corrosive to iron and steel pipe, tanks and other equipment. Represented by J. Wright Reeve and A. B. Christen.

ANTI-HYDRO WATERPROOFING Co.—Protective covering for concrete and cement masonry which is subject to direct contact with acids, alkalis, oils and various chemicals. Represented by B. A. Meyer, M. W. Meyer, Mrs. M. D. Hausling, T. Moore, W. C. Kober, C. A. Brown, M. E. Townsend and B. E. Lamphier.

APEX CHEMICAL Co., INC.—Industrial chemical products for the textile, leather and fur-dyeing industries and the manufacture of rubber, printing ink and allied products. Represented by S. M. Hermann, Hugo Helburn, Charles B. Rasenberger and Herman Rothstein.

ARKELL SAFETY BAG Co.—Elastic paper linings for barrels, bags, boxes and drums. Represented by P. J. Morales.

ARMSTRONG CORK Co.—Insulating brick to prevent loss of heat from furnaces, ovens, boiler settings, kilns and other high-temperature equipment; insulation covering for high-pressure and superheated steam lines, tanks, feed-water heaters, evaporators, electrically-heated ovens and hot surfaces; and cork coverings for brine and ammonia lines, cold-storage rooms and other installations where low and constant temperatures are required. Represented by S. L. Barnes.

ARNOLD, HOFFMAN & Co., INC.—Oils, water softeners, gums, starches, dextrines, pigment colors, caustic soda and liquid chlorine. Represented by H. H. Hall, W. R. Metcalfe, C. L. Berntson, G. D. Curtis, H. P. Geier and E. Siedenburgh.

ATLANTIC ENGINEERING Co.

ATLAS ELECTRIC DEVICES Co., INC.—Apparatus for testing colored, printed and dyed material against the fading action of sunlight. Represented by C. W. Jameson and H. S. Thayer.

ATOMIZED PRODUCTS CORPORATION.

AVERY ROCK SALT MINING Co.

BACHMEIER & Co., INC.—Applications and methods for the practical uses of dyes, including the exhibit of a new wood pulp paper card, and silk, leather, acid and chrome woolen sample cards. Represented by W. C. Baur, H. A. Tourrelle, William Lindemann, Henry J. Repp, G. Marston Lord and Henry Gettler.

BAINSON Co., THE.

BAILEY METER Co.—Various types of Bailey fluid meters for measuring steam, water, gases and chemicals; V-notch weir meters having capacity of 60,000 lb. per. hr.; specific gravity recorders, draft gages and a differential gas pressure recorder accurate to 1/10,000 in. of water. Represented by E. G. Bailey.

BAKER & Co., INC.—Platinum laboratory ware and apparatus for chemical purposes; platinum, gold and silver and other precious metals. Represented by E. H. Pelletreau, H. Klausmann and Harold Whitehead.

BAKER, J. T., CHEMICAL Co.—Exhibit of "Baker's Analyzed Chemicals." Represented by W. P. Fitzgerald.

BAKER, JOSEPH, SONS & PERKINS Co., INC.—Laboratory and commercial mixing machines for dry powder and liquid work. Represented by A. Vollrath, J. C. Caley and S. D. Gridley.

BARBER ASPHALT PAVING Co.—Acid-proofing qualities of mastic flooring and exhibits of native lake asphalts and compounds. Represented by F. F. Massey, Theodore Thomas, C. N. Forrest, J. S. Miller, J. A. Topping, H. C. Hottel and F. J. O'Neill.

BARRETT Co., THE.—This company's exhibit will form a part of the general exhibit of the Allied Chemical & Dye Corporation.

BAUSCH & LOMB OPTICAL Co.—Chemical, metallurgical and binocular microscopes, metallographic equipment, optical measuring instruments, including colorimeters, refractometers and saccharimeters. Represented by C. L. Oswald and E. H. Anthes.

BEACH-RUSS Co.—High vacuum pumps, heavy liquid pumps, acid pumps, rotary air compressors and gas boosters. Represented by H. C. Russ and C. A. Beach.

BECKER, A. J.—Special types of carboy carriers and wooden carboy packages. Represented by Messrs. Becker, Barnes, Chuster and Boon.

BECKER, CHRISTIAN, INC.—Analytical chainomatic balances, specific gravity chainomatic balances, bullion and torsion scales. Represented by W. C. Symington, A. T. Millroy, J. W. Wetz, J. K. Dunn and S. W. Hess.

BECKLEY PERFORATING Co.—Perforated metals, welded tanks, sheet metal work, perforated monel metal agitator and coil tanks and monel metal varnish kettles. Represented by F. P. Huston, T. R. Harvey and T. P. Carlson.

BELLE ALKALI Co.—This company's products are exhibited in the booth of Arnold, Hoffman & Co., Inc.

BETHLEHEM FOUNDRY & MACHINE Co.—Chemical apparatus such as sulphonators, autoclaves, nitrators, etc., made of special non-corrosive iron. Represented by Robert E. Wilbur, J. George Lehman, A. H. Stevens, R. H. Stevens, A. O. Hartley, George Ettele, S. O. Solt, C. E. Volkhardt and R. W. Fluck.

BLACKMER ROTARY PUMP Co.—Various types of solid and lined rotary pumps. Represented by A. L. Rock and F. F. Goertz.

BLACKISTON'S SON, P., & Co.—Publications on chemistry and allied sciences. Represented by Walter B. Hilt.

BLAW-KNOX Co.—Forge and hammer welding process for the manufacture of homogeneous steel-plate vessels, clam-shell buckets for rehandling material and for excavating, etc. Also a general line of furnace appliances, sectional steel buildings and materials for general construction. Represented by William C. Coffin and D. C. Grove.

BOYER, KIENLE Co., INC.—A complete line of seed and nut oils, together with byproducts. Represented by J. R. C. Boyer and Charles F. Kienle, Jr.

BRISTOL Co., THE—Recording instruments, including pressure and vacuum gages, liquid level gages, thermometers, pyrometers, psychrometers, voltmeters, millivoltmeters, ammeters, shunt ammeters, wattmeters, frequency meters, electrical and mechanical time recorders, etc. Represented by H. L. Griggs.

BRITISH AMERICAN NICKEL CORPORATION, LTD.

BROWN INSTRUMENT Co.—High- and low-temperature measuring instruments, including indicating and recording pyrometers, recording thermometers, resistance thermometers, indicating and recording instruments for pressure, vacuum, time and operation. Represented by J. P. Goheen, G. W. Keller, J. D. Andrews, George Goodman, M. J. Hess, S. G. Ketterer, V. VanVliet and M. H. Leister.

BUCKMAN & PRITCHARD, INC.—Commercial articles made from zirconium silicate, including refractory bricks, cupola blocks, various sized crucibles, spark plug porcelains, high-tension insulators, electric heater units, pyrometer protection tubes and chemical ware. Represented by H. H. Buckman and G. A. Pritchard.

BUFFALO FOUNDRY & MACHINE Co.—A full line of vacuum driers, evaporators, chemical apparatus, sugar apparatus,

etc., showing new developments in Buflovak and Buflokast apparatus. Represented by E. G. Rippel.

BUILDERS IRON FOUNDRY.—Exhibiting a standard Venturi meter outfit consisting of a small Venturi meter tube on discharge from a motor-operated rotary pump; also registering devices and indicating recorders. Represented by C. G. Richardson and D. J. Purdie.

BURRELL TECHNICAL SUPPLY Co.—See exhibit of Mine Safety Appliances Co.

CALCO CHEMICAL Co.

CANADIAN PACIFIC RAILWAY Co.—Exhibiting a colored map showing the industrial resources of Canada.

CARBORUNDUM Co., THE.—Carborundum refractories consisting of brick, tile and shapes, muffles, saggers, etc., made of Carbofrax. Also carborundum refractory cements and a new refractory material which will be known as "Zirfrax." A complete line of abrasive products, consisting of grain, wheels, paper and cloth, rubbing stones, hones, etc., will be exhibited. Represented by C. E. Hawke, C. F. Geiger, S. A. Fenno, J. H. Harriott, W. L. Meek, F. J. Harrington.

CARBROX Co., INC.—An exhibit of carbrox, a vegetable decolorizing carbon used as a substitute for bone black in a great variety of industries. Represented by H. M. Shilstone and O. L. Barnebey.

CARRIER ENGINEERING CORPORATION.—Air-conditioning equipment, including complete automatic temperature and humidity control. Represented by J. E. Bolling, R. T. Tree, A. E. Stacey, Jr., and R. H. Ward.

CASH, A. W., Co.—Exhibiting section models showing internal construction and operation of the company's pressure reducing and regulating valves. Also other steam appliances such as pump governors, fan engine regulators, strainers and relief valves. Represented by Paulsen Spence, R. H. Keith and R. C. Cory.

CELITE PRODUCTS Co.

CENTRAL SCIENTIFIC Co.—DeKhotinsky constant temperature appliances, oil- and fuel-testing instruments, high-vacuum pumps, electrical appliances for the laboratory and various analyzed chemicals. Represented by O. T. Louis and S. L. Redman.

CHADWICK-BOSTON LEAD Co.

CHAPMAN ENGINEERING Co.

CHAPMAN STEIN FURNACE Co.

CHARLESTON INDUSTRIAL CORPORATION.—Exhibits showing the advantages of the City of Nitro, W. Va., as a location for chemical manufacturing plants. Represented by J. C. Hutsinpillar, R. J. O'Brien, M. F. Chase, W. H. Campbell and H. G. Scott.

CHEMICAL COMPANY OF AMERICA.

CHEMICAL EQUIPMENT Co.—Ceco acid-resisting valves, pumps and sprays, vacuum evaporators and tank car unloading systems. Represented by Robert V. Cook, R. T. White, Arthur Wright and C. A. Murphy.

CHEMICAL PUMP & VALVE Co.—Packingless centrifugal pump and valves, and other equipment for chemical manufacture. Represented by A. B. Antisell and F. A. Warter and others.

CHIRIS, ANTOINE, Co.—Synthetic aromatic chemicals, essential oils and perfume and flavoring materials of domestic and exotic origin. Represented by men from the sales department and technical staff.

CLEVELAND-CLIFFS IRON Co.—Photographic views of various manufacturing departments, also samples of various chemical products. Represented by Charles B. Hall, Austin Farrell and E. J. Hudson.

CLIPPER BELT LACER Co.—Three different types of belt lacing machines will be exhibited and also the application of the different sizes of belt hooks to all kinds of belting. Represented by William F. Kall.

COLTON, ARTHUR, Co.—Machinery for pharmaceutical manufacturers. Represented by R. L. Colton, F. X. Roellinger and B. W. Scott.

COMMERCIAL SOLVENTS CORPORATION.—Butanol, acetone and denatured alcohol and the products in which they are used. Represented by P. G. Mumford, H. E. Hall, C. L. Gabriel, Charles Bogin and T. F. Carty.

CONTACT PROCESS Co.—Sulphuric, muriatic and nitric acids, fuming sulphuric acid, oleum, mixed acid and salt cake. Represented by H. von Rucker and J. E. Curry.

CONTAINER CLUB.—Will display corrugated and solid fiber shipping boxes used for packing and shipping, etc. There is also to be demonstrated a device known as the Webb paper and box tester which is used in determining the strength of the board used in the manufacture of the boxes. Represented by J. D. Malcolmson and J. M. Webb.

COOPER HEWITT ELECTRIC Co.—An interesting display of mercury vapor arc lamps, the commercial source of ultra-

violet light, will be shown to illustrate the various applications of the Cooper Hewitt Uviarc lamps. These will include photo-chemical appliances, therapeutic apparatus, water-sterilizing equipment, color-testing instruments and outfits especially designed as a source of monochromatic light for polariscopic, spectroscopic and interferometer work. Represented by L. J. Buttloph and M. B. Firehock.

COORS PORCELAIN Co.—Chemical and scientific porcelain for use in the laboratory control of practically all manufacturing operations. Also porous porcelain mass electrolytic cells. Represented by H. F. Coors.

CORNING GLASS WORKS.—A full line of Pyrex laboratory glassware. A number of experienced glass blowers will be at work making such pieces of laboratory apparatus as is possible under the conditions imposed. Represented by I. B. Cary, K. Kraissl, A. S. Eggleton, F. F. Pfeiffer and G. W. Drake.

CRANE Co.—A full line of pipe, fittings, valves, etc., in iron, steel and brass, and as a specialty their Cranefilt traps and pressure-regulating valves. A motor-operated gate valve will also be among the working exhibits. Represented by W. L. Oswald, William Sink, W. L. Whyte and J. F. Lee.

CRANE PACKING Co.—John Crane metallic packings for steam, air, oil, water and various chemical services, such as the handling of dilute or concentrated sulphuric acid, benzene, acidulated benzene, caustic soda solution, etc., Represented by Julian N. Walton, F. E. Payne and Miss Betty D'Vorin.

DAVISON CHEMICAL Co.—Exhibiting the various grades of sulphuric acid, 16 per cent to 18 per cent acid phosphate, concentrated acid phosphate, magnesium fluosilicate, precipitated silica, pyrites cinder, sintered ore and silica gel. A silica gel absorber and activator will also be in operation, showing the absorbent qualities of this material. In addition there will be a working exhibit of catalytic gel for the conversion of SO_2 to SO_3 . Represented by C. Wilbur Miller, E. B. Miller, W. D. Huntington, J. R. Wilson, A. E. Marshall, W. A. Patrick, B. F. Lovelace, E. C. Holden, P. A. Davis, G. E. C. Connolly, J. B. Thomas, F. E. Wagner and A. Harvitt.

DAVIDSON, M. T., Co.—Pumping engines, condensers, evaporators, etc., used in chemical and allied lines. Represented by John Lowe, William E. Brennan, F. O. Kompass and Thomas J. Rogers.

DE LAVAL SEPARATOR Co.—A special feature will be the exhibit showing the De Laval method of refining cottonseed oil and also of brightening stock manufacture in the petroleum industry. General types of equipment for chemical and manufacturing projects will also be exhibited. Represented by Walter D. Cleary, A. F. Meston, John H. Lisle and Robert Kostelak.

DEPARTMENT OF MINES OF CANADA.—Economic minerals and ores found in Canada, together with some of the more important products manufactured from them. Represented by Robert A. A. Johnston.

DETROIT CHEMICAL WORKS.

DETROIT RANGE BOILER & STEEL BARRELL Co.—A display of "Perfect" metal bilge barrels of the closed type and with full removable heads. There will also be samples of both light and heavy drums and the new friction top Detroit light drum. Represented by W. B. Goddard and C. C. Choate.

DEVINE Co., J. P.—Illustrations of installations of several different types of apparatus, including a large quadruple effect vacuum evaporator having 26,000 sq.ft. of heating surface, a complete installation of a vacuum chamber drier with material being dried on the trays, and complete with the auxiliaries—i. e., surface condensers and dry vacuum pump. Represented by J. P. Devine, L. W. Graves, H. W. How and A. N. Howes.

DIAMOND STATE FIBRE Co.—A full line of vulcanized fiber sheets, rods and tubes, and also a new waterproof insulation, Condensite Celoron. Represented by Charles M. Bogert and E. J. Sniffen.

DINGS MAGNETIC SEPARATOR Co.—Exhibiting the laboratory apparatus known as the Magnetic Tube Analyzer, which is used for determining the amount of magnetic material in any substance which is concentrated magnetically. Represented by A. H. Ackermann, J. E. Randall, E. F. Oates and R. A. Manegold.

DISTILLATION INDUSTRIES, INC.—Exhibiting a demonstration of the Whitaker-Pritchard process of destructive distillation applied to the manufacture of illuminating gas.

DOMINION BUREAU OF STATISTICS.—Statistical charts showing the development in Canada of the chemical and metallurgical industries. Represented by S. J. Cook.

DOMINION WATER POWER AND FORESTRY BRANCHES, DEPARTMENT OF THE INTERIOR, CANADA.—Exhibit showing the

water-power and forest resources of the Dominion of Canada. Represented by W. B. Stokes.

DORR, Co., THE.—Exhibiting working models of the Dorr thickener, classifier, agitator and pumps manufactured by the company. The sewage clarifier and screen for the mechanical screening of municipal sewage and trade wastes will be shown, also a cane sugar juice clarifier and various other pieces of equipment and processes controlled by the company. Represented by G. W. Repetti, Frank Bachmann and F. A. Downes.

DOW CHEMICAL Co.

DRAPER MFG. Co.

DRYING SYSTEMS, INC.—Spray drying equipment for drying of liquids such as chemicals, milk and food products. Represented by F. A. Lippert and C. H. Currier.

DU PONT, E. I., DE NEMOURS & Co.

DURIRON Co.—Centrifugal and reciprocating pumps, exhaust fans, kettles, valves, cocks, pipe and fittings, laboratory apparatus and various other equipment designed to carry corrosive materials. Represented by M. W. Smith, W. E. Pratt, R. H. B. Elkins, E. A. Suverkrop and T. Jabine.

EAGLE-PICHER LEAD Co.—Lead pigments, lead pipe, lead castings and other specialties; lithopone, zinc oxide, slab zinc and model sublimed white lead plant will also be exhibited. Represented by J. R. MacGregor, H. Gates, C. E. Gilson, W. Van Berlo, H. B. Taylor and D. T. Eastman.

EAST JERSEY PIPE Co.—Hercules-Electric hydro extractors and electric extractors. Represented by H. H. Stephens and J. L. Haring.

ECONOMIC MACHINERY Co.

ECONOMY ENGINEERING Co.—Standard and specially designed portable elevators, tiering machinery, barrel storage racks, etc. A feature will be the recently developed hand-electric portable elevator or tiering machine. Represented by T. R. Tordoff, T. A. Duffey and L. H. Liebel.

EDGAR BROS. Co.

EGYPTIAN LACQUER MFG. Co.—Various articles upon which lacquer and lacquer enamels have been used to produce or preserve the finish. Represented by Charles Schlott, Frank G. Drake, C. E. Hayward and B. Popper.

EIMER & AMEND.—Bingham & Green viscometer and plastometer, Brooks rotating autoclave, calorimeter accessories, E. & A., A. D. L. and Whatman filter papers, mercury sealed stopcocks, electric titration apparatus, Fisher thermometer, Fleming and Fisher combustion bulbs, Freas ovens, balances, hot water mixers and water stills, Gramercy reagent bottles, Hortvet cryoscope, hydrogen-ion apparatus, MacMichael viscosimeter, microscopes, refractometers, colorimeters, Pickel extraction apparatus, replaceable unit furnaces and hot plates, and U. S. Navy emulsifier. Represented by Theodore Taistra, assisted by Messrs. Grille, Fisher, Chalfont, Banner, Churchill, Shulenberger, Eimer and Amend.

ELECTRO BLEACHING GAS Co.—Exhibit of liquid chlorine and of textiles and pulp bleached with this product. Represented by S. W. Jacobs, James B. Duggan, G. R. Ellis, W. J. Weed, W. A. Kennedy and D. K. Bartlett.

ELECTRO CHEMICAL SUPPLY & ENGINEERING Co.

ELECTROLYTIC ZINC Co.

ELMORE, G. H.—Continuous centrifugal driers, acid-resisting centrifugal pumps and various equipment for ore dressing and coal washing. Represented by R. C. Comley.

ELYRIA ENAMELED PRODUCTS Co.—Glass-enameled cast-iron apparatus for chemical manufacturing purposes. A complete glass-lined still set up with a hot oil circulation system for high-temperature work will also be exhibited. Represented by W. E. Gray, Jr., R. W. Smith, D. B. Etters, S. A. Smith, W. I. L. Duncan, E. P. Poste and M. Donauer.

EMPIRE LABORATORY SUPPLY Co.

ENGELHARD, CHARLES, INC.—Le Chatelier pyrometers, electric resistance thermometers, Unicurve base metal couples, automatic temperature and pressure controllers, Impervite porcelains and electric furnaces. Represented by C. W. Hubbard and D. S. Bessemer.

EVERLASTING VALVE Co.—Various types of valves for special valve service. Represented by E. N. Corning, S. E. Carman, D. A. Jenkins and F. S. Schultz.

FEDERAL PHOSPHORUS Co.

FLEISHER & Co., W. L., INC.—Exhibiting a spray drier in operation, with samples of various materials which have been spray dried; also air-conditioning apparatus. Represented by W. L. Fleisher, A. W. Lissauer, R. E. Keyes, D. L. Connelly and S. W. Fletcher.

FLETCHER WORKS, INC.

FLORASYNTH LABORATORIES.

FOUNDATION OVEN CORPORATION.

FOXBORO Co., INC.—Indicating and recording instruments such as thermometers, gages, carbon dioxide recorders,

liquid level gages and temperature controllers. Represented by W. W. Patrick and Clarence Fuller.

FREEMPORT SULPHUR Co.

FUEL PRODUCTS CORPORATION.

GARRIGUES, INC.

GEIGY Co., INC.

GENERAL BAKELITE Co.—Bakelite raw materials and the following finished products made from them: Agitators, airplane propellers, beads, bowling, billiard and pool balls, bushings, camera frames, dental lamps, distributor heads, electric drill parts, fire extinguishers, gears and pinions, impregnated fibers, instrument tops and handles, insulators, jewelry, knife-handles, oil-test cups, ornaments, pipe stems, pistol grips, switch blocks, telephone instruments, water ozonator parts, welding goggles, wire insulation and wireless apparatus.

GENERAL CERAMICS Co.—A complete line of chemical stoneware, standard shapes and forms of fused silica, and a display of magnesia ware. Represented by P. C. Kingsbury, Hubert Royer, K. J. Peters, J. F. Curran, R. S. Beecher and Lucy Walters.

GENERAL CHEMICAL Co.—This company's products will be exhibited in one of the booths constituting the Allied Chemical & Dye Corporation's exhibit. Baker and Adamson laboratory chemicals and the Herreshoff roaster furnace will be shown. Represented by G. G. Ackerson, J. M. Keating, G. N. Vardy, J. E. Wilson, W. J. Kramer and W. R. Chappell.

GENERAL ELECTRIC Co.—The features of the exhibit will be an automatic arc welding outfit and a 50-lb. brass-melting furnace. Furnace exhibit will comprise a semi-cylindrical furnace, a small toolroom muffled arc furnace used for treating tool steel, etc., in the shop, a soldering iron furnace for medium and heavy duty irons, and an automatic control board for a single electrode furnace for sixty-cycle, 230-volt operation. Represented by L. W. Shugg.

GENERAL FILTRATION Co., INC.—Exhibiting Filtrons acid-proof artificial stone filter plates in various shapes and grades and in models showing commercial installations; also exhibiting Electro-Filtros, the acid-proof diaphragm. Represented by F. E. Leiby and W. W. Robacher.

GEORGIA LEAD WORKS.

GIBSON & PRICE Co.—This company's exhibit is a part of that of the United Lead Co.

GLAMORGAN PIPE & FOUNDRY Co.—The exhibit will consist of the following apparatus: A standard direct-motor-driven nine-compartment rotary vacuum filter, a standard duplex direct-motor-driven vacuum pump, a 3-in. high-frequency turbine pump, direct-motor-driven, a standard direct-motor-driven caustic flaker, and a working model of a continuous discharge gas-fired vertical limekiln. Represented by C. H. Hinnant.

GLENS FALLS MACHINE WORKS.—Iron, brass and bronze foundry, paper and pulp machinery. A feature of the exhibit will be the rotary sulphur burner. Represented by O. J. Mills and Frederic S. Chaffee.

GOULDS MANUFACTURING Co.—Exhibiting a line of reciprocating, centrifugal and rotary pumps. Represented by H. R. Gumbert, H. J. Angell, W. J. O'Neill and E. E. Brereton.

GRAVER CORPORATION.—Exhibiting models of water-softening equipment, water-filtering equipment and photographs of acid, chemical and oil storage tanks; also other installations of special steel plate work. Represented by K. W. Bartlett and John J. Felsecker.

GRINNELL Co., THE.

GRINNELL Co., DRYER DIVISION.

HANOVIA CHEMICAL & MANUFACTURING Co.—Quartz glass laboratory wares, special apparatus of quartz glass for laboratory processes, electric resistance furnaces for laboratory use, mercury-vapor arc lamps for various chemical processes—e.g., bleaching, dyeing and testing of colors, oils, etc., Laboratory thermometers with platinum spiral inclosed in quartz glass. Represented by F. W. Robinson, J. P. Rainbault, A. L. Schweickart, C. C. Minter, J. W. Kolbert and E. Simmonds.

HARDINGE Co.—Conical ball and pebble mills as used for crushing, grinding and pulverizing will be shown with the accessory parts necessary for different classes of operation. The application to chemical industrial and metallurgical processes will be illustrated. A feature of the exhibit will be a full working size mill set up completely and equipped with all necessary accessories including chain drive and electric motor. Represented by William H. Baker, H. W. Hardinge, Harlowe Hardinge, R. B. T. Kiliani, V. A. Stout, Robert S. Schultz, Jr., G. F. Metz, Alden Crankshaw and James G. Parmelee.

HAUSER-STANDER TANK Co.—Exhibiting a cylindrical

shaped agitator tank designed especially for chemical use; also a rubber-lined cylindrical tank for the storage of muriatic acid. Other equipment of interest to users of wooden tanks will also be exhibited. Represented by S. Hauser, Jr.

HAYNES STELLITE Co.

HAYS, JOSEPH W., CORPORATION.—Exhibiting various forms of combustion efficiency apparatus such as draft and pressure gages, gas analyzers for flue gas analysis and other special purposes, automatic carbon dioxide and draft recorders and a new float-type recording draft gage for ranges below 3 in. W.

HEPWORTH, S. S. Co.

HERCULES ENGINEERING CORPORATION.

HEYDEN CHEMICAL Co.

HOOKE ELECTROCHEMICAL Co.—An exhibit of the various chemicals that can be manufactured electrolytically from salt, with various samples of caustic soda, bleaching powder and liquid chlorine. Represented by W. H. Chamberlain, B. K. Hotchkiss, G. F. Reale and W. J. Smith.

HUFF ELECTROSTATIC SEPARATOR Co.—Exhibiting a Huff electrostatic separator showing the purification of rock salt, mica, feldspar and fluorite; also a Plumb pneumatic jig for concentrating various ores. Represented by H. B. Johnson, F. R. Johnson and William E. McKee.

HUNGERFORD, U. T., BRASS & COPPER Co.

HUNTER DRY KILN Co.—Exhibiting a model of the Hunter drying system which illustrates the principle of utilizing humidity in connection with drying. Represented by Harry Hunter, O. M. Ragsdale and A. B. Stonex.

HUYCK, F. C., & SONS.—Operating the Kenwood Mills. Exhibiting Kenwood all-wool filter cloth. Represented by E. A. Rees and G. L. Gundel.

HUYETTE, PAUL B., Co., INC.

ILLINOIS ZINC Co.

INDUSTRIAL FILTRATION CORPORATION.—Exhibiting a continuous rotary filter in operation with the necessary tanks and pumps, a small-size continuous rotary hopper dewaterer, and a model of the open-tank type of filter. Represented by William H. Harding, George D. Dickey and Harry W. Conrad.

INNIS, SPEIDEN & Co., INC.—Will exhibit a complete line of industrial chemicals, including photographic chemicals, dye intermediates, talc, casein and milk products and various heavy and fine chemicals of domestic and foreign origin. Represented by E. H. Manahan, H. G. Mackelcan and C. L. Speiden.

INTERNATIONAL CARBON PRODUCTS Co.—Graphite products, the crude ore, from which domestic flake is manufactured into products suitable for crucibles, foundry facings, paints, pencils, batteries, electrodes, water compounds and packing. Represented by H. B. Johnson and Charles D. Burrage, Jr.

INTERNATIONAL COOPERAGE Co., INC.—Exhibiting a complete line of tongued, grooved and plain barrels, such as are particularly adapted to the shipment of dry chemicals, lime, plaster, cement, paste and plastic materials. Represented by B. E. Cuthbert and E. H. Kattman.

INTERNATIONAL NICKEL Co.—Various forms of monel metal partly and completely fabricated with particular attention to its application in the chemical industry. Represented by G. A. Wotherspoon and E. A. Turner.

INTERNATIONAL SALT Co. OF NEW YORK.—Exhibiting various kinds of salt used for chemical purposes. Represented by W. T. Chisholm, George A. Walter and H. J. Osborn.

INTERNATIONAL SMELTING Co.—See exhibit of Anaconda Copper Mining Co.

IRVING IRON WORKS Co.—Exhibiting metallic fireproof ventilating flooring and steps. Represented by Walter E. Irving, Paul Leon Price, W. H. Roope, H. H. Schuldt, J. M. Madden and H. H. Bunker.

ISKO BAUTZ Co., INC.—A display of water floated silica and soft silica of various grinding and consistencies.

ISKO CHEMICAL Co., INC.—Caustic soda and chloride of lime. This company's products and those of the preceding company are exhibited by Innis, Speiden & Co., Inc.

JEWELL POLAR Co.—A display of water-distilling equipment of laboratory and industrial types. Represented by A. C. Jewell, J. H. Needler, R. E. Henry and C. Munson.

K-B PULVERIZER Co., INC.—Exhibiting Pulverburner, a coal-pulverizing and burning equipment and a standard K-B hammer mill. Represented by A. J. Barnebl, Jr., E. H. Brown and J. K. Blum.

KELLOGG, THE M. W. Co.—Exhibiting high-pressure autoclaves, direct-fired kettles and various other chemical equipment manufactured from Kellogg forge-welded steel "Chemi-Steel." Represented by H. Le Roy Whitney.

KENART SYNTHETIC PRODUCTS Co.

KENNEDY VALVE MFG. Co.

KEWAUNEE MFG. Co.

KIEFER, KARL, MACHINE Co.—Exhibiting bottle-rising, filling and corking machines, filling and packaging equipment, filters and pumps. Represented by E. E. Finch, A. J. Sterling and Matt C. Finn.

KLIPSTEIN, A., & Co.—A display of industrial chemicals, colors, dyestuffs, varnish colors, tanning materials, oils and waxes. Represented by A. Klipstein, Jr.

KNIGHT, MAURICE A.—Exhibiting acid-proof chemical stoneware of all shapes and sizes. Represented by Maurice A. Knight, Charles Dennison, Samuel J. Baril, G. Gordon Urquhart and Percy Sawyer.

KOPPERS Co., THE.—Exhibiting a miniature model of a battery of byproduct coke ovens and of various improved types of gas governors and continuous tar stills. Represented by Charles R. Meissner and D. E. Price.

KOPPERS PRODUCTS Co.

KOVEN, L. O. & BRO.

LAKE ERIE CHEMICAL WORKS of the General Electric Co.—Exhibiting tungstic acid, sodium tungstate, tungsten metal powder, mango powder (iron manganese oxide), opaque glass enamel and finish. Represented by W. S. Murtfeldt.

LAMIE CHEMICAL Co.

LEAD-LINED IRON PIPE Co.—Exhibiting lead-lined iron pipe, fittings, valves, stop cocks and block-tin-lined iron pipe and fittings. Represented by Daniel H. Regan, Harry F. Peck, Thomas E. Dwyer and Joseph C. Huestis.

LEEDS & NORTHRUP Co.—The exhibit comprises pyrometers of the potentiometer type, indicating, recording, signaling and controlling, and electrical instruments for the determination of the chemical conditions of solutions by the measurement of electrolytic conductivity of hydrogen-ion concentration. Represented by O. Brewer, C. R. Cary, E. H. Day, G. H. English, E. B. Estabrook, E. A. Keeler, R. D. Milner, A. M. Redding, G. W. Tall and P. H. Taylor.

LEFRANC CHLOROZONE WORKS.—Exhibiting the Schwenk carboy filter. Represented by L. W. Schwenk, V. E. Schwenk, R. F. Rutledge and W. P. Joerger.

LEWIS, GREEN, MCADAMS & KNOWLAND—Displaying a typical experimental drier such as has been successfully used for the solution of a number of drying problems. Represented by R. G. Knowland and John H. Holton.

LIBERTY BY-PRODUCTS WORKS, INC.—A display of various chemicals, soaps and oils. Represented by E. J. Zillessen, W. H. Zillessen, A. D. Washington and A. Naab, Jr.

LIQUID CARBONIC Co., THE—Displaying cylinders containing 99.9 per cent CO₂ connected to a 6-drum outfit, such as is used by many chemical industries. Represented by E. D. Hale, C. S. Wheaton and L. W. Greiner.

LITTLE, ARTHUR D., INC.—Exhibiting the following limited number of subjects as examples of this organization's work in the fields of chemistry, engineering and business management. A silk purse made from a sow's ear, a new plywood glue developed in their laboratory and now made under their technical supervision, single coat gray enamel ware produced for a leading manufacturer. "A. D. L." quantitative filter paper. Process exhibit, separation of zinc from complex ores, and a study of available economies in the fuel situation. Represented by Robert F. La Baron and Frank Farley.

LUNG MOTOR Co.—Exhibiting a simple resuscitating device for use in cases of gas or fume or smoke poisoning, or in apparent drowning or in electric shock collapse, etc. Represented by L. D. Jones and Max Jacobson.

LUNKENHEIMER Co., THE.—The display will consist of valves, boiler mountings, oil cups, grease cups, lubricators, oil pumps and similar products used in the engineering field. Valves constructed of bronze, nickel alloy, cast iron, Monel, electric furnace cast steel and special non-corrodible alloys adapted for the chemical industries will be shown.

LUZERNE RUBBER Co.—Exhibiting a general line of hard rubber articles, especially adapted for use in the handling of acids or corrosive liquids. Represented by H. E. Case.

MAAS & WALDSTEIN Co.—This company will have two exhibits, one of lacquer and lacquer enamels and the other of leather solutions with samples of lacquer and lacquer enamel, and wood and metal finished with these materials. Represented by H. C. Flanigan, C. Frey, G. J. Karl, W. S. Elwin, J. A. Weiss, S. L. Dickinson and H. E. Maynard.

MAGNA METAL CORPORATION.

MAGNESIA ASSOCIATION OF AMERICA.—Exhibiting samples of 85 per cent magnesia pipe and boiler covering, magnesia blocks and lagging for hot steam surfaces, magnesia plastic, and samples of carbonate of magnesia. Represented by C. J. Stover and G. S. Stuart.

MANHATTAN RUBBER MFG. Co.—Exhibiting hard-rubber-coated blowers and pipe and equipment, including a hard-rubber-coated centrifugal in operation. Also transmission belting, conveyor belting and rubber hose of all kinds. Rep-

resented by W. A. Pritchard, Harry Snyder, W. L. Sturtevant and others.

MANNING, MAXWELL & MOORE.

MATHIESON ALKALI WORKS.—Exhibiting soda ash, caustic soda, bleaching powder, liquid chlorine, bicarbonate of soda, sesquicarbonate of soda, and various chlorine solvents, such as tetrachloride, ethylene chloride, etc. Represented by John A. Kienle, John W. Boyer, B. T. Brooks, H. M. Mabey, J. H. McMahon, E. E. Routh, J. A. Rose, W. D. Marshall, R. J. Quinn, R. C. Staples, R. A. McMichael, L. R. Yancey, G. N. Davis and J. B. Peake.

MEAD & Co.—Grinding and pulverizing mills including the small sized Mead mill for laboratory and small production purposes. Represented by Paul O. Abbe, Inc.

MERCK & Co.—Exhibiting a general line of fine chemicals, particularly medicinals and pharmaceuticals. A feature of the exhibit this year will be the large number of useful salicylates, such as salicylic acid, sodium salicylate, methyl salicylate, phenyl salicylate, etc.

MERRILL Co., THE.—Exhibiting the Merco Nordstrom plug valve. Represented by H. P. MacGregor.

METALS DISINTEGRATING Co., INC.—The following products will be exhibited: Zinc dust, tin dust, lead dust, aluminum powder, magnesium powder, copper powder and nickel powder. Represented by S. G. Schatzberg, D. A. Morris, E. J. Hall and P. V. Dair.

MIDLAND CHEMICAL Co.

MINE SAFETY APPLIANCES Co.—Exhibiting different types of the Burrell industrial gas masks, such as are used by fire fighters, steel workers, operators of gas producers and in other industries where carbon monoxide is met. There will also be shown a simple device which indicates immediately the presence of carbon monoxide gas. Other safety equipment such as oxygen-breathing apparatus, electric lamps, gas indicators, first-aid outfits, steel signs, etc., will be shown. Represented by G. H. Burrell, J. L. Lehman and H. J. Segrave.

MINERAL POINT ZINC Co.

MOJONNIER BROS. Co.

MONARCH MANUFACTURING WORKS, INC.

MONO CORPORATION OF AMERICA.—Exhibiting automatic analytical and recording apparatus for the analysis of oxygen in hydrogen gas, hydrogen in oxygen gas, chlorine in chlorine gas, carbon monoxide in producer gas and sulphur dioxide for the sulphite industries. Represented by F. D. Harger and Albert Saunders.

MONEL METAL PRODUCTS Co.

MONSANTO CHEMICAL WORKS.

MORSE CHAIN Co.—Exhibiting a number of samples of different size chains, showing the Morse rocker joint, ranging in size from $\frac{3}{8}$ -in. pitch to 3-in. pitch and in several widths illustrating the chain as used for $\frac{1}{2}$ hp. to 5,000 hp. Represented by R. G. Anderson and various members of the sales staff.

MOTO METER Co., INC.—Exhibiting the Boyce Moto-meters, with particular emphasis on their application to industrial uses, such as the indication of temperature in chemical vats, tanks, ovens and drying rooms, coal piles, refrigerators, kettles and pasteurizers, etc. Represented by J. C. Elverson.

MOTT, THE J. L., IRON WORKS.—Exhibiting acid-resisting enameled cast-iron kettles, stills and autoclaves, and also furnaces suitable for their mounting. Represented by J. J. Blackmore, and T. H. Blackmore.

MULTI METAL Co.—A display of wire cloth in brass, copper, bronze, Monel metal, steel and tin coated wires, also metallic filter cloth, a complete line of standard laboratory testing sieves, and samples of wire cloth ranging from No. 2 mesh up to No. 300 mesh. Represented by Siegfried Stern, Frederick Stern and S. Pullman.

NASH ENGINEERING Co.—Hytor air compressor and vacuum pump, Jennings return-line heating pump, drier exhaust unit, centrifugal pump and sump pump. Represented by Irving C. Jennings, R. H. Carpenter, H. M. Wylie and G. B. Wright.

NASSAU VALVE & PUMP CORPORATION.—Exhibiting the Chemetal acid-resisting valves and centrifugal pumps. Represented by A. T. Haviland, C. Schmitt, J. Figel and B. W. Dezotell.

NATIONAL ANILINE & CHEMICAL Co., INC.—The exhibit of this company will be especially artistic in design, and the decorative effects have been carefully considered in order to show the avenues of usefulness for this company's dyes. A feature of the exhibit will be a colorist's laboratory, in which dye testing will be done.

NATIONAL BINDING MACHINERY Co.

NATIONAL FILTER CLOTH & WEAVING Co.—Different styles and weaves of cotton filter cloth for various filter presses.

Represented by M. W. Smith, E. Boffin, L. R. Prior, T. Moors and T. Dunn.

NATIONAL GUM & MICA Co.

NATIONAL LIME ASSOCIATION.—The association will exhibit a model of a lime plant, charts showing the operations in lime manufacture and the distribution of the uses of lime, together with various materials, such as glass, leather and lime stucco panels, which are made with the use of lime. Represented by M. E. Holmes.

NATIONAL RESEARCH COUNCIL.—An exhibit intended to show the necessity for fundamental chemical research, and the relation of organic chemistry to peace- and war-time industries. Represented by H. E. Howe, H. S. Kimberley and O. E. Roberts.

NATIONAL ROSIN OIL & SIZE Co.—Exhibiting various grades of rosin oil and pitches such as are used in the manufacture of greases, printing inks, canvas belting, waxes, paper cables and brushes. Represented by Richard Bender.

NEWARK WIRE CLOTH Co.—A display of wire cloth of all grades, metallic filter cloth and testing sieves. Represented by A. A. Campbell, L. C. Campbell, J. C. Campbell and E. J. Korn.

NEW BRUNSWICK CHEMICAL Co.—Exhibiting a general line of textile soaps, sizings and finishes, also terpol hydrate, which is a special warpsizing made by this company.

NEW ENGLAND TANK & TOWER Co.—This exhibit will show a complete outfit, in operation, including tank, stirrer and direct-connected motor-driven agitator. Different types of stirring equipment and of apparatus for transporting semi-liquids and liquids will also be shown. Represented by Arthur E. Hall, George E. Hall Conrad Pennucci and Warren O. Chace.

NEW METHOD UTILITIES Co.—Exhibiting photographs and working drawings of a refrigerating and ice-making system without moving parts, which has recently come into use in chemical plants. Represented by B. K. Nagel and H. A. Leeuw.

NEW JERSEY ZINC Co.—Besides exhibiting its entire line of zinc products, this company will feature Horse Head rolled zinc for building construction work. Zinc leaders, eaves-troughs, Spanish tiles, flashings, valleys, fittings, etc., installed on an improvised portion of roof, will be displayed. Other zinc products and byproducts will include zinc oxide, slab zinc, zinc dust, Albalith, lithopone, zinc sulphate, feathered zinc, salt cake, sulphuric acid, muriatic acid, and zinc chloride. Represented by W. H. Hendricks, A. E. Mervine, F. C. Ryan, S. C. Reynolds, F. W. Edwards, S. T. Ballinger, C. F. Beatty and H. W. Henderson.

NEWPORT CHEMICAL WORKS, INC.—The exhibit of this company will illustrate its slogan of "Coal to Dyestuff." Represented by Giles Low, J. S. Lange and C. F. Schumann.

NEW YORK CENTRAL IRON WORKS Co., INC.—Exhibiting photographic views of steel tanks, stacks, breechings and chemical equipment of all kinds. Represented by Paul G. Koch, H. M. Olson, C. E. Plack and C. R. Rupp.

NEW YORK JEWELL FILTRATION Co.—Exhibiting the operation of the refiltration system which is applied in paper making and in other industries where the conservation of water is essential. Another feature of the exhibit is various types of chemical feeding devices which are used for regulating the dosage of chemicals in large filtration plants. Represented by A. L. Sollder, Arthur M. Crane, E. K. Sorenson and D. C. Williamson.

NIAGARA ELECTRO-CHEMICAL Co.

NICHOLS COPPER Co.—An exhibit to show the use of copper sulphate (as Bordeaux mixture) in the cultivating of fruit and vegetables; the use of red copper oxide in marine paints, and the production of copper wire and ingot bars, cakes, slabs and cathodes. Represented by G. P. Hitchcock.

NITROGEN CORPORATION.—Exhibiting various products of ammonia made by synthesis from atmospheric nitrogen. Represented by A. Nagelvoort and J. C. Clancy.

NORWALK IRON WORKS Co.—Exhibiting a new Norwalk vertical three-stage oxygen compressor and a multi-cylinder ammonia refrigerating compressor. Represented by A. R. Betts.

OBERMAYER, THE S., Co.—Hott-Patch furnace cement for power and chemical plants. A small electric furnace will be used for demonstration of the product. Represented by E. D. Frohman, F. P. Bullion, H. E. Beckman, J. M. Hildebrand and W. R. Cummings.

OLIVER CONTINUOUS FILTER Co.—Exhibiting a complete Oliver continuous and automatic filter in operation. Represented by H. A. Morrison, C. T. Eastman, C. W. Moore and L. W. Knapp.

PACIFIC COAST TALC Co.—This company's products will be exhibited with those of Innis, Speiden & Co.

PALO Co.—Exhibiting the following apparatus: Hess-Ives tint photometer, American-made spectroscopes and refractometers, Durieux filter paper, analytical balances, Meker burners and various types of furnaces, including those used for high-temperature crucible work and for fusion, heat-treating, annealing, etc. Represented by L. A. Pfluger, H. A. Peterson and M. J. Seavy.

PARKS-CRAMER Co.—Exhibiting a small-size standard Merrill process system such as is used for supplying heat by oil circulation. High-duty humidifier heads and a heat and humidity regulator will also be exhibited. Represented by Alexander B. McKechnie, Thayer Francis, Stuart H. Caldwell, J. W. F. Macdonald, A. W. Thompson and Frank G. Bell, Jr.

PENNSYLVANIA SALT MFG. Co.

PERMUTIT Co., THE.—A display of a model of the Zeolite water softening and filtration equipment manufactured by this company. Represented by A. T. Smith, R. W. Epple, J. S. Shedden and G. E. Boyd.

PERRY & WEBSTER, INC.

PERTH AMBOY CHEMICAL Co. See exhibit of Roessler & Hasslacher Chemical Co.

PFAUDLER Co., THE.—Exhibiting a glass-lined closed jacketed mixer (furnished with an enameled steel agitator) which is used in the manufacture of chemicals, dyes, printing inks, coal-tar products, etc. Other standard glass-lined equipment and accessories will also be exhibited. Represented by R. B. Kilmer, I. E. Colvin, J. A. Cowles, P. S. Barnes, F. J. Bresnan and T. D. Wilson.

PHILADELPHIA DRYING MACHINERY Co.—An exhibit of the various types of Hurricane drying machines, including the cabinet tray drier and truck tray drier. Also a photographic display of various installations. Represented by W. W. Sibson, C. H. Reumann, E. K. Moore and S. Watson.

PHILADELPHIA QUARTZ Co.—Liquid, solid and powdered forms of silicate of soda. Represented by R. C. Brown, W. H. Buxton and A. W. Moore.

PITTSBURGH-DES MOINES STEEL Co.—Exhibiting pictures and blue prints of various installations of structural steel work. Represented by Ivan A. Bickelhaupt.

PNEUMERCATOR Co., INC.—A display of a complete line of gages for the indication of depth, weight, volume or specific gravity of any liquid stored in tanks at any pressure. Represented by H. S. Parks and William Thomas.

POTDEVIN MACHINE Co.

POWER SPECIALTY Co.

POWHATTAN MINING Co.—Asbestos in its various stages of manufacture from the mining of the crude asbestos to the fabrication of the finished product will be exhibited. Represented by Fred A. and Frank Mett.

PRECISION INSTRUMENT Co.—Exhibiting a general line of boiler room and gas plant specialties, including the precision single and multiple indicating and recording gages, combustion recorders, orsats, gravimeter, calorgraphs, etc. Represented by L. D. Vorce, E. C. Rack, Robert Hooper and R. H. Tilghman.

PROCTOR & SCHWARTZ, INC.—Exhibiting a model of the Proctor driers for drying colors, chemicals, raw stock, soap, etc. Samples of all kinds of materials dried in Proctor driers will be exhibited and a projectoscope will show various installations in representative chemical plants. Represented by E. B. Ayres, H. S. Landell, D. D. Hollenbaugh, A. O. Hurxthal and Mrs. A. E. Reiter.

PROVOST ENGINEERING Co.

PYROELECTRIC INSTRUMENT Co.—Exhibiting a line of electrical precision instruments, including pyrometers and apparatus for hydrogen-ion determinations, both electrometrically and colorimetrically. Represented by W. C. Harter and Harry L. Saums.

QUIGLEY FURNACE SPECIALTIES Co.—Materials and equipment for furnace construction and operation, including a high-temperature cement for bonding fireclay and silica bricks and blocks, as well as granular refractories, a specially prepared cellular refractory brick used in insulating furnace structures for the conservation of heat, and a highly refractory fire sand used with a suitable binder for making rammed-in linings for furnaces, special tile, patches and repairs. The Quigley powdered coal system will also be demonstrated. Represented by W. S. Quigley, H. A. Kimber, J. H. McPadden, F. W. Reisman, W. H. Gaylord, Jr., W. A. Toohill and C. C. Gantzman.

RARITAN COPPER WORKS.—See exhibit of the Anaconda Copper Mining Co. for a description of products to be displayed by this company.

RAYMOND BROS. IMPACT PULVERIZER Co.—An exhibit of operating models showing the various types of pulverizers, roller mills and air-separating plants produced by this company. The machines will be in actual operation, grinding

representative materials. Represented by C. M. Lauritzen, W. M. Cook, Joe Crites and S. B. Kanowitz.

RAYMOND LEAD WORKS.—Exhibit with the United Lead Co.

READ MACHINERY Co.—An exhibit of different types of mixers such as are used for mixing pharmaceutical products, pastes, polishes, food products, etc. Represented by D. D. Strite.

REFINITE Co., THE.

RELIANCE GAUGE COLUMN Co.

RHODIA CHEMICAL Co.

ROBERTSON, JAS., LEAD WORKS.

ROESSLER & HASSLACHER CHEMICAL Co.—Exhibiting a large number of chemicals applicable to electroplating, ceramics, mining, cleaning, bleaching, dyeing, oxidizing, paint manufacture, soap making, tanning, rubber industry, hydrogenation, refrigeration, steel tempering and case-hardening, electric cells, fireworks, fireproofing, etc., together with solvents, colors, rare metals, metal oxides, fumigators, insecticide and fungicide products. Represented by Sterling Temple, M. S. Stewart, T. V. Ainslie, F. Abegg and C. S. Williams.

ROTO Co., THE.—Exhibiting a line of tube-cleaning apparatus, which consists of specially designed motors operated by compressed air or steam, equipped with specially designed tools for the removal of deposits from the heating surfaces of tubular apparatus such as steam boilers, economizers, condensers, heaters and other apparatus of a similar character. Represented by W. R. Van Nortwick, W. M. Kelley and J. V. Doherty.

RUGGLES-COLES ENGINEERING Co.—Exhibiting models, photographs and drawings of the various types of driers manufactured by this company. Represented by F. E. Finch, W. H. Glomb and J. K. Towers.

SALMON FALLS MANUFACTURING Co.—A display of Toron-treated fabrics, together with samples of rubber products and insulators which have been manufactured by the use of Toron-treated fabrics. Represented by A. Russell Atwater and W. B. Pratt.

SANDOZ CHEMICAL WORKS, INC.

SANDUSKY COOPERAGE & LUMBER Co.—A complete line of barrels suitable for packing both dry and liquid chemicals. Represented by A. O. Theobald.

SARCO Co., INC.—Sarco temperature regulators for tank, room and kiln control. Sarco steam traps for low and high pressure. The new Sarco radiator trap Type "E" and the new Sarco (Fournier) indicating thermometers for chemical and industrial purposes. Represented by Clement Wells, E. J. Ritchie, G. H. Burke and G. F. Corder.

SCHAEFFER & BUDENBERG.—A complete line of efficiency-promoting instruments, such as indicating and recording gages, indicating and recording thermometers, counters, tachometers, calorimeters, etc. Represented by Messrs. Undeutch, Campbell and Schipper.

SCHUTTE & KOERTING Co.—Complete line of power plant equipment, consisting of: Oil-burning, oil-heating and oil-cooling apparatus; feed-water heaters, injectors, condensers, stop check valves, trip throttle valves, reducing valves and engine stop valves; pump primers, undergrate blowers; also other Koerting steam, water, and air jet appliances, and the Schutte line of lead-lined and special duty valves, which are used in the chemical industry. Multi-jet condensers in operation under vacuum and also open for inspection. Schutte engine stop system with overspeed tripping device also in operation. Represented by Messrs. Kimberly, Gessleman, Philbrook and Keet.

SCHWARTZ SECTIONAL SYSTEM.—Sectional filing cabinets and auxiliary desks for chemical laboratories. Represented by M. P. Schwartz.

SCHWENCK CARBOY TILTER Co.—See Exhibit of Lefranc Chlorozone Works, Inc.

SCIENTIFIC EQUIPMENT Co.—As Eastern Sales Division of Central Scientific Co. and Kewaunee Mfg. Co., will exhibit a representative line of American-made laboratory furniture and apparatus. Represented by J. M. Roberts, S. L. Redman, A. B. Carter, Charles G. Campbell, O. T. Louis, Charles Ress, Edward Breitwieser, Joseph R. Fisher, Theodore Fuchs, Jr., and A. V. Hoveling.

SCOTT, ERNEST & Co.—Photographs showing a number of installations which have been furnished to various trades and are used for reclaiming chemicals of value from factory waste liquor, deposits, etc. The apparatus illustrated by the photographs will consist of: Vacuum evaporators as used by the soap trade for recovering glycerine from waste spent lyes, paper pulp mills for recovering the caustic alkali from waste black liquors, cotton finishers for recovering the caustic from waste mercerizing waters, glue and gelatine manufacturers for concentrating their liquors,

caustic soda manufacturers for concentrating caustic soda liquors, distilled water manufacturers for making pure water from sea, brackish and other waters, packing houses for concentrating tankage liquors, and many other uses; vacuum driers as used by food, paint, salt and other manufacturers; solvent extraction apparatus as used by oil manufacturers for extracting oils from seeds, beans, nuts, etc., also from waste filter press residues, grease from bones, oil from fish waste and other waste oily and greasy materials, such as sewage, wool scourings, packing-house tankage, etc.; ammonia stills for making pure ammonia; and wood-distillation plants. Represented by H. Austin, R. W. MacGregor and C. E. Bradley.

SEMET-SOLVAY Co.—Model of a Semet-Solvay byproduct coke oven, which is complete in every detail. A model illustrating the use of Solvay granulated calcium chloride as a natural dust layer and binder for roads, tennis courts, playgrounds, race tracks, etc. In addition a complete line of products manufactured by the company will also be displayed. Represented by E. C. Scott.

SEYDEL MFG. Co.—Samples of fifty or more benzoates together with literature covering their uses in the fields of medicine and of preserving foodstuffs. Furamine dyes, which are used for dyeing skins and furs. Represented by Edmund E. Smith.

SEYMOUR & PECK Co.—Wooden shipping drums which are used as shipping packages for aniline dyes, dry colors, insecticides and other dry chemicals. Represented by C. B. Arnold and Mrs. C. H. Bacon.

SHARPLES SPECIALTY Co.

SHEFFIELD BY-PRODUCTS Co.—This company's products will be exhibited with those of Innis, Speiden & Co.

SHERWIN-WILLIAMS Co., THE.—The manufacture of paints, varnishes, dyes, chemicals, pigments, coal-tar products, insecticides, etc., will be illustrated by exhibits of important raw materials, samples of the finished product and examples of merchandise finished with these products. Represented by A. W. Steudel, J. O. Hasson, L. D. Walker, A. J. Binder, B. N. Van Cleve and M. K. Barrett.

T. SHRIVER & Co.

SILICA GEL CORPORATION.—See exhibit of the Davison Chemical Co.

SLY, W. W., MFG. Co.

SNYDERFIBA CORPORATION.—Paper barrel and drum making machines in full operation, making barrels and drums in all sizes and diameters from 10 in. up to 19½ in. by 30 in. long, together with a complete display of samples of various packages and different types of heading, as used by customers. Represented by Charles Ashmun and Oscar Duryea.

SOLVAY PROCESS Co. This company's products are shown in the exhibit of the Allied Chemical Dye Corporation.

SOUTHERN COTTON OIL Co., THE.—Products of cottonseed oil and the following byproducts derived therefrom: Cottonseed linters, distilled cottonseed fatty acids, cottonseed pitch and paint products. Represented by W. E. Fackert, Philip Brendel and George J. Drewes.

SOUTHERN RAILWAY SYSTEM.

SOWERS MFG. Co.—Dopp seamless steam and oil jacketed kettles, mixers, vacuum and pressure pans, and soap cutters. Some of this equipment will be in operation. A sawed-up section of a jacketed kettle, showing the seamless construction. Also samples of over 100 different products now being made in Dopp apparatus. Photographs and blue prints of various styles of kettles and agitators, etc. Represented by A. E. Howlett, R. Bellows, Austin M. Kuhns, G. Gordon Urquhart, C. E. Brown and R. C. Boggess.

STANDARD OIL Co. OF N. J., CHEMICAL PRODUCTS DIVISION.

STANLEY, W. W.

STAR BOX & LUMBER Co.

STAR CORRUGATED BOX Co., INC.

STEIN, HALL & Co., INC.

STIMPSON EQUIPMENT Co.—Mitchell electric vibrating screen which is applicable in handling screening problems with crystalline or granular materials. Represented by James A. Lane.

STUART & PETERSON Co.—Chemical apparatus consisting of steam jacketed kettles, steam jacketed vacuum pans, porcelain-lined evaporating pans and chemical storage cans. Represented by H. E. Jacoby and F. P. Kearns.

SULLIVAN MACHINERY Co.—Working models of the Sullivan air lift and displacement pumps. Represented by L. R. Chadwick, John Oliphant and L. E. Gilbert.

SWENSON EVAPORATOR Co.—Swenson evaporators and equipment. Represented by F. M. DeBeers, P. B. Stadler, P. H. Appell, G. Gordon Urquhart and F. F. Mackentepe.

TAGLIABUE MANUFACTURING Co.—Tag-Roesch automatic time-temperature-humidity controller. This device regu-

lates the valves on a heating coil and a spray, so that the humidity is gradually decreased at the same time as the temperature is increased. Easy adjustments enable almost any desired temperature-humidity schedule to be duplicated. Tag automatic controllers of temperature, pressure, vacuum, time, liquid-level and condensation discharge. Tag indicating thermometers, chemical thermometers and hydrometers. Tag recording thermometers with improved operating mechanism, and evenly graduated chart, micrometer per. adjustment, pen chart-pressure adjustment, pen-lifting device, etc. Represented by L. C. Irwin, T. Dougherty, V. Wichum, W. W. White and A. Traudt.

TAKAMINE LABORATORY, INC.—Polyzime and Neco-Malt. Represented by J. W. Coleman, Jr., Milton Tanner and William Newel.

TALC & SOAPSTONE PRODUCERS' ASSOCIATION.—The various kinds of talc and soapstone mined and milled in the United States will be shown. Specimens of the crude talc rocks, ground tales, talc crayons and articles in which talc has been used will constitute the exhibit. The aim of the producers is to call attention to the numerous and growing uses for talc and soapstone in the manufacture of paper of various grades and in textile, rubber, paint, soap, glass, ceramic, linoleum, leather and other industries as well as in the manufacture of toilet preparations.

TANNER, CHARLES S., Co.

TAYLOR INSTRUMENT Co.—A representative line of industrial indicating and recording thermometers and pressure gages, recording and indicating pyrometers, temperature and pressure regulators, laboratory thermometers and hydrometers. Represented by E. N. Huriburt, J. W. Schwarz, F. E. Ely, J. P. Gilmore, H. W. Kugler and Walter N. Maurer.

TECHNICAL PRODUCTS Co.

TEXAS GULF SULPHUR Co., INC.—A special feature of the exhibit will be photographs of sulphur mining. Represented by H. R. Wemple and A. S. Cosler.

THERMAL SYNDICATE, LTD.—Complete line of Vitreosil, laboratory apparatus and plant equipment. Vitreosil will be shown in the transparent, translucent and opaque grades. The special feature of the exhibit will be a new type of distillation unit designed especially for the production of chemicals of high purity but adaptable to many other distillation problems, including those which require fractionating. Complete information can be obtained regarding the use of Vitreosil in sulphuric acid concentration, nitric acid, and hydrochloric acid manufacture as well as in many other specialized uses. There will be on exhibit a design showing a new type of hydrochloric-acid unit in which both the cooling and the absorption of the gas are done in Vitreosil. Represented by W. W. Winship, S. L. Tyler, W. E. Strevg and F. A. Wenman.

THERMO ELECTRIC INSTRUMENT Co.

THWING INSTRUMENT Co.—A full line of temperature measuring and recording apparatus and a line of paper testing apparatus, including basis weight scales, humidometers and tearing testers. Represented by C. B. Thwing, Edward J. Albert, H. K. Walton, J. H. Torrey and J. H. Houghton.

TITANIUM ALLOY MANUFACTURING Co.

TITANIUM PIGMENTS Co., INC.

TOLHURST MACHINE WORKS.—The following motor-driven centrifugals especially prepared for use in the chemical industry will be in operation: A 40-in. Tolhurst heavy chemical type suspended centrifugal with bottom discharge basket; a 48-in. direct motor driven Tolhurst self-balancing centrifugal with tinne'd basket; a 40-in. Tolhurst self-balancing centrifugal arranged for bottom discharge; a 40-in. Tolhurst center slung centrifugal arranged with covered top and bottom especially prepared for handling volatile solvents; a 26-in. Tolhurst motor drive solid curb centrifugal of the open top type, with rubber-lined case and rubber-covered basket; a 12-in. laboratory centrifugal of the semi-commercial type. Represented by W. C. Dutton, John S. Gage, B. M. Pilhashy, W. J. Westaway, T. A. Bryson, T. M. Stuart and R. K. Cheney.

TOWER MANUFACTURING Co., INC.

TYLER, W. S. Co.—Woven wire screen, ton-cap, Hum-Mer electric screen, Ro-Tap testing sieve shaker, Tyler standard screen scale testing sieves.

UEHLING INSTRUMENT Co.—Uehling CO, recording equipment, draft recorders, vacuum recorders, draft analyzers, absolute pressure indicators, combined barometer and vacuum recorders and various other indicating and recording instruments. Represented by F. F. Uehling, C. J. Schmid, C. C. Phelps, R. E. Terhune and H. D. Thomas.

UNION STEAM PUMP Co.—A complete line of pumping machinery for the chemical industry. Union simplex, du-

plex and triplex types of pumps for either steam or power drive. Centrifugal pumps, air and gas compressors, surface and jet condensers. A new improved rotary pump for viscous liquids. Represented by George L. Todd, R. W. Friedman and K. D. Smith.

UNION SULPHUR Co.—Represented by W. N. Wilkinson and W. M. P. Taylor.

UNITED CHEMICAL Co.—This company's products will be exhibited with those of Innis, Speiden & Co.

UNITED FILTERS CORPORATION.—Small models of an American continuous vacuum filter, Sweetland pressure filter, and United plate and frame filter press; also one complete disk and rotary valve from an 8 ft. diameter American continuous vacuum filter and the latest type of roller cake remover for automatically discharging the cake from this type of filter. Represented by Robert C. Campbell, E. J. Sweetland, L. D. Thompson and C. M. Stanley.

UNITED HAMMER Co.—A Fairbanks pulverizing hammer for use in the chemical laboratories in the preparation of pig-iron and other samples for laboratory tests.

UNITED LEAD Co.—A complete line of United acid-resisting products will be shown: Chemical lead tube lined wrought steel pipe, flanged and screwed fittings, chemical lead-lined valves, special apparatus, hard lead and block tin-lined centrifugal acid pumps, block tin-lined pipe, fittings and valves, also chemical lead-lined and covered and block tin-lined and covered special apparatus such as tanks, agitators, autoclaves and evaporators. Represented by George H. Checkley, J. W. Spotten, C. R. Andrews, C. L. Meyer, W. J. Donnan, H. Hempel and F. Freiherr.

UNITED METALS SELLING Co.—See exhibit of Anaconda Copper Mining Co.

UNITED STATES CAST IRON PIPE & FOUNDRY Co.—Details of the manufacture of castiron pipe and large castings will be illustrated by an actual section of flange pipe and pictures showing the history of cast-iron pipe, and modern methods of production. Helander barometric condenser. Represented by H. A. Hoffer, J. C. Capron and C. D. Donaldson.

U. S. BUREAU OF STANDARDS.

U. S. INDUSTRIAL ALCOHOL Co.—Various grades of alcohol and the new product "Alcorub."

U. S. INDUSTRIAL CHEMICAL Co.—Thirty or forty chemical products will be exhibited by this company, among which are distilled iodine, tincture of iodine, ethyl ether, denatured absolute ethyl alcohol, oxalacetic ester, isopropyl ovalate, isoamyl propionate and ethyl isovalerate. Represented by B. R. Tunison.

U. S. STONEWARE Co.—Representative pieces of glazed acid-proof chemical stoneware, including various shapes and sizes of acid containers, pipe lines, mixers, manifolds, faucets, etc. Represented by F. S. Wills, J. J. Chamberlain and G. M. Wills.

VALLEY IRON WORKS.—Laboratory autoclaves and sulphonators of various sizes. Represented by Thomas Senior.

VALLEZ, H. A.—Two Vallez rotary filters will be in operation. Represented by H. A. Vallez and Arthur Vallez.

VAN NOSTRAND, D., Co.—New books and recent editions of standard reference works will be featured and special books relating to pure and applied chemistry will be shown. Represented by E. M. Crane, A. G. Heany and P. H. Healy.

VITREOUS ENAMELING Co., THE.—Vitreous enameled pans and traps for drying drugs, paints and chemicals and food-stuffs. Being non-corrosive, easy to clean and very durable, these pans are well adapted for use in plants where vacuum or shelf driers are employed. Represented by Harry Warman and Charles E. Bullard.

VOLAND & SONS, INC.—Assay, analytical and bullion balances and weights. Represented by George G. Voland, Emil L. Voland, Harry C. Henn, George J. Brentano, John Kisting and John Schwab.

WAILES DOVE-HERMISTON CORPORATION.—Anti-corrosive paints, solutions, enamels, mastics and special bituminous compositions for the protection of iron, steel and concrete exposed to atmospheric moisture, electrolysis, acids, acid fumes, alkalis, sewage, brine, etc., buried in the ground or submerged in fresh, salt or acid water. The products exhibited will include Bitumastic solution, Bitumastic liquid paints, Hermastic and Bitumastic enamel and Hermastic pipe coating. Represented by Willard T. Chevalier and Ray B. Nisbet.

WALLACE, JOSEPH H. & Co., INC.—The exhibit will consist of a stump from cut-over pine lands of the South, surrounded by samples of products which may be obtained from this waste wood. These products include turpentine, pine oil, rosin, tar, pitch, wood pulp, purified cellulose suitable for making gun cotton, kraft paper, fiber board and book paper. There will also be photographs and explanatory

charts. Represented by Messrs. Greenwood, Burleigh and Stevens.

WALLACE & TIERNAN Co., INC.—A general line of chlorine control apparatus, including units for the production of bleaching solutions used in the paper, textile and kindred fields, for the sterilization of water, disinfection of sewage and tannery waste. Chlorine cylinder valves, Venturi type gas flow meters, pressure-reducing valves, etc., for the general chemical industry. Also dry feed equipment for heavy chemicals and the Palmer water spray apparatus for the examination of air. Represented by M. F. Tiernan, W. J. Orchard, L. H. Goebel, R. V. Donnelly, R. V. Henkel, G. D. Peet and J. C. Baker.

WEDGE MECHANICAL FURNACE Co.—Data will be available for answering questions raised by anyone interested in the Wedge mechanical burner. Represented by Leslie H. Webb and Carl S. Fogh.

WESTINGHOUSE ELECTRIC & MANUFACTURING Co.—Automatic regulator and control equipment for steel-refining furnaces. Motors for chemical industry, both a.c. and d.c., together with control equipment. Specially treated coils, George Cutter industrial lighting fixtures for indoor and yard lighting, together with other electrical equipment especially designed for the chemical industry. Represented by G. H. Jaspert, C. B. Gibson and C. G. Schluederberg.

WHEELER, C. H., MANUFACTURING Co.—High vacuum apparatus consisting principally of different types of Radojet air ejectors such as single-stage, double-stage, as well as double-stage with surface inter-condenser types. These pumps have been extensively used in chemical plants in connection with evaporators and stills for producing high vacuum, the advantage being that they have no moving parts, their operation being based on the ejector principle. Represented by Charles Lang and J. Dobson.

WHEELER CONDENSER & ENGINEERING Co.—Evaporator, condenser, circulating pumps, Edwards air pumps, steam jet air pumps, cooling tower and a brass and copper tube exhibit. Represented by J. L. Kretzmer, F. H. Schubart, E. H. Chapin, R. D. Spear and R. T. Erwin.

WHITALL TATUM Co.—An exhibit of glassware and rubber ware from crude material to the finished product, with special emphasis on "Nonsol" chemical glassware.

WHITE, WILBUR, CHEMICAL Co.—This company's products will be exhibited with those of Innis, Speiden & Co.

WHITLOCK COIL PIPE Co.—The exhibit will feature coils and bends made up of iron, steel, copper, brass, aluminum pipe and tubing. Also solvent recovery heaters, coolers, hot-water heaters, high-pressure piping. Represented by William A. Evans, C. I. Babcock, F. J. Brengel, W. C. Beekley and H. J. Anderson.

WILL CORPORATION, THE.—Ion-O-Meter, Will shaking apparatus, Will combination extraction apparatus, Faltin water still, and Will bottle washer are to be exhibited. Represented by William Dalton and R. T. Will.

WILLSON GOGGLES, INC.—Safety goggles and respirators. A new type of safety goggle of much interest to safety men will be shown for the first time. Represented by T. A. Willson and F. M. Rockwell.

WINNER Co., THE.—A demonstration of the Winner steam trap. Temperature control regulators for steam, hot water and ammonia. Winner boiler compound. Represented by Allen A. Smith, Thomas W. Monahan, R. Fruiesen and F. L. Valliere.

WINSLOW & Co., INC.—A full line of acid-resisting brick and shapes. Represented by E. H. Winslow.

WOLF, JACQUES, & Co.—Sizing and finishing materials, colors and mordants for fabric printing, hydrosulphite for discharge printing and stripping, textile gums for printing and finishing, soluble oils, softeners, and Monopole oil. Samples of silk, cotton and woolen fabrics printed and finished with these materials. Represented by S. E. Tylee, Jr., and others.

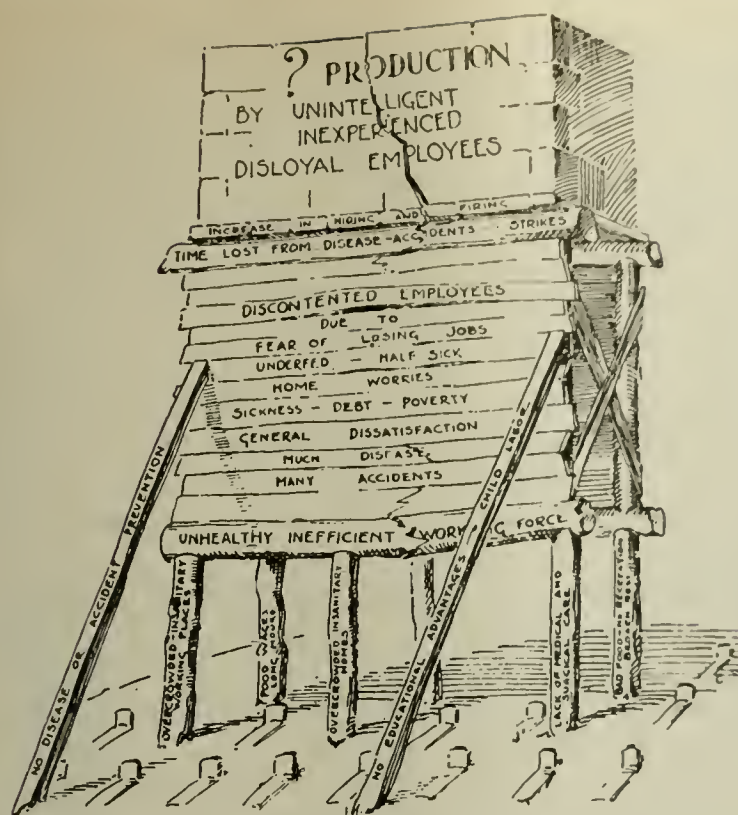
WORTHINGTON PUMP & MACHINERY CORPORATION.

YALE & TOWNE MANUFACTURING Co.—A model A-17 crane truck and a model C-6-36 trailer. These two units will be used to move the greater part of the material being exhibited from the receiving platform to the various booths. Represented by C. T. Gies, H. C. Yost and J. C. Morgan.

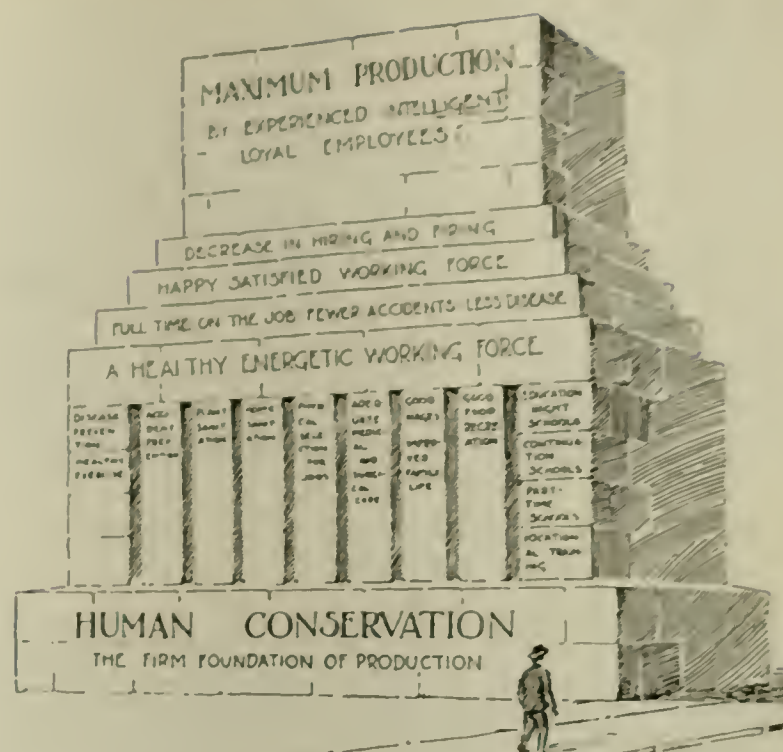
YOUNG BROS. Co.

ZAVON Co., INC.—Zavon, a textile solvent used in the cotton, silk, woolen and fur industries. Represented by George A. Reeder, Esther C. Cannon, John Stokes, C. C. Harding, L. W. Kearns and C. A. Aeschmann.

ZELLER LACQUER MANUFACTURING Co., INC.—Lacquers, thinners, lacquer enamels, bronzing liquids, solvents and solutions, as well as the finishes obtained through the uses of such products. Represented by Hugo, Richard, and Gustav Zeller.



HUMAN WASTE
THE FOUNDATION OF PRODUCTION



From "Industrial Medicine and Surgery,"
Saunders Pub. Co., Philadelphia.

Human Waste in Industry

Strong Emphasis Is Placed on the Role of the Physician in Industrial Plants,
With an Outline of the Preventive and Curative Medical Services
Which Can Be Rendered to the Working Forces in Industry

By HARRY E. MOCK, M.D.
Fellow American College of Surgeons

THE physician and the engineer are joining hands in the fight against industrial waste. For the first time in the history of our nation professional fences are being torn down. Every individual, group or national organization fitted by training or experience to help in this fight are being called to the colors. Most of the problems of the engineer deal with the physical properties of the plant, the machinery and many of the economic equations of management, while most of the problems of the physician in industry deal with the physical phases of the life of the working force, both in the plant and in the home. The importance of the civil, the mechanical, the electrical, the chemical and every other type of engineer to industry has been recognized for generations. Today the human engineer is likewise becoming an important factor in industry.

CO-OPERATION BETWEEN ENGINEERS AND PHYSICIANS TO CORRECT HUMAN WASTE

The nation in its rapid industrial development has been prodigal with its natural resources. No greater example of this prodigality can be found than in the wasteful attitude toward human life and limb. The concerted effort now in progress to correct industrial waste promises to accomplish the greatest reforms in public health, the prevention of disease and accidents, the medical care of the working people and other

human conservation measures ever witnessed in this country.

Surveys and scientific research! Make a survey and learn the size of the problem! Search and research for the scientific principles, both in engineering and in medicine! These and similar slogans during the last several years have resulted in the accumulation of a mass of information and material. We are now entering upon a period of practical application of these principles to the everyday problems of existence.

DOCTORS' OFFICES ARE RECENT ADJUNCTS TO INDUSTRIAL PLANTS

Universities and colleges, noted for centuries as storehouses of knowledge, are now becoming reservoirs of service to the people. To have a part in this greatest of all conservation movements is an honor to be sought for, and medicine with its various specialties is ready and anxious to co-operate.

The years 1909-10 mark the first concerted movement on the part of certain industries to conserve the health and limbs of their working forces. Prior to that date many concerns had their company surgeons, but the chief duties of these doctors was to anoint the bruises, tie up the cuts and splint the breaks—first aid and emergency care vitally important in any health program, but representing only one angle of the great problem of human maintenance.

At that date, a little more than a decade ago, a few industries began to establish well equipped doctors' offices in their plants, manned by broad-visioned physicians who saw in this group practice living human laboratories for their endeavors—human laboratories wherein the physician, assisted by the industrial nurse, the eye specialist, the dentist, the safety and sanitary engineer, could work out the methods of and observe the results of prevention of disease and accidents, supervision of the health of the working force, treatment of minor ailments in the plant office and supervision of treatment of serious illnesses in the homes of the employees and of all forms of sanitation in the plant, even extending his services into the hygiene of the home and the community.

IMPORTANCE OF MEDICAL WORK IN INDUSTRIAL PLANTS

Gradually, during the last ten years, the number of industries developing some type of a human maintenance department in their respective plants has increased. These departments have usually featured or stressed certain angles of the human engineering program—few concerns have developed a comprehensive, rounded system. For example, one industry has stressed welfare work, and because it has a competent social worker in charge, feels that it is meeting excellently this problem of human maintenance; another has stressed the "safety first" work, and depends almost entirely on its safety engineer to reduce human waste and he in turn can scarcely see how anything but accidents could cause human waste in industry; other industries have stressed the "industrial relations department," usually headed by the employment manager, and he too frequently cannot see the importance of the medical work as a definite part of the industrial relations or curtails the expense of the medical department in order to stress some other angle of his problem—the lay mind cannot grasp the importance of health supervision, early diagnosis or expensive emergency care to prevent more expensive prolonged illness and disability.

On the other hand, too many industries have stressed the medical work and have neglected the other angles of human maintenance—sociological work, employment, safety and sanitation. Again, many of these concerns have fooled themselves or have been fooled into thinking they have a medical service when they employ a cheap doctor for a few hours a day and one or two visiting nurses, and carry on a medical service which is a mere mechanical routine, a farce, a service in name only. The doctor who is only using his industrial practice as a "pot boiler" is not usually interested in the great problem of reducing human waste in that industry.

Of the 2,200 physicians, good, bad and indifferent, engaged in some form of industrial health service in the United States, 500 have affiliated themselves with the American Association of Industrial Physicians and Surgeons. This organization stands for the best possible medical service, preventive and curative, which can be rendered to the working forces of industry. Of this latter number it is conservative to estimate that at least seventy-five are serving great industries which have whole-heartedly adopted every method advocated to conserve the human forces in their employ. From their experiences abundant data have been accumulated to prove our charge of excessive human waste in

industry; likewise to prove the remedial measures adopted are sound and effective.

There is a strong appeal to human sympathy in this subject. As Americans we thoroughly believe in the principle that all men are created equal. We are gradually adding a supplementary principle—namely, are created equal and must have equal opportunity to survive, re-create and live in peace and contentment. However, with this human appeal in the background, I intend to emphasize solely the sound economic principles, the increased efficiency, the saving in labor turnover, the accrued profits to the management and to the workers, the conserving of the nation's human resources which inevitably follow the elimination of human waste in industry.

The last census shows that approximately 42,000,000 persons compose the great industrial army of this country. Figures gathered by the U. S. Commission on Industrial Relations in the years 1913 to 1915 show an average loss of nine days per year on account of illness to the American wage-earner. Figures collected from a great many industries having good, fair or indifferent systems of medical supervision of their working forces show an average of four to seven days per employee lost annually due to sickness. Thus it is evident that even an average type of health supervision will cause a reduction of at least three days per employee in the annual morbidity rate. The cost of the medical service, including many other functions besides those of health supervision, did not exceed an average of \$2.25 per employee per year in ninety-nine industries surveyed by Magnus Alexander.

ECONOMIC LOSS DUE TO SICKNESS

Reducing industrial waste due to sickness by a plan of medical supervision of the entire wage-earning force of the country would result in the following saving in dollars and cents to industry, to the individual and therefore to the community:

42,000,000 workers, losing nine days per year, at an average wage loss of \$3 per day ($42,000,000 \times \27).....	\$1,134,000,000
Reduction of three days per year by medical supervision leaves six days' annual loss, or $42,000,000 \times \$18$	756,000,000
Saving in lost wages to employees.....	\$378,000,000
Cost of medical services necessary to accomplish this, as well as many other forms of savings ($42,000,000 \times \$2.25$).....	94,500,000
In normal times we may assume that the loss in production or in the efficiency of the entire working force equals at least the amount paid in wages, therefore reduction of sickness would save to industry and to workers.....	283,500,000

ECONOMIC LOSS FROM ACCIDENTAL INJURY

Quoting from Dr. Eugene Fisk, we gain another viewpoint on the monetary loss resulting from accidents in industry:

If, as Mock estimates, 200,000 people are permanently disabled by industrial accidents annually, and if we assume that \$35 is the average cost of replacement, this means a direct waste in turnover alone of.....	\$7,000,000
Add to this for those disabled four weeks or more ($875,000 \times \$35$).....	30,625,000
Add for those killed ($28,000 \times \$35$).....	980,000
Increased production costs due to industrial accidents	\$38,605,000

At least 75 per cent of the accident rate is preventable.

Even greater reduction has been made in some plants by safety measures and education. The economic value of these lives on the lowest basis of computation is \$8,000 each and the saving of 20,000 of them (75 per cent) would mean an economic gain of \$160,000,000.

Accidents cripple the efficiency of the working force. Trained employees who are injured must be replaced by new, often inexperienced, workers. It is hard to estimate the loss to industry by this form of forced labor turnover.

ACCIDENT PREVENTION IS CHEAPER THAN PAYING COMPENSATION

Injured employees, non-producers now, cost industry a terrific toll in compensation. In Pennsylvania the gross total of workmen's compensations awarded and paid for fatal and disability cases during two and a half years, Jan. 1, 1916, to July 1, 1918, amounted to \$16,917,000—the amount actually paid to 577,053 injured workers or their families. A cheap price surely, for of this number 3,789 lost either arms, legs, hands, fingers or toes; 1,157 lost one eye; 29 were totally blinded and 7,575 were killed outright. It is difficult to estimate the cost to the industries or to the injured employees (or to the doctors and hospitals often forced to give free care) for the medical and surgical services to these cases.

Figures from many states having compensation laws would indicate that considerably more than \$100,000,000 annually is disbursed in payment of compensation claims to injured workmen throughout the United States. One-half this sum spent by the states in an intelligent accident prevention program would reduce accidents 75 per cent and the amount paid in compensation at least three-fourths. Prevention is cheaper than paying compensation. Compare these two items:

No accident prevention, cost of compensation.....	\$100,000,000
State accident prevention programs, cost.....	\$50,000,000
Cost of compensation for reduced number of accidents.....	\$25,000,000
	<u>\$75,000,000</u>

Here is one common meeting ground for engineers and doctors for the elimination of one of the most appalling examples of wastage in industry.

ECONOMIC LOSS FROM PREVENTABLE DISEASES

Statistics innumerable can be furnished to prove the economic loss from preventable diseases and accidents in industry. But statistics are not as convincing as actual examples of a few methods of preventing human waste.

Engineers can readily understand the importance of examining one thousand intricate, expensive machines which the management of the industry had decided to install. Naturally, this examination would be made before setting up and using the machines, especially if certain damaged parts in the mechanism might cause an explosion which would damage, perhaps irrevocably, some of the other machines. Why not, then, the same solicitous care of the human machine?

When I was making a plea for certain preventive measures which would reduce the number of accidents to our soldiers from industrial causes during the recent war, an old medical army Colonel said to me: "The soldier is the cheapest commodity we have in this great war machine. We expect them to get injured, wounded and killed." He was a small-caliber, narrow-minded

officer, of course. The majority of those in authority saw the value of prevention, realized that the fighting man was the most expensive commodity in the army. The idea of prevention was thoroughly sold to this great industry organized for the purpose of war.

Today, and more true of the past, too many employers and captains of industry have looked upon the worker, the soldier in the industrial army, as the cheapest commodity in his institution—a machine to be used to the utmost and when premature age, sickness or injury overtook it, to be scrapped without further thought. The idea of the expensiveness of this machine and the economy of conserving its usefulness by preventing these misfortunes must be as thoroughly sold to industry as it was to the army.

ECONOMIC LOSS DUE TO UNINTELLIGENT HIRING OF APPLICANTS FOR WORK

The old system of hiring and placing a man on a job and the system still in vogue in many industries was to have the foreman or the employment manager interview the applicant, ascertain his occupational qualifications and then assign him to the job. No thought was given as to whether the man had a bad heart or high blood pressure or an incipient kidney disease when he was assigned to the heavy work of trucking, running a roller machine or running up a ladder fifty or a hundred times a day. Yet this heavy work, incompatible with his damaged physical machine, was responsible for his premature breakdown and mayhap his death. The expense of hiring that man and breaking him in to a job for which he was physically unfit was a dead loss to the industry. Nevertheless he was replaced by the same stupid, blind method of hiring. No thought was given as to whether the man employed had tuberculosis. He had, but he was placed at the job of packing in a poorly ventilated room, in close proximity to a hundred fellow employees. The dust from the packing paper made his disease grow rapidly worse. His coughing and occasional spitting infected three of the men working near him. Just as he was becoming a good packer he was forced to quit. Fear of losing his job and placing his family in want had kept him at work on the days when he should have been home in bed. When he finally gave up the fight his disease was so advanced it was incurable. The three other men, with gradually decreasing efficiency, continued to work until the foreman said:

"What's the matter with you men? You used to be good packers, but now you're no good a 'tall. Get out! You're fired!"

Four men thrown on the scrap heap! Four families a drain on the community because of the unintelligent system of hiring and firing so prevalent in industry! In these same industries expensive intricate machines are very carefully examined by engineers.

Annually throughout the land thousands of such cases of organic disease, kidney trouble, tuberculosis, syphilis, mental and nervous disorders and other incipient disease conditions are being blindly employed, permanently damaged, menaces to fellow employees, and prematurely scrapped as the derelicts of industry. Here is another field where experience has proved that wastage in industry can be eliminated.

EXAMINATION OF APPLICANTS FOR WORK

In 1912 the routine medical examination of applicants for work before they were placed on the job became

a definite function in a few large industries. Later, in 1914, other industries took up this system in order to protect themselves against employees with deformities, hernias, one eye blindness, etc.—conditions which might make the concern responsible for compensation, as in that year employees' compensation acts were passed in a few states. In some industries there were selfish reasons behind the adoption of this method, but among the pioneers in this field humanitarian reasons and sound, scientific business principles prompted the action.

The examination of applicants for work should be for the sole purpose of discovering:

First, those applicants who have some condition in their bodies which makes their presence in the plant dangerous for themselves, for others or for property.

Second, those applicants who have physical or mental defects not entirely unfitting them for employment, but which require careful selection of work in order to preserve their health and make them efficient workers.

Carefully conducted physical examinations will show between 2 and 3 per cent of all applicants totally unfit to work because of conditions enumerated in the first class. Approximately 25 per cent of the applicants will have some diseased condition which can be corrected or which requires the selection of his work as explained in the second class.

Scientific placement, therefore, in order to reduce this form of human wastage in industry, necessitates close co-operation between the physician and the employment manager. The first learns the physical qualifications of the applicant, the latter his occupational qualifications. Scientific placement results according to the following formula:

Physical Qualification

+ Occupational Qualification

= Job

ECONOMIC ADVANTAGES OF MEDICAL EXAMINATION
OF APPLICANTS FOR WORK

The number of applicants who have contagious diseases is not great, but even one case of diphtheria or scarlet fever thrown in among the old working force becomes a potential factor for great havoc, a destroyer of efficiency and an added loss to industry. In one year the writer and his assistants examined 8,000 applicants for work and found 170 cases of contagious diseases, all of whom were rejected permanently or temporarily, as follows:

Cases		Cases	
Tuberculosis.....	102	Mumps.....	6
Syphilis (active).....	10	Streptococcic sore throat.....	18
Gonorrhea.....	16	Smallpox.....	1
Diphtheria.....	8	Trachoma.....	1
Scarlet fever.....	2		
Measles.....	6	Total.....	170

It is self-evident that the health of employees in this industry was greatly protected by preventing these applicants from going to work. The financial saving to the concern by preventing at least five possible epidemics among their working force cannot be estimated.

Four years ago I obtained figures from ten large industries having a total working force of 102,400, which conducted careful medical examinations of applicants for work. The profits to these ten employers

from this system amounted to \$288,000 in one year after paying for their entire medical and nursing services, including all the other functions of the medical departments. Details of these statistics can be found on page 88 of Mock's "Industrial Medicine and Surgery."

HEALTH SUPERVISION OF WORKING FORCE

It is customary for engineers periodically to inspect and examine the plant machinery in order to discover early the signs of wear and tear and when necessary to repair in order to preserve its working span and effective operation.

In a nutshell, that is the purpose of the physician in industry—the human engineer. Not only must the portals of the plant be guarded against unsafe applicants for work but the old working force must be constantly supervised to guard against contagion and epidemics among its members; to discover the incipient diseases early before their advance has robbed the concern of competent, trained workers; to see that the sanitary conditions outside in the community, inside in the plant, and among the employees are such as to conserve health, contribute to their contentment and by all of these add to or maintain their efficiency.

Periodical physical examination, or the examination whenever otherwise indicated, of the old employees is the best method and only scientific means provided for a thorough supervision of health. If these examinations are slipshod or merely routine, devoid of all personal interest in each individual case, very little value accrues to either employee or employer. But if medical talent is employed in whom the managers and foremen have confidence and if every laboratory and other facility is given to examine the workers thoroughly, then great value accrues to the management, to employees and to the community. Such a medical department becomes a veritable community health center and has untold influence over the health of the families of the workers. Without attempting to give home medical service to the families, many opportunities are presented for the visiting nurse or the doctor to relieve illness in some member and thereby relieve worry and increase the efficiency of the wage-earner. After an employee has been thoroughly examined in the doctor's office at the plant, he insists on a thorough examination of some member of his family when that one is forced to consult the family doctor. Thus even the caliber of the outside physician is improved. Not only does an efficient medical department decrease industrial waste but its influence and ramifications decrease human waste in the community itself—preserving to each industry a healthier, more loyal future generation of wage-earners.

WORK FOR DENTISTS AND EYE SPECIALISTS IN
CONSERVING AND RECLAIMING EMPLOYEES

Dental departments in industry have become established units of the medical system in at least fifteen concerns. They are absolutely vital in discovering the diseased conditions about teeth, especially those conditions which insidiously lower the vitality of the worker and often are responsible for the absenteeism which is thought to be due to some other disease. No system of health supervision is complete that does not include dental examinations and some arrangement whereby remedial measures can be placed within the financial reach of each wage-earner.

The eye specialist has become invaluable in the program of conserving and reclaiming employees. In various industries from 35 to 56 per cent of the employees were found with defective vision uncorrected by glasses. While thus far I have found no method of computing the increased output of these workers after they were fitted with glasses, yet the testimony of many managers and foremen indicates that practically all of them have become more efficient and steadier on the job. The good eye specialist can increase the efficiency in whole departments by suggesting and supervising changes in illumination. He can help enforce the protective measures installed for the prevention of eye injuries.

WASTE FROM MINOR INJURIES

Besides the usual measures incorporated in "safety first" and accident prevention programs, the physician in industry can eliminate many sources of waste the result of accidents. Minor injuries are said by accident casualty companies to cause considerably over 50 per cent of the disability cases. This is due to the fact that most of these slight injuries are neglected until some complication, usually an infection, forces the worker to consult a doctor. Forcing every case, no matter how slight the injury, to see the doctor in the plant at once and the use of tincture of iodine on every scratch, pin prick, nail wound or other lacerating wound have resulted in a great decrease in infections and in minor injury disability. Sherman reports only 0.1 per cent of all accident cases in the Carnegie steel mills become infected. In my experience I found that 78 per cent of all accident cases reporting to the doctors' office in 1909 were infected. By instituting the rules about reporting and using tincture of iodine at once there was an immediate reduction of 28 per cent in the number of infected cases. This decrease continued until only 7 per cent of all cases showed the least sign of infection and only 0.2 per cent lost time on account of infections.

Immediate care of every injured employee, treating each case as serious from the moment of injury and the use of the best hospital facilities will reduce the lost time on account of accident disability and will reduce materially the number of cases of permanent disability and permanent deformity. Here again careful physical examinations of the employees will often reveal potential causes in the human machine for accidents either to themselves or to fellow employees.

Real co-operation must be developed between safety engineers and physicians in industry to obtain 100 per cent value from any accident prevention program.

CASUALTIES IN THE INDUSTRIAL FIELD

It is conservative to estimate that the casualty lists from the industrial army in one year in this country are at least three times greater than the casualty lists sustained by our army in the World War during the bloodiest year of fighting. Millions have been spent by the Federal Government for the reclamation of our disabled soldiers, and a great many more millions must be spent before the nation's promise of rehabilitation to the disabled is even properly administered, let alone realized. These efforts to rehabilitate the soldier have awakened the nation's conscience to the importance of rehabilitating or reclaiming the disabled from industry.

From the industrial field alone, consulting statistics

furnished by the Department of Labor in 1917, one finds that annually 875,000 men and women are disabled for more than four weeks as the result of accidents sustained in industry; that annually 76,000 suffer loss of members, and at least 200,000 are otherwise permanently disabled by industrial accidents, that each year 28,000 are killed as a result of industrial accidents. Conclusions drawn, after the investigations of many different authorities, indicate that at least 250,000 wage-earners are lost annually in our country due to occupational diseases.

RECLAMATION OF THE DISABLED

With the exception of some of our large industries and a few far-visioned insurance companies, practically no organized effort has ever been made for the reclamation of these hundreds of thousands of permanently disabled men and women. A few industries salvage their disabled, making them efficient and independent, others give injured employees easy jobs where they can make a living, but the very softness of the job robs them of all incentive, and the bitterness engendered by dying ambition adds to their incompetency, forcing them on and on to the scrap heap. The majority of concerns settle with and then dismiss their injured workmen for whom they are legally responsible; the disabled for whom they are morally responsible are scrapped without a settlement. These men, trained for certain occupations, who meet with permanent handicaps, are the waste products of our industrial life. Too often when the handicapped individual is employed he is ineffective, because the job was chosen for him without considering his physical fitness for it. Many of these disabled men for whom no employer feels responsible drift from one job to another, constantly dropping to a lower level, until finally they relinquish all effort to work. These become the loafers, the beggars on the corner, the shoestring merchants on the street, the poor, physically handicapped and mentally debased flotsam and jetsam of our civilization. The great majority of these handicapped persons cry out not for charity, not for the easy job, but for a chance to make good and to advance. The testimony from a great many employers who have employed handicapped individuals indicates that they are efficient, capable and will often stick by the job better than the able-bodied man.

NEEDED FEDERAL LAWS FOR VOCATIONAL TRAINING OF THE HANDICAPPED FROM INDUSTRIAL ACCIDENTS

I prophesy that within the next ten years every state in the Union now having employees' compensation laws will likewise enact laws and establish machinery providing for the rehabilitation of these permanently handicapped individuals. Already Rhode Island, Pennsylvania, California and Illinois have adopted rehabilitation laws providing for more or less limited efforts along this line. The Federal Government has enacted the Smith-Sears bill, which deals with the vocational training of the handicapped from industrial accidents by co-operating with state efforts. All of this is more or less piecemeal legislation, especially the latter law, as vocational training constitutes only about 10 per cent of the problem. It is placing the cart before the horse, but nevertheless even this law indicates an awakened conscience on the part of the lawmakers.

In an effort to work out a practical solution of the entire problem of rehabilitating the physically handi-

capped both from accident and disease, an organization has been perfected in Chicago during the last year, composed of leaders in industry and education, a large group of women representing the various social agencies, and a medical board of representative physicians and surgeons of the city. This is known as the Service League for the Handicapped. It has an executive committee made up of fifteen of the most influential business men, with medicine, education and safety engineering also represented. Its board of management is composed of delegates from almost every agency in the city dealing with some phase of the problem of the handicapped. Through its connections with the public school system, the universities and many industries and through its own workshops which are now established, practical re-education of the handicapped for lucrative employment is made possible. It maintains an employment bureau which directly or through the state and private employment agencies is successfully replacing many handicapped individuals in industry. This Service League stands as a halfway house between hospital, where the reconstructive surgery is done, and the future employment of the disabled, where his rehabilitation will be completed.

No plan for eliminating human waste in industry is complete that does not include this salvaging process—a process which aims to reclaim those who become disabled in spite of all the great preventive measures which are being advocated or have been installed. Keep in mind human salvage as well as the elimination of human waste.

COMMUNITY CO-OPERATION

The burden of the care of the sick and injured from industry must fall on either the individual, industry or organized charities, when neither the first nor the second is responsible financially for that care. The succor of the individual and of his family by the charities is humiliating and after all is a tax, as the majority of the community must contribute to charities. Frequently the burden is too great for the individual endeavoring to carry it alone, and as a result insufficient or improper medical, surgical and hospital care is obtained, resulting in prolonged disability and often complete loss of the wage-earner, either being a very material loss to industry. Many large industrial concerns and groups of smaller industries have proved their ability to organize efficient medical departments. These, or insurance companies representing them, assume the cost of furnishing adequate medical and hospital care and the additional cost of paying compensation sufficient for the family to maintain its integrity and its natural position in society, and add the expense of such protective measures to the cost of production. Even this burden is a tax on society, for the consumer must ultimately pay, yet the benefits in return to all society offsets this tax a thousand-fold.

The alternative method is for the state to impose a sufficient tax to meet these problems of prevention, treatment and reclamation of the disabled wage-earners. Personally, I do not believe many states are equipped to handle the problem as efficiently as are individual industries or groups of smaller industries. The tax would undoubtedly be much greater than if the burden was carried by a small addition to the cost of production.

The physician in industry more than any one else

has come to realize that the questions of health in industry, as well as many of the other industrial relations problems, deal not only with the individual employee, but rather with the employee and his family.

COMMUNITY HEALTH CENTERS THE SOLUTION FOR ELIMINATING HUMAN WASTE

When considering the preventive and the remedial measures as a means of eliminating human waste in industry, all methods developed must be applied to the community as a whole. The organization of community health centers to which industries will contribute for the adequate supervision and care of their working forces will undoubtedly be the ultimate solution of this great economic and social problem. Such centers would enable the development of a co-operative plan between community and the industries of that community for the purpose of eliminating human waste. It would safeguard for industry the expensive human machine while employed in the plant, while on the streets and while at home. It would guarantee a better system of preventive medicine, better medical and surgical care, better hospital provisions and would prolong the work span and life span of every individual.

Laying aside the old doctrine of "the survival of the fittest," we seem to be entering upon a new era—the conservation of man, the noblest work of God.

Chicago, Ill.

Loss in Production Due to Ill Health

A report on national vitality prepared in 1909 for the National Conservation Commission, appointed by President Roosevelt, estimated that there were then about 3,000,000 persons seriously ill at all times in the United States. This meant an average annual loss per person of thirteen days owing to illness. It was estimated that 42 per cent of this illness was preventable, and that such prevention would extend the average life by over fifteen years.

The committee appointed by the Federated American Engineering Societies to study the elimination of waste in industry states in the summary of its report (July, 1921) that since the 1909 report was issued an evident reduction in illness has been accomplished, so that today an estimate of between eight and nine days is probably near the fact.

Tuberculosis is the most important disease among industrial workers, two or three deaths per 1,000 per annum occurring at the working ages. It is estimated that 3 per cent of the wage earners, or about 1,250,000 lives, are affected. The economic loss from tuberculosis death rate as affecting the working population is \$500,000,000 annually.

Pneumonia, influenza and typhoid fever are the most important communicable diseases among adults. Influenza and pneumonia, in non-epidemic years, take about 35,000 lives in the working ages and account for at least 350,000 cases of illness. Typhoid fills close to 150,000 sick beds annually and takes 15,000 lives, mostly in the working ages.

In a large industrial area hookworm infection was present among at least 5 per cent of the laboring population.

Malaria is so seldom a direct cause of death that it is difficult to estimate its extent and influence, but it is responsible for much sub-standard health, and probably affects 1,500,000 persons annually, covering 27,000,000 days' absence.

Waste Due to Poor Engineering and Management

Sound Engineering Practice and Competent Management Are the Most Effective Methods of Eliminating Waste—Accurate Cost Records of What Has Been Done Should Make Possible the Prediction of Improved Results

BY DEXTER S. KIMBALL

Dean of College of Engineering, Cornell University

FOR a number of years certain industrial engineers have been advocating a more careful consideration of industrial wastes as a part of more efficient management. Received rather complacently at first by managers, this idea has now grown to be one of the most prominent and also one of the most promising fields of industrial betterment. The appointment by Mr. Hoover, as president of the Federated American Engineering Societies, of a special Committee on the Elimination of Industrial Waste has done much to arouse still greater interest in this matter, and the forthcoming report of this committee is expectantly awaited. A very interesting feature of this report is a recommendation that uniform cost systems be established in all industries as a means of evaluating and checking industrial waste. This is a perfectly logical conclusion. Costs, if properly considered, are financial statements of what has occurred. They provide a basis for comparison of results and also for predicting future policies.

WHAT IS INDUSTRIAL WASTE?

Like all seemingly new industrial problems that receive such publicity, the elimination of industrial waste will be much discussed, no doubt, and possibly some extravagant claims will be made concerning it. Some confusion seems to exist also in the minds of some of those who have discussed the matter as to just what is definable as industrial waste, and before going further it may be well to inquire just what the term really involves; for waste can be prevented only when it is understood.

WASTE OF MATERIALS

Waste of materials is usually quite tangible and, hence, usually preventable. If a workman uses more material of any kind than is actually necessary for a given operation, waste results; or he may waste material through spoiling the work on which he is employed. Material may be wasted through inefficient or inadequate equipment, as in the case of a boiler room where coal is not properly burned. Also great material wastes often occur because of careless handling and storing of material, through actual loss of material and through preventable depreciation.

LABOR WASTES

Labor wastes are not always so evident. If a man expends more time upon a piece of work than is necessary, waste results; or if he is paid for time during which he does not produce, money is wasted. Time may also be wasted through the use of inefficient equipment or poor methods. The loss through these last two resources are often very great and often not appreciated.

It does not follow, however, that waste results when a man works eight hours when he could work ten. Perhaps eight hours is as long as he should work. Nor can it be said that there is a waste because a plant operates only eight hours out of the twenty-four. In some industries it is necessary to operate continuously to produce economically, but the term "waste" must be applied with care to the period during which a plant operates. Again, it does not follow that a workman wastes time because he is not working every minute of the time for which he is paid. He usually can produce more product if he is given definite rest periods. This is a fact proved by actual experiment.

IDLE EQUIPMENT

Losses and wastes due to idle equipment are also somewhat elusive. Clearly there is a waste of time and of interest on investment when a machine stands idle though there is work for it but, because of poor planning, the work is not ready. It does not follow, however, that all such idle time of equipment is chargeable as waste. Quite frequently, and particularly with large equipment, it is not possible to keep all machines in operation; yet these machines may be absolutely indispensable to the life of the business. The interest on investment during idle periods is a just charge against production, and should be so recognized and cared for in the costs, and if this is done, such interest cannot be classified as a waste. It may occur that the line of work that demands machinery and equipment which operate only occasionally does not pay a profit, and in such case the entire procedure may well be called a waste.

ALL WASTES NOT PREVENTABLE

It should be remembered also that all wastes are not preventable. Wastes of material and time through carelessness or bad management can usually be reduced to small amounts, if not entirely eliminated. But buildings and other property, even when kept in good repair, waste away slowly and in course of time must be renewed. Unless provision other than repairs is made for such wasting away the capital invested will in time be depleted. And again it may not pay in some instances absolutely to prevent all waste. Thus the wasting losses through radiation from a steam pipe may be reduced to a small amount by covering the pipe with a thick layer of non-conducting material. The cost of covering the pipe with a layer of such material, thick enough to prevent any radiation whatsoever, would in all probability be greater than would be warranted by the saving made over the case where a moderately thick layer was used.

The foregoing brief consideration of industrial wastes should make it clear that wastes cannot in general be detected by casual observation. In many cases, of course, the waste may be so apparent as to be so detected, but many large wastes are difficult to detect and difficult to prevent. And it will be obvious that unless the character of the waste is known it is most difficult to prescribe remedies for it. This is particularly true of wastes due to careless or inefficient management and organization. And even when the character of the waste is obvious it is not often easy to evaluate by observation the amount of the loss occasioned.

PREVALENCE OF LACK OF KNOWLEDGE

Most industrial waste and loss are due to lack of knowledge, and many data are available which indicate that the majority of business failures are due to incompetence; particularly that form of incompetence that comes from lack of accurate knowledge of some part of the business.

Bradstreet's reports for 1911 and 1921 give some very interesting data on the matter which indicate that four-fifths of the business failures in this country are due to incompetence of one kind or another on the part of those that fail. And no doubt much of the incompetence comes from lack of knowledge regarding some phase of the business, and particularly regarding wastes and wasting losses.

One of the most effective methods of evaluating wastes is through the cost system, and no cost system is worth considering that cannot be used to evaluate any given waste. The character of wasting losses naturally varies with the character of the business, though some wastes, such as depreciation, are common to practically all industries. A cost system may or may not reveal the character of wasting losses in a given industry, but cost-finding methods can always be employed to evaluate any loss once its character is determined. Every careful manager should therefore study carefully the wasting losses peculiar to his business, evaluate them by financial standards through his cost system and proceed to eliminate, as far as possible, those that are important enough to be considered. A few particular cases may make these points clearer.

LOST TIME

In all industries there is more or less lost time. Machinery breaks down or lights are temporarily extinguished, thus causing temporary idleness for which pay is not deducted; or workmen are idle because work or tool is not at hand. In many cost systems such lost time is charged directly to some productive job order number and thus buried in the cost. If the amount of lost time is small, this may be all right, but a better procedure is to carry all such lost time to a separate account and distribute this account in the expense or overload. Such an account becomes a measure of efficiency in management and will show not only the amount of such losses, but can be made to show the responsibility for such losses. Usually the most of these losses are due to poor planning of the work on the part of those in charge or to inefficient care of equipment and lack of foresight in keeping important machinery in proper repair. Such an account will not, however, reveal wasted time due to "loafing" on the part of the workers themselves.

Lost time in its relations to the payroll may be very important in itself, and if the idleness involves high-priced machinery, this factor may be of much greater importance, since then there is loss of interest on invested capital. This type of loss has several aspects. First, there may be loss of time in operating machines well fitted for the work in hand for the reasons already enumerated. Again there may be waste of time because of work performed on equipment not well suited for the purpose. And, lastly, there may be machines or processes in the plant that are used to such a small degree as to be a source of loss instead of profit. Occasionally, of course, as has been stated, machines and processes may have to be retained, though used only occasionally because of some peculiarity of the business. But an examination of many plants, particularly old plants, will show equipment and apparatus that are occupying valuable space and yet yielding so small a return as to constitute a loss. The case is analagous to the farmer who keeps an unproductive hen or cow, and the remedy is the same in both cases—through cost-finding methods. A record of all idle time for all equipment and a comparison of this idle time with the earnings of machines showing a large amount of idleness will often result in changes in equipment that will cut off much wasted time. Information of this kind can be easily obtained through ordinary cost-finding methods.

STOREKEEPER CUTS DOWN WASTE OF MATERIAL

Good cost methods are always useful in preventing wasteful use of material. It is still customary in many shops to permit workmen to draw material at will from the stores. It is true, of course, that in small shops, particularly where the material is of no personal value, it may not pay to employ a storekeeper and workmen may be permitted to help themselves from bins and racks. Such cases are rare, however, and usually it pays to have a storekeeper. It is a small enterprise indeed where a storekeeper will not save his wages. It is universal experience that workmen, when allowed to draw material at will for fabrication or general supplies, become careless and wasteful not only as to the quantity drawn but also as to its economical use. Loose storeroom methods also are likely to lead to dishonesty and petty pilfering on the part of employees.

Under a good cost system the storeroom is closed to all but the storekeeper and his assistant, and no material may be issued without a proper order any more than money can be obtained at a bank without a check. Material is just as valuable as cash in the safe and should be so treated. Under a good cost system all material drawn is charged to some production or expense order and properly accounted for. Aside from the actual savings made by properly regulating the withdrawal of material from stores, such regulations serve to accentuate constantly the value of material and assist in forming habits of thrift in all concerned.

Material wastes due to overissuing or careless drawing of material can be kept in check by good storeroom and cost methods. There is usually, however, a considerable amount of unavoidable material waste due to cutting, sawing and other fabrication processes. In the case of copper and similar valuable material, these wastes may be considerable, and even with

cheaper material, as sheet steel, when large quantities are used the value of the scrap may be great. If the waste is in such form that it may be returned to stores and used again for other purposes, the cost system should be such as will credit the original job with such salvage value as may be fair to it.

DEPRECIATION OF MATERIAL

Another common source of material waste is depreciation of stores materials due either to poor storing or to obsolescence. The remedy for the first cause is obvious, but the second is not always so easy to recognize or to obviate. Obsolete unworked material usually comes from careless ordering or changes in design, and many kinds of stored material depreciate rapidly, particularly if it is at all special in character. Finished product often depreciates through obsolescence due to changes in market conditions. Cost-finding methods, as usually operated, will not reveal such losses, but a close study of the inventory will make such losses apparent. The engineering or designing department can do much to lessen these losses by consulting the inventory when designing new apparatus so as to use material on hand where possible.

Depreciation of buildings and equipment through wear and tear, action of the elements, obsolescence, etc., are, however, wasting losses that can be and should be clearly shown and compensated for in the cost system. The method so much in use of charging off depreciation as a lump sum or percentage annually is no longer considered good business accounting. Losses of this kind are a legitimate part of costs and should be included so far as possible in the charges made for each machine and process as the work passes through them. In all good cost systems systematic provision is made for including depreciation in the regular cost of production. In this way, and in this way only, can intelligent compensation be made for such losses.

SPOILED WORK

An excellent example of the value of a cost system in evaluating wastes is in connection with spoiled work. It is still common practice to charge spoiled work to the job order number under which it has been performed. If the spoiled part is one of a large number, this procedure may often be defended. But more modern practice is to carry the cost of spoiled work to a special account that is discharged into the expense or burden as in the case of lost time. No matter what disposition is finally made of such an account, the practice is good in that such an account gives the manager an idea of the magnitude of this waste and the information necessary to correct the loss if it is serious. Spoiled work, like lost time, is a measure of the efficiency of management. Some managers go so far as to keep a record of the breakage of small tools and apparatus by individuals partly as a means of evaluating the loss and partly as a psychological check on carelessness.

Other specific examples could be given of the relation between cost finding and wastes, but the foregoing should be sufficient to indicate these relations. Obviously these wastes may be due to incompetence or carelessness on the part of either employer or employee, or both. Wastes due to poor management are not always easy to detect or evaluate. Thus a rearrangement of machinery or changes in administrative methods may not be reflected in the costs as

clearly as in the examples cited. In general, however, all such changes must eventually affect costs in some way or another, and in fact the result of any and all charges can be evaluated accurately only by a study of comparative costs.

PLANNING IN ADVANCE

The foregoing discussion has assumed that costs are considered only as a record of what has been already accomplished, and this is the usual conception of cost-finding methods. A more modern view is to consider costs as results to be attained, planning deliberately to arrange machinery, personnel and wages in advance so as to produce the desired result; and advanced thought in management is moving steadily in this direction. Careful consideration will make it clear that wastes such as lost time, material wastes, losses due to broken machinery, etc., can be greatly lessened by careful planning and foresight. The planning department, which aims to accomplish these results, is now a common feature of modern plants and many enterprises that produce complex and refined products are now running on schedules prepared in advance that cover the entire range of operations in which all time elements and all ways and means are predicted in advance of production. Undoubtedly the remedy for much industrial waste lies in managerial changes of this kind.

It will be clear, for instance, that if the amount and quality of material for a given piece of work are determined in advance and provision is made so that only this amount of material can be drawn for this purpose, much of the material waste now so common in many plants would disappear. The case of plant supplies is equally clear. Every manager knows that when workmen are free to help themselves freely to oil, brooms and similar material the tendency to waste the supplies is almost irresistible. Many careful managers now determine in advance just what the needs of each man may be and arrange a budget for all supplies, thus preventing unnecessary waste. Departmental expenses can be budgeted in a similar manner. It will be noted that aside from the actual savings thus attained, such methods tend to stabilize the costs, making prediction much more definite.

FUNCTION OF THE MODERN COST SYSTEM

It should be remembered, however, that budgeting and predicting of costs in advance can be accomplished only after accurate data are available. The power to predict in advance rests generally upon a knowledge of what has already been accomplished. A modern cost system, therefore, should perform two functions—namely, recording what has been done and making possible the predicting of what should be done. It does not follow because a piece of work has cost a given amount that it cannot be performed for less than that amount. One of the greatest criticisms of modern cost accounting methods is that usually they tell simply what has occurred and do not show what should occur. If the manager can have placed before him the statement of work accomplished and also a statement of the wasting losses and other defects in his organization and methods, it is usually not a difficult task to make such changes as will make prediction of results and the attainment of the same a hopeful possibility.

Ithaca, N. Y.

The Educational Waste in Industry

BY HOLLIS GODFREY

President, Drexel Institute, and Chairman, Council of Management Education.

IF IT be true that 50 per cent of the waste today in industry is due to management, the fault lies in industry and the college. That 50 per cent may be termed the educational waste, as it never could exist had there been proper co-operation between the colleges and industry in the past. The energy of education is the one force which is directed to stop management waste. Education is the salvation of industry.

COLLEGE MAN, PROPERLY TRAINED, NEEDED

Go to the captain of industry today and ask him what type of man he needs in his management group. He will tell you the college man when properly trained. He will tell you that the average college man is not properly trained and that for two years he is virtually useless to the organization; he will tell you that it costs at least \$2,500 to train that man before he can accept a position of responsibility in the company. But he will emphasize the fact that the man he takes into the corporation when a fresh graduate from college cannot accept responsibility and that his training has almost been a detriment in so far as industry is concerned.

It has been my good fortune to make a study of industry across the United States and to talk industrial waste and educational waste in industry with more than 275 of the largest employers of men. The average opinion of college men is the same. All agree, however, that the college man holds the key to the situation, that it is his problem upon entering industry to stop the leaks, to increase production, to decrease cost and to stabilize industry. How is he going to do it?

INDUSTRY LOOKS TO THE COLLEGES

In the face of almost universal criticism, industry yet looks to the college for the solution of its problems. Industry, with its keen, practical eye, sees farther than the mere lad who comes to its door to gain a livelihood; industry looks to the future. The great capitalist of today who studies the balance sheets sees that the educational waste in industry must stop, and in stopping that waste the very waste in management is terminated. The captain of industry knows that 12,000 men each year leave the colleges and enroll in industry with no previous training to equip them for life in industry; he knows that it takes two years to train those men in the plant at a cost of \$2,500 each and he knows that forces today are at work to stop these losses. Industry is interested in the project which has for its purpose the training of these thousands in the college, is grappling with the problem of the undergraduate to save the boy years of work and to save industry 24,000 years each year and millions of dollars in money.

A MOVEMENT TO BRING THE COLLEGE AND THE INDUSTRY TOGETHER

I have the honor to be the chairman of the Council of Management Education, which is dedicated to the work of eliminating this frightful waste in industry and the college. No one is to blame for the mistakes of the past, but, thank God, we are seeing light today.

The difficulty has been that industry and the college spoke two languages, two tongues which neither could speak or comprehend. Industry wanted the college to help, the college wanted to help; but both were in the position of a French manufacturer who would do business in America with French measurements and language, both of which the American manufacturer could not understand.

Slowly through the years a movement has been on foot to bring the colleges and industry together. The greatest step was made during the war. We had gathered around us in Washington the leading men of industry and the leaders in the college world. They worked, planned, dreamed together and when the armistice was signed some of these men decided that the great advance should not be lost. A survey of the entire country followed. This was made through the Technology Clubs Associated, and from this body of war workers and growing out of a conference held in Drexel Institute, Philadelphia, in March, 1920, of those most vitally concerned, the Council of Management Education has come.

THE WORK OF THE COUNCIL OF MANAGEMENT EDUCATION

Today the Council is backed by industries having a combined capital of \$23,000,000,000. Sixteen basic industries are in the movement and a number of others desire admittance as soon as the Council can undertake additional work. The colleges of the country, through the American Council of Education, which has appointed a group of educators to co-operate with us, are working in the closest accord. The majority of the colleges have written independently and offered their entire services. The Governors of every State in the Union save four have appointed representatives to act with the Council.

Thus, industry and the colleges are "getting together." It is an earnest effort to form a central body to consider the problems of each for the benefit of each. It is a non-profit-making body of the highest academic standing and its work is for public service alone.

A CLEARING HOUSE BETWEEN THE INDUSTRIES AND THE COLLEGES

As a great clearing house between the industries and colleges of the country it studies the problems of the firm which needs chemists, engineers, men versed in any particular line and, in turn, it studies the problem of the college to supply the men. It is a problem of industrial demand and educational supply. The men in the Council speak the language of the industry and of the college; each holds a major professorship in one of the leading universities and each has had his turn in cold, practical industry. Men of this type alone can take the facts of industry and college and make them available to both.

Eliminate waste—waste in the chemical industry, iron, cotton, rubber—the Council of Management Education has dedicated itself to this task as a service to mankind. I may add that it has been the good fortune of the Council to include several of the nation's greatest chemists in its roll. We earnestly ask the co-operation of all industries and hope the readers of CHEMICAL & METALLURGICAL ENGINEERING will assist the Council in its great task of service.

Drexel Building,
Philadelphia, Pa.

The Role of Research in Waste Elimination

Encouragement of Fundamental Research in America Is More Urgently Needed Than Stimulation of Industrial Research—Fallacy of Curtailing Research and Disrupting Organization in Times of Industrial Depression—Examples of Waste Eliminated by Research

By HARRISON E. HOWE
National Research Council

FOR the purposes of this discussion waste may be defined as materials, time or labor unnecessarily used in industrial operations and as finished products which fail to measure up to standards set for first quality in any given field. We may also include under waste values delivered in excess of requirements, but we shall not consider the profitable utilization of otherwise waste byproducts of industrial operations, for that subject, while never exhausted, has frequently been presented in convincing style. It is because most people think only of byproduct utilization when research is mentioned in connection with the elimination of waste in industry that there may be some justification for this article.

While the application of the results of research frequently presents a new problem as difficult as the original investigation, it is not to be confused with fundamental research. There are still many productive scientists, especially among the various kinds of engineers, who classify difficult development or control work with true research, and who are a little prone to think that real accomplishment is theirs rather than the theorist's. And yet we all know, if we will but pause to consider, that our work if sound must be based on the laws, principles and theories developed and established through research on real fundamentals usually many years before their practical application.

NEED FOR MORE FUNDAMENTAL RESEARCH

There is far more need to encourage fundamental research in America than to stimulate industrial research, notwithstanding the fact that many industries are not yet founded upon a science. A number of great industrial laboratories have shown their appreciation of this by taking up such work and others have made substantial contributions to educational institutions and organizations striving to encourage such research, that more may be accomplished. President Nichols of Technology in his inaugural address calls attention to the fact that we have about exhausted the store of knowledge which has been hundreds of years in accumulating and that we must have new facts in order to make greater progress. While we may not be in immediate danger, the time may soon come when several lines of industrial development will be hindered awaiting the completion of research just as were the sciences dependent upon optical instruments before Abbe's plea for improved optical glass, without which his dreams could not come true.

FALLACY TO CURTAIL RESEARCH IN HARD TIMES

With this state of affairs, why will industry consent so readily to the curtailment of research when soft times pass? This policy leads to one of our serious industrial wastes. It has been surprising to find how

many firms have made what seems the mistake of breaking up laboratory organizations even to the point of losing men of long terms of service. Such industrial retardation as that through which we are passing offers an excellent opportunity to weed out undesirable or inefficient workers, but it is not the time to dispense with valuable men. As it is, the present really offers to the courageous the chance to build up a strong laboratory organization and the time to engage upon problems which must be put aside in busier times. It is a pleasure to point to those concerns which firmly believe in research as their most potent anchor. These have undertaken research convinced that it will not only enable the elimination of waste to the point where costs will be much lower but that quality will be so improved as to enable the market to be held in the face of poor business and lead customers to discard competitors' wares first when purchases are curtailed. This faith has been justified, and such manufacturers have retained their staffs in the laboratory.

Ideas grow rusty as does machinery. It is not easy to pick up the problem just where it was shelved when the laboratory was closed. Recently a company which had established a research laboratory a year or two ago decided to close it and disband the staff. Something like \$100,000 had been spent and some of the problems were nearing completion. What possibility has that company to realize a return on the money spent? The problems were either unfortunately chosen or the work upon them poorly managed or a blunder has been made in stopping work. Research cannot be profitable unless well managed and adequately supported for sufficient periods of time and unless several well-chosen problems are in hand. Every problem cannot be a winner, and allowance must be made for the disappointing ones.

UNNECESSARY PRODUCTION OF SECONDS

The unnecessary production of seconds is an important industrial waste and usually indicates a lack of proper control of raw materials or of the process. Goods sold as first quality which in use prove to be second quality are even worse. Before materials can be so managed as to give a high percentage of first-quality product, research may be required to determine why reactions go the way they do. The more we know the why of what takes place, the better can we govern the procedure. While we still lose much from unsound castings, just recall the state of the art before research showed the beneficial use of metal scavengers and provided the considerable list of deoxidizers from which the foundry may now choose according to its needs. Some of these materials produce such vigorous reactions as to raise the temperature of the metal, thus serving to bring cold baths to the proper pouring temperature.

Research has not only provided improved pyrometers

but has shown many industries how to use them. It has been found that the relatively few degrees between estimated and real temperature often account for second-grade or useless products. It has been difficult for the research man to convince the others of the importance of a few degrees of heat. The failure to check the accuracy of the pyrometer is an illustration. On one occasion this meant the rejection of 70 per cent or more of a small heat-treated steel part. After trying everything else a research man was called. He checked the pyrometer first, found the error and soon after had the plant on a basis where 95 per cent of the product passed as first grade.

CHECKING AUTOMATIC INSTRUMENTS

In many industries waste has been eliminated by the installation of scientific instruments designed for automatic measurement or control. But instruments wear or get out of order and need occasional inspection. There is the case of a gas company which was operating at a loss. It was a chemical engineer who found that its meters were incorrect, and the simple process of correcting the meter turned a loss of fifteen cents per thousand cubic feet into a profit of as much or more. Recording pyrometers have done much in eliminating waste, for they assist in the standardization of processes in accordance with best practice and enable mismanagement of apparatus to be detected easily. Apparatus for automatically analyzing flue gases and recording the content of carbon dioxide has provided checks on firing-room practice that has saved quantities of fuel. More recently a new type of indicator for high-speed internal combustion engines has been developed in the research laboratory, and by means of this device it is not only possible more accurately to determine the performance of the motor but to obtain more power through an adjustment of timing, etc., precise to a degree not previously attainable. With millions of internal combustion engines in use the elimination of waste accompanying a small increase in efficiency becomes very important. A 30 per cent increase has been attained in several instances with the aid of this indicator.

RESEARCH AIDED TRANSCONTINENTAL TELEPHONE

When it became desirable to talk across our continent there were those who thought the only possibility lay in reconstructing all the telephones then in use and providing them with new transmitting equipment. This would have cost a huge sum and would have entailed extensive waste in discarding otherwise useful parts. Research prevented such waste by devising the audion and the amplifier. These instruments enable masses of energy to be controlled by a few electrons so that sound waves may be strengthened and magnified without changing their characteristics. Energy may thus be brought in to make up for losses and to balance the lines. This is one of the reasons why long-distance telephony is often more satisfactory than local calls and why millions of telephones without change in themselves had their radius of usefulness increased enormously. Research made unnecessary expenditure which would have been many times the cost of this research.

Now we are about to see another step taken in the installation in many of our largest cities of the automatic telephone, heretofore used principally in smaller places. This does involve replacement of plant and equipment to a large extent, but it will be a saving

through better efficiency and reduced cost of operation. Waste often ensues in a plant due to reluctance to replace antiquated equipment when new machinery, etc., has been developed to the point of effecting large savings in time or labor. Indeed, many plants contribute to waste because of poor layout and improper equipment which is used rather than undertake the first cost involved in putting the plant on a sound basis.

RESTORATION OF CRIPPLED INTERNED GERMAN SHIPS

When the German fleet in American waters was crippled by its crews they were under the impression that they had wasted or destroyed a vast amount of property at a time when it was most valuable. For some years research had been devoted to welding—gas, thermit, electric. With many problems still unsolved, the art has made substantial progress and in record time—a tenth that allowed by the wreckers—the ships had been repaired and a waste eliminated.

IMPROVEMENTS IN ELECTROPLATING

Electrodeposition of metals has been a potent factor in waste elimination. Research has shown how electroplating can be used to bring a part up to dimensions or weight and save it from the scrap heap. Examples are common in which electroplating enables a cheap metal to serve in place of a more expensive one. This is not only true where it is a matter of color or finish but where durability is the factor. Recently a method has been perfected whereby a plate for engraving can be so built up as to have a surface harder than steel, and more durable. As one master plate serves for the production of a number of plates for the presses, the possible saving is obvious.

ELIMINATION OF CORROSION

Waste due to corrosion is as extensive as any other, and research is showing the way to its elimination. As a result we now know something of how to remove oxygen from the water in heating systems and plumbing. Where open feed-water heaters are employed most of the oxygen is eliminated and the remainder disappears when the water is caused to flow over steel sheets so placed as to cause the oxygen to combine chemically with the iron of the sheets rather than later with the iron in the pipes. Water so treated has no after-corrosive effect. It has taken time and effort to show that such corrosion is caused by oxygen and not by carbon dioxide or other agents. Zinc plating has been found to be a very efficient base coating to resist many types of corrosion and upon it the desired finish may be built up. The lacquers, the enamels, the acid- and alkali-resisting paints, varnishes, vitreous enamels, glass linings, improved earthenware and fused quartz indicate what has been accomplished in providing weapons against corrosion.

Research has taken another means of defense against this wasteful agency by the preparation of non-corrosive alloys. Some of these have remarkable properties fitting them for unusual service such as substituting for platinum and offering an opportunity to conserve that precious metal. Others of these alloys have been found of greatest use in cutting metals, as for instance stellite, said to have one and a half times the efficiency of tungsten steel.

These alloy steels have so increased the possible productivity of men and machines that to endeavor to operate without them constitutes an industrial waste.

A given machine equipped with ordinary steel tools can be operated three times as fast if tungsten steel cutting edges are used, which means increased productivity for the machine operator as well.

DETERMINING SPECIFICATIONS FOR RAW MATERIALS

Resources are wasted in industry when there is failure to employ industrial research in determining specifications for raw materials. Cost alone is never a safe guide and even well-established brands may change at times. Progressive manufacturers now realize that their service departments are incomplete without research men who co-operate with the users of their product in learning their exact requirements. One manufacturer knew that he must use a peculiar paper in a certain type of cable and was in the habit of buying a costly grade from a reliable source. In time research was employed to find just what it was in a paper that the cable required and the result was a saving of \$9,000 a year on a pre-war cost basis. The tendency to regard cost as the true index of value in a particular case has often led to waste in the purchase of lubricating oils and further waste in their use, since proper lubrication was not always obtained. Lubrication is still a difficult subject, but there are several scientific factors involved in selecting a proper oil and in many cases the laboratory has found less expensive oils more satisfactory for a given purpose. Without research upon the subject suitable oils could not have been produced, and without research upon their use consumers might be subject to much the same practice as were householders who bought their butter of a man who understood the average unadvised purchaser. He displayed butter at three prices. His sales were almost all from the most expensive. All the butter came from the same tub.

RESEARCH ON STRENGTH AND NEW TYPES OF MATERIALS

Waste has been eliminated through researches upon the strength of materials. When no accurate data were available it was necessary to have every member of a structure much oversize to be sure it was strong enough. Engineers still employ large factors of safety, but research has provided data from which to calculate specifications. In days gone by it did not make so much difference if a timber was 12 x 12 when 10 x 10 would have been ample, but that is no longer true. It will become increasingly difficult to obtain large timber and because we now know something of the strength of timber of the various species it has been possible to effect larger savings, which will be surpassed by those of the future. What is true of wood is also true of most other building materials.

Research must also be credited with new types of structural materials which, because of their strength, elasticity and other desirable qualities, can perform heavy duty even in small cross-section and thus reduce weight, which means saving power. Vanadium steel will serve as an illustration. It has done its share in making possible the very serviceable light-weight car; while its machining qualities are such as to make a given finished part cost about one-third the cost of the same part from, say, a high-carbon steel which would have the same strength but which is machined with great difficulty and requires much grinding. As research increases our knowledge of the properties of pure metals and their alloys we will be in an ever better position to eliminate industrial waste, for we shall be better

able to make alloys for each particular purpose and perhaps embody in them qualities which will mean still further savings. Core loss in electrical machinery is a case in point.

IMPROVEMENT IN BOXING AND PACKING

It has been estimated that more than \$55,000,000 is claimed annually from the common carriers for damage done to goods in transit due almost wholly to imperfect boxing and packing. The opportunity to eliminate this waste has been seized upon and research begun. The factors in the problem include the kinds and thickness of woods and the nailing and strapping of the package in relation to the size and weight of the contents. Crates and fiber containers are included. A standardized drum with scientifically placed baffles and other obstructions is used in these investigations to duplicate the strains and stress to which the package is subjected in transit, and while the work has not been completed, much waste has already been eliminated with the co-operation of shippers who have sent their traffic men and packers to become familiar with these newly established data.

An amount nearly as large represents the yearly waste due to losses in seasoning lumber. This waste comes from a lack of knowledge of the fundamental laws underlying timber drying and our inability to design and operate suitable kilns without such information. Research may be relied upon to secure the data.

WATER SOFTENING

There are still many manufacturers who fail to realize what research in water softening has done for them. They continue to waste costly materials in hard water and let their product suffer when the art of water softening has been brought to a very satisfactory stage through research. The more advanced methods for water softening do not involve the use of chemicals from which there might remain residues deleterious to fabrics, etc., and from the commercial softeners development is now turning to the domestic needs. Many textile mills use literally thousands of pounds of soap for water softening without appreciating the fact, and laundries add substantially to this waste.

NEW TYPES OF ILLUMINATION DUE TO RESEARCH

When the statement is made that the country's annual electric light bill would be \$400,000,000 greater if carbon lamps were used today in place of the latest forms of incandescent lamps, only a part of the story is told. To eliminate such an unnecessary expenditure is important indeed, but while the new types of illumination have given more light for our dollar they have also given a quality of light which has made possible a class of work in the absence of daylight that has greatly extended productivity. Present-day lighting is such that practically any plant can go upon a 24-hr. day if conditions make it advisable. It has its effect on office as well as plant, and where costs are high the architect no longer hesitates to count as useful rooms into which the sun never shines. Research in ventilation is playing its part in this same problem and will make possible the elimination of waste time through the great vehicular tunnel which is to connect New York City with the mainland.

But there is another phase of the illumination question.* Even the most improved devices must be properly used. That has been and still is a problem for

research. We have been shown how to place lighting units, the proper use of reflecting surfaces and the most advantageous colors.

WOOD TREATMENT

Research is often called in hurriedly to stop waste and loss. The call is too frequently postponed until the last moment, with fatal results to the enterprise or industry. The damage which marine borers can do has been known for a long time and various treatments for piles have been devised with a view to proofing them against the attacks of these destructive mollusks. It was recorded that marine borers thrive only when the saline content of the water is ten or more grains per gallon. A year or two ago due to drought the level of the rivers emptying into San Francisco Bay fell and salt water in greater concentration than usual entered these streams. Within the year the borer adjusted himself to the new conditions. He fell to work and caused nearly \$20,000,000 worth of damage to marine structures. Piles that had been treated were cut off in a few months. Others treated in the same way endured. Many odd relationships developed. The stake for which research fights the tiny mollusk is large indeed and the scientists are organizing their work to include biology, chemistry and engineering. The problem will be broken up into its several phases and these solved. In time from his work will come fundamental principles and, following these, methods for so building our extensive marine structures as to make them reasonably permanent.

METHANOL, A PROMISING FIELD

Methanol is an important solvent. So far nothing has been found really to take its place and its only source is the destructive distillation of wood. This must be hardwood. Any device for increasing the yield of methanol becomes more and more important as our hardwood supplies are used. Research may show the way to synthetic methanol. It has already been found how to increase the yield 15 per cent without increasing laboratory costs. The laboratory work indicates that by the use of an inexpensive chemical it may be possible to get an increase of 50 per cent in yield. Anything less than the maximum yield naturally gives rise to an industrial waste. The waste in use of this and other solvents is being prevented by solvent recovery according to methods devised in the research laboratory.

TIME AND MATERIAL CONSERVED BY RESEARCH

The conservation of time and material effected by research is just another way of saying that even though prices seem high at times we would not enjoy what we have but for the savings made and the waste thus eliminated. A five-cent piece could not buy a telephone call today but for research, and it would cost more to finish your automobile but for the same agency. Spray systems are quite satisfactory for much painting and finishing work, while modern drying systems permit solvent recovery and temperature control, which are important factors in lowering first cost and insuring satisfactory work.

By the application of the centrifugal clarifier to the varnish industry, rejections of finished materials have been reduced from 50 to 5 per cent and there has been a saving of 80 per cent in labor plus the elimination of much material waste.

It would be difficult to make even a rational guess as to the horse power that has been saved through the use of ball and roller bearing developed in recent years for shafting, heavy machinery, and in many installations requiring continuous duty.

The increase in available horse power per pound of coal via the steam turbine may be properly credited to research. Without question waste will be eliminated in our highway construction as a result of research now under way.

In fact, whatever the field of endeavor, research has effected elimination of waste, and no doubt still greater savings can be made by its continued application. It is certain that waste cannot be eliminated unless we know just where, how and why it occurs. There is no sure way of knowing these things unless we call in research. In the past the most important wastes have been found where least suspected and more waste will be eliminated when our industrialists come to know research better.

Washington, D. C.

Waste Due to Interrupted Production

The amount of idleness or unemployment in industry can be evaluated only through rough estimates. The Committee on Elimination of Waste in Industry stated in its report (July, 1921) that in the best years, even the phenomenal years of 1917 and 1918 at the climax of war-time industrial activities, when plants were working to capacity and when unemployment reached its lowest point in twenty years, there was a margin of unemployment amounting to more than a million men. This margin is fairly permanent; seemingly one or more wage earners out of every forty are always out of work. This unemployment means for the worker a loss in wages, for industry increased overhead due to idle equipment and idle materials, and for the public lessened purchasing power, with all its attendant evils.

During periods of industrial and business depressions unemployment reaches its greatest amount. Such depressions appear more or less regularly at seven or ten year periods and each brings its increase in unemployment and wastage of the productive capacity of industry.

In January, 1921, a nation-wide survey of employment made by the U. S. Employment Service of the Department of Labor showed that there were 6,070,648 workers then employed in industry, as compared with 9,402,000 in January of 1920, a decrease of 3,331,352 or approximately 35.5 per cent.

In addition to minimum and climacteric unemployment, many essential industries show a high unemployment or idleness once a year or oftener. Practically all industries are in a sense seasonal.

Not only does intermittent unemployment reduce the productive capacity of the industry in which it exists, but it brings other wastes. One consequence is a concrete but fallacious industrial philosophy, the "make work" or "lump of work" theory. This is the belief that there is only so much work to be done and that the sensible course of action is to retard production to make employment last throughout the year, or to uphold prices.

Another form of unemployment comes from open conflict between management and labor. Here it should be said that in the past, at least, the amount of waste from the general run of strikes and lockouts through loss of wages and curtailment of production has been less than is popularly supposed.

Waste Due to Lack of Standardization of Chemicals

Careful Standardization of Chemical Products Will Result in Eliminating Misunderstandings Between Buyer and Seller, Will Reduce the Diversity of Products to the Ultimate Advantage of the Consumer and Will Facilitate National and International Trade in Chemicals

By WALLACE P. COHOE
Consulting Chemical Engineer

AS A DIAGNOSTICIAN of sick processes the consulting chemist often finds that loss of production, waste of material and failure to maintain standards of quality in finished products are quite as frequently due to a lax supervision of the raw materials entering into a process as they are to carelessness in the actual manufacturing process itself. Processes which have been running along quietly for years often do get "sick." This may happen suddenly without warning. Hydrogen peroxide becomes effervescent, potassium iodide goes yellow or will not crystallize properly, an azo color goes off shade badly, cotton piece goods will not fill properly, a previously steady-going evaporator suddenly bumps and primes, the lacquer on polished brass peels and flakes, a causticizer will not settle properly and its contents will not filter satisfactorily.

In every plant something of this character happens from time to time. When this does occur, the workman in charge is likely to report to old Bill, the foreman, "Bill, I can't get her up to strength, she ain't going right." To this old Bill is likely to retort, "It's that there new stuff the purchasing agent got last. Get some of the old stuff." But the former material is all used up and they sit up at nights trying to get the process back to normal. Production and quality both drop, so old Bill goes to the superintendent with his troubles. "Say, boss, my department is on the kibosh. That there new stuff oughtn't never to have come into the place."

USE AND ABUSE OF "SPECIFICATIONS"

The superintendent, knowing that many a shrewd idea may hide behind a misused past participle, decides to investigate and checks his specification on the material from the new source, finding that it should give no trouble. He has the laboratory check the former analyses, but no clue to the mystery is found. If there is no plant laboratory, much heated correspondence ensues between the purchasing department and the makers of the product under question.

In the meantime "old Bill" back in the plant is in worse trouble than ever. He cannot get any production worth mentioning and the shipping department is hounding him. It is time for a general inquest. Possibly an outsider has to be called in. It is unnecessary to go into the details of that inquest. We have all attended many. The verdict in the actual case I have in mind did not condemn the new material, but laid the blame upon a too high percentage of iron in one of the heavy chemicals used in the process. This heavy chemical had been purchased for years from the same manufacturer, but a new shipment had not been up to the usual standard. This lapse in quality, in this case by loss of material, loss of customers and expense of investigation, not only ate up the profits of a depart-

ment for a considerable period but caused a loss of confidence in the minds of the selling staff, who naturally disliked the task of explaining to dissatisfied customers.

"But," my critic will retort, "that plant just mentioned was not run properly. Now, in our plant that tank car of blankety blank would have been tested as soon as it was spotted and if not up to specification——." "Specification," that is the word.

It is a fact that where business is properly operated today it does buy and use materials which must come up to a definite specification before they are put into process. The extent to which this practice is carried out is an indication of how far a manufacturer has progressed beyond the rule-of-thumb stage. Some manufacturers buy upon a good specification and leave the matter there, trusting to the manufacturer of the raw material to maintain a specification set forth in the buying contract. This is a dangerous practice and is productive of many losses. Not only must raw materials be bought upon specification, but in this present day when mistakes do occur in spite of most honest intentions, it is necessary thoroughly to examine goods delivered in order to know whether they meet the contract specification.

NEED OF STANDARDIZED SPECIFICATIONS

While it is generally admitted that specifications are common in the buying and selling of chemicals, it may also be truly said that standardization is not general. "But," a manufacturer may say, "why should we worry about standardization if our customers are satisfied with the goods they buy upon specifications which are drawn up to suit their own individual needs?" This point of view is natural, nor is it unreasonable when an industry is in an infant stage and consequently at a time when standardizations are difficult to formulate. If the chemical industry be still an infant industry struggling to find itself, then it is unwise to talk of standardization. Our industry, however, has, we think, emerged from its swaddling clothes, and, if it be not yet a full-grown man, it is at least a hardy stripling, old enough to play the game according to rules.

ADVANTAGES OF STANDARDIZING SPECIFICATIONS

Standards are rules, and rules, like laws, are made not to suit each individual case but rather to yield the greatest good to the greatest number. If a manufacturer of heavy chemicals, for instance, is obliged by his customer to modify his products to suit the individual needs of each individual purchasing them, the result in the end will be a higher price to be paid by each on account of this diversity of product. There is the apocryphal case of the varnish manufacturer who advertised and sold to his customers varnishes which

ran from spar varnish to cheap furniture varnish, all of which came from the same tank in his warehouse. A chemical manufacturer, even if he wished to do something like this, could not, because he is continually being checked by his customer. Is it not possible, however, by careful standardization to reduce the diversity of products to the ultimate advantage of the consumer?

STANDARDIZATION LEADS TO BETTER BUSINESS

Let us examine some of the reasons why standardization makes for better business. Disagreements in business between reasonable men—and the majority of folks in this world are reasonable—usually take place because the two parties to an agreement are not talking about the same thing. A disagreement usually takes place by steps. First, there is moderate protest, then active discussion, upon which follows mutual recriminations and often finally litigation. Both parties are honest; the seller has delivered so much of a certain commodity described in a phrase, while the buyer has received so much of the same commodity, but the meaning of the phrase describing the merchandise in the mind of the seller does not convey the same idea to the mind of the buyer. In other industries this condition has led to the formation of a number of standards. For instance: a fruit grower in western New York may send a consignment of "No. 2 Northern Spy Apples" to England and both he and his English customer understand what the phrase "No. 2 Apples" means.

MISUNDERSTANDINGS RESULTING FROM LACK OF STANDARDIZED GRADES OF CHEMICALS

Up to within the last few years in America the bulk of trading in chemicals has been between the manufacturer of them and another manufacturer who uses them in his own process. Our advent into the larger world trade during the war led to a widening of the field of trading in chemicals. Chemical brokers bought large quantities of chemicals from manufacturers, which they in turn might ship, for instance, to South America or the Far East. A banker in the meantime might be asked to lend money upon warehouse receipts. Numerous disputes arose about and fault was found with the quality of the chemicals being traded in. "C," the customer in the Far East, refused to take delivery of the goods which "B," the broker, had purchased from "A," the original manufacturer, while "D," the banker, was often at a loss to know whether or not he had made a loan upon worthless goods. "A," the manufacturer, and "C," the customer in the Far East, probably each knew what he was talking about. "B," the broker, and "D," the banker, had not this knowledge. If, however, there were available standard specifications describing chemical products, such difficulties as these, which are really encountered in trading and banking, would become reduced to a reasonable minimum.

POINTS TO BE CONSIDERED IN THE STANDARDIZATION OF CHEMICALS

If we are to attempt standardization of the common chemicals which are bought and sold daily there are several points which deserve consideration.

In the first place, any stated standards must be reasonable if such standards are to serve the common good. Such standards must avoid the unnecessary refinements which chemists are rather prone to demand in the products of others.

Secondly, such standards should embody as far as

possible existing practice and should tend toward the simplification rather than a multiplicity of specifications. An attempt was made some years ago by the American Chemical Society to formulate a set of specifications, but this attempt met with no success. Apparently there is no desire on the part of the manufacturers of heavy chemicals for standard specifications, although these same manufacturers are very strict in their demands upon others. It is most natural that these gentlemen should fear a disturbance of their routine by an attempt to standardize these products, and it is the writer's opinion that the growth of a set of standards should be an evolution.

Thirdly, such a set of standards should be so drawn up as to provide for the average consumer. If any particular consumer must demand a specification more stringent than the average, then it would seem reasonable that he should pay the price for the same without putting a burden upon the majority.

Fourthly, a commercial standard should contain the following:

- (a) A terse phrase describing the substance.
- (b) A term accurately setting forth the proportion of the essential material in it.
- (c) A series of grades, by numbers or letters, which will indicate the percentages of extraneous or harmful substances allowed.

STANDARDIZATION OF CHEMICAL PRODUCTS WILL FACILITATE INTERNATIONAL TRADE

We are now at a period when transportation is bringing together the ends of the world, when men widely separated are doing business with one another, and, by the use of standards in many trades, do get along successfully in their commerce with one another. When lumber, wool, cotton, fruit, grain, naval stores and many other things are graded it is unfortunate that in the chemical trade a set of common standards generally agreed to does not exist. Yet we have heard it claimed that chemistry is an exact science.

New York City.

Performance Standardization

The Committee on Elimination of Waste in Industry, Federated American Engineering Societies, in the summary of its report (July, 1921), in dealing with performance standardization states that performance standards should be developed as a valuable aid to planning and production control. Under the week-work system such standards are the basis of a just measurement of the individual worker's performance and of the adjustment of his wage rate to his capacity. Under the piece-rate system they are the basis of just rates. Without standardization of appliances, conditions, work content and method, no valid performance standard can be maintained.

By constantly comparing actual performance with the standards and promptly investigating the causes of the departure from standards, the manufacturer can quickly detect adverse conditions as they creep in, and rectify them. Performance standards, in fact, will enable him to plan the size of his plant and operating force for a given volume of business for continuous operation.

Methods of wage payment should be adopted, equitable and just in their basis, insuring a proper relationship between effort put forth and results achieved by all who participate in the enterprise.

The Personnel Problem: To Eliminate the Waste of Human Effort

Many Wastes of Time and Production Can Be Attributed to Improper Selection and Placement of Personnel and to Management's Failure to Recognize the Value of Training, Transfer and Promotion of Deserving Employees

BY L. B. HOPKINS
Treasurer, the Scott Company

TEN girls worked in a payroll department, computing hours worked and earnings. Each week a line of dissatisfied employees formed at the pay window to complain of errors in pay. Then two other girls, older and more capable, were hired to check the work of the ten younger girls. One day one of these two girls was shifted from inspection to the actual figuring of hours and amounts. For the first week she averaged fifty cards an hour. The younger girls averaged thirty cards an hour. The older girl caught her own mistakes. The younger girls didn't. The two older girls got \$18 a week, and the younger ones got \$15.

The department head did some figuring. The result was that as soon as he could he transferred the ten younger girls, replacing them with the two older girls and four more like them—girls who had a slightly better education and more sense of responsibility in their work. These six girls handled the job that the ten younger girls had been doing and practically eliminated the line of disgruntled employees at the pay window. The result was a direct saving of \$78 a week and an indirect saving of a good deal more.

When the manager asked what had been done to reduce the complaints at the pay window he heard this story. He then told it in a meeting of department heads and said: "There are types of work in all departments that demand specific characteristics in those who are to perform those tasks effectively. In this case it is evidently cheaper to employ a higher grade of help than has been the practice in the past, in order to obtain persons qualified for the work. Some of the rest of you may find something of value in this interesting case."

HIGH LABOR TURNOVER DUE TO IMPROPER PERSONNEL SELECTION

Twenty-five inspectors of small metal parts were required in a machine department of another company. It was not difficult to get men to take these jobs, but it seemed impossible to keep them. They wouldn't stay. The plant superintendent talked to the foreman about his labor turnover. The foreman defended not only himself but the employment office. He convinced the superintendent that as foreman he was not disagreeable, unjust or overbearing. In fact, the superintendent knew him to be a foreman who could get out work and at the same time hold the good will of his employees. But employees didn't stay on the job. The superintendent questioned the foreman about the selection of employees for that work by the employment office. The foreman replied that the employment office was co-operating 100 per cent, and added: "They're

putting a higher grade bunch in there all the time, but they won't stick."

After more study of the causes of turnover in this small parts inspection group it was found that by making the trays smaller and lighter, women could do the work as well as men and that some women would stay on the job. Women who had had a high school education wouldn't stick. They got tired of the everlasting monotony, just as the men had, but women who had had less education and who were nimble fingered frequently liked the work and stayed. After a long period of trial and error, this plant discovered that it is bad business to use too high a grade of help on a job. These are actual cases. They really happened.

SELECTION OF EFFECTIVE WORKERS

One might go on telling all sorts of causes of waste in human effort because the man or woman on the job couldn't do it or didn't like it. They happen all the time. They have been happening for years. They are so common that the causes can be grouped and classified and studied, and they have been. In many cases the general principles for effecting a remedy have been worked out and in a number of instances the technique for avoiding specific mistakes has been developed.

Here, for instance, is an important general principle:

If your workers are to be effective, they must be adapted for and interested in their work. And a force of effective workers is the surest guarantee against inefficiency and wasted effort that a manager can have.

If accountants could set up an inefficiency account that would show all of the minutes of all of the days that employees don't work because they don't want to, plus all of the time wasted in waiting to be told, or in attempting to do that which they are incapable of doing, it would be a startling amount:

Some managers are shocked when told that such waste is to a considerable extent not only avoidable, but absolutely up to them. To allow such waste to continue unchecked is certainly chargeable to inefficiency of management. It is management's responsibility to provide those means already tried and proved elsewhere for eliminating this cause of waste. Furthermore, management is responsible for developing new methods for conserving time now wasted, through study and research. But what are these means that have been proved through actual tryout?

ANALYZING THE REQUIREMENTS OF THE JOB

First of all, it is necessary to know the important requirements of the various jobs. Too often you will hear a job described as one that requires brains, or

guts, or education, or accuracy, or as just a plain-going steady job, or a job where a person must be able to stretch himself when necessary. Frequently an attempt has been made to hit upon the real requirements.

In a New England mill they were hiring persons to learn machine tending who were quick with their fingers. This was a mighty good start, but for a long time they overlooked the fact that short persons couldn't reach to perform some of the operations without standing on a soap box. That is just what the short persons did. After a comparison of output of the two groups—those who used soap boxes and those who didn't—it was evident that length of reach was a factor in success on that job. Simple, you say. Yes, it is, but only after you have recognized that analyzing the requirements of the job means actually finding out what things are needed in individuals to fit them for a particular occupation.

The head of an accounting department complained to the employment office because the handwriting of the new clerks being hired was so poor. The employment office thereafter made applicants copy three or four lines of text onto the application blank. This, they said, gave them a pretty good slant on the applicant's penmanship. It did, but later on it was discovered that many applicants wrote a beautiful hand and at the same time made horrible figures. And in the accounting department the job in question was posting figures day in and day out. Now they request the applicant to copy several numbers of five or six digits each on the application blank, and they know about his ability to make figures before they put him to work on a job where making figures is the chief qualification needed.

STUDYING AND DEVELOPING THE SOURCES OF LABOR SUPPLY

Some jobs require a great deal of the ability to learn and others don't. Some jobs offer a real opportunity to advance, others are out-and-out blind-alley jobs. Unless you can make something more out of your blind-alley jobs, or until you can, it's a mistake, and a wasteful mistake, to put an ambitious person on those jobs. It is just as wasteful to load up positions that bristle with opportunity with persons who haven't the capacity or the desire to go ahead.

With a knowledge of the requirements of the various jobs, the foundation is laid for making wage studies, for developing a promotion program, for establishing training courses and for selecting, placing and transferring employees. Moreover, this knowledge will make it possible to determine whether the applicants for work in your organization are of the right type to supply you with those well suited to the nature of the work in your industry. This is often referred to as "studying and developing your sources of labor supply."

Sally Jones received the following letter one day last spring:

Dear Miss Jones: We are writing to you because you worked for this company for a year and a half. We want to get in touch with those former employees who, like yourself, were able to handle our work in an intelligent and capable way. You know our organization and the kind of work we do. Do you know of any girls who desire a position that you think would make the right type of employee for us?

If you do, won't you give us their names and addresses, or if you prefer, tell them to come into our employment office for an interview and ask for Mr. Smith?

If you would be interested in obtaining a position with us again at any time, please let us know. We should like to have you back with us.

We want to take on a number of capable girls just as fast as we can make room for them in the organization. Very sincerely yours,

FRANK SMITH,
Employment Manager.

Fifty of these letters, made personal by a reference to actual dates of employment or to the correct length of service, built up a most desirable source of supply for a Middle Western company at a time when it was exceedingly difficult to get any help at all. Ministers, priests, doctors, lawyers and retail business men will often appreciate being furnished with a supply of little notes of introduction to the employment manager, that they can give to men or women and boys or girls who desire positions. These and other methods can be used almost anywhere to build up a desirable supply of labor from which selection can be made for positions as they become open in the organization.

VALUE OF MODERN EMPLOYMENT METHODS

The selection of the right persons for your type of work is again not a matter of sleight-of-hand, but involves only the use of quite ordinary and commonsense methods. Nobody is capable of making perfect selections. There isn't any way known of discovering beforehand all that one might want to know about a person who is to be hired. There are men who can avoid a great many of the mistakes that are being made every day in numberless plants and stores and offices where modern employment methods are not in use. These men who can avoid the more common mistakes are not gifted with the power to read minds or any other supernatural power, but they do know the methods needed in employment work and how to use them.

A bright-faced fellow seventeen years old walked into the office of such an employment man a few months ago and asked for a chance in the drafting department. He wanted to learn drafting, he said. The employment office interviewer knew of such an opening and thought he might find in this healthy and hearty youngster a good apprentice for the drafting department.

In the interview it developed that the boy's father was dead and that the boy was carrying out his mother's wishes in trying for a chance to take up drafting. It certainly was to his credit that he wanted to do what his mother wished. The next question brought out the fact that he knew nothing about drafting and had not thought of it until his mother suggested it. His school record raised a doubt as to his qualifications for the drafting room, however, for he had just finished the eighth grade at sixteen and had not moved or had a long sickness during the school period. It at least raised the question as to why he was two years longer in completing eight years of schooling than the normal boy would have been. In a test for alertness, he did rather poorly and he was very poor on the arithmetic questions in the test. The boy was asked to come back the next day. Meanwhile the interviewer 'phoned the boy's teacher and learned that he had always had trouble with mathematics. She added that she couldn't understand his case at all, that he was a good boy, though lively, that he tried hard, she knew, and that everybody liked him that ever met him.

The next day the boy was given a chance, not in the drafting apprentice course, but in the merchandise department. Already his sales are equal to those of some

older men in the department and his personality is adding daily to his own and the company's "good will" in the community. He likes the job and is interested in it.

SELECTING SKILLED LABOR AND TECHNICAL EXPERTS

The selection and placement of skilled labor, retail sales persons, experts in accounting, engineering, chemistry, etc., and professional men offers comparatively little difficulty in picking men qualified for the positions to be filled. Their previous training and experience, their education and achievements are a matter of record that can be easily obtained and checked. The most common error in the placement of such specialists is the all too frequent assumption that a man with an exceptionally good record in his special field will of necessity make a success in another field. A very capable physician may be quite incapable of administering a medical department in industry. A skilled machinist is not qualified, because of that fact alone, to be a foreman. The best chemist in the organization would quite possibly make a mess of the job of office manager.

In this fact lies another important principle of personnel work. Because a man has succeeded in one type of work you have no right to assume that he will succeed in any other situation demanding quite different qualities and abilities.

Let's take your family physician and consider his qualifications for a supervisory position in your business organization. It is to be presumed that you have confidence in his knowledge of medicine, since he is still your family physician. How well is he adapted, as you know him, for the position of department head? Here are some of the qualities which the position of department head demands. How would you rate him in each of these qualities?

RATING A DEPARTMENT HEAD

I. Consider his success in winning confidence and respect through his personality.

II. Consider his success in doing things in new and better ways and in adapting improved methods to his own work.

III. Consider his success in winning the co-operation of men, in welding them into a loyal and effective working unit.

IV. Consider his success in organizing the work of a department, both by delegating authority wisely and by making certain that results are achieved.

V. Consider his success in making his department a smooth running part of the whole organization; his knowledge and appreciation of the problems of other departments.

VI. Consider his success in improving men by imparting information, creating interest, developing talent and arousing ambition.

VII. Consider his success in applying specialized knowledge in his particular field, whether by his own knowledge of ways and means or through his use of sources of information.

It will be interesting, for purposes of comparison, to pick a man from your own organization whom you consider to be very successful in running his department and judge him in terms of these same qualities. It may be that you will find that some of these seven qualities are not particularly well adapted to the requirements of executives and supervisors in your or-

ganization. They were prepared to cover the essential qualities in a specific case, but you can substitute wherever necessary and still discover from actual tryout that even exceptionally capable individuals differ in their abilities and that while they are without question successful in one field, they might be totally unqualified for another.

TRANSFER AND PROMOTION OF EMPLOYEES

It is just as important to recognize that those individuals who have failed in the specific task to which they have been assigned may be assigned to different work and succeed. It has been and still is true that considerable waste is incurred in many organizations by dismissing from the organization men who have fallen down on some specific task. Frequently such men could have been placed elsewhere in positions for which they were fitted, had anybody taken the trouble to discover in what these men were interested and for what their training and experience fitted them.

The management that recognizes its employees as individuals, with different individual abilities, and that endeavors to find the right position for the individual who has been unfortunately placed is developing a type of loyalty and good will in the organization that no amount of propaganda and profit-sharing will obtain. The transferring of employees should not be limited, however, to those who are not getting along well in their present positions. The greatest incentive that can be established for conscientious, effective, whole-hearted service is found in the policy that establishes the principle of promotion within the organization and in the management that sees to it that this principle is put into practice.

This practice is not only an opportunity for management to build up an effective organization, but it is also management's responsibility to the workers, to the community and to the owners of the business. Nor does management's responsibility cease when it has made possible the recognition and promotion of those employees who by their own efforts have succeeded in fitting themselves for greater responsibilities. If it is the policy of the company to obtain intelligent, capable, ambitious employees for those positions where these qualities are needed, then the company should offer the opportunity for these persons to receive training that will fit them to go ahead.

PROPER TRAINING OF EMPLOYEES

Many companies have recognized this responsibility and are conscious of the advantages that accrue from training courses. Because of the pressure of other work and a lack of serious thought on the subject, it too often happens that a most unfortunate waste creeps into the whole training program. This sometimes occurs through the misdirected effort of an overzealous director of training, who enlists as large a number of students as he can, regardless of their capacity to learn or their adaptability to the courses in which they are registered.

Some months ago a manager asked a consultant of his acquaintance to look over the office boy situation in his company. Two of the cases covered in the report are of interest and to a considerable extent are related to that manager's training problems.

Case 1. "Joseph Decker is now fifteen years old. He quit school at fourteen years of age, in the sixth

grade. This suggests that he had difficulty in doing elementary school work. He scored very low in the intelligence tests. The indications are that this boy's mental capacities are limited. He has been urged, however, to take the bookkeeping course and is really attempting to swing it, without much success. Here is an indication that the boy is ambitious and would like to fit himself for more responsible work. The important question is: Are his capacities too limited to enable him to succeed in this work? If so, then it would be wise to transfer him. He is mechanically inclined and interested in the assembly operations in the plant. His interest might be elicited and the opportunity offered him in a suitable training course and a transfer effected to an operating department."

Case 2. "William Brennan is now sixteen years of age. He quit school at thirteen years of age, having completed the eighth grade. He obtained a very high score in the intelligence tests. His schooling and his test score and his service record with the company indicate that he is bright. He is taking a course, on his own initiative, in mechanical drawing, in a night school. He has been an office boy here for a year and a half. It might be desirable to transfer this boy to the engineering and test department, where he could come in closer touch with the company's drafting work."

WASTES DUE TO MISFITS IN SUPERVISORY POSITIONS

In another company a similar investigation was made of the foremen, assistant foremen and supervisors. There were numerous cases found of men who had been excellent workers. Some had been lifted out of work where they were making a real success into supervisory positions for which they were not fitted. Such positions should have been reserved for men qualified to grow into assistant foremanship and foremanship duties and responsibilities. These misfits as supervisors were, however, persuaded to take the foreman's training courses and in some cases they had never mastered the common school work of the seventh and eighth grades.

When you have misfits in supervisory positions, the waste that results from wrong placement is multiplied all along the line. A poor supervisor wastes the time of his superintendent. He wastes the time of his associates. He wastes the time of his workers and frequently this holds up the work of other workers all through the organization.

All of the principles that govern correct personnel work for the rank and file of the workers are applicable in maintaining the executive and supervisory force.

The source of supply for foremen and department heads demands careful study and cultivation. The selection, placement, transfer, promotion and training of these representatives of management all offer a means for keeping the morale of the organization up and the waste of human effort down. If the worker is to be effective in his work, his foreman or department head must certainly be adapted for and interested in his job. And like the worker, those who direct the work of others are themselves entitled to the assurance that their manager will interest himself in their opportunities, their capacities and their desires.

This then is the personnel problem: to develop and co-ordinate the opportunities, capacities and desires of people at work. In the solution of this problem lies, in a great measure, the solution of the problem of reducing the scrap pile of waste time in industry.

Philadelphia, Pa.

Waste Due to Restricted Production

Waste due to restricted production has been analyzed by the Committee on Elimination of Waste in Industry, and the following is an abstract from the summary of its report (July, 1921):

Restriction of individual output for which workers are responsible are susceptible of measurement. They are of two kinds. On the one hand, when workers are scarce the less conscientious workers become independent and slacken speed, whereas when workers are plentiful, they work with greater diligence and care for fear of unemployment. On the other hand, the dread of unemployment is so pronounced that employees engaged in seasonal enterprises frequently restrict production in order to make employment last longer; some workers, moreover, through consideration of their fellow employees limit production to provide work for them, a practice which ultimately results in an economic loss.

Important restrictions of output by employees can result only from collective action. In the building trades, for instance, some painters' unions do not permit of the use of a brush wider than 4½ in. for oil paint, although for certain classes of work a wider brush is more economical.

The tools of the engineer are standard weights and measures, scientifically established. He cannot serve industry unless he can set standards for production and can measure work performed. Many unions now oppose the use of such standards.

Unions are charged with restricting the use of machinery. Painters' unions refuse to allow their men to work on a job where a spraying machine is being used, making claim that the use of the machine is injurious to the health of the workman.

All such restrictions, so far as they prohibit the use of the best and most efficient machine, constitute limitations of output. The actions of most unions, however, are confined to the restriction of the use of machinery rather than its prohibition.

RELATION BETWEEN MANAGEMENT AND WORKERS

Management has a definite responsibility in selecting, upgrading and maintaining personnel.

Experience indicates that the best results can be obtained when employment and personnel direction develops a sense of mutual interest in production on the part of management and workers. To accomplish this management should stimulate the interest of workers, individually and collectively, in creation, in craftsmanship and in the contribution of their experience and knowledge to the productive processes. "Industrial relations" to be effective should be closely allied to production and concern itself with educating the workman in the science of process, recording his accomplishment and enabling him to become conscious of the relationship of his work to the whole.

During the past few years there has been a widespread advance in extension of employment and personnel methods in industry and many of the accruing advantages are now generally known. Among these is a means whereby the worker has a direct avenue of approach to his employer, and the employer has a means for communicating organization policies to the employee. Such industrial education and training as has been conducted by certain leading manufacturers has obtained beneficial results, and it is believed that further developments along these lines is desirable.

Disclosing Waste Through Better Cost Methods

Many Industrial Failures Are Traceable to Blind Dependence on Cost Determined by Rule-of-Thumb Methods—Modern Cost Systems Will Disclose Waste in Unprofitable Products, Idle Labor and Machinery and Erroneous Methods

BY ERNEST J. WESSEN

Industrial Engineer, W. T. Rawleigh Company

IT IS scarcely necessary to urge the need of accurate cost determination. If the voluminous literature which has been dedicated to this subject, the hundreds of articles which have appeared in technical journals, pages of advertising, to say nothing of the pretty little pamphlets brought with each mail, have not educated the industrial executive to the real need for accurate cost knowledge, then certainly existent economic conditions have.

The progressive manufacturer keenly realizes that if he is to survive the coming aggressive and intensive competitive era, he must not only know what his product costs him, but—of more importance—he must have such control over his manufacturing operations as will enable him to keep his costs at minimum levels. Without a comprehensive knowledge of his costs, he will be unable intelligently to compete with those who have provided adequate cost control, and must inevitably meet defeat at the hands of his progressive competitors. It is scarcely possible to overstate the case in urging the need for cost knowledge.

VALUE OF DETAILED MANUFACTURING COSTS

The value of accurate detailed manufacturing costs may be divided into two phases: First, the commercial value arising from the necessity of having an accurate knowledge of costs in order that selling prices may be intelligently fixed. Second, the technical value to the management in placing at its disposal pertinent cost data enabling the manufacturing executive to establish proper control over manufacturing operations. The greatest value of cost information to industry is its technical value.

It is not impossible or indeed extremely difficult for manufacturers to approximate closely the cost of the finished article by rule-of-thumb methods. In fact, if he is painstaking, his results may be startlingly close to those obtained by more complex methods. However, this is the exception rather than the rule. A large percentage of industrial failures due to managerial incompetence can be traced to blind dependence on costs arrived at through antiquated rule-of-thumb methods.

Granted that we arrive at exceedingly accurate costs of finished products by rule-of-thumb methods of estimation, this is of no avail if we lack sufficient control over our manufacturing operations to enable us to meet our competitors' prices. Indeed, few healthy, industrial executives are satisfied with trailing their competitors; most of them prefer to take the lead. The lead cannot be taken and held without manufacturing control, and manufacturing control cannot be established without detailed cost data. Obviously, there is only one way to obtain this information—through a cost system.

The successful cost system must isolate the various

elements of factory costs in such a manner as to permit the manager to make a quick and accurate analysis of manufacturing conditions. The figures obtained must be of a current rather than of a historical nature. In other words, the results must be compiled and placed in the hands of the executive in ample time to permit the establishment of positive control over current operations. The progressive manager is not concerned in what has been done, but in that which is being done. The system must further provide for the establishment of cost standards by which subsequent costs may be controlled.

Such a system will disclose unprofitable products, waste, idle machinery, idle labor and erroneous methods. It will enable the management to formulate policies and assist in successfully carrying out such policies. Standardized costs will be established, comparative economy of operations ascertained. It will be possible to place the factory on a budget basis. Selling prices may be fixed with confidence—in fact, profits practically assured under normal conditions. Indeed, once such figures have been made available they become indispensable.

SYSTEM SHOULD BE SIMPLE

The efficient cost system is as simple as is consistent with sound manufacturing practice; all frills are eliminated. Its operating cost is extremely low as compared to the returns received; hence it is productive. Cost figures are sufficiently detailed as to render intelligent deduction practical, but not in too great detail. Extremely elaborate analysis of cost is seldom justified. Cost figures obtained are accurate within the bounds of feasibility. Accuracy in costs must be striven for, but strictly speaking is unattainable. In short, the system must be eminently practical.

It is not a difficult task to install such a system; the expense is not great and the need for it is fully recognized. Despite this the Federal Trade Commission states that out of 250,000 manufacturers in the United States but 12,000 have adopted some sort of a cost system. Ninety-five per cent of our manufacturers facing unknown conditions without a knowledge of their costs, in other words, entering upon uncharted seas without a compass! Clearly this apparently apathetic attitude on the part of American manufacturers must be due to some well-founded cause, especially in the light of the great publicity which this subject has been given.

The cause for this reluctance on the part of manufacturers to adopt modern cost methods is easily found. In the first place the results obtained from the average cost system have not justified the claims made for it at the time the system was sold to the manufacturer.

Many worthless but expensive systems have been foisted upon industry.

FAILURE OF MODERN COST PRACTICE

If we accept all cost systems in operation today as representative applications of modern cost practice, then modern cost practice has failed. There are, of course, many excellent systems in operation, but that the majority of those installed during the past five years have failed is not to be denied. Their failure has been so complete as to arouse doubts in the minds of industrial executives as to the soundness of the fundamental principles upon which these systems were based. In this fact will be found one of the major reasons for the reluctance to adopt modern cost methods.

We shall not undertake to cite here the innumerable ways in which cost systems have failed, in many cases disastrously. It will suffice to say that failures have been so numerous and in some cases so ludicrous as to destroy the confidence of many manufacturers in the judgment of those who are supporting the movement for "better cost methods." That the majority of systems in operation have failed and proved impracticable is not to be denied. However, the failures are not due to inherent defects in fundamentals. Probably another factor tending to further the apathetic attitude of manufacturers has been the apparent incompetence of many of those attempting to further the movement. This latter condition as well as the failures of so many systems can be attributed to nothing other than the conditions existent at the time the movement for manufacturing costs received its greatest impetus.

HISTORY OF MODERN COST METHODS

Probably no other phase of industrial management has been born under such unfavorable conditions as cost finding. Prior to 1917 there were few cost systems in the United States worthy of the name. Here and there would be found a system maintained largely for its commercial value. It was looked upon by most manufacturers as an expensive fad, and at the time we entered the World War cost finding was practically unknown.

After April 6, 1917, and until October of the same year the War Department made practically no attempt to obtain immediate production. According to Benedict Crowell, Assistant Secretary of War, "the department was engaged in determining requirements and formulating plans for mass production." ("America's Munitions.")

In October the department's plans had been formulated and the awarding of contracts began in earnest. During the preparatory period the cost-plus contract had been decided upon as the most equitable basis upon which war material might be obtained. In a few months time the Ordnance Department alone had in force 8,000 of this type of contract, the Signal Corps, with the Aircraft Division, as many more. The Quartermaster Corps Construction Division and other branches also awarded large numbers of these contracts. A conservative estimate would fix the total number of these contracts in effect during the early months of 1918 at 25,000. Many manufacturers had more than one active contract, but it is a safe assumption that these contracts were divided among not less than 15,000 manufacturers.

The accurate determination of manufacturing costs is essential to successful operation under the cost-plus type of contract. The preliminary studies of the War Department had shown the officials that it would be necessary to maintain a large staff of cost accountants to check manufacturing costs under this type of agreement. Accordingly in September the Ordnance Department attempted to obtain the services of over 1,000 cost accountants. In October and November the Signal Corps alone employed 700 cost accountants, and in a few months' time the War Department had employed several thousand men as cost accountants. Not all of them bore this title, it is true; some were production experts, some accountants and others appeared under other classifications, but they were all employed for cost work. The different titles were used to open the non-competitive positions of the Civil Service to those who could not meet the far from exacting requirements of the Civil Service Commission.

It was just as essential to the manufacturer that he too be equipped with means for determining his manufacturing costs as it was to the Government that it have its cost men. Although some contractors performed work of such a simple nature as not to require the services of a cost man, we can safely estimate the number of cost accountants employed by industry during the latter part of 1917 and early months of 1918 at 7,500. This was the real birth of cost accounting.

In a short period of but a few months no less than twelve or fifteen thousand men were employed as cost accountants. Where did they come from? With only several hundred cost systems in operation, we know that as a rule they came without previous experience in the work which they were to take up. It is interesting to note just how these cost executives were obtained.

PLACES FILLED WITH ILL-EQUIPPED YOUTHS

The accountants in charge of the cost-accounting sections of the various War Department offices first endeavored to obtain trained accountants for the supervisory positions, but hundreds of these men were required by the regular accounting branches and with the selective draft and only a small number to draw upon this source was soon exhausted. Men with book-keeping experience and executive clerks were next called upon and so on, until we find the positions of assistant cost accountant and cost clerk filled by young men still clutching their business college diplomas in their right hand. The same conditions existed in the cost organizations built up by manufacturers. Are we to wonder that we are today finding the systems installed by these well-intentioned young men defective?

Under certain conditions it might have been possible to build up this force of men from the ranks of those particularly fitted to take up the work of the cost executive. On the other hand, those fitted for this class of work were in urgent demand for other phases of war work.

That this group of men failed in the task assigned them will be evidenced by an inspection of the records of the U. S. Court of Claims. Their task was to obtain cost data sufficiently comprehensive and authoritative to form a basis for the adjudication of the claims of those manufacturing under cost-plus contracts. A comparatively simple task when we think of the task we have assigned the present-day cost exec-

utives. Nevertheless, due to faulty cost data, wrangles over cost elements and other causes, the Court of Claims has many cases still awaiting settlement. All of this as well as present conditions are due to the fact that those selected for the work did not possess the essential qualifications of the cost executive.

ESSENTIAL QUALIFICATIONS OF COST EXECUTIVE

The clerk with an aptitude for figures and detail or the accountant whose experience has been confined within the limits of accountancy is not qualified to assume the duties of a cost executive except in so far as his personal characteristics may qualify him for that work. Indeed, at present few men will be found who possess all of the essential qualifications of the cost executive.

This indispensable member of the progressive industrial organization must be of the executive type. He must be at once aggressive and tactful, courageous and loyal. He must possess resourcefulness and originality, imagination and initiative. It is scarcely necessary to add that he must be reliable and honest.

So much for the general qualifications. Many executives in all industrial activities possess these desirable characteristics, but the cost executive must possess many essential qualifications obtained only through training and experience. The present low level of efficiency of most cost departments is due largely to the failure of manufacturers to consider these special qualifications in selecting their cost executives.

KNOWLEDGE OF SHOP AND ENGINEERING PRACTICE ESSENTIAL

A good knowledge of shop practice is necessary. Without this knowledge, even the most simple problems of cost finding cannot be treated intelligently. A superficial knowledge will not suffice. Unless he is familiar with shop practice, the entire system will be operated upon a conjectural basis.

A knowledge of engineering practice is indispensable. It is at least difficult to imagine one without this knowledge successfully determining power costs and making intelligent distributions of these costs, particularly where high-pressure steam and exhaust steam are used in large quantities in the manufacturing processes. Depreciation, obsolescence and depletion rates can be intelligently fixed only by one having at least some knowledge of engineering fundamentals. Burden distribution is essentially an engineering problem requiring engineering treatment, and last, he must establish standards with the precision of an engineer.

COST EXECUTIVE SHOULD BE ANALYTICAL AND HAVE KNOWLEDGE OF STATISTICAL LAWS

The cost executive must above all be analytical. He must be able to interpret cost data into terms sufficiently clear to arouse the management to immediate action. He must know what is pertinent and be able to isolate such facts from the mass of cost information flowing through his department. His studies and resultant cost reports must be exhaustive. Above all he must analyze his figures with a detached viewpoint.

The compilation of cost data requires statistical treatment. Certainly it is a phase of statistics. Without a knowledge of statistical laws on the part of the compiler, cost statements are of little value and apt to be misleading. Frequency, dispersion, correlation and other phases of statistics enter into the cost executive's

daily work. By statistics we do not mean graphical presentation. So much has the word statistics been abused that the average industrial executive has come to look upon one who prepares attractive graphical charts as a finished statistician. Although these charts are valuable if intelligently prepared and not overdone they are not essential to successful cost finding and something more than the ability to draw charts is required of the cost executive along statistical lines.

The science of accounting provides for the exact recordation of known business transactions or facts. With the engineer's training and the knowledge of the statistician the cost executive is called upon to determine facts by means of approximation and averages. The accountant shuns this practice and denies that accuracy is unattainable. The successful cost executive realizes that he cannot attain accuracy, hence he establishes standards of accuracy and attempts to approach these standards in his daily work.

KNOWLEDGE OF ACCOUNTING OF MINOR IMPORTANCE

Last and of least importance, the cost executive should have a knowledge of the theory of accounts and practical accounting. One possessing the qualifications outlined in the foregoing will have no difficulty in rapidly mastering sufficient accounting knowledge to enable him to supervise the allocation and posting of results obtained by his system.

All of the above pertains largely to the operation of existing systems. As for the design and installation of a practical cost system, it is essentially the work of an engineer. To design a comprehensive system for the average factory manufacturing a multiplicity of products calls for engineering training and constructive ability. Even staid firms of public accountants now recognize this fact and their cost men are as a rule called cost engineers or some similar term from which the word accountant has disappeared.

FAILURE OF SCHOOLS OF COST ACCOUNTANCY

Where may men possessing the above qualifications be obtained in sufficient numbers to place industrial cost determination on a sound basis? Certainly not from schools. The writer recently examined the curricula of a number of well-known schools teaching cost accountancy. The following is representative and is the course of study adopted in one of the best known accounting schools in the United States:

Requirement for matriculation—high school diploma.

Sixty class periods in twenty weeks.

Studies:

Theory of accounts.

Practical accounting.

Auditing.

Law.

Economics and finance.

Can we imagine the ambitious young man applying these teachings in determining production centers, ascertaining power costs, or coping with complex burden problems? No! As a matter of fact accountants have failed to apply even good practical accountancy to their work in cost departments. Had burden reserves been established in 1917 by those to whom fell the task of developing practical cost methods for industry, our whole economic structure might have been favorably changed and surely the effects of the present period of depression would not have been so disastrous to many of the 250 industrial concerns which have failed during the past six months.

Cost practice must conform to the principles of accountancy in so far as the actual recordation of ultimate cost elements are concerned. Beyond this cost finding is not a function of the accounting department. The successful cost man is a natural executive, an engineer by training with a knowledge of statistics and familiar with the fundamentals of accountancy. We shall not be able to obtain men with these qualifications readily—in fact, they will have to be developed. For the present, the task of setting cost finding on a sound practical basis is directly up to the manufacturer and the technicians forming his present organization. The task is not difficult or expensive.

REMEDIAL MEASURES

In the majority of industrial organizations will be found individuals competent to solve different phases of our cost problem. By organizing these men into a group and properly co-ordinating their efforts we shall obtain a functional group competent to consider the problem before them and arrive at a practical solution. Its task will be the development of the new system or the simplification and improvement of an existing system. This group should be known as the cost committee or board.

The specific duties of the cost committee would be to determine the general method to be followed in cost finding. It should then fix production centers (if required) and develop media for the collection of costs. It would be its problem to arrive at the various methods to be followed in the determination of and distribution of burden. It would decide upon and develop a practical system of tabular and graphical reports for transmitting cost intelligence to the management. After the fundamentals had been established the actual task of compiling cost data would be delegated to a cost department headed by a capable executive working under the committee's instructions. The committee should not find it necessary to devote more than a few hours each week to its task.

In this manner a practical cost system can be developed and cost standards established. However, this in itself is not enough. We must have some method of checking standards—in short, manufacturers must establish common standards. Again, not all organizations have all of the men necessary to make up a complete cost committee. The incomplete committee seeking advice on certain phases of its work, as well as the committee seeking common cost standards, must go outside of its own organization for assistance and advice.

MANY ORGANIZATIONS COULD AID

In this connection there are many organizations that can render service of inestimable value to the manufacturer by assisting in the determination of common cost standards and standard cost practice and helping the manufacturer in his effort to obtain a practical cost system. These organizations may be divided into six groups:

1. Community industrial organizations.
2. State and national manufacturers and trade associations.
3. Technical societies.
4. Industrial cost associations.
5. Manufacturers of machine tools and equipment.
6. Federal bodies.

Due to economic conditions nearly every manufactur-

ing community houses several plants manufacturing similar products. This should prove of great value to the manufacturer in aiding him to arrive at proper cost methods. Through the exchange of ideas and discussion of their cost problems at community manufacturers' associations, the cost committee would be greatly aided in its work. Conditions as to labor and material costs vary among communities, hence community common cost standards would prove of greater value to the local manufacturer than national standards. However, both standards are necessary for comparative purposes, the national common cost standards serving as a check on local standards. The Rochester Industrial Management Council and such groups as the Sherman (Tex.) organization of industrial managers are excellent examples of what may be accomplished through the organization of industrial executives in the community.

NATIONAL TRADE ASSOCIATIONS

National trade organizations are rendering a wonderful service in the development of uniform cost methods. Already many systems have been developed along practical lines and adopted. This means standardized cost practice and common cost standards and to many manufacturers has proved to be the solution to their cost problem. However, it is of tremendous importance that the national executives of these organizations exercise good judgment in the selection of uniform methods. Several of these uniform systems are open to the same criticisms as has been applied to our present general cost methods. Associations having uniform cost methods adopted several years ago upon the advice of consultants might well examine these methods for defects and take the necessary corrective measures where defects are found.

TECHNICAL SOCIETIES

There are ten different terms for "burden," eight different expressions used in lieu of "direct labor" or "direct material." The very word "cost" has not been clearly defined. There is no general agreement as to where factory costs start and stop. At least twenty-five different methods are offered for use in determining depreciation rates and four recent authors are at variance as to the method of determining material costs. Standards must be established. The various standardization committees of the technical societies can accomplish a great deal along this line. The American Society of Mechanical Engineers could render a great service by determining and publishing depreciation rates on standard equipment, while the American Society of Civil Engineers might render a similar service with reference to the depreciation rates on structures.

INDUSTRIAL COST ASSOCIATIONS

Recognizing the urgent need for a better knowledge and control of costs, the Industrial Cost Association, with headquarters at Pittsburgh, was organized a little over a year ago. The membership is limited to manufacturers and managers of industrial corporations, firms, trade associations and employees in executive supervision of their cost methods. The aims of the association are to stimulate interest of manufacturers in correctly determining costs, standardize terminology, establish basis principles, simplify cost accounting and educate members in the use of modern methods of cost

analysis and control. The growth in membership of this national body has been rapid and is an excellent indication of the intense interest manufacturers are taking in the correct determination of costs. Much progress has already been made by this association, and there is no question that it will be a powerful factor in placing cost determination on a sound and practical basis.

Little, if any, progress has been made in five years in the formulation of sound principles for the determination of depreciation rates. Ardent advocates of any one of twenty or thirty different methods of determining the depreciation rates applicable to items of plant and equipment will be found in any industrial community. Even the accountants in the Internal Revenue Department have failed to clarify the situation as regards income tax deductions. However, as stated before, this is not an accounting problem.

MAKERS OF MACHINE TOOLS AND EQUIPMENT

By working in conjunction with technical societies the manufacturers of machine tools and equipment can dispel a great deal of the confusion existing at this time. Their files contain ample data from which authoritative information covering the life of their product under various conditions might be compiled. Such information published in a form similar to that adopted by the National Electric Light Association in connection with power requirements of equipment would greatly simplify one of the cost executive's most vexatious problems.

FEDERAL BODIES

Much valuable information which would be of great assistance in standardizing cost methods is stored away in the governmental archives at Washington. The act of Sept. 26, 1914, and later the Clayton act authorize the Federal Trade Commission to make public from time to time such information as it shall deem expedient in the public interest. The aid of this commission has been proffered to industry a number of times by its former chairmen. The intelligent preparation and publication of bulletins on cost methods would greatly increase the value of this commission to the public.

It has first-hand experience and knowledge with many existing systems. This commission could furnish a great deal of authoritative information on the establishment of the necessary reserves required by sound cost practice. Other departments, such as the Bureau of Standards, could render real service along various lines, all with the purpose of placing industry on a sound basis of cost control. With the intelligent co-operation of the above-mentioned bodies and a distribution of technical cost functions among those members of industrial organizations qualified to perform these functions an accurate practical cost system is easily attained.

UNTOLD MILLIONS LOST THROUGH LACK OF PROPER COST METHOD

During the past five years lack of proper cost methods has cost American industry millions upon millions of dollars. Unless manufacturers take the necessary steps to fortify themselves with a sound basis for the fixation of selling prices and, of more importance, provide means by which they can intelligently control their manufacturing operations it is but a matter of a

few years before such manufacturers will be eliminated by their more farsighted competitors.

Industrial executives who have blind faith in their existing cost system will do well to examine into methods used and take the necessary corrective measures to place their house in order. In many of the most progressive manufacturing institutions in the country it will be found that the much-vaunted savings effected by industrial engineers or men holding kindred positions will be nearly offset by making a proper redistribution of burden rates over the period of abnormal production. Through the application of inadequate burden rates on overloaded plant facilities the manufacturer has been left "holding the bag" during the present period of depression. It is his move! To avoid a checkmate or at least to escape a stalemate at the hands of his progressive competitor he must move intelligently and quickly.

Once methods have been established and proved sound they should be adhered to despite the wailing of impractical theoreticians. It should always be borne in mind that actual costs cannot be definitely established, but practical costs are within the reach of all.

Freeport, Ill.

Opportunity for Governmental Assistance in Waste Elimination

The opportunity for governmental assistance in waste elimination has been outlined by the Committee on Elimination of Waste in Industry in the summary of its report (July, 1921). It recommends the establishment of a national industrial information service, a national statistical service, a body of principles for the adjustment of labor disputes and a nation-wide program of industrial standardization.

A national industrial information service should furnish timely, regular and complete information on current production, consumption and available stocks of commodities, supplementing the work of private agencies.

A national statistical service should be established and maintained covering employment requirements and conditions throughout the country. The fundamental knowledge required to make a correct analysis of unemployment in any period is not at present obtainable. The meager information for such a study has to be collected from many agencies. These are under no central control, they are often not in contact and frequently duplicate effort.

A body of principles for the adjustment of labor disputes should be accepted which can be developed with experience. Thus far American legislation for the settlement of these problems presents almost as many varieties as there are states.

A nation-wide program of industrial standardization should be encouraged by the government in co-operation with industry. In the standardization of design of product, methods of procedure and number of models, there rests a large opportunity for the reduction of waste. It is not sufficient, however, to attempt to standardize the product of a given industry, for almost every industry is so dependent upon others that they too must co-operate. The Federal Government could call together the representatives of the trade associations of interdependent industries and in co-operation form committees for this purpose. The opinions or decisions of such committees might from time to time be promulgated as standards of practice.

The Elimination of Construction Wastes

A Comprehensive, Dollars and Cents Analysis of the Preventable Wastes in the Construction Industries and a Thorough Understanding of the Responsibility Imposed Upon the Contractor, Owner, Architect, Engineer and Workman

BY GEORGE W. BURPEE

Vice-President, Dwight P. Robinson & Co., Inc.

WASTE exists in the construction industry as in other industries, and, it may be, to a greater extent due to the peculiar conditions surrounding construction operations. The relatively short duration of each job entails an almost continuous process of organizing and reorganizing, building up a working force on a small nucleus, and in numerous cases moving a force from one section to another.

For the purposes of this article, only those phases of the construction industry have been considered which pertain to the assembly of materials of construction into the completed work. No attempt is made to cover the manufacturing or merchandizing of building materials.

The number of men engaged in the United States in the construction industry thus defined is estimated for the year 1919 by the Prudential Insurance Co. at 1,575,000, as compared with a total working population of 42,503,000. The number of workmen employed in the construction industry is exceeded only by the numbers employed in agricultural pursuits, general manufacturing and steam railways.

The annual expenditure involved in the construction industry in the United States for the years 1919 and 1920 is estimated to be \$3,640,000,000. The statistics available for the first six months of 1921 indicate that expenditures for this year will not be much less. These figures will be used for purposes of argument with the realization that prices both of materials and labor are above normal.

The sources of waste considered in this article are those due to the customary manner of letting contracts, to the abnormal risk in the construction business, artificial restriction of output, intermittence of employment, labor turnover, use of construction plant and tools and a few other miscellaneous causes.

WASTE DUE TO THE MANNER OF LETTING CONTRACTS

Considered in the chronological order in which waste appears on any construction undertaking, the manner of awarding the contract comes first.

The general procedure on building work is this: The owner, either directly or through his architect or engineer, prepares plans and specifications for the project in mind and invites contractors to submit bids for the complete work. The contractor must take the plans, determine in detail the quantities of each item involved in the project, fix the unit prices for which he believes the work can be performed, prepare the estimate for the entire project and submit his proposal.

From observation and experience, it is estimated that an average of eight general contractors submit proposals on each project and an average of two and one-half sub-contractors in turn furnish proposals to each

general contractor for each of the items of the project to be sublet—a total of twenty to the eight general contractors. If bidding on building work, each of the eight general contractors must prepare a quantity survey for the entire project and each of the sub-contractors must prepare a quantity survey to cover the item on which he proposes to bid. Here is one of the greatest wastes in the construction industry and one of the wastes which can be easily eliminated by having the quantity survey prepared by the architect or engineer, as is the common practice on engineering projects.

The cost of preparing the quantity survey to each general contractor and his corresponding sub-contractors is estimated to range from \$500 to \$1,500 for each \$1,000,000 involved, or, for eight general contractors, a total of \$4,000 to \$12,000 for each \$1,000,000 involved in a contemplated project. This cost does not include any allowance to the contractor for determining the price for which he will perform the work, since that cost must be incurred by each contractor even if he is supplied with a quantity survey. If the quantity survey be prepared by the owner's architect or engineer, the cost of one operation only will be incurred and the saving for each \$1,000,000 of contemplated work will be \$3,500 to \$10,500.

The total contemplated work for the United States—that is, work on which bids were requested—for the years 1919 and 1920, based on the F. W. Dodge Co. statistics for the twenty-seven northeastern states, is estimated at \$6,200,000,000 and \$7,000,000,000 respectively. An approximate figure of \$6,000,000,000 will be used. Of this total more than three-quarters represents building work on which lump sum bids are requested, as compared with less than one-quarter, which represents engineering projects to be let on unit price or cost plus a fee basis. Assuming that \$4,500,000,000 worth of work is tendered for, that an average of eight general contractors bid and that the cost of preparing each quantity survey is \$500 per \$1,000,000 of the estimate, then the total cost of making the quantity surveys for this volume of work would amount to \$18,000,000, of which all but \$2,250,000, or say \$16,000,000, would represent waste due to multiplication of effort.

WASTE DUE TO THE ABNORMAL RISK IN THE CONSTRUCTION INDUSTRY

It has been estimated on the basis of income tax returns that the risk involved in the construction industry is extreme when compared with manufacturing, commercial pursuits, mining and quarrying. These sources of information show that in manufacturing industry the loss is 3c. for every dollar of gain; in trading, mining and quarrying, 7c. for every dollar of

gain; while in the construction industry, the loss is 25c. for every dollar of gain.

The total volume of work performed in the United States during 1920 has been previously estimated at \$3,640,000,000. Of this total, probably 4 per cent would represent net profit, say \$145,000,000. At the ratio of 25c. to one dollar, the corresponding loss would be approximately \$36,000,000. That the construction industry can be placed on a plane of no business loss or even that it can be placed on a plane of as small a loss as manufacturing, mining, quarrying, trading, etc., is not to be expected, but it seems reasonable that it can and should reach a plane where the loss would not be greater than 10c. instead of 25c. on every dollar of profit in new construction. On such a basis, the loss would be \$14,500,000 instead of \$36,000,000, or a saving of \$21,500,000.

The causes of abnormal losses in the construction industry include the natural tendency to let work to the lowest bidder unless there is some positive reason for not considering his bid, ambiguous plans and specifications which leave room for doubt as to their interpretation and lack of a quantity survey supplied by the owner, and the practice of requiring lump sum bids where quantities are not definitely ascertainable and working conditions cannot be foreseen.

The remedies for these losses consist of a thorough investigation of the contractor before letting the contract, the furnishing of a quantity survey by the owner which will insure all contractors bidding on the same quantities, the standardizing of specifications so that they will mean the same thing to different contractors, letting work on unit price or on cost plus a fee basis when quantities are not ascertainable and conditions unknown.

WASTE DUE TO ACCIDENTS TO WORKMEN

Forty-two of the forty-eight states in the Union have passed employers' liability or workmen's compensation acts which hold the employer liable for accidents incurred by workmen in his employ. The compensation acts provide for the payments to be made to the workman, the safeguards with which the employer is to surround his operations and, through the state insurance commissioner, the rates which are to be charged by the insurance and indemnity companies for carrying the employers' liability or workmen's compensation insurance.

The amount of such insurance which the contractor must carry ranges from about 3 to 10 per cent of the payroll. The rates vary quite decidedly for different states. For instance, the rates for New Jersey, a low-rate state, compared with those for New York, a high-rate state, for some of the commoner building trades are:

	Rates per \$100 of Payroll	
	New Jersey	New York
Masonry.....	\$3.36	\$8.30
Concrete work on buildings.....	2.94	7.49
Carpentry work outside.....	3.51	11.564
Carpentry work inside.....	0.70	2.102
Structural steel workers.....	9.07	27.569
Grading.....	0.98	2.397
Cellar excavation less than 12 ft. deep, no subaqueous work or blasting.....	1.15	2.76
Blasting.....	13.83	22.80
Millwright work.....	1.72	3.833
Miscellaneous labor.....	1.72	3.833
Supervision, including superintendents and engineers.....	1.19	1.560

An average rate may be conservatively estimated at 4 per cent of the payroll cost. It has been pointed out that the total volume of construction business carried on in the United States during 1920 was roughly \$3,640,000,000. Assuming a ratio of labor to total cost of work of 1 to 4, the payrolls for this work would aggregate approximately \$910,000,000. At a rate of 4 per cent the total cost of compensation insurance would be, say, \$36,000,000.

WASTE DUE TO RESTRICTION OF OUTPUT BY LABOR ORGANIZATIONS

An extremely serious cause of waste in the construction industry is due to restriction of output by labor organizations. This is an economic waste which directly affects the owner but indirectly affects the workman himself, since the resulting waste of capital prevents its use for other production, which in turn would offer increased opportunities for employment.

Those who are interested in a more detailed treatment of this particular phase of economic waste in the construction industry are referred to a splendid paper presented by Charles R. Gow of Boston before the Boston Society of Civil Engineers on March 24, 1921. Mr. Gow estimates that the restrictions imposed in Boston by labor organizations increase the cost of building at least 25 per cent. The average for the entire United States, however, would probably be closer to 10 per cent. On this basis, on the approximate volume of construction work completed during 1920, \$3,640,000,000, the waste would amount to \$36,000,000.

WASTE DUE TO INTERMITTENCE OF EMPLOYMENT

Another most serious economic waste in the construction industry is intermittence of employment. This is classed by the Committee on Elimination of Waste in Industry of the American Engineering Council as the greatest waste in the construction industry, and considering that the loss is suffered by owners, contractors and workmen, this is very probably true. The comparatively short period of employment of workmen in the building trades throughout the year is not generally recognized.

If by some means the building period could be distributed more nearly over the entire year, instead of being bunched in about eight months, it is probable that labor would accept a slight reduction in hourly rate so long as the yearly earnings would not be reduced. The result would be that the owner would be paying for net time worked instead of for such a high percentage of idle time as well. Take the carpenter as the typical case. He works 73 per cent of the year. If his work could be distributed so as to enable him to work 90 per cent of the year for the same total earnings, the saving to industry would be 17 per cent of his annual earnings. This ratio applied to the total estimated labor payroll of approximately \$900,000,000 for 1920 would be \$15,300,000.

WASTE DUE TO LABOR TURNOVER

A loss closely allied to the waste due to intermittence of employment is the loss through changing personnel of employees, commonly called labor turnover. The losses due to this labor turnover are greatest during periods of scarcity of labor, since the tendency during those periods is for workmen to feel more independent, to be less efficient and quicker to move from

one employer to another. Consequently it is difficult to determine with any degree of accuracy what the losses due to this turnover are. Some approximation, however, may be made to indicate the possibilities. Assuming 1,575,000 men engaged in the construction industry and an average number of engagements for each man per year of four, the total number of men engaged would be 6,300,000. If the average number of engagements per year could be reduced to three, the saving would be 1,575,000 engagements a year, and if each engagement cost only \$5, including the cost of employment bureau and the cost of training the new man to his work, the total loss to the contractor alone, neglecting entirely the loss to the workman, would be about \$8,000,000.

WASTE DUE TO LACK OF PROPER COST ACCOUNTING

Another waste in the construction industry which may correctly be attributed to incompetent administration is extravagance in the use of both materials and labor. The most effective means of controlling such waste has proved to be the maintenance of accurate and promptly available records of materials used, and unit costs of labor involved in installation. There is nothing new about such cost accounting, but it is not a rash assumption that numerous contractors apparently carrying on work with a high degree of success are not taking advantage of a proper accounting system which would enable them to effect considerable savings for themselves and the owners.

On large undertakings this saving might amount to 10 per cent or more of the total payroll. On the job of average size of \$30,000 the saving would be less in proportion. For all work the saving would probably average 4 to 5 per cent per year or, say, roughly \$4,000,000.

WASTE DUE TO IMPROPER CONSTRUCTION EQUIPMENT

The average cost to a construction undertaking for the use of construction equipment is approximately 1½ per cent of the total cost of the work. The labor cost of erecting and handling but not operating this construction equipment is 0.4 per cent; making the total cost to the job for the use of plant 1.65 per cent of the total cost of the undertaking. On the basis of an annual volume of work amounting to \$3,640,000,000, the annual cost for construction plant would be about \$60,000,000.

The average cost of small tools is about 0.75 per cent of the total cost of the undertaking and on a similar basis would amount to \$27,300,000. The total annual cost of both construction plant and tools would be roughly \$90,000,000.

It is obvious that good judgment must be used in selecting and laying out the construction equipment required for the execution of any undertaking. It is not unusual to observe work on which the intelligent use of equipment would reduce labor costs appreciably after making allowance for the rental on the equipment. Possibly it is a more unusual occurrence, but it is far too common to observe work where the savings effected by the use of plant do not justify the amount of plant involved. More frequently still it happens that a proper amount of plant is in use but is not so arranged as to produce the best results. Observation indicates that the annual loss due to improper or improperly arranged equipment exceeds 10 per cent of the rental of equipment, or more than \$6,000,000.

All contractors are familiar with losses which occur in the use of small tools, and various means have been employed to reduce such losses, such as the refusal to supply tools to those trades which customarily supply their own tools; the charging against each individual of the value of the tool which he borrows from the store room, holding him responsible for its return; and maintaining a salvage corps whose duty is not only to look after all scattered material but also to check up tools which may be found lying around. The experience of one construction company indicated an annual loss of as high as 20 per cent of the value of the small tools which was eliminated by the vigilance of the salvage corps. Ten per cent would appear to be a conservative estimate of the preventable waste in small tools, or say \$3,000,000.

MISCELLANEOUS WASTE

Various miscellaneous forms of waste occur in the construction industry which are difficult of translation into concrete figures. Among these is bad management, which in a degree is responsible for all of the losses which have been previously dealt with, and, in addition, for other losses more out of the ordinary, such as excessive costs for material and labor, waste of material, errors in executing work, as well as errors of judgment which may result in the performance of the work at a loss both to contractor and owner.

Multiplication of effort on the part of the owner, architect, engineer and contractor. This consists in maintaining various sets of inspectors, material checkers, time keepers, etc., who are certainly not necessary on all work. Closer co-operation among owner, engineer and contractor should do away with a certain amount of this multiplication of effort. The contractor frequently needs no more supervision than the architect or engineer, and the contractor who requires more inspectors than are necessary to assist in the interpretation of the owner's, architect's or engineer's ideas should not be employed on the work.

CONCLUSION

To sum up, there is waste in various forms in the construction industry, some of which can be materially reduced by proper effort on the part of the contractor, the workmen, the owner and his architect or engineer. It is believed that the following figures represent roughly the annual amount of preventable waste with a volume of business equal to that of 1920:

Manner of letting contracts.....	\$16,000,000
Abnormal risk in the construction industry.....	21,000,000
Accidents to workmen.....	30,000,000
Restriction of output.....	36,000,000
Intermittence of employment.....	15,000,000
Labor turnover.....	8,000,000
Lack of proper cost accounting.....	4,000,000
Improper use of construction equipment and tools, .	9,000,000
Total.....	\$139,000,000

This amount is equivalent to 3.8 per cent of the total annual expenditure in construction work and is practically equal to the total annual net profits of the entire construction industry.

Rough as these figures are, it is believed that they err in being low rather than high.

With such a showing, the responsibility clearly devolves upon all engaged in the industry to exert themselves to eliminate the preventable waste. It can be done.

New York City.

Some Considerations on Fire Waste

Industry in General, and the Chemical Industry in Particular, Is in Need of a Fuller Appreciation of Fire Hazards and the Appalling Waste Due to Destruction by Fire—
Review of Possible Fire Hazards

BY NICHOLAS RICHARDSON
Research Engineer, Watertown Arsenal

OUR fire waste is enormous. Daily and hourly much of our wealth goes up in smoke. Our dwellings, factories, crops and forests are being destroyed at a rate which must cause every thoughtful person often to doubt our general intelligence. The daily accounts in the press of disastrous fires, the continual spectacle of fire engines dashing through the streets of our cities, the smoke of our forest fires, have become a national institution which would appear to be accepted with complacency, and it is impossible to believe that the public in general can have any true appreciation of how great and how serious a waste it all entails. A very large proportion of this waste is preventable and therefore unnecessary.

INSURANCE A TAX TO HELP THE FEW

There are some, doubtless jealously regarding themselves as responsible citizens, to whom the spectacle of a fire or the dramatic newspaper account of a conflagration is no more than a welcome diversion, and it is no exaggeration to say that there are many such. How often, when it is learned that "the loss was fully covered by insurance," is a feeling engendered that there has been practically no loss at all, and how many of us forget that insurance is simply a taxing of the many to help the few! We are all obliged for self-protection to indemnify the careless and the negligent.

When material is destroyed by fire it is gone, irretrievably lost, and the world is so much the poorer. When any useful thing is wasted we must inevitably pay more for that thing than we otherwise should, and every fire increases the burden of living.

We are speaking now of the actual waste of goods by fire, but it must also be remembered that there is an enormous consequential expenditure of money, time, energy and thought for fire-fighting and for protection against hazards which ought not to exist. Is not all this also waste?

The foregoing remarks are commonplace and trite. The appalling facts are repeatedly being published, and homilies on the lines of the above are reiterated in current trade and technical journals. The business man, while smoking a cigarette in an interval of business, reads such remarks with weariness, and closes the paper with a feeling of boredom, the while nonchalantly throwing his cigarette through the office window. The cigarette falling ignites an awning below; a blaze occurs; an alarm is rung; the firemen arrive; traffic is held up; the awning is destroyed, windows are broken and hundreds of dollars' worth of goods damaged.

The owner of the awning at once communicates with his insurance agent, and in a day or two he sees, not without satisfaction, a new awning beautifying his premises. And so trivialities of daily life go on.

Fire hazard is always present, and must be so under the conditions in which we live. Our very existence depends on slow oxidation and a large proportion of the substances which are necessary to our lives, particularly material necessary for our food, clothing and shelter, the fundamentals of existence, have so great an affinity for the oxygen of the atmosphere that it requires but a slight increase in temperature to start rapid combustion and the necessities of life are violently converted into different and useless compounds, and as far as we are concerned they are irretrievably wasted.

Such being the case, it would seem natural that every person would learn from the cradle that fire must be regarded as a vicious enemy and that continued heed and care must be given that uncontrolled fire shall not be allowed to start. But that it is not so is evident from the record of our fire waste. There is, however, some hope for the future. The increasing instruction of children in schools as to fire dangers, the training given to Boy Scouts and the institution of "clean up" and "fire prevention" periods will doubtless tell in a more careful and less wasteful generation. In the meantime, however, the waste goes on, as the following figures will show.

RECORDED FIRE LOSS NEARLY QUARTER MILLION YEARLY

The Actuarial Bureau of the National Board of Fire Underwriters lately published a table showing the recorded fire loss in the five-year period from 1915 to 1919. This table includes the losses on insured property only, and a large addition must be made to account for uninsured and unreported fires. It is important to note that forest fires are not included and it would be difficult to estimate in dollars the loss and waste due to the destruction of growing timber. The amount must be enormous, and the waste thus occasioned to one of our most important national resources is deplorable.

During the five-year period from 1915 to 1919 there was a recorded and insured waste of \$1,133,100,676. To this amount is added 25 per cent, which is a conservative estimate of the value of uninsured and unreported losses. The total thus reaches the staggering figure of \$1,416,375,000. The National Board of Fire Underwriters in publishing the figures points out that this amount if used instead of wasted would provide homes for a population exceeding that of the State of Connecticut. In the five-year period considered there has therefore been an annual fire waste to the amount of \$226,620,135 in recorded and insured fires.

The present five-year period promises to exceed this startling record. The waste during 1920 was considerably more than \$500,000,000, or double the average

annual waste of the five-year period considered. Nor is there much hope for a betterment this year. From January to June, 1921, the fire record stands at \$164,-926,300 and there appear no grounds for an expectation that the record for the coming half year will be low enough to bring the year's total to a figure at all favorable in comparison with the average of the past, enormous though that average is.

25 PER CENT ENTIRELY PREVENTABLE

In examining the table it will be seen that the losses with their causes are arranged in the order of their magnitude. The first and most striking fact is that 25 per cent of the total is due to causes which are entirely preventable, the remainder being classed as "partly preventable." Space will not permit of detailed

RECORDED FIRE LOSS DURING FIVE-YEAR PERIOD BETWEEN 1915 AND 1919		
Preventable Causes	Amount of Loss	Per Cent of Total
Matches and smoking.....	\$73,474,348	6.4
Defective chimneys and flues.....	56,650,915	5.0
Stoves, furnaces, boilers and their pipes.....	55,133,181	4.9
Sparks on roof.....	29,271,585	2.6
Petroleum and its products.....	25,910,434	2.3
Open lights.....	13,956,032	1.2
Hot ashes and coals, open fires.....	11,806,754	1.0
Gas, natural and artificial.....	10,203,330	0.9
Ignition of hot grease, oil, tar, wax and asphalt....	4,490,269	0.4
Rubbish.....	3,511,824	0.4
Steam and hot water pipes.....	1,851,434	0.2
Fireworks.....	1,499,854	0.2
Total.....	\$287,759,960	25.5
Partly Preventable Causes		
Unknown causes, probably largely preventable....	\$360,587,544	31.8
Exposure, including conflagrations.....	202,176,433	17.8
Electricity.....	84,086,471	7.4
Spontaneous combustion.....	49,702,886	4.4
Lightning.....	39,828,489	3.5
Sparks from machinery.....	31,862,424	2.8
Sparks from combustion.....	25,144,191	2.2
Incendiarism.....	21,596,965	1.9
Miscellaneous known causes.....	20,193,164	1.8
Explosions.....	10,162,149	0.9
Total.....	\$845,340,716	74.5
Total fire waste in five years.....	\$1,133,100,676	

analysis of these preventable causes, nor is an analysis necessary. Any intelligent man can see at a glance how simple and obvious the causes are.

Can any valid excuse be offered for waste caused by defective chimneys and flues, or fires caused by hot coals and ashes? It is sad to acknowledge that smoking is accountable for nearly 6½ per cent of the total; and the reformers who are now working to place tobacco under the ban along with liquor have in this an argument difficult to refute.

It may here be remarked that "exposure, including conflagrations," which accounts for nearly 18 per cent of the total waste, is one of the peculiarly vicious features of the causes of fire waste. It is here that the innocent suffer for the guilty and where one who employs all means to prevent fire may suffer disastrous losses owing to the neglect and carelessness of his neighbor.

"COMMON" HAZARDS

In the language of fire prevention, the potential causes of fire are classed as "common" and "special" hazards. Common hazards are those which are met with everywhere, and include the fire hazards of heating, lighting, power, disposal of rubbish and the like. It is very easy to learn how all common hazards may be safeguarded, and it can truthfully be said that any fire originating in a common hazard is evidence of neglect which may amount to criminality on the part of someone.

As shown in the table, common hazards are by far the greatest causes of fire waste, and it is in the common hazard class where there is the greatest field for improvement. The means for safeguarding all the common hazards have long been practically standardized, and ignorance can no longer be claimed as an excuse for fire waste arising from common hazard causes. The National Board of Fire Underwriters, the National Fire Protection Association and other organizations publish information covering all prevention methods for common hazards. Such information is available to all. Instruction given in schools and other institutions must place all this information at the disposal of everybody.

"SPECIAL" HAZARDS

In the field of special hazards there are problems of more interest to the technician and specialist, and there is still much opportunity for research. Special hazards are the potential causes of fire arising from the technique of manufacture, and practically every type of manufacturing has its peculiar and necessary special hazards. In this connection most of the credit for safeguarding innumerable manufacturing processes is due, not to the manufacturers themselves but to insurance interests, and not only the protection of special manufacturing processes but also the proper arrangement and conduct of industrial operations effectively to prevent or minimize possible fire waste frequently must be pointed out by insurance men.

To illustrate this line of thought, an example may be taken by considering the common course of events when a new factory—let us say, for example, a chocolate and candy factory—is started. The plant is designed by engineers in consultation with a candy-manufacturing specialist, and the plans are laid out for the most efficient and economical handling of material from raw stock to finished product. The type of construction may be of the best and the provisions for the safeguarding of common hazards may be above criticism. The plant is built and finished and production begins. The building machinery and stock represent a large capital outlay and the dread of loss by fire looms large, although the president of the concern himself "cannot see where a fire can possibly start." The plant, however, must be insured and a policy is written covering buildings, machinery and stock. Then comes the question of the rate to be paid, and the treasurer learns some things which may cause him many bad moments.

INSURANCE "REQUIREMENTS" APPAL THE MANUFACTURER

The insurance engineers inspect the plant and in due course a list of "requirements" arrives, only on the execution of which will a rate be made which appears to approach reasonableness according to the ideas of the treasurer. In the first place, the plant is not protected with automatic sprinklers, an omission which causes the rate to be several times as great as it otherwise might be. It is then discovered that there are no "cutoffs" of value, and for the first time the obvious fact is noted that if large values in stock and machinery are concentrated together without division walls which could stop or at least check the advance of fire, the chances of a large destruction resulting from a possible small fire are many times increased. The erection of dividing fire walls or "cutoffs" is strongly objected to by the production manager and it

is difficult to convince him that a small fire could completely stop his entire production for a long period and in a few moments wipe out all the saving which he could show by the elimination of fire walls or divisions.

It is then pointed out that raw stock or possibly finished goods of large value are stored in basements resting directly on the ground and no provision made for drainage of water, and in this case it probably will be impossible for the insurance engineer to convince the works manager that the expense of "skidding" or raising all stock from the floor is worth while, nor will he possibly be convinced until a small and perhaps insignificant fire occurs in some upper floor, and the water used in extinguishing the fire, flowing to the basement, damages the whole stock therein. The writer remembers a case where the actual fire loss was \$10; the water used in extinguishing the fire damaged goods to the extent of \$14,000, and an expenditure of a few dollars only in raising the stock from the basement floor would have saved it all.

COMMON PRACTICE TO TAKE A CHANCE

The special hazards of chocolate and candy making, then, receive the attention of the insurance engineer. It is found that the dry and hot rooms are made of wood, that cocoa grinding is carried on in an important part of the building without protection against explosions, that there are unprotected ducts between floors and many other special hazards not protected in any way. The managers blame the architect, the architect blames the production manager, they all damn the insurance companies, and the insurance engineer marvels at the ignorance and pigheadedness of some great executives! The matter ends in a "business" man's decision. It is calculated that it will be to immediate financial benefit to refrain from carrying out the requirements and to pay the larger rate. So things are left to chance. All may go well and no fire may occur; on the other hand, a fire may occur and the resultant loss and waste will inevitably be many times greater than would have been the case had the advice of the insurance interests been heeded. This simple scenario may appear to be highly colored, but every incident is founded on fact, as any insurance engineer can testify.

It is time that elimination of waste by fire be recognized as a duty by the large business interests and a more altruistic attitude assumed by those who deal with the material of the common wants of men. That a few may increase their riches by risking the resources of the world is a terrible wrong, but it is unfortunately a widespread custom.

CLOSE INVESTIGATION OF FIRE RISKS NEEDED IN CHEMICAL AND ALLIED INDUSTRIES

New production methods are continually being adopted in practically all types of manufacturing. Many of these methods may entail some fire risk and therefore a close investigation of all changes in manufacturing processes should be made before they are put into practice. In the so-called chemical and allied industries this is especially necessary. Of late years the great increase in the synthetic production of many substances has introduced many hazards into manufacturing which can be appreciated only by technical men of high training. Our chemists have as high skill as

any in the world and at the present time our colleges and technical schools are turning out young men equipped with scientific knowledge who willingly accept minor positions in chemical factories. There is an abundance of knowledge and ability to foresee and guard against possible dangers, but with it all too often the fire hazard situation is overlooked or wilfully neglected. The chemist who has conceived a process is too anxious to have his ideas pushed to fruition, and the production man is too eager to obtain a large and low cost output to permit any delay or additional expense which might be necessary to make the process actually safe. It is an unfortunate fact that highly gifted technical men are not always good business men, and on the other hand a good business man seldom has sufficient technical knowledge to appreciate the practical dangers which may accompany some brilliantly conceived technical process.

POTENTIAL RISKS OF FIRE IN CHEMICAL PLANTS

An outside person critically inspecting a large number of chemical and allied plants cannot but be impressed by the numbers of potential risks of fire waste which may appear to him self-evident. How often is dye grinding carried on in the same building and right in the midst of a stock of finished dyes, whose value may reach hundreds of thousands of dollars. Such stock can be rendered valueless, or in other words can be turned into waste by a comparatively slight accident. Again, how often is nitrating—a process always accompanied by the greatest danger—practiced in close proximity to valuable machinery and large amounts of flammable material. The writer has suffered contempt little short of insult from chemists and managers who are eminent in their line because he has pointed out possibilities of fire and explosion waste and suggested preventives which were obvious in their simplicity. And not a few times has the possibility suddenly changed to an actuality; and waste to a greater or lesser extent has followed.

LITTLE STUDY OF FIRE AND EXPLOSION DANGERS

The study of fire and explosion dangers in dye and other synthetic chemical factories has been made by very few. Indeed, no one who is not an experienced chemist is capable of tackling the subject with intelligence. There are of course a number of dangerous processes which today are so common in chemical manufacturing that the dangers incident to them are or by this time should be well known to all, but the attempts at "short cuts" and the continual introduction of the manufacture of new compounds may be accompanied by unexpected dangers.

The history of a case could be recited where an old and (in its own estimation) careful concern registered indignant surprise when it was suggested that its plant for making H acid represented considerable danger. The accident which followed not long after "surprised" a workman into the next world and the insurance companies to the tune of thousands of dollars.

The types of organic compounds which are synthetically manufactured are never very far removed from true explosives. Sometimes it takes but little to change innocuous material into a sensitive explosive.

It must of course be recognized that occasionally a manufacturer is unable to carry on his business were

he to protect himself against possible accident in a manner which is actually effective. Circumstances may be such that he is obliged to trust to chance that an accident will not occur. He probably considers that he is in fact properly protected by the insurance he carries, and from his own financial viewpoint it is possible that he is so protected. But when the accident occurs there is an addition to the world's waste for which somebody will certainly suffer. It may be argued that advance is made only by those who will take chances, but nothing can be considered as true progress if preventable waste is the accompaniment.

INVESTIGATIONS THAT SHOULD BE MADE

Attention has been drawn above to the fact that research and progress in fire prevention and the proper safeguarding of dangerous manufacturing processes have been initiated and to the largest extent carried on by insurance interests. This is proper and natural enough, but it is unfortunate in creating an impression among many that it is only a trick of fire underwriters to increase their profits. It would be well in many instances if the insurance features could be disregarded and fire prevention problems considered solely from their necessity in order to reduce waste. There are simple broad lines on which all new industrial propositions should be carefully investigated before they are put into any considerable operation. Such an investigation should examine into the following matters:

The nature of the raw stock to be used; its degree of combustibility and susceptibility to damage by heat, smoke and water; the safe storage of raw stock; the avoidance of concentration in one area in order that the smallest practical amount may be subject to damage by any one fire. The same of course applies even more to the storage of finished goods, these representing not only the material itself alone but also the labor and thought expended upon it. True fireproof construction of all manufacturing and storage buildings is naturally the most desirable in the majority of cases.

FIREPROOF BUILDING MAY BE IDEAL FURNACE

In this connection it must be remembered that fireproof construction does not mean that a building is composed only of non-combustible material, for although such a building will not burn it can very easily be destroyed by fire. It is understood that Mr. Edison discovered this fact by practical experience. It is remarkable, but nevertheless a fact, that many experienced business men cling to the delusion that if machinery and stock are housed in fireproof buildings no further anxiety need be felt as to fire. The absurdity of this is evident, since many a strictly fireproof building is so designed that it becomes an ideal furnace for the burning of combustible material.

In continuing the review of the possible fire conditions inherent in any proposed manufacturing enterprise, a close study of the separate and individual processes should be made. Any process producing dust and processes using volatile flammables will certainly be exposed to danger of explosion. Where such dangers are very great, such processes should be isolated. It is usually easy to arrange any dangerous process in such a way that the occurrence of an accident will entail only small waste, but it is essential that a recognition of the danger and adoption of precautions take place before an accident can occur.

An example of the great possibilities in the prevention of fire waste and loss by the scientific study of special hazards may be cited in the history of cotton mills. In the past cotton mills were particular sufferers from fire losses and were considered as a type of manufacturing to which fire was an inevitable concomitant. With the organization and development of the Factory Mutual Insurance Association honest efforts were made to improve conditions. The type of construction, the handling of stock, the peculiar fire risks incident to cotton picking, carding and spinning were made the careful study of trained engineers, and methods and means of annulling dangers were rapidly devised. Automatic sprinklers, together with efficient fire-fighting appliances, were brought into general use—in a word, the whole question of preventing fire waste was taken up carefully and systematically. The result is that cotton mills today have an excellent record as to fire waste, and fire losses of any magnitude due to the heavy special hazards of cotton manufacturing are almost unknown.

It would not be fair, however, to compare an old and standardized industry such as cotton manufacturing with so new and inexperienced an industry as synthetic dye making. The point, however, lies in the fact that if attention is given to fire prevention the fire waste due to special hazards in any industry will be enormously decreased.

NEW INDUSTRIES CREATE NEW HAZARDS

Our industrial growth has been great, and every year sees types of industries begun that are new to the country. Since this is a country of new things, it behooves us to have our eyes open to new dangers. It is superfluous to specify examples of new enterprises where grave dangers may be introduced unless the need of scientific fire prevention is recognized from the very beginning of operations. The phenomenal increase in the use of gasoline and fuel oil, necessitating the installation of storages for great stocks of these flammables right at the very doors of our industrial centers, is only one example. At this writing news comes of a fire where millions of gallons of oil have just been wasted and where had proper consideration been given to fire prevention in the isolation of units and the proper construction and diking of tanks, the waste of one of our most valuable and limited national products would have been immensely reduced, if not entirely prevented.

Nothing has been said of our waste of life by fire, but when it is emphasized that 20,000 persons meet death annually by fire, and meet death in the most terrible way imaginable, enough has been said on that point. It is horrible even to think of what death by fire means, and it is impossible even to estimate the economic loss in the waste of human life.

Enough has been said to justify an earnest plea for the more general recognition of the needlessness of our colossal fire waste. For the reproach of our fire waste owing to common hazard causes we are all to blame, and every one of us can help to reduce the national blot. As to the waste due to special industrial fire hazards its reduction lies with the heads of factories.

The protection of much of our national resources lies in their hands and setting aside selfish and present financial gains they should consider it a duty to the nation to see to it that preventable fire waste shall cease so far as they are concerned.

Location as a Factor in Eliminating Industrial Waste

The Main Factors to Be Considered in the Selection of Proper Location for Industrial Plants Are: The Influence Which a Proposed Industry Will Have on the Community, Raw Materials, Transportation, Labor Supply and Power

BY VICTOR V. KELSEY
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THE importance of the proper location of industries as a factor for the elimination of industrial waste is a point conceded by all, but is frequently overlooked until too late to make a change.

In selecting a location for an industry a number of important questions naturally arise which should be thoroughly answered before reaching a final decision for the plant site. To arrive satisfactorily at the correct answers it is necessary to make a careful analysis of all the major economic conditions. This duty falls to the lot of management, and if properly done it means the first step in overcoming industrial waste, 75 per cent of which is now attributed to inefficient management.

The committee of the American Engineering Council defines waste in industry as "that part of the material, time and human effort expended in production represented by the difference between the average attainment on one hand and the performance actually attained on the other." The sources and causes of waste are classified by them as follows:

1. Low production caused by faulty management of materials, plant equipment and men.
2. Interrupted production, caused by idle men, idle materials, idle plants and idle equipment.
3. Restricted production, intentionally caused by owners, management and labor.
4. Lost production, caused by ill health, physical defects and industrial accident.

To this list should be added the waste caused by locating plants in communities not properly adapted for them, resulting in high cost of production and sometimes ultimate failure, all of which must be paid for by the public.

The first charge of industrial managers is proper plant location. This factor satisfactorily taken care of is a step forward to success.

INFLUENCE WHICH A PROPOSED INDUSTRY WILL HAVE ON THE COMMUNITY TO BE CONSIDERED

Such necessary conditions to be met as raw materials, transportation, markets, labor supply, etc., are of no more importance than a full consideration of the influences prevalent in the community, in so far as they relate to industrial development and the influence which the proposed industry will have on the community. Any number of localities are seeking new factories and offer many attractive inducements. Frequently these inducements include a free tract of land in the section set aside for plant development. The industry moves in, becomes established, starts the manufacture of its product. Then the community wakes up to the fact that instead of having an asset it has a liability, for the reason that the fumes, dust or odors arising from the manufactur-

ing processes become obnoxious to the people of the community and they sometimes declare them a nuisance, which results in loss of production and thus creates an industrial waste.

The writer has in mind three large chemical industries which were improperly located for the reasons stated above.

The first of these three was very properly placed near its source of raw materials and later a town grew up practically surrounding the plant. The town builders in this instance were at fault, as the town could have been located at a sufficiently great distance from the plant to avoid the annoyance caused by the dust.

The second of these industries was located in a section of a town which was building up rapidly and the fumes from the sulphur compounds that were manufactured soon became a marked nuisance. The management was decidedly at fault in this instance, as it must have known that the odors from the plant would not be welcomed by the community.

The third industry selected a large site near a growing town, with a full knowledge on the part of the management that sooner or later its presence would not be cherished by the citizens of the town, and it so happened that the "city fathers," in their zealotry to promote industrial expansion, asked few if any questions as to the products to be manufactured other than that they were told the textile plants took a goodly portion of their finished wares. The odors from this plant and the fact that large quantities of explosive and flammable materials must be carried in stock create both a nuisance and a hazard to the community. Sooner or later someone will demand an investigation which may result in loss of production.

With proper care and foresight so-called undesirable chemical industries can select locations relative to towns or cities that will result beneficially to all concerned. This class of industries, as well as all others, owes much to the community in which they are located. They are an integral part of the community, no less so than the churches, schools, stores, theaters, etc. They must get the proper viewpoint in their relation to the community, and the converse of this must prove to be true, and when this is accomplished then a great deal of the prevailing industrial waste will cease.

SOURCE AND PERMANENCY OF RAW MATERIALS

The source and permanency of the raw materials is usually one of the most important controlling factors in deciding upon a location. A dependable supply of the proper quality of raw products must be assured.

I have in mind a plant built in the East, designed to reclaim a certain waste material produced by the large brass mills in the same general territory. The plant

was located near the source of its raw product and was operated profitably. The management decided that the same type of plant, though of smaller capacity, located in a city in the Middle West would also prosper. They failed to ascertain the amount which could be had of their raw product nor did they inquire with sufficient care into the location. As a result it proved to be, first, so far from their factory that they could not afford to pay the heavy transportation charges, and second, the amount of raw material available was not sufficiently great to permit operating their plant to capacity even though it could be economically assembled. This particular plant was a financial failure from the day it was completed and the whole blame lies at the door of the management in failing to make a thorough and proper analysis of their most important raw material.

TRANSPORTATION FACILITIES

A number of large and important industries operating today are feeling the pinch of freight rates on their raw materials. When the present sites were selected the raw materials were, in most instances, relatively close at hand. These sources have, in a great many cases, become exhausted and the industries are now forced to go great distances for them, which means competition with plants making similar products located near their basic materials, and competition grows keener each year.

The markets for the finished product is a factor of prime importance, but inasmuch as they are usually scattered, the relative proximity to the producing factory is not, as a rule, of as great importance as the source and proximity of raw materials. The carrying charges on finished articles, while generally higher than on raw products, do not aggregate as much, in most instances, as they are shipped in smaller quantities to the ultimate consumer.

Transportation facilities are important from the standpoint of permitting, in most cases, the assembling of the raw materials and the distribution of the finished ware in the most economical way.

If possible, a location should be selected which permits the raw materials to be assembled by the shortest hauls, thereby taking advantage of minimum freight rates and the distribution of finished articles over the most direct routes.

LABOR SUPPLY

The question of labor supply is one that receives more attention than perhaps any of the others in deciding upon a proper location for a factory. Some managers contend that the small community offers the best inducement for contented labor and minimum labor turnover, and while the supply is not so great or so flexible as in the larger centers, production can be maintained at higher levels and accomplished at lower costs.

In my opinion the smaller communities offer the best inducements for labor providing certain essential factors are carried out so as to make the labor contented, such as suitable homes built in attractive designs and on lots sufficiently large to provide space for lawns and vegetable gardens.

The plan of building a string of company houses all of the same design does not make contented labor. The quality and design must be such that the workman will have a desire to purchase, and arrangements must be effected to enable him to make the purchase by paying a small initial sum, followed by monthly payments within the limits of his earnings.

Along with the housing development must be provided recreational centers such as baseball fields, tennis courts, moving picture theaters, good schools and churches. Conditions of this kind will obtain and hold highly skilled workmen as well as unskilled workmen.

Industrial communities built up in this manner permit the workmen to have a voice in civic affairs and thus intensifies their interest in their work and in their homes.

POWER SUPPLY

The experiences of the coal shortage a little more than a year ago are fresh in the minds of all industrial managers. Never before has the matter of power been so forcibly brought to the front as a tremendous factor in production. As a result of this experience proposed industries consider most carefully locations in their relation to adequate coal supplies and other supplies of power. Hydro-electric developments are now being considered which heretofore were thought to be out of the question as requiring too much money for their installation. This type of power source will make remarkable increases during the next few years. Big central generating stations designed to furnish power to a number of plants in their territory will be built up in greater numbers in the near future. Power-generating units, though more costly in design than in past years, will be installed in increasing numbers on account of their greater efficiency, thus tending to lower the cost of power. The essential point is the nearness to the coal mine of dependable quantity and quality, except sites that offer power from hydro-electric stations.

CLIMATIC AND OTHER FACTORS TO BE CONSIDERED IN THE SELECTION OF POWER SITES

The size and topography of the proposed site are important from the standpoint of permitting expansion and affecting the cost of building.

Climatic conditions have a direct bearing on the speed with which labor accomplishes its work and on the cost of living. The colder climates require more and heavier clothes and a greater amount of fuel for the winter months than would have to be provided in a warmer climate, thus necessitating somewhat higher wages.

The advertising value of a plant site may or may not be an economic factor. It is believed that the public can be induced to purchase wares of merit by proper advertising and that the home of the manufactured article has very little effect in an advertising way.

Decentralization of industry has its advocates, and not without reason. There is greater flexibility to be had, both by the management and by labor, in communities that are not crowded due to a number of big industries being situated close to one another.

Sociological conditions are far better in the less congested districts and, as a rule, there are fewer laws to contend with which tend to stifle industry.

It is believed that industrial engineers in general will do well to prepare a list of certain conditions to be met in selecting the proper plant location.

A great many data are now available from numerous sources, but these have not been compiled in a systematic and orderly way. Such a compilation would be of great help to chambers of commerce, industrial agents and others interested in recommending sites for industries. The right kind of information would stop further industrial waste due to improper plant location.

Corning, N. Y.



Reduction of Waste Through Accident Prevention

The Chemical Industry in Many of Its Branches Is in the Development or Quasi-Experimental Stage in This Country—It Is Therefore Important That Its Industrial Accidents Should Be Carefully Analyzed

BY L. A. DEBLOIS

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IF THE chemical industry of the United States is to compete successfully with the longer experience and the cheaper labor of European countries, it is admitted that the highest operating efficiencies must be attained and the greatest economies effected; in a word, waste of time, labor, power and material must be coaxed down to the irreducible minimum, without sacrifice of quantity production and with constantly improved quality. To achieve this irreducible minimum it behooves us to subject every possible source of waste to the closest scrutiny and to consider well before it is rejected as unavoidable or too trivial for our attention. In fact, the terms unavoidable, trivial and "inherent to the industry" should be regarded with suspicion, as possible spurious currency, until their true value is proved.

ACCIDENT PREVENTION A MATTER OF UTMOST CONCERN TO THE CHEMICAL INDUSTRY

No one denies that accidents cost money, though many reckon their cost only in terms of liability insurance premiums. Their bearing on the available man power of the country was emphasized during war-time labor shortage, but in these times of glutted labor markets it has lost much of its former significance, and yet accident prevention is, or should be, today a matter of utmost concern to the chemical industry. It is not, however, that the Europeans have progressed farther in accident prevention measures than ourselves, but that to overcome other of our competitive disadvantages we should excel them in this field at least and profit by the economies that will result.

IMPEDIMENTS TO ACCIDENT PREVENTION

There have been two great impediments in the onward march of what accident prevention enthusiasts are pleased to call "universal safety": First, a lament-

able failure to measure the far-reaching consequences of the average industrial accident, and second, the sublime and childlike faith of the human race in its own interpretation of what is "luck," "chance" or "Providence" as applied to accident occurrence. The first has led to an indifference to accidents which appeared of minor importance at first sight, but which were actually of profound significance in their bearing on industrial conditions; the second has persuaded us that many accidents are unavoidable or are caused by an inherent hazard or are mere chance occurrences when quite the contrary is true.

Most of us are inclined to regard accidental injuries as merely affecting the health and prosperity of the injured person and his or her immediate dependents, or, when liability for the accident is involved, the possible expense and annoyance to—in the case of industrial accidents—the employer. Under this point of view the accident with its train of consequences is commonly regarded as a complete episode, disagreeable, happening rather unexpectedly and not closely associated with the normal efficiency and routine of the industry in which it occurs. This is the everyday, every man point of view; but of late there has been developed by safety engineers a notably broader conception of the situation which promises to exert a powerful influence on the detection and reduction of industrial waste and inefficiency.

ELIMINATION OF CIRCUMSTANCES CONTRIBUTORY TO ACCIDENTS LEADS TO INCREASED EFFICIENCY

The new conception regards the nature and extent of injury as relatively unimportant, except of course for its humane aspects and in so far as it affects the cost of compensation. In fact, it regards it as being largely fortuitous: a man may be slightly injured or he may be killed under almost identical conditions. The impor-

tant matter is the train of circumstances that led up to the accident causing the injury. This can be made clearer by selecting an example. Let us assume that an elderly employee has been injured by a fall while in transit between buildings. Relatively the extent of his injury makes little difference. Investigation, however, reveals that he followed the usual route taken by the other employees and that there was ice on this path. Investigation further shows that other employees passing that way slipped but were agile enough to avoid a fall; or walked more cautiously; or went around the icy place. Whether they slipped, or slowed up, or detoured, their transit between buildings took an appreciably longer time than if there had been no ice there. By stop-watch the trip took four and one-half minutes instead of the normal four minutes. The ice was momentarily lowering their efficiency $12\frac{1}{2}$ per cent. This was the real lesson in the accident; the injury to the elderly employee was not a mere unconnected episode, but a warning of the existence of conditions leading to inefficiency. We remove the ice, then, not alone to prevent accidents but also to allow our employees to proceed on their way without loss of time—loss perhaps insignificant in each individual case, but in the aggregate worthy of our attention.

ELIMINATION OF ACCIDENTS BY IMPROVING THE EQUIPMENT

We may select as another illustration the operation of a battery of power-driven presses into which the raw material is fed manually by the operators. Three of these men have had their fingers caught by the descending dies and amputated. We may provide guards to prevent these accidents or we may adopt an automatic feeding device. The latter is selected and applied, the actual speed of the machines remaining unchanged. A month's trial demonstrates the fact that not only have we eliminated the accidents but we have increased the machine output 15 per cent. This latter result was somewhat unexpected and at first we are inclined to attribute it to the saving of time formerly lost through injury. That we have saved this is true, but it is not nearly enough to account for the increased output. Finally we reach the conclusion that the injuries were, after all, only the result of inefficient conditions of operation, quite unrecognized by us at the time, and that when they were eliminated the inefficiencies were eliminated also, unconsciously but effectively. Between the two was a subtle but definite relation. We conclude that inefficiency produces accidents occasionally, near-accidents frequently, and waste continually.

PROBABILITIES OF ACCIDENT OCCURRENCES

And now concerning the "providential" side of accidents. A close study of almost any single case invariably reveals a considerable number of circumstances contributory to the accident, but so inextricably interwoven with what we may call the primary injury causation (the act that brought about the injury) as to be in reality co-operative rather than contributory. The simultaneous occurrence of each of these contributory circumstances was essential to the occurrence of the accident, although all varied in their relative importance. Out of such a study we come quite naturally to the conclusion that a certain accident will always take place when all factors necessary to it occur simultaneously. It then becomes only a question of their simultaneous occurrence. If one factor, or contributory

circumstance, has a probability of occurrence of one in ten, and another has a probability of one in one hundred and the accident itself requires the simultaneous occurrence of both, it will occur inevitably once in one thousand times. There is nothing "providential" in this, no element of chance or luck any more than in the application of a match to a keg of gunpowder, and the sooner we lay aside such supposition the faster we will advance along the road to universal safety.

FOREMEN'S PART IN PREVENTING ACCIDENTS

The injured workman is very generally blamed for 60 to 75 per cent of the accidents. Undoubtedly he might have done something in most cases that would have prevented the accident from happening, might have exercised a little more care or forethought. But the important question for the employer to answer is what could he, the employer, have done. It is his productive efficiency and plant morale that are suffering by accidents, and to a degree far out of proportion to the mere injury. To whine about the responsibility of the workman is not mending matters. What kind of supervision are he and his foreman maintaining that injuries are allowed to occur at all? Are these foremen not part and parcel of his staff and subject to his influence? Injuries mean waste, and if this sort of waste is permitted by them, why not other sorts?

WASTE AND INEFFICIENCY PRECEDE ACCIDENTS

Probably the most frequent variety of injury occurring at all chemical plants is to the eyes from the entrance of foreign particles, often of acid or caustic. These accidents are commonly attributed to the failure of employees to wear the protective goggles that the plant provides for their use. Reasonably satisfactory goggles for practically every purpose are now obtainable and once provided it is squarely up to the manager of the plant and his staff, including the foremen, to see that they are worn. The usual excuse is "but my men won't wear them; they say—," etc. What nonsense! Would the management tolerate for an instant their refusal to mix or handle the raw materials or finished product in the way specified? The fault lies with the management, which is half-hearted in its insistence that goggles shall be worn and is inclined to blame the men for accidents which happen when they are not worn. It is absolutely within the power of any capable foreman to maintain the proper use of goggles, provided he has the expressed support of the plant manager.

But there is another angle to all this. It is quite proper that the eyes should be protected from the entrance of drops of acid and particles of caustic, but what are such materials as acid and caustic doing outside their proper pipe-lines, containers, etc.? These materials are valuable, and though the tiny drop or particle in question has an infinitesimal value, it was not the only drop that fell or particle that flew. Examination may show that considerable acid got away through the leaky gasket before any accident occurred or that considerable caustic was regularly wasted by the clumsy method of breaking up the solid caustic with a pick. If tanks are leaking, if repair men are not draining pipe-lines before breaking joints, if valve-gland packing is blowing out, if there are loose ingredients on floors and platforms, if mixing tanks are overflowing or splashing, if there is dust in suspension or dense fumes are liberated, then waste and inefficiency

are at work and accidents, the inevitable warning of the existence of such conditions, are taking place. The use of goggles will protect the eyes and save a man from total blindness—as it has done in hundreds of authenticated cases—but it will not greatly decrease industrial waste or inefficiency.

FALLACY OF "UNAVOIDABLE" ACCIDENTS

Not only are satisfactory goggles obtainable, but special protective clothing, including gloves, helmets, aprons, boots, safety carboy carriers which permit one man to do safely the work of two, carboy inclinators, safety acid jugs, sample bottle carriers and other devices. And yet with all the improved protective appliances, disabling and distressing accidents from acid and caustic continue to occur by hundreds, and many are classed by those who are themselves directly responsible for their occurrence as "unavoidable" or due to "inherent risk of the business."

There are two major classes into which these accidents may be divided—operating accidents and repairs accidents. Both classes may be diminished by better supervision in the operating field and by better supervision in the drafting and design departments. Many a careful repair man suffers an injury as the indirect result of parsimonious provision of inadequate space for routine and periodic repairs or the failure of the design engineer to give serious consideration to the need of such repairs—repairs as important and as inevitable on a chemical plant as the operation of the plant itself. Many an operator is injured as result of this same want of forethought, imagination or operating familiarity on the part of the design engineer or draftsman, who has utterly failed to consider matters of accessibility, adjustments, cleaning, oiling, etc. Behind them all, and properly sharing a proportion of the liability, is the manufacturer of machinery who, in order "to meet competition" or because "there is no demand from trade" fails properly to guard his product or provide for safe adjustments and repairs.

Take, for example, the common filter press. A few types are provided with gear and pinion or worm and gear setting-up devices, but the majority depend on the archaic—or at least Archimedean—bar and screw. It is not an uncommon experience in a chemical plant to see four or five men straining on these heavy bars, which are apt to slip from their sockets when rotated below the horizontal. It is safe to say that hundreds of men have had their feet crushed, legs broken, hands smashed or have been ruptured in this way. With a geared setting-up device, one man or at the most two men can do the work of four—and with safety.

SUPERVISION FOR SAFETY NEEDED IN THE PURCHASE OF EQUIPMENT

It is evident, then, that supervision for safety in the purchase of equipment is as important as supervision in design. Guards for exposed gearing are frequently supplied only as "extras," sawguards do not come with circular saws, essential quick-stopping devices are not given gratis with mixing rolls and calenders, and belt-shifters are not generally provided with an automatic locking device. The general design of the equipment should be scrutinized. The square-head jointer is still on the market. Some years ago one of the leading pump manufacturers turned out a plunger-type boiler feed-pump that was admirably adapted for cutting off the fingers of power-house engineers—and did its work

cleanly and efficiently—and only recently we encountered a boiler blow-off valve made by a reputable manufacturer so arranged that the bolts which held down the bonnet could come off while blowing down the boiler, and in fact did so. One wonders sometimes how much thought the manufacturers give the accident prevention question nowadays!

PREVENTION OF ACCIDENTS DURING REPAIR WORK

There is no doubt that the matter of plant repairs is an important one from the viewpoint of accident possibilities, particularly where there is a high degree of hazard in the materials of production. All too frequently there is no definite rule laid down by the management as to the relative responsibility of the operating foreman and the repairs foreman, and in default of this they are at loggerheads. The operating foreman should be the one man intimately familiar with the peculiar hazards attached to the matters under his immediate charge and should be charged with the general safety of repair gangs at work in his area, not to the extent of interfering with individuals but as advisory to their foreman. A recent serious accident involving three men overcome by fumes while making repairs inside a tank would have been avoided had the repairs foreman warned the house foreman of his intentions.

Also the repairs foreman, for his part, should not accept with implicit faith statements that all tanks are clear of fumes, that valves are closed, that pipes have been drained and are free from pressure, that switches are open and electric lines are dead, that "no one's going to open that valve, or start the motor, or throw the clutch." For the protection of his men he must quietly assure himself of these things and place padlocks, warning signs or blocking where they are necessary, and in doing so he must not take risks to which he would not subject his own men. There are also the after-accident precautionary measures to be attended to—the goggles and rubber gloves, the gas masks and life-lines, the bucket of water at hand in case of an acid or caustic splash, the location of the nearest water-shower and the condition of exits in case of a flash-fire or explosion. All such matters require careful supervision and constant drilling of foremen, but results will be found to pay for themselves. We should remember that the repairs foreman is rather an important factor in plant operation.

SAFETY BOOSTERS' CLUBS

The photograph heading page 403 shows the mechanical department of the Repauno Works of the du Pont company grouped beneath a sign which reads: "Something to Crow About: 590 Days Without Accident; Average Number of Men for the Year—160."

They finally completed 776 days without a single lost-time accident, though the department contained practically all the repairmen of the plant. This shows what can be done. And it is indeed amazing how the spirit of accident prevention, once awakened in foremen and men, does not die. The foreman of an average force of 643 construction men formed a "Safety Boosters Club" with the motto "Ninety Days or Bust." They "busted" twice, but finally reached their goal in the face of a 67 per cent labor turnover. In the whole period of 305 days there were only five accidents, an aggregate loss of 168 hours and a total cost of \$6. One combined explosives and acid plant, averaging about 250 men, has recently accomplished an unbroken record of fifteen months without an injury (five years ago

it averaged forty-eight lost-time injuries a year) and now seriously declares its intention of establishing a five-year record of freedom from accidents. Surely such men as these have lost all confidence in "luck" and have set up determination in its place!

PREVENTION OF ACCIDENT FROM INDUSTRIAL POISONING

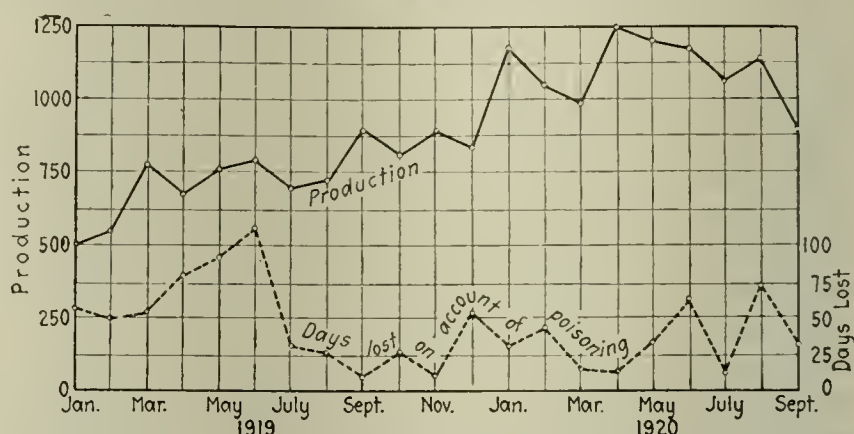
In some branches of the chemical industry industrial poisoning from the ingredients or finished product introduces a special hazard even greater than that of injury by accident. This is particularly true of the dye industry, in which the possibilities of severe poisoning under careless methods of manufacture are legion. Associated with these are special hazards of explosion from excess pressure brought on by chemical reaction, explosions by virtue of rapid chemical decomposition, dust explosions, fume explosions and flash fires. Often the small-scale chemical manufacturer, the experimenter or the byproduct tyro discovers this to his cost and loss. The larger manufacturer, who has learned lessons from his earlier experiences, develops his processes through the laboratory stage, through the "semi-works scale" to the final full-scale equipment, which is itself for a long time changed and improved, but always with an eye open to accident and poisoning possibilities. Careful chemical supervision is of course necessary, but also careful safety and medical supervision. Production foremen and supervisors must not concern themselves solely with matters of quantity and quality, but must be constantly impressed by the management with the almost paramount considerations of safety to life and health. They must be made to feel that these matters cannot be left solely in the hands of the safety inspector and plant doctor. They must realize their own responsibility and accountability.

PERSONAL CLEANLINESS

Personal cleanliness on the part of plant employees is the *sine qua non* of the control of industrial poisoning, and it must be continually checked. To provide the facilities is not sufficient; their use must be encouraged and, if necessary, enforced. With this must go constant medical supervision, not of the variety that waits for patients to arrive with its feet upon the therapeutical desk, but the sort that goes forth, sees the men at their work, calls them by name and acquires their confidence. These, however, are prophylactic rather than curative measures. Poisoning may still occur and yield only to radical changes in equipment or methods. "But think of the expense—we have no money for changes!" Nor have you money to pay sick labor that is non-productive, to pay hospital bills, to pay funeral expenses and compensation for dependents. "Yes, but we don't pay for those, the insurance company does that." Quite so, but what do you pay the insurance company—1 per cent of your payroll, or 2 or possibly 4? In 1920 the du Pont company took care of its injured men on a more liberal scale than provided for by the state compensation acts at a cost of about 72c. per \$100 of payroll, which included medical, surgical and hospital costs and salaries of safety men engaged in compensation and settlement work. The estimated saving through self-insurance and accident reduction was sufficient to pay for all accident prevention work, both structural and educational, the salaries of safety departments at the plants and in the main office, and leave a net balance of 64 per cent as profit on the year's work.

BENEFICIAL RESULTS OF ACCIDENT PREVENTION

In the past ten years 75 per cent decrease in the severity of accidents has been attained in the plants of the du Pont company. To what extent this has effected productive efficiency it would be impossible to say. It has doubtless had its effect; though no well-defined line can be drawn between industrial waste and waste by accidents. It will, however, be of some interest to the readers of CHEMICAL & METALLURGICAL ENGINEERING to



INDUSTRIAL MALADY CURVES, DYE WORKS E. I. DU PONT DE NEMOURS & CO.

note a corresponding effect in the case of industrial poisons.

Coincident with the changes in equipment and methods in the manufacture of trinitrotoluol—one of the first industrial poisons encountered by the du Pont company—the following results took place:

Per 1,000,000 Lb. Handled in Manufacture		
Year	No. of Cases	Hours Lost From Poisoning
1914	11.	391
1918	0.2	11

And among the more varied ingredients and products of the dye works, the time lost on account of industrial poisoning decreased in 1920 39 per cent as against 1919; while the production in pounds, by virtue of changes, improved methods, etc., increased 47 per cent, giving in one year a net decrease of 58 per cent in number of days lost per unit of production.

Whether accident prevention and disease prevention promote productive efficiency or more efficient methods reduce accidents and poisoning is immaterial, so long as one recognizes the inseparable relationship that exists between them.

Wilmington, Del.

Responsibility of Owners in Waste Elimination

The owners of industry, through the banking function or otherwise, share in the responsibility for eliminating waste in industry. They have the duty particularly of assisting in stabilizing production. Carrying out such a policy is peculiarly the banker's interest. This is the conclusion reached by the Committee on Elimination of Waste in Industry of the Federated American Engineering Societies as stated in the summary of its report, July, 1921.

While it is true that balance sheets and income statements are gages of the degree of success of a business, it is evident from the assay of waste that these statements often do not reveal all or even the greater part of the facts regarding production. Certain banks have special industrial staffs to give service to their customers and to study industrial questions more closely. It may not be long before such things as good management methods are universally recognized as commercial assets.

Elimination of Waste in Industry Due to Poor Lighting

Industrial Accidents and Resulting Wastes of Man Power as Well as Costly Losses of Time, Materials and Production Can Often Be Avoided by the Installation and Proper Maintenance of Adequate Illumination

By WARD HARRISON

Illuminating Engineer, National Lamp Works

A CHEMICAL plant is a conspicuous example of an industry in which a large proportion of the work is necessarily carried on throughout the twenty-four hours. Consequently dependence must be placed upon artificial illumination for fully one-half of the time. More than this, many of the plants connected with the industry are so constructed that there is very little window space in proportion to the total floor area. In order to avoid an atmosphere of gloom and of dark areas where unseen dangers may lurk, and to keep such a plant clean and orderly, it may be necessary to use artificial light during the greater part of the day. As a rule a high level of artificial illumination over the large areas is not necessary, because the work does not involve fine discrimination of detail except at the gages, hydrometers, etc., where special lighting is usually provided. On the other hand, it is desirable to provide at least a moderate amount of illumination throughout the plant for the reasons mentioned above, and particularly in order to protect the workmen from accidents.

The opinion is often expressed by the layman that a greater amount of artificial light is used than necessary. Frequently he believes there is as much illumination in a brightly lighted room as there is in daylight out of doors. The facts are, however, that out of doors one may measure 500 to 1,000 or even 5,000 units of light. Indoors near the windows perhaps 100 units and less than 10 units anywhere is scarcely considered a good working light in the daytime. Often the night illumination in the same plants is around 0.1 of one unit of light (or 0.1 foot-candle as it is called). From 3 to 6 foot-candles is not too much for the general illumination of a chemical plant.

Accident hazard is particularly great in dimly lighted chemical plants. Obstacles may lie on the floor unseen until someone stumbles and is injured. An acid drip may go unnoticed, or the light may be so dim that the label on a dangerous chemical cannot be distinguished. The proverbial dark corner, however, does not exist in the case of a well-planned lighting installation in an interior with light colored walls and ceilings. An effective means of keeping corners clean and empty is to paint them white.

INDUSTRIAL ACCIDENTS CAUSED BY POOR LIGHTING

The largest item of waste in industry of which we have definite knowledge is the waste of man power due to accidents; and the chemical and steel industries are no exception in this respect. Regarding the relation of waste and accidents one can do no better than to quote directly from an article¹ by R. E. Simpson of the Travelers Insurance Co. "It has been definitely

established that ten years ago approximately 24 per cent of our industrial accidents were caused by poor lighting. In the intervening decade much progress has been made in the art of illumination and in promoting the safety of workers, with the result that this percentage has been considerably reduced. . . . If we admit that 15 per cent of our industrial accidents are due to the misuse of light sources what does this represent in financial and economic loss? . . .

"Our conception of the total economic loss that the foregoing figures involve will depend largely upon the unit costs with which they are associated. If we con-



FIG. 1. AN EFFECTIVE MEANS OF KEEPING CORNERS CLEAN

servatively estimate \$20 as the average weekly wage and assume that \$20 per week is needed in addition to cover medical attendance, hospital charges, loss in production, insurance and the various other items that enter the cost of an accident, we find the total annual cost, in round figures, approximates \$2,000,000,000, the part chargeable to poor lighting therefore being about \$300,000,000. This is a sum in excess of our yearly industrial-lighting bill, and hence we see that the misuse and inadequate use of lighting facilities in industry cost more than the light itself."

WASTES OF TIME AND PRODUCTION

The preface to the Wisconsin Industrial Lighting Code, in explaining why the state is concerned in the regulation of factory lighting, also discusses the economic advantages of good lighting as follows: "Finally, inadequate illumination decreases the production of the industries of the state, and to that extent the wealth of its people. Factory managers who have installed improved illumination are unanimous in the conviction

¹I. E. S. Transactions, vol. 15, No. 8.

that better lighting increases production and decreases spoilage."

Waste of time due to lack of supervision and discipline is also characteristic of dimly lighted areas. In such places a workman will take advantage of the opportunity which permits him to sit unnoticed in some dark corner, smoking or dozing for a while when in the meantime some important process is carried too far; in a well-lighted room such a scheme would not even suggest itself. It is a well-known fact that workmen are more contented in an orderly, well-lighted plant, and that contented workmen do more work and are more careful in their work. Order and neatness are much easier to maintain when there is sufficient light.

WASTES OF MATERIALS

A large item of waste in the chemical industry is the waste due to spoilage of entire batches of material. This is often caused by the incorrect reading of thermometers, hydrometers or gages traceable to lack of light. In plants that have a poor general lighting system and even in plants that have good general lighting, a special light is usually provided for reading gages. Bare lamps or poorly shaded lamps giving rise to direct glare should not be used for this purpose, and care should be exercised to place the lamp and reflector at such a height as to avoid reflected glare or "specular reflection" from the lamp on the gage.



FIG. 2. ILLUMINATION OF A GAGE GLASS

Another common cause of spoilage of batches is incorrect judgment of material, which may also be due to lack of light or to distortion of color. In order to avoid spoilage of batches due to color distortion, the so-called daylight lamps may be used. These lamps are particularly desirable in chemical laboratories and sample testing rooms and in fact wherever color discrimination is necessary. There are also devices on the market which reproduce with even greater exactness almost any quality of daylight desired, such as north skylight or noon sunlight. These are for use where a high degree of accuracy in color matching is necessary.

PRODUCTION AND LIGHTING COSTS

It may be of interest also to note briefly the results of some tests which have been conducted in order to determine the relation of lighting to production. In all of the efficiency tests conducted to date, the highest level of illumination investigated has invariably shown the greatest production and the greatest economy. In fact, in the range considered the relation of decreased production costs to total lighting costs is of the order of 10 to 1. Four such tests which were conducted in Chicago industrial plants under the supervision of W. A. Durgin show increases in production of 10 to 20 per cent resulting from better lighting.

During the last decade the trend of practically all manufacturing costs except the cost of light has been upward. In terms of other manufacturing costs, light now costs only one-tenth of what it did ten years ago. The cost of lighting per unit today is less than 3 per



FIG. 3. RLM STANDARD DOME REFLECTOR

cent of what it was in the days of the tallow candle. This means that where a number of years ago the cost of light prohibited the manufacturer from using more than a certain small amount, necessary for actual vision, he can now afford to use many times that amount of light, in order to carry on his manufacturing operations most economically.

EQUIPMENT FOR PROPER LIGHTING OF CHEMICAL PLANTS

A few practical suggestions as to the proper lighting for such plants as are typical of the chemical industry might be useful to those who are interested in installing a lighting system which will assist in establishing the greatest economy in the working of the plant.

As has been previously mentioned, a general lighting system is desirable, supplemented by local lighting for work requiring fine discrimination of detail. For the general illumination of the ordinary processes in this industry, from 3 to 6 foot-candles of illumination should be supplied. A type of lighting equipment which has a wide application is a porcelain-enameled steel reflector. A great variety of such reflectors have been used for industrial lighting, but some time ago, through the co-operation of the principal manufacturers of steel reflectors and the engineers of the lamp

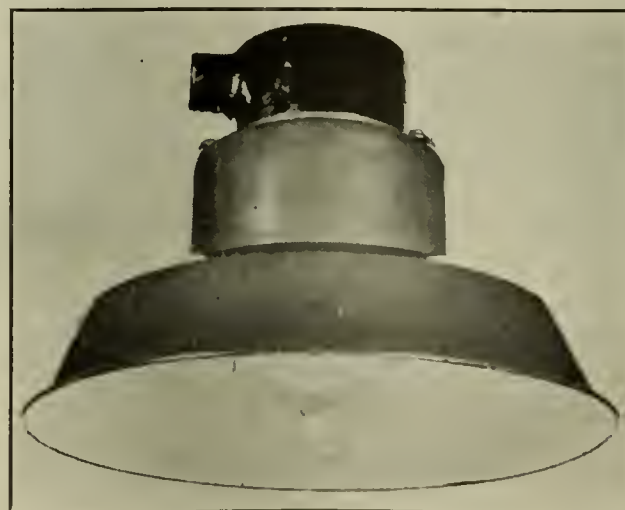


FIG. 4. VAPOR-PROOF UNIT

manufacturers, specifications were drawn up for a standard porcelain-enameled steel dome reflector which embodied the advantages of the numerous older types and which omitted many of their defects. The specifications for this design have been issued by the research laboratories of the General Electric Co., and are

known as Reflector and Lamp Manufacturers (abbreviated RLM) Standard Specifications. Reflectors which comply with these specifications bear a statement to that effect in the form of a certificate of Inspection Service over the signature of the Electrical Testing Laboratories of New York City, which has been retained to conduct such periodical inspections and tests as will insure the uniform maintenance of the high quality prescribed in the specifications.

In order to reduce glare and glaring reflections, and to get better diffusion of the light, bowl enameled



FIG. 5. FOOT-CANDLE METER

lamps are preferable for use in RLM standard dome reflectors, except when the units are hung at a considerable mounting height—for instance, at least 18 or 20 ft.

In chemical plants it is often necessary to protect the electrical connections from acid fumes and flammable vapors. Vapor-proof units of rigid construction, able to withstand atmospheric conditions, have been designed for such locations.

MAINTENANCE OF ADEQUATE ILLUMINATION

Proper maintenance of a lighting system is a matter of great importance. In plants connected with the chemical or steel industries there is usually more or less smoke and dust in the air and the lighting system is particularly likely to deteriorate from this cause. Dirty reflectors, walls and ceilings darkened by smoke and dust, blackened lamps left in service as long as they continued to burn, empty sockets, unobserved burnouts, and replacements with lamps of wrong size or improper voltage rating are prime causes of inadequate illumination.

There are two methods by which the maintenance of any selected value of illumination can be assured: First, by allowing for an enormous depreciation in the light and consequently using much larger lamps than would ordinarily be considered necessary; and second, by maintaining the system properly and allowing for reasonable depreciation. The second, more generally practical, method involves: (1) The use of a depreciation factor, or factor of safety, in the original design of the system to insure adequate illumination when the system has depreciated a normal amount. (2) The cleaning of lighting units at frequent regular intervals. (3) The replacement of lamps which have become blackened in service by abnormally long life. (4) The use of lamps of the correct voltage rating for all replacements. (5) The refinishing of ceilings and walls at reasonable intervals.

How large an amount should be added to the intensity considered adequate, or, what amounts to the same thing, by how large a factor the intensity considered adequate should be multiplied to insure proper illumination at all times, depends upon the specific conditions surrounding any particular installation. In general, when installed in relatively favorable locations, open-reflector units show a depreciation which ranges from 10 to 25 per cent in four weeks time. Where excessive smoke and dust are the rule, the depreciation over the same period may be as high as 40 per cent. The depreciation of ceilings and walls depends not only upon the characteristics of the location—i.e., whether clean or dirty—but upon their original color as well.

USE OF THE FOOT-CANDLE METER

A device has recently been developed which will be found extremely useful in the proper maintenance of a lighting installation. This device is known as a foot-candle meter, for it measures the illumination at the work directly in terms of foot-candles. The instrument is shown in Fig. 5. With it the illumination can be read directly from the scale without computations or adjustments. In one large establishment where the superintendent uses a foot-candle meter systematically as a check on his maintenance department, readings of illumination intensity are taken at regular intervals at fixed stations throughout the plant. These readings are recorded in such a way that the successive readings are readily comparable. When any inconsistency appears in the records, an investigation is made and the proper remedy applied. The illumination in the offices



FIG. 6. CHEMICAL LABORATORY ILLUMINATED BY MEANS OF BOWL ENAMELED LAMPS IN DOME STEEL REFLECTORS, HAVING AN UPPER SECTION OF GLASS TO SUPPLY LIGHT TO SIDE WALLS AND CEILING

and important work places of this establishment is never allowed to fall below 6 foot-candles without immediate correction. By measuring light actually delivered to the work, the foot-candle meter automatically reveals the combined effect of all possible causes of depreciation.

Ignorance of the magnitude of the depreciation which follows the neglect of a lighting system has been responsible for the expenditure of many kilowatt-hours without adequate return. In other words, light saves accident and waste, but light itself, too often, is wasted.

Nela Park, Cleveland, Ohio.

Eliminating Manufacturing Wastes With Machinery

A Recognition of the Importance of Engineering Research and the Extensive Use of Automatic Machinery as a Means of Eliminating Wastes in Labor, Time and Materials—"Watchful Waiting" Policy Must Be Changed to An Offensive One

BY J. E. HIRES

President, Automatic Machinery & Equipment Co.

A STUDY of the development of the use of automatic machinery in manufacturing plants reveals a tremendous revolution in methods and processes in the last century that can be outstripped only by the still further improvement which inevitably must come in the next. From the invention of the cotton gin, to which all of our schoolday American histories point as the beginning of modern industrial methods, to the present-day slogan of many of our food manufacturers—"Not touched by human hands"—there lies in every industry a trail of obsolete machinery and equipment that has furnished many a meal for the scavenger of our manufacturing plants—the junk dealer. In some instances, so quickly have improved machines been produced and so ruthless has been the law of price based on competitive cost that new machines have superseded equipment almost new, but obsolete.

ATTITUDE OF THE MANUFACTURER

One reason perhaps for this very condition has been the failure of the manufacturer to grasp the importance of engineering research toward the improvement of his methods. Too often he has waited for an outsider to build a machine for his business and then been forced to adopt it, after it had already been sold to his competitor, in order to enable him to stay in the business. From an improvement standpoint he has adopted the "watchful waiting" policy, with the result that better machinery has been forced on him as a defensive measure, rather than being developed and patented by him for the benefit of his own business.

This, perhaps, is too severe an arraignment of the managerial ability of our country to pass over without some comment on the other side. It is true that the average manufacturer has found his hands so full in producing his own goods that he has had neither the time nor the capital to spend in building machinery for the production of those goods. It is also true in times such as the "cost-plus war period" just passed that the manufacturer has been more concerned with immediate results than with the building of machinery that will save something six months hence. But in times of depression, such as the present, every avenue of cutting costs must be followed out, and incidentally in nine times out of ten the machinery which is designed and built for the purpose of cutting costs has the added advantage of greatly increasing the capacity for production during the busier days ahead.

LACK OF DESIGNING AND ENGINEERING STAFF

Another big handicap in the manufacturer's path has been the lack of the expert designing and engineering staff which is required to build the needed machinery. He may have and often does have mechanics of ordinary

ability, with good ideas as to how certain processes could be done to better advantage, but they do not have the broad experience in the designing and building of automatic equipment which will bring those ideas into actualities. Furthermore, he cannot find in the average machine shop, that does a general repair and "build-to-specifications" business, the caliber of men who can solve his problems.

CO-OPERATION IN DEVELOPING MACHINERY

The designing and building of automatic machinery is in a way a business in itself, and yet it is a business which must be closely linked up with that of the manufacturer whom it serves. This must be the case for two reasons:

First, the manufacturer must be assured that he will receive the benefit in the way of "patent rights" of any machinery built for him, because after all he or his men will contribute many of the ideas embodied in the final machine. He will give, in other words, the intimate knowledge of the requirements of the business and the idea of what is to be accomplished, while the designer and builder of the machinery, acting in the capacity of consulting engineer, brings to the problem the technical knowledge and skill required to solve it and the broad experience in the construction of similar equipment in many other lines. There is undoubtedly a timidity among some manufacturers toward allowing anyone from an outside company to become acquainted closely with the manufacturing processes in their plants. There is, perhaps, a feeling that their methods are to some extent secret and a fear that ideas gained by an outsider may be carried to competitors in the same line. However, this is not the case in dealing with a reputable company, which is making a specialty of just this kind of business and whose whole business naturally rests upon its careful guarding of its client's interests.

Second, it is only in this manner that the average manufacturer can reasonably approach such a problem. He cannot afford to hire the men or purchase the equipment to design and build his own machinery. The volume of his work would not justify the expense, for men who can do this work cannot be hired at ordinary mechanics wages and some of the equipment required will not be found in the ordinary machine shop. And yet it must not be thought that there is anything mysterious in the perfecting of labor-saving machinery. There is nothing in the business of equipment designing and construction akin to the popular conception of the inventor, producing through divine inspiration or black magic a completely new world wonder. On the contrary, the rules of the business are as simple, the methods as direct, and the results as sure as that of any

other business. Whatever is accomplished is based on something already accomplished. Very often the most valuable work of a consulting engineer in this capacity is simply improvements on present machines, and furthermore many of apparently the most wonderful new machines are based on other machines that have failed. It is simply a question of remedying a defect here or adding an improvement there, which turns failure into success and changes a junk heap into a machine "that almost seems intelligent."

SAVING IN LABOR, CAPITAL AND OVERHEAD

There are certain underlying principles which govern the use of machinery that apply to any manufacturing plant, whether it is making thumb tacks or caramels. These are certain points for which the consulting engineer looks when he enters a plant. The most common idea of automatic machinery is that it is a labor-saver, and it is possible that the greatest saving lies in that direction, although in many cases an even larger saving may be made in materials. For instance, a sirup-filling machine was constructed primarily with the idea of replacing six girls filling by hand with one man operating the machine. The saving made in labor was perhaps \$15 per day per machine. But the greatest saving of the machine was in the elimination of waste due to overfilling and underfilling by the hand method. Shortfills were eliminated and instead of cans going out with one-half ounce too much sirup in them, the net weight could be accurately adjusted by the filling machine to within three one-hundredths of an ounce. Figuring one machine turning out 60,000 cans per day, this meant a saving of 30,000 oz. of sirup, or 1,875 lb., valued in this instance at 10c. per lb., or \$187.50 per day saving. Very often, too, there is a considerable saving in capital as well as operating expenses.

The substitution of mechanical for hand labor invariably means greater production in less floor space. It may mean the dropping of plans for additional buildings which were considered necessary in order to increase production, for in any case where hand labor is used increased production is obtained only by more help, and more help means more room, more boilers, more rest rooms, more office force to handle the larger payrolls, or, in general, more overhead. Another tremendous source of saving is in the elimination of carrying skilled employees over periods of depression in business, simply because they have become so necessary that they must be retained until business picks up. In many industries hand labor is used in processes where it requires months or even years of apprenticeship before an employee becomes efficient. If these employees are discharged in a time of depression the loss to the business in starting up again is often greater than the loss of paying the employees during the idle period.

CONTINUOUS MANUFACTURING OPERATIONS

One of the most common sources of inefficient operation in the manufacturing plant is the lack of continuity in the process. The product starts in one department and has something done to it. It is put down, picked up and trucked to the next department, where something else happens to it, and so on through all the departments of the plant. It may spend days, weeks or months in its journey through the plant, sidetracked at some junction point, just as our freight cars were sidetracked when a troop train went through, and each time it is sidetracked it is put down and picked up again.

Many machines which are not continuous in their operation can be found in plants where the speed of production is determined altogether by the operator who sets the machine in motion and stops it at each operation, and very often with some comparatively slight adjustment those machines can be made to operate continuously and be fed automatically, so that their production is predetermined and not dependent on the personal feeling of the operator. The ideal operation of the plant is a continuous one, from the receipt of the raw material to the loading of the finished product into the freight car, without stopping at any stations en route, where the track might be blocked by an accumulation of stock from the shipment ahead that for one reason or another did not get out on time. This means, of course, the careful co-ordination of the work of different departments. It means the reducing to a common denominator—or, perhaps better, the increasing to a common denominator—of the speed of the process in each department and the installation of carefully planned conveying equipment, which will keep the product moving continuously from process to process at the right time throughout the plant.

USE OF AUTOMATIC EQUIPMENT

Generally speaking, there are certain processes in almost every plant which can be handled automatically, and the perfecting of the equipment to handle them is usually confined to modifying existent plans, so as to meet the special requirements of the individual product. For instance, the filling of liquids into cans or bottles can be accomplished continuously on the rotary principle. The size of container to be filled, the density and viscosity of the product to be filled, all will have a decided bearing on the details of the machine. It is true that if the liquid to be filled is a food product, some special precautions from a sanitary standpoint will have to be taken in the construction of the machine that would not apply if the liquid to be filled were paint or oil, but, again, that is a detail which will not alter the general principle. Similarly the labeling, wrapping and packing of goods, and the conveying of goods in process and finished product can all be accomplished automatically regardless of whether the product is olive oil or soap, camera films or patent medicines, with due allowance being made for the difference in size, shape and weight of the particular packages to be handled.

INTERESTING INDUSTRIAL APPLICATIONS

It is interesting to note some of the particular applications in modern industry. There is the nailing machine for example, which at one stroke makes a completed box as fast as a man can drive a single nail. There is the automatic ticket printing machine, which has taken the printing of theater tickets out of the hands of the local job printer, because he could not compete at twice the price with the automatic machine. In this instance an immense business has been built up based on the patent rights of one machine, that proved such a labor-saver that no other printing establishment was able to compete in its particular field.

There are sealing machines for canning factories that seal a hundred cans per minute and eliminate the labor of fifty operators soldering by hand. Forty per cent of the cost of manufacturing calendars today is in the hand labor required to collate the sheets after they are printed. A machine is now in process of development which will collate these sheets and pad them at

the rate of five hundred per minute. Moreover, the application of such machinery is not confined entirely to hand labor. Frequently it is possible to replace clerical labor by machines, such as coin counters and automatic weighing and measuring machines. There is a machine in the hide and leather industry which automatically measures the surface of a hide, of however irregular proportions it may be. So one might continue endlessly pointing out the saving of time and materials, the increase in productive capacity and the elimination of the labor problem in industry after industry that has been accomplished by the introduction of automatic machinery.

RECOGNITION OF ENGINEERING RESEARCH

The function of this article, however, is to point out the possibilities of improvement through the more extensive use of machinery and to define a reasonable policy which the average manufacturer might profitably follow in order, first, to protect himself against the possible loss of his business through his competitor producing more efficiently and underselling him, and second, to insure to himself the benefits to be derived from the patent rights of new inventions which are constantly being evolved in every line of business. To accomplish this purpose the "watchful waiting" policy must be changed for an offensive one, which starts with a budget for research engineering work and the recognition of the fact that money spent for experimental work in developing new methods and processes is a legitimate and in fact a very necessary part of modern economical production.

PAINSTAKING EFFORT AND EXPERIMENT APPRAISED BY ULTIMATE RESULTS

After the appropriation is set aside for this work, the next point to be realized is that the first machine built to do a given piece of work is going to cost probably three times as much as it ought to cost and three times as much as it will cost to produce identically the same machine after it has been perfected and all the plans and patterns are completed. In other words, the building of the first machine is experimental. Failures in different points will occur and must be overcome. Unexpected obstacles arise, so that the first machine will seem to cost an enormous sum compared with any other machine in the plant or even with identically the same machines which follow it. The excessive cost of that machine, however, must be considered as spread over the other machines that follow it and the money to pay that cost is to be repaid by the savings made by every one of those machines put into use. Automatic machinery cannot be produced out of thin air, or purchased to fill a given need at so much a ton. It requires painstaking experiment and effort and must be appraised in the final analysis, not by what it costs for the first machine, but by what it saves and by the advantage the patent rights give the manufacturer in enabling him to undersell his competitor.

If every manufacturer would take the attitude that the improvement of his methods of manufacture was as much a part of his business as the actual production of his goods and set aside an appropriation for this research engineering work, it is safe to say that in the long run no appropriation he makes will yield any better, surer returns.

Philadelphia, Pa.

Some Causes of Low Production

In the summary of the report of the Committee on Elimination of Waste in Industry (July, 1921), some of the causes of low production are grouped under: Faulty material control, faulty design control, faulty production control, lack of cost control, lack of research, faulty labor control and ineffective workmanship.

The average manufacturer has no calendar of operations except the dates of starting and finishing a job. He largely regulates deliveries of materials by visits to the job, or through statements received from the job superintendent. Haphazard methods of planning result in delays for want of material, or in burdening the job by an oversupply of material. Another waste resulting from inadequate control comes from the speculative purchasing of raw materials. Fortunes are made or lost in this practice.

The defective control of design results in a major waste, since it prevents standardization of product.

The lack of adequate methods of production control is evident in every industry. It is one of the outstanding weaknesses.

It is found that at least ten hours per week per man is thrown away on energy-wasting and time-wasting work resulting from lack of shop methods, while an additional two or three hours per man per week are wasted in unnecessary work. The lack of production control is not a question of large versus small plants. Some of the large plants as well as some small ones show a large waste factor.

The majority of the industrial plants studied lack a knowledge of costs and have no cost control. Therefore there is no adequate method of judging fairly and accurately when improvements are needed and when waste is occurring. This prevents prompt correction of defects.

While certain industries are ahead of the rest in plant research, the need for more intensive research activity is apparent in every industry.

The cancellation of orders is a condition peculiar to certain industries. Purchasers buying on long-time contracts return unsold goods at the end of the season, and claim and receive credit.

LABOR TURNOVER AND INEFFICIENT WORKMANSHIP

A high labor turnover is a rough index of one of the common wastes resulting from inadequate labor management. This is an important factor of labor waste because of its magnitude and because of the expense involved in training new workers to take the place of those who leave. Employment managers are rarely employed even upon the largest jobs, and "hiring and firing" is at the will of the foreman or superintendent. Another fault in labor control is improper or inadequate rate setting. If the rate is set too high, it means unequal payments to the workers or else cutting rates later on. This policy is responsible for much of the friction in industry.

Another loss resulting in low production arises from inefficient workmanship. For much of this management is responsible through failure to provide opportunities for education or special training. Management cannot, however, do more than provide these facilities, and experience has shown that it is difficult to interest workmen in training courses which are designed to increase effectiveness. Further, much ineffective workmanship arises from lack of interest in work or lack of pride in good workmanship.

Elimination of Waste in Industrial Power Plants

Shall an Industry Own Its Power Plant or Buy Its Power?—The Determining Factor
Is the Relation of Heating and Process Steam to Power Demand—
The What and Why of Fuel Economy

By DAVID MOFFAT MYERS
Consulting Engineer

IT IS an interesting fact, and one little realized, that the factory power plant possesses an enormous advantage in the production of economical power, an advantage entirely lacking in the modern central station of our "superpower" ideas. The fact may be very simply explained. The central or so-called "superpower" station has a single object to fulfill—i.e. to supply consumers with power and with power alone—whereas the natural and unavoidable product of every steam-power plant is not only power but heat as well. And furthermore, this product divides itself (again unavoidably) into about 20 parts of power and 80 parts of heat. These 80 parts of heat are absorbed by the cooling water of the condenser and wasted. The condenser's one object is to assist in converting the largest possible proportion of the heat of the steam into power and is necessary for this purpose. When a condenser is not used, 86 to 95 per cent of the heat is available in the exhaust for heating and about 4 to 12 per cent converted into mechanical energy.

This represents the best that can be done in actual practice in our effort for efficiency when power alone is the object sought. The waste of steam, heat and fuel to the condenser is in the average case four times as great as the useful energy produced. Natural laws have bound us to this narrow limitation, which may be only slightly improved as we learn how to construct steam power apparatus for still higher steam pressures and greater temperature ranges.

The central plant has no market for this heat, to produce which it has been compelled to consume four-fifths of its coal.

USE OF EXHAUST HEAT FOR HEATING PURPOSES

The usual industrial plant, on the other hand, has frequently a very large demand for heat as well as power. In many cases and in numerous kinds of manufacture all or the major part of this exhaust heat can be utilized for processes and for the heating of buildings. In the majority of industrial plants heat is needed for the plant during the cold months of the year. In all such industries all or a portion of the otherwise wasted heat which is a pure byproduct of their power generation can be effectively utilized to take the place of its equivalent of direct steam from the boilers. Thus, for example, in an industry where there exists a large demand for heating and process steam the economy of

the situation would be represented approximately by the following comparison:

Case 1. Combination power and byproduct heating. Five to 10 per cent of the heat of the steam converted into electrical energy to supply the power demands; 90 per cent or more for heating and process work; no steam wasted.

Case 2. Power and heat from separate sources, the former from a superpower plant, the latter from a boiler plant in the industrial establishment. The boiler plant will have to produce 90 per cent as much heat (steam) as in case 1, and at the same time it will be necessary to buy power which has been made with an 80 per cent waste of steam and is consequently proportionately expensive, since the consumer must pay for the 80 per cent waste of steam as well as for the power.

Each industrial plant has its own particular requirement for so much heat and so much power, but the more heat it requires the more cheaply can it make its own power as a byproduct of its heating and process steam. There are many plants which require little or no heat. Here power alone obtained at the lowest cost is required. Whether such an industry should own its plant or buy its power is purely a question of the engineering economies of the situation.

Modern central stations can produce power more economically than the small industrial power plant when power alone is wanted. The losses over long and costly transmission lines both electrical and financial must be considered, however, in the case of central station power.

THE FIELD FOR SUPERPOWER

Superpower as now conceived has its legitimate range of service and will find its appropriate and economical field of consumption in those industries, principally the medium and smaller sized plants, where the heating requirements are relatively small, and in some cases where capital might earn more when invested in factory extension for increase of production than in the building of a power plant. Then there are also many plants where the necessary heating may be largely accomplished by surplus heat from process furnaces, kilns, etc. In such the outside power may often be supplied with the best possible results.

From the standpoint of steam and fuel conservation, however, the operation of the superpower station as now planned is exactly comparable to that of an industry which throws away 80 per cent of its partly finished product. The directors of such an undertaking would not rest until some valuable market were found for turning this huge loss into profit. By the same logic a new conception is needed of what could more truly be termed superpower. Such a conception at once in-

¹"Superpower" as produced refers to a rather large extension and improvement of our existing system of electrically connected steam- and water-power plants along the north Atlantic seaboard. It is estimated that possibly 15 per cent may be water power. Congress some time ago appropriated funds for preparation of a report designed to show the cost of executing this plan and the economies which might result. The plan aims to supply efficiently made energy for general railroad and industrial consumption with the hope of eliminating many small power plants apparently less efficient and to reduce the coal carried by the railroads by transmitting the equivalent energy in the form of electric current.

volves the necessity of a market for the byproduct heat of the power plant, and this immediately presents a picture of what has already been accomplished together with a vision of further possibilities and economies. In many industries exhaust steam has been utilized to the fullest extent, with the consequently specific economy of byproduct utilization. There are many well-tried specific means and equipment, prime movers and heating systems for effective execution of such combination of heat and power. And these of course require engineering judgment and experience in their correct selection and arrangement. The point is that such truly efficient plants have for long been a proved and accomplished fact.

IMPROVE CENTRAL POWER STATIONS

The next step is to improve our central power stations along the same general lines as far as possible. In large cities the stations now selling power only should revise their policies toward real fuel conservation and plan for the development of combined heat and power systems so as to furnish both commodities to present consumers. Isolated cases have already been reported and in one case the income to the central station from the sale of heat alone paid for the cost of its power production. The block system of central heat and power plants should be further developed. If modern heat and power stations could be built near large industries requiring both heat and power, great economies in steam and fuel would be effected.

ELIMINATION OF WASTE IN RELATION TO POWER

It has been stated previously that superpower talk is in the air, and every factory owner and manager is concerned with its relations to his own power problem. I have therefore introduced my subject by presenting a few fundamental facts which may assist to some extent in a clearer understanding of how this power is produced and how it may or may not economically apply as a source of industrial power in any particular case, each of which must be skillfully diagnosed on its individual merits and in accordance with its local conditions.

While it is quite logical and often appropriate to begin a discussion of power plant economy with the fuel supply, the boiler plant and its generation of steam, then the distribution and various applications of the steam, I have elected a different order of treatment in this case and for this reason: In the industrial power problem both from the standpoint of operation and of design, which includes the question of purchased power, the determining factor is almost always this element of heating and process steam in relation to power demand. I am therefore placing this determining factor first with the object of getting for it the emphasis to which it is properly entitled.

It is an economic blunder of the first magnitude to use direct steam for heating or process work without first deriving from that steam its quota of mechanical or electrical energy, when such application is available. And conversely it is equally poor engineering and bad business to use steam for power generation alone when it is possible to utilize the large percentage of byproduct exhaust heat for manufacturing processes or for heating buildings.

I very often find prevailing among owners and managers the idea that low-pressure steam can be made

much more cheaply than high-pressure steam, and they therefore feel that if they could eliminate their engines and turbines and make low-pressure live steam for heating instead of using exhaust from engines a great saving in fuel would be effected. As a matter of fact, at the same boiler and furnace efficiency exactly the same amount of fuel is required to supply the same quantity of heat whether the steam is at 1-lb. pressure, at 100 lb., or any other pressure. The only gain possible might be 1 to 3 per cent better boiler efficiency due to lower flue temperatures made possible by lower steam and boiler temperature.

It was formerly thought impracticable to use exhaust steam except at very low pressures. Ten- to 30-lb. pressures are now rather common. And as I write I have in mind a large rubber-manufacturing plant where a 10,000-kw. non-condensing turbine is being installed to take steam at 250-lb. pressure and exhaust into vulcanizers at 80- to 100-lb. pressure. The electrical energy so generated will be virtually a byproduct of the direct steam formerly used by the same vulcanizers as far as fuel is concerned, and its total cost per kilowatt-hour will be a very small fraction of the cost at the plant of energy delivered from a modern and efficient power station located directly at the mouth of a coal mine only ninety miles away.

Where all the exhaust steam can be used, a common old-fashioned slide valve engine will produce byproduct power in a factory for a fraction of the fuel required for the same power made by a modern steam plant operated condensing.

EXTRACTION TYPE OF STEAM TURBINE USEFUL

Where all of the exhaust steam cannot be used all of the time, the extraction type of steam turbine may often furnish the solution. This turbine, which operates condensing, is designed so that exhaust steam can be drawn from between the high- and low-pressure stages after doing work and producing electrical energy through the higher range of expansion. When less exhaust or extraction steam is needed, the surplus automatically passes on through the low-pressure stages of the turbine to develop more electrical energy and permits the throttle to cut down the use of the equivalent live steam from the boilers. In this way a steam balance is maintained for all combinations of heat and energy demand. There are several other methods of producing this desirable balance of heat and power without waste of exhaust steam, which can be applied in accordance with conditions and requirements.

There is also the mixed pressure type of turbo-generator. This operates condensing on low-pressure steam with provision for automatically receiving direct steam from the boilers in case the imposed load and available exhaust so require. Thus in case there exists in a plant a surplus of exhaust steam for which there is no heating demand this exhaust steam can be made to produce electrical energy.

The distribution and application of the heat of exhaust steam have become very efficient with the development of modern methods and equipment. Among these should be mentioned the vacuum return line system of low-pressure heating; the forced hot water system of circulation; automatic thermostatic control and the improved methods of air conditioning, ventilation and drying.

Having now touched with some emphasis upon the "determining factor" (the relation of heat to power)

in the economy of industrial power supply, the matter of next importance is the boiler plant.

Economy is the product of two elements—design and operation. The final efficiency is equal to the efficiency of the equipment multiplied by the efficiency of the management; or the efficiency of the machine times the efficiency of the brain; the machine multiplied by the man behind it. This means that you can, without redesigning your old plant, very considerably improve its efficiency and economy, unless your plant happens to be one out of a thousand, which a thousand to one it is not. This is the principle upon which the Fuel Engineering Section of the U. S. Fuel Administration was based during the war, and it resulted in saving 25,000,000 tons of coal annually by improvement of operation without change of equipment. This saving would have been doubled if there had been time to perfect the organization and fully extend the work.

USE OF "WHAT INSTRUMENTS"

The first step is to make sure you are getting the best possible results from the equipment you already have. You should have the means of knowing every day the results you are getting. The essential figure you need to know is equivalent evaporation per pound of coal. The obtaining of this information involves the continuous measurement of weight of feed water or steam, weight of coal and feed water temperature and steam pressure. These together with occasional B.t.u. determinations of the coal used, will enable you to know the efficiency of your plant and how it compares with standard efficiencies for your kind of coal and equipment. These instruments tell what results you are getting, and may be termed the "what instruments."

USE OF "WHY INSTRUMENTS"

Then when you find your results are too low, you will want to know why, so that you will be enabled to correct the preventable waste discovered. The determination of the causes of the waste is made by another class of instruments, which should be known as the "why instruments." In this class belong flue gas analysis apparatus and flue pyrometers which will check the one greatest loss in most boiler plants—the "dry gas chimney loss"—and the pyrometer will also indicate losses due to short-circuiting of gases and leaky baffles. Draft gages are also "why instruments." It will pay good dividends to apply a plastic airtight coating to the outside surface of all brick set boilers to stop air leakage, and be sure that all clean-cut doors and their frames receive due attention as well as header and other connections where air leaks are likely to occur. I have found in a "good" plant as much air leaking through the settings as was passing through the grates.

HOW MEASURING INSTRUMENTS PAY

Good judgment is required in selection of boiler plant instruments so that reliable records may be obtained. The records must be reduced to utmost simplicity without omitting essentials. The instruments must be chosen with regard to size of plant and human equipment, so that they will not cause an undue burden on the operating staff.

In one small plant where I recommended a very simple form of coal and water records alone, the evaporation was increased from 6 to 9 lb. per pound of coal and the equipment was paid for in about two months by the saving in fuel.

In another plant where the coal and water were already under measurement, continuous CO₂ recorders ("why instruments") were installed and resulted in additional savings which paid for the investment in three months. These instruments were used in conjunction with a simple bonus system for the firemen and shared by the engineer whose duty it was to keep the recorders in perfect order.

In the average factory plant very large savings can be made simply by operating the boiler plant on a production basis on the same principles which are always applied to the other departments of the business. The investment possibilities of so doing are very great; so great that it can be laid down as a definite, inflexible rule that every boiler plant should be placed under a suitable system of continuous records and observation. Ten per cent of the fuel consumption is a very conservative estimate of the resulting economy which follows such a plan when intelligently applied. This statement is based on experience in many plants of great variety. A simple change in the method of handling the fires often results in saving thousands of dollars a year in fuel. The need for such a change would not be discovered unless the "what measurements" and the "why instruments" showed the corrections to be applied. A quarter of your coal bill may be wasted or saved merely by the method of operating employed, without regard to the design of your plant.

RULES FOR FUEL ECONOMY OPERATION

A few simple rules for fuel economy operation follow:

1. Maintain your equipment in first-class condition.
2. Keep the boilers clean, inside and out. This means free from scale and sediment inside and free from soot and dust outside the heating surface.
3. Keep soot from obstructing draft passages in breeching and chimney.
4. Employ instruments to know what results you are getting and why. Multiply these records and observations by your brains. In other words, make use of them.
5. Buy some brains and training, as well as brawn for your fire room. They cost more and they are worth more. They always pay good dividends. If I were allowed but a single recommendation, that one would be my choice. If you follow it, you will rejoice in good combustion with the savings consequent thereto, and many other economical blessings.
6. All surfaces wasting heat by radiation, such as steam piping, steam drums, feed-water heaters and other equipment, should be kept properly covered with high-grade insulating material. In one small plant \$3,000 per year could be saved in this way. Insulation always pays good dividends.
7. See that the feed-water is heated by exhaust steam. There is 1 per cent economy in every 10 to 11 degrees rise in the temperature of the feed-water when so heated.
8. Steam-consuming apparatus must, of course, be kept in prime order, but of course it is not always done. Thousands of tons of fuel are wasted through leaky and badly set engine and pump valves, to say nothing of leaky pistons and rings; then there are also leaks in steam piping and waste through badly operating steam traps and high-pressure drips. These things are so simple that one hesitates to record them, but the waste of fuel through these simple and foolish channels is so great that a good operating engineer can frequently make a reputation by correcting them. Be sure you have a good operating engineer and don't skimp on his salary. He will earn it many times over.

ACTUAL EXAMPLES OF LARGE DIVIDENDS

I shall leave the rest of this story with him and shall now proceed to a story or two of what is accomplished when good operating and good designing are joined to-

gether as one. Although these stories are from my own experience, they can be duplicated from the note book of many a contemporary.

First there was the case of a steel company where \$50,000 investment in better stokers, automatic coal scales and a little system of records returned \$60,000 per year in fuel savings, or 120 per cent interest on the "securities" purchased.

One of the largest rubber companies in which furnace improvements, new chimneys, a boiler water softener and plant recording instruments with a system produced a saving of \$850,000 a year for an investment of \$683,000, or an interest return of 124 per cent.

In a woolen mill, a small one, where the heating had been done by direct steam from the boilers and the power supply was partly from its own compound condensing engine and partly from purchased current, a saving of \$8,000 per year in the cost of current was made with an investment of \$5,000, or a return of 160 per cent. This was accomplished by placing a non-condensing unit between the boilers and the heating system to supply the latter with exhaust steam in place of direct steam and deriving from this engine-unit by-product power to replace the purchased power.

In a large wire mill a large saving was made by purchasing power at a low rate instead of extending and improving the power plant. The saving was chiefly due to the fact that the owner was able in this case to get a quicker return on capital invested in the expansion of his production facilities than could be obtained by investing in power plant extension.

LARGE DIVIDENDS FROM IMPROVED METHODS

In another plant it was found by the preliminary study and investigation that an economy of \$40,000 could be made in fuel and operating expenses by spending \$148,000 on the remodelling of the existing plant which included provision for doubling the power output and for additional steam capacity. This work included a change in the kind of coal to one giving a greater quantity of heat per dollar delivered, the installation of suitable automatic stokers, labor-reducing coal-handling equipment, overhead feeder bunkers, automatic individual coal scales and feed-water measurement; the installation of an extraction type steam turbine unit to handle the power and heating demand in the most efficient manner, and improvements in electric power and distribution. The turbine was designed not only as an extraction machine but also to receive and convert into electrical energy any surplus exhaust steam available in the summer months.

In another plant manufacturing a variety of standard articles an opportunity was found to produce an operating saving of \$260,000 annually by the expenditure of \$250,000. A large factor of this economy was the fullest application of exhaust steam to building and process heating, thus reducing the combined cost of heat and power to a minimum.

It must of course be realized that it is impossible to treat with any pretense of thoroughness so great a subject as the Elimination of Waste in Industrial Power Plants in the very limited space here afforded. It is hoped, however, that the few suggestions I have attempted to indicate will assist to some extent in stimulating the kind of productive thought that precedes action.

New York, N. Y.

Estimated Savings With Superpower Central Stations

At the meeting of the Worcester Section of the American Institute of Electrical Engineers, Feb. 2, 1921, Henry Flood, engineer-secretary of the Superpower Survey, in speaking about What Superpower Means to the North Atlantic Seaboard, quoted a few figures which may best cover the potentiality of superpower central stations.

Nearly 40 per cent of the total value of manufactured products in the United States come from the north Atlantic seaboard region, and 35 per cent of the country's power is generated there.

This industrial supremacy can easily be visualized from the fact that one out of every eight persons living therein is an industrial worker, while for the remainder of the country there is only one out of every twenty-five persons so employed. New England is even more intensely developed from the industrial viewpoint, as one out of every 6.4 persons is a wage earner in its factories.

As great as are the power requirements of the region today, they are small compared with those of tomorrow.

The unassociated total power requirements have increased from about 15,000,000,000 kw.-hr. in 1910 to about 27,000,000,000 kw.-hr. in 1920, with a corresponding increase in machine capacity from 8,600,000 kw. to approximately 14,800,000 kw.

ESTIMATED GROWTH OF ENERGY REQUIREMENTS

It is estimated that the power growth for the next decade will increase the total energy requirement to about 50,000,000,000 kw.-hr., and assuming the superpower to be in operation, about 18,700,000 kw. of machine capacity will be required to satisfy this load increase.

Electric public utilities furnished in 1920 about 12,000,000,000 kw.-hr. with a machine capacity of 4,000,000 kw., and it is predicted that by superpower operation the power to be furnished from central supply sources will grow to about 36,000,000,000 kw.-hr. by 1930 and will require a machine capacity in the neighborhood of 9,000,000 kw.

These estimates, which are conservative, call for 5,000,000 kw. additional power-plant capacity in the central supply systems during the next ten years, an increase of 125 per cent over the power plant capacity now in existence.

In the manufacturing industry the estimated power requirement of 1920 has been placed at 12,400,000,000 kw.-hr., and it is estimated that the central-station systems supplied about 2,750,000,000 kw.-hr. of this total requirement. By 1930 it is conservatively estimated that the total power load of manufacturing industry will increase to about 19,000,000,000 kw.-hr. and that superpower can economically furnish at least 10,000,000,000 kw.-hr., or slightly over 50 per cent of the total.

Had superpower been in operation in 1920 a saving of about 30,000,000 tons of coal having a value of about \$162,000,000 could have been effected through its economies over the present performance of central stations, steam locomotives and isolated manufacturing plants, and by 1930 the superpower system should effect a saving of 53,000,000 tons per annum, with a value of \$286,200,000 when compared with present practice.

The Patent Situation

Inadequate Salaries and Insufficient Personnel Are the Causes of Waste in the Patent Office for Which Industry Must Pay in Costly Delays and Burdensome Litigation—Analysis of Legislation Designed to Remedy the Situation

By EDWIN J. PRINDLE

Chairman Patent Committee of the American Chemical Society

OUR patent system is of the first importance to the industrial prosperity of our country; but, until comparatively recently, it has worked so steadily and unobtrusively that the American public has come to be almost as unconscious of it as of the force of gravitation. The interruption of the patent system would be almost as disastrous to our successful competition with the rest of the world in manufacturing, agriculture and inventing as would be that of the law of gravitation to our physical lives.

The public has been apt unconsciously to think that inventions would be produced at the same rate whether or not there were a patent system and that our patent law simply imposed an unnecessary taxation, not realizing that if it were not for the inducements held out by the patent law the articles whose prices are objected to would not be produced at all.

SALARIES ARE UNATTRACTIVE TO QUALIFIED EXAMINERS

This attitude on the part of the public has so far affected Congress that, although the Patent Office is the only self-supporting bureau under the Government, its examiners are not even paid as well as scientific and legal employees in other bureaus which are not self-supporting. For instance, the salaries of the primary examiners of the Patent Office were fixed in 1848 at \$2,500 per annum, which was one-half of the salary of the Chief Justice of the United States and was substantially equal to the salaries then paid United States District Judges and members of the House of Representatives.

In the seventy years since that date the examiners' salaries have been raised but 10 per cent, while the other salaries mentioned have been raised 300 per cent and more.

As the practice of patent law outside of the Patent Office is a profitable profession, the Patent Office became very largely a training school for patent lawyers, who left it as soon as they felt properly equipped for outside work.

There has been a class of examiners who would prefer life in the Patent Office, with its dignity and security, if the salaries were anywhere near adequate, even though the salaries and profits in the practice of patent law outside of the Patent Office would be much larger. The gradual rise in the cost of living being greatly increased by the war, it became not only impossible for many examiners to exist upon the salaries paid in the Patent Office, so that they have been resigning at the rate of 25 per cent of the total force per annum, but it also made the Patent Office positions so unattractive that it has been impossible to induce sufficient men who have the proper educational qualifications to take the examinations to fill the positions. It has therefore been necessary to appoint unqualified persons as examiners,

and there is now a considerable percentage of unqualified persons filling those positions. More than 10 per cent of those now performing the duties of examiners in the Patent Office have not been able to pass the qualifying examination.

EXAMINER'S DUTIES ARE OF UNUSUAL IMPORTANCE

The war has taught the nations involved in it to be efficient as they have never been before, and a number of them have been improving and strengthening their patent systems. Our patent system has shown by its wonderfully successful operation that in its fundamental principles it is the best patent system in the world, but it did not begin to be so supremely successful until we adopted the principle of granting patents not only exclusively to those who were the original and first inventors of the inventions in question, but also only for those inventions which were not known to the American public nor, broadly speaking, accessible to them through the patents or publications of other countries.

It is chiefly for the determination of these two questions that the Patent Office exists. That determination requires that the examiners shall be thoroughly versed in patent law, and they should also be well versed in law in general. It also requires that the examiners should have a deep historical, theoretical and practical knowledge of the classes of inventions under their jurisdiction. They should be able to comprehend and analyze the fundamental principles underlying an invention. They should also be capable of seeing whether similarities or differences between previously known or rival inventions are matters of substance or only matters of form, and of distinguishing between differences which, although comparatively slight, are yet of substantial commercial and inventive importance and those differences which, on paper, may seem to be considerable, but really are unworthy of a patent.

They must either know or be capable of finding out and understanding the law which is applicable to the particular state of facts before them or, as is occasionally the case, they must make new law by applying the basic principles to a state of facts which has no parallel in the recorded decisions. Examiners often pass upon inventions which are of very large importance to their inventors and of much greater importance to the public, and such large interests should only be intrusted to the best qualified men who can possibly be obtained by any reasonable salaries.

PATENTS SHOULD BE GRANTED WITH REASONABLE PROMPTNESS

The situation of the Patent Office has become desperate. The volume of work has increased very rapidly year by year for a considerable time, and the field of search necessary to be covered to determine the ques-

tion of validity has become broader and broader. However, the number of examiners has been increased only to a proportionately slight extent, the examining corps, as a whole, all the while having been weakened by the changes in it before mentioned. The result is that the Patent Office has become more and more unable to keep the quality of its work up to its former high standard, and it has also fallen farther and farther behind in turning out its work. In many cases unless a patent is granted with reasonable promptness, it might as well never have been granted, so far as the inventor is concerned, for the opportunity of disposing of it or of putting the invention on the market will have passed.

INVALID PATENTS ARE LOSSES TO GOVERNMENT AND INDUSTRY

Moreover, the effort to keep from being submerged by the constantly rising flood of work has made it more difficult for examiners to make their searches thorough enough to determine whether the inventions are novel or not. The result is that patents which are partly or wholly invalid are being granted with increasing frequency. This is a very serious matter. An invalid patent means loss to the inventor and others who invest under it, and it may mean a very burdensome expense in litigation to one accused of infringing it and to the Government through taking up the time of the courts. These avoidable delays and defects in the Patent Office work tend strongly to discourage the production of inventions, and if they are allowed to continue and increase, the Patent Office will practically cease to function. Without considering the loss to individuals, which is serious, the loss to the American public would be incalculable if the Patent Office is permitted to become further impaired.

While it is not generally realized, it is nevertheless a fact that there is no one activity of our Government which is more important than the maintenance of the patent system. It has made us the most inventive of nations and enabled us to maintain the foremost position in manufacture and agriculture. Our unusual inventiveness is due almost wholly to our patent system; for Americans, being Europeans by extraction or immigration, are no more inventive naturally than the people of the nations with which we compete.

LAMPERT PATENT OFFICE BILL

In an effort to remedy this situation, the National Research Council appointed a committee at the request of the Patent Office, which, after investigation, formulated and obtained the introduction into Congress of a bill very moderately increasing the salaries and numbers of examiners and the clerical force of the Patent Office. The salary which the bill proposed for a primary examiner was but \$3,900 per year.

This bill received the support of the American Chemical Society, the Federated American Engineering Societies, the National Association of Manufacturers and many other organizations. In fact, the scientific, engineering and manufacturing societies and interests of the country were practically a unit in favor of the bill.

The bill passed the House of Representatives and would have passed the Senate but for the fact that an unrelated section, known as the Federal Trade Commission section, was introduced into the bill by amendment in the Senate, and opposition to that section pre-

vented the passage of the bill. In the present Congress, the bill has been re-introduced as the Lampert Patent Office bill, H.R. 7077. A favorable report upon it was unanimously voted by the Patent Committee of the House of Representatives, and the bill would apparently pass the House if it could be brought to a vote. The policy of retrenchment is understood to be preventing such action, the Government not realizing that the net effect of the Patent Office bill not only will not increase the expenses of the Government, but, on the contrary, will increase the income of the Government. Not only will the increases in salaries provided by the bill be paid out of the increased fees which the bill provides shall be charged for patents, but restoring the Patent Office to normal and efficient operation will result in the production of wealth in the form of inventions that will provide incomes affording taxes that will substantially increase the income of the Government.

NOLAN TREATY PATENT BILL

The Nolan treaty patent bill was passed in February, 1921, in response to an emergency resulting from the war. Under existing treaty provisions and our law, an inventor is given one year, after filing an application for patent in his own country, within which to file applications in treaty countries, with the same legal effect as to priority over other inventors as if his applications had all been filed simultaneously. In case of a contest with another inventor in one of the countries foreign to the applicant, the inventor is given the same benefit of priority as he would have had if all the applications for the patent had been filed simultaneously.

During the war many inventors in the countries foreign to the United States were unable to take advantage of such treaty provisions, and many American inventors failed to file applications for patents abroad, because they were in war service or because they did not know whether the outcome of the war would make foreign patents worthless and they likewise failed to pay annual taxes on their patents. The European countries extended the time within which applications could be filed or fees paid and our Government passed the Nolan treaty patent bill in order to reciprocate. If such bill had not been passed, the European countries would have invalidated applications for patents and payment of fees which they had accepted from American inventors in the expectation that such a bill would be passed here.

The bill protects American inventors and manufacturers to the extent that it reserves a license under any patents granted or validated by reason of such act to any American citizen who, before the passage of the bill, was *bona fide* in possession of any rights in patents or applications for patents which might conflict with any of the patents applied for by aliens, and the bill also preserves to any citizen of the United States, his agent or successor in business the right to continue any manufacture, use or sale commenced before the passage of such act by such citizens, even though such manufacture, use or sale might infringe a patent granted or validated by the said bill.

STANLEY COMPULSORY WORKING AND LICENSE BILL

The Secretary of War found that a considerable number of war inventions made in this country were being patented by others than their real inventors and the patents assigned to the Krupps in Germany. He therefore caused the Stanley bill to be introduced in Con-

gress to prevent aliens from patenting inventions here and then using those patents to enjoin the manufacture of the inventions in this country. The preventive measure is a condition to be inserted in the grant of all patents to aliens to the effect that any patents issued to persons who are not citizens of the United States shall be worked in this country within two years from the date of issue under penalty of having licenses granted under them by our Government to others who wish to work them in this country.

I believe that the bill is of doubtful efficacy to accomplish its purpose and is extremely unwise when considered in all its reactions. If an invention—and particularly a chemical one—were important enough for the Germans to want to prevent manufacture in this country, it would be worth their while themselves to manufacture here sufficiently to prevent the granting of licenses. This would tend to bring about the German manufacture here which we tried so hard to eradicate during the war, under the name of “peaceful penetration.” If the invention were not one of sufficient value to make it worth while for the Germans to manufacture here, it would probably be one concerning which Americans would be indifferent as to whether it was manufactured or not. If the bill really hurt the Germans, then it would tend to induce them to keep secret all inventions which could be kept secret, and not to patent them. This course would deprive the American public of the knowledge of the inventions which they would derive from patents therefor and which they would be free to put in practice when the patents had expired.

OBJECTIONS TO THE STANLEY BILL

The Stanley bill would be in contravention to the Geneva International Convention, to which the United States is a party, as this convention provides that each country shall grant to the nationals of the other countries which are parties to it the same rights and privileges as they do to their own.

The enactment of the Stanley bill would undoubtedly result in the enactment of similar provisions in most or all of those countries which do not now require that American-owned patents shall be worked, so that Americans would be required to work most of their foreign patents. As there are many more American-owned foreign patents than foreign-owned American patents, the net result would be a disadvantage to our country.

In and out of Congress there is some sentiment in favor of applying a compulsory working requirement under penalty of having licenses granted to all United States patents without distinction as to whether they are granted to American or other inventors. If the Stanley bill were enacted in its present form, there is danger that it would be used as an entering wedge for such a general working requirement, and it is even possible that the present bill would be expanded for that purpose. I believe that such an amendment to our patent laws would be a catastrophe.

The test of the advisability of enacting the Stanley bill or any bill should be whether it will tend to increase or discourage the production of inventions, and if the advantage is not clearly in favor of such a bill it should not be enacted. It is dangerous to try experiments, for the common inventive faculty having been slowly developed through generations, it would take many years to restore it after it had become atrophied through disuse.

The following are some of the objections to a compulsory working requirement:

Many an invention which well fulfills its particular object is “ahead of its time” and is of no commercial value until the art and the commercial conditions with which it must co-act have grown up to it. This frequently does not take place until the later years of the patent, and of course may require many years longer than the monopoly of the patent. The cost of working an invention is almost always considerable—frequently very large—and if it were required that each patent should be worked within two years after issue, the working of such an invention would often be a total loss. Frequently the patentee would not be able to work it and would permit the patent to lose its salability, for a patent cannot usually be sold unless the complete monopoly, without any outstanding licenses, can be transferred. If, during the later years of the monopoly, it should appear that the patent would have been valuable if it had been worked, the inventor would be embittered by his needless loss, and many of those who would know of his experience would be deterred from inventing.

Any development to produce an invention goes through a course of evolution. Processes of manufacture and apparatus or machinery for that purpose frequently have to be invented. Auxiliary inventions often have to be made. Thus there is usually a group of patents that are necessary to protect the development and to prevent others from discovering and patenting some of the inventions in the group. Such a development frequently takes a number of years to reach a conclusion, and until that time it cannot be told whether there will be anything of sufficient value to be worth while putting on the market. Still, under the Stanley bill, it would be necessary to work each of these patents, which is in effect a fragment, within two years after its issuance, under penalty of having licenses granted to some competitor.

DISCRIMINATES AGAINST THE POOR INVENTOR

The Stanley bill discriminates between the rich and the poor inventor. The poor inventor would usually not be able to work his patent. Our patent system has been the door of opportunity, through which many men in the United States have risen from poverty to wealth. In so far as applying for and obtaining patents, in which there were no interference contests, and retaining the monopoly of those patents unimpaired, our patent system has heretofore treated all men alike. It should continue to do so.

The cost of working patents would greatly decrease their salability, for many corporations even would not buy a patent with such an expenditure attached as a certainty, and the purchaser would always pay much less for a patent carrying such a condition.

Many inventions which are patented under our system are of relatively small ingenuity, and often of no commercial value to their inventors, and yet, taken together in a single art, they occasionally lead the way to a point of view from which someone sees an opportunity to make a really important invention. These small inventions would not be made or patented if there were a general compulsory working requirement in effect in this country.

The compulsory working requirement in this and in other countries has not proved of substantial benefit.

New York City.

The Elimination of Waste in Marketing

Marketing From the Point of View of the Manufacturer Can Be Made More Profitable by the Application of Better Methods of Distribution and by the Establishment of Improved Selling Policies

BY WILLIAM R. BASSET

Miller, Franklin, Basset & Co., New York

WE ARE frequently told of commodities which double and treble in price between the producer and the consumer, the blame being laid on faulty methods of distribution. Careful thought is not commonly an activity of the publicity-seeking fault-finder nor of his eager readers, therefore it does not occur to most that the profits of a long string of middlemen and handlers cannot be tacked onto the ultimate price unless consumers want the product badly enough to pay the price. The buyer makes the price ultimately—not the seller. In normal times—which comprise about ninety years out of each century—the buyer will not pay the charges of middlemen unless those charges represent a service which the customer values more highly than the money it costs him. Ask any of the financially dead or dying middlemen who sprang up in nearly all trades between 1915 and 1920 if this is not so.

As a consumer, I of course acclaim any reform which reduces prices, but in my professional capacity I am more interested in seeing the profits of producers increase. And that is not incompatible with constantly reduced prices to buyers.

I shall therefore in this article discuss faulty marketing from the point of view of the manufacturer, to whom such wastes represent unnecessary deductions from his profits.

Right off, it occurs to us that manufacturers may be classified as those who do not do their own marketing and those who have some degree of control over their marketing.

INDUSTRIES IN WHICH MIDDLEMEN FLOURISH

The manufacturers who do not do their own marketing are generally those whose product is more or less staple, who sell an un-trademarked, unadvertised product in bulk through factors, brokers, wholesalers, speculators, or anyone with the price. It is in industries of this sort that middlemen flourish, for it is they who presumably furnish the knowledge of the consuming markets which the manufacturers lack.

Frankly, I have never been able to understand the mental process of a manufacturer who, while retaining but a narrow margin of profit himself, will trust his marketing—even his very existence—to the mercy of middlemen who have no object in safeguarding his affairs. The usual explanation which such men make is that they are skilled manufacturers but are not salesmen; that they prefer to leave the selling to others more skilled in it; that a selling organization is a nuisance and an expense; and that by dealing with a few large distributors they avoid the effort and risk of handling multitudinous small accounts; that, being relieved of all these details, they can give their entire attention to producing, at which they are skilled, and, by improved processes, make more money than they would gain by improved marketing. The trouble is that, failing an

individuality and reputation both for their business and for their product, they must compete practically on price alone, which keeps their margin of profit down, no matter how much they improve their methods. Their attitude suggests that they are, in fact, too lazy to study and master marketing technique.

However, every year a few of these old-established concerns reform and take over their marketing, and I believe that within a few years most of them will have joined the procession or have dropped out.

Ignorance of selling on the part of the members of the firm is not a valid excuse, for they can, if they wish, have their marketing problems solved by any one of dozens of advertising agencies which are highly skilled and which will outline every step in marketing in accordance with the peculiar needs of their client.

Manufacturers who exercise some degree of control over their marketing range all the way from those who sell directly to the consumer to those who sell through wholesalers. But they have in common the realization that to be permanently successful they must have a business personality. They know more or less accurately who buys their goods and why, and they know that control of their marketing, while it entails effort and expense, returns more than enough profit to offset it. But the wastes in marketing of concerns like this cannot be solved with a gesture, for they are complex and hidden.

CONTROL OF MARKETING BY COST ACCOUNTING

The control of marketing is seldom based on an accurate knowledge of those facts which would unerringly point out where profits lie. I concur in the statement made by a well-informed commercial banker that "best sellers" in a line are properly objects of suspicion. Too often they are easy to sell, not because of their merit, but because they are unwittingly sold at a loss.

I know of a concern which manufactured fourteen products. Three-quarters of the business was done on three of the items. Low profits on the gross sales led this concern to install modern cost methods by which profit and loss was developed by lines. Seven of the items, including the three best sellers, each netted a loss; three which were only moderately popular with the management and customers showed a slight profit, and the four items which nobody in the concern loved made up the losses of their ten brothers and returned the slight net profit which the concern made as a whole. With these definite facts in hand, the management discontinued five of the lines, raised the prices on two, declined to sell three unless in assortments with more profitable items, and pushed the sales of the profitable ones. On total gross sales only half as great as before the net profit was increased 450 per cent. And this in a competitive market where war inflation was not a factor.

One cannot rigidly classify any phase of business and say, "This is a marketing problem," or "This has to do with production alone," or "Leave this to the bankers; it is in the realm of finance." Business is not so simple as that. Often the method of attacking a problem as a simple thing without ramifications results in policies damaging to profits. In the instance just given, we found that wrong selling was caused by wrong cost accounting.

So, as a starter toward sound and economical marketing, I earnestly recommend correct accounting of the cost of manufacturing.

INEFFICIENCIES ELIMINATED BY CORRECT COST ACCOUNTING

Correct cost accounting will not only show in which lines profits lie; it will often indicate manufacturing inefficiencies which, when removed, will leave a satisfactory profit.

I recall one little-known concern which, as a result of accurate cost finding, not only relegated its best seller to the ranks but promoted one of its unimportant products to the vacancy, with the result that the concern has become not only highly profitable but known throughout the world as the maker of the once little-thought-of product. This was a result of the cost system showing gross inefficiencies in the manufacture of the unimportant and little sold product. When the inefficiencies were corrected, it became possible to reduce the selling price so drastically that the product became purchasable by many people to whom it had previously been out of reach. At its lower price, it has become practically a universal necessity.

"Well bought is half sold" is an axiom in merchandising; "well made is half sold" is no less true in manufacturing. Low price for good quality is an argument that needs no high-priced salesman to get across.

SELLING POLICIES DICTATED BY COST CONTROL

High selling costs caused by great difficulty in selling indicate either that effort is being wasted in attempting to sell a product unadapted to the market, for which no need is felt, or that poor manufacturing makes the selling price too high. In the first case the concern had best look around for a product that the public wants—if redesign will not fit it to the market. If the selling price makes the product difficult to sell, the manufacturing methods had best be studied in an attempt to reduce costs. Here a cost system will be of help in two ways: First, by showing just where inefficiencies exist. Second, if the cost methods are modern, they will indicate the extent to which costs will fall as a result of increased production. With this knowledge the manufacturer can set a selling price which may be actually lower than his present cost of production, but which he knows definitely will quickly sell so much of his product that with the increased production will come lowered costs and a satisfactory profit. This is of value not only in settling upon permanent selling policies but also for temporary use in stimulating sales in times of business depression.

ANALYSIS OF SELLING COST

Much of what I have said so far will to many thoughtful readers seem like emphasizing the obvious; that I have stressed the elementary principles of marketing. That is true, yet it is exactly in violations of first principles that many of the selling wastes occur. But

I am going now to describe something not quite so obvious. It is a recent development in cost accounting, which has nothing to do with manufacturing but which dissects selling expenses and indicates plainly wrong policies and wastes which are strictly of a selling nature.

It is, I believe, nearly universal practice to state the selling cost for the business as a whole as a percentage of the total year's sales. That is, with gross sales of \$2,000,000 and a selling expense of \$300,000, to call the selling expense 15 per cent, which for the whole business it of course is. But it is also customary to assume that the same percentage applies for each sales district and for each individual deal. If 15 per cent selling expense leaves a profit of, say, 10 per cent, it is easy to figure that so long as the total selling expense remains at 15 per cent, all sales, all customers and all territories are profitable, and if for the entire business the selling expense jumps to 30 per cent, it is assumed that all sales are made at a loss. Now suppose that a warm old friend of the company strolls into the office some day and gives us his customary spring order for \$10,000 worth of our product. Did it cost us \$1,500 to make that sale? Or take a small finicky buyer at the end of a 125-mile branch line out in Nevada on whom our salesman spends an entire day six times a year and who total orders in that time amount to \$500. Does it cost only \$75 to have him for a customer? Do we make a profit on his business?

The first man is so profitable that he is bound to be the target of all of our competitors. Some day, if we don't watch out, a competitor will make it worth his while to transfer his patronage. The other customer is probably not profitable and unless he can be developed we would be better off without him. But the books of most concerns are littered with accounts like his. He furnishes one of the greatest wastes in industry, which springs from the unreasoning effort to get an increasing volume of sales.

EXPENSE ACCOUNTING FOR EACH CUSTOMER

The idea that increased volume of sales necessarily means increased profits is a natural deduction from the percentage method of figuring selling expense. But it actually costs more and more to "comb" a territory thoroughly.

I have seen concerns make a good profit so long as they confined themselves to skimming the cream from the market, and go broke when they went out to get all the business in sight. Of course, someone must sell the small fellows in the out-of-the-way towns; I don't condemn selling to them. But I insist that some manufacturers are organized to do it at a profit while others are not. The buyer who would be unprofitable to one might well be profitable to another.

The first step is to find out just what it normally costs to have a salesman make a call on a customer or prospect. This normal cost per call will likely be different for each business, perhaps for each territory. In territories where customers are thick and towns close together, it may be low; in the Western States it will undoubtedly be high.

I recommend that an expense account be opened for each customer. Here he is debited with all calls made upon him at the normal cost per call, which, let us say, is \$10. He is also charged with any other expense such as advertising, or the freight on returned goods. He is credited with the net manufacturing profit on the goods

sold him. This gives us an accurate line on how profitable each customer is to us, and the cause for the loss if he is not. He may require an undue number of calls to straighten out kicks; he may buy principally those lines which carry a narrow profit; he may have the habit of rejecting shipments; for any one of a dozen reasons his trade may be unprofitable.

Since we know just why he is unprofitable we may be able to educate him into a profitable customer or he may be so hopeless that we would do better to drop him. Or there may be reasons of policy for retaining him, even though he is hopelessly unprofitable. In any event our actions are not based on a false idea of what it costs to sell.

TERRITORIAL SELLING COST ANALYSIS

A report which is of value is the territorial analysis. In the upper part of this we gather all of the items of selling properly chargeable to the territory, which includes the direct items such as salesmen's salaries and expenses, branch office expense and those indirect charges made up of share of general sales expenses, share of advertising, share of clerical expense and so on. The shares are not based on the volume of business. The method of distribution of selling cost is different for nearly every business. Take the general sales expense, for instance. If the sales manager spends most of his effort supervising salesmen, the number of salesmen in a territory would be the fair measure of how much of his salary should be charged to each territory. If, however, the sales manager is occupied with the solution of sales problems, it is usually best to have him keep an approximate record of the time he devotes to the problems of each territory and to distribute the

expense on that basis. A different method is used to determine the shares of clerical effort; and still another to determine how much of the advertising expense is chargeable to each territory. In this way, we build up the total selling expense by territories.

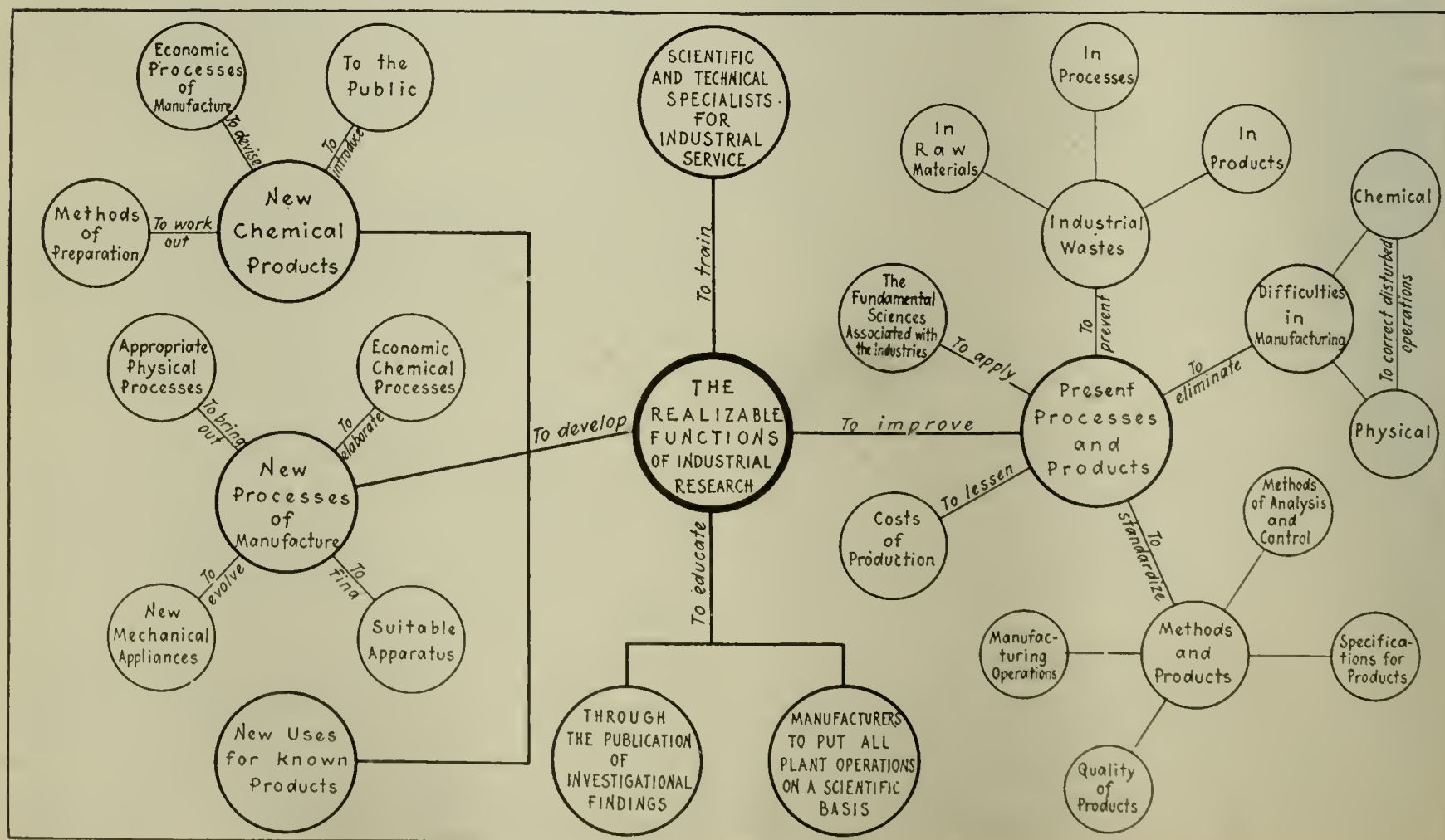
At the bottom of the sheet we note the number of calls made and extend it by the normal cost per call. Comparing this figure with the total actual expense shows whether the territory cost more or less than normal. If more, the cause may be either a reduced number of calls or extravagance on one or more items of expense. We divide the total calls made into those made on customers and those made on prospects. This gives us the amount of money spent in developing new business. We may even determine upon a proper proportion of the total expense which should be spent in development.

A supplementary report may well be used on which we list all customers and the net profit on each. From this we deduct the total by which the selling expense of all territories exceeds normal, and to it we add the amount by which all territories are below normal. This gives a figure from which is deducted the amount spent on sales development to give the net profit.

These reports properly devised to suit the needs of the individual business will analyze thoroughly the selling expense—show where the effort is good and where poor. The reports will not of themselves make profits; but they will give accurate data to the management on which they can build profit-making policies. They will help dispel the fog that has always hung over selling, and by indicating what the wastes are, will show how they may be eliminated.

New York City.

Hamor's Chart of the Aims of the Purposeful Study of the Problems of Chemical and Physical Technology



Wastes in Litigation

Losses Arising From Litigation a Potential Factor in the Success or Failure of Any Industry or Business
—Lack of Knowledge of Technical Terms and Standards on the Part of the Courts a Strong
Argument for the Establishment of Arbitration Courts Within the Industry

BY WELLINGTON GUSTIN

Member of the Chicago Bar

THE average business man, upon going into business, at least in the past, has never figured on the probable losses that may arise from necessary litigation. This is a factor that cuts down profits, if it does not entirely destroy them, in nearly every business enterprise. Insurance against losses by litigation has not yet developed, though perhaps it is as certain a loss as that arising from credits, which are now being insured, or from other contingencies no more certain to happen.

But a very potential factor for harm and loss to any industry or business is possible litigation. It has put many a promising enterprise on the rocks. Anything from total disruption of business to a destruction of all expected profits on a contract may result from disputes ending in the courts. When men cannot agree the courts are necessary as a final arbiter, and it is not intended to lead any reader to take any statement herein as derogatory of the courts of justice. They are the bulwarks of our rights, our liberty and our civilization. But a broader intelligence will admit and encourage business men especially to take every reasonable step to prevent litigation. Here the ounce of prevention adage holds true, as almost any litigant will testify.

CHEMICAL INDUSTRY OFFERS WIDE LATITUDE FOR LITIGATION

In the chemical industry there is the widest possible latitude and opening from which claims and court actions may develop. In the manufacture and sale of chemicals and chemical products the specifications may be open to attack because lacking in certainty between the parties, because there may be no definite or known standard by which the parties may contract and to which they may refer to settle their disputes outside of court. An accepted authority, or standard known and accepted by the industry, would be a big step forward in the interests of the industry as well as the individual members composing it.

As the industry now stands a court, through its judge or jury, must pass upon the scientific and intricate questions of quality or other properties of chemicals, etc., which may happen to be in dispute between buyer or seller. And mayhap, to prove his case, a litigant will be required to bring in all the knowledge of the industry on the particular products in question as well as the customs and usages of the trade. Then all this will have to be done over again should a similar situation arise in litigation. This results in involved expense on every litigant.

There is another feature to be considered, and that is that after a case is litigated whether the correct results have been obtained and justice done; whether it would not be more satisfactory to the trade for men educated and trained and learned in the business to

pass upon and decide questions of fact of which they have a peculiar and particular knowledge than to permit of these questions being decided by judges and juries unlearned in the particular field of science and fact being investigated.

MUTUAL MISTAKES IN LANGUAGE OF CONTRACT

Sometimes a party to a contract contends that the language used and as interpreted by the other party does not express the "mutual" meaning of the parties. Whether it does or does not presents a serious question of fact that might be obviated or precluded by a recognized standard. The remedy of the complaining party is to go into a court of equity and have the contract corrected on the grounds of mistake of fact on the part of both parties. One can appreciate the difficulty encountered should the other party to such a contract deny there was a mutual mistake. In the ordinary case, the costs of such a proceeding and the obstacles to obtain proper evidence and make proof to show that language used in the contract did not express the mutual meaning of the parties are so great that justice is not had; and only when large amounts are involved and the litigants have sufficient resources to litigate and perhaps pay fees to scientific experts in the chemical industry may the true facts and a proper construction of certain agreements be arrived at.

Now when it is contended that the words of the contract do not express the mutual meaning of the parties, what may we, in the chemical industry, refer to as a standard? Have we anything definite and certain that will conclude these matters—prevent the use of the wrong words, or that will give such meaning and standard to the technical words of the science and industry, designating the standards of chemicals manufactured, sold and used commercially or otherwise, to prevent the claims that may arise out of the meaning of the contract in these respects?

LANGUAGE OF CONTRACT CONSTRUED BY COURT

Should an instrument of agreement contain language which, when it is sought to apply it to the subject matter of the contract, becomes ambiguous, a court is required, when the case is brought before it for a decision, to look to the facts and conduct of the parties, the surrounding circumstances bearing on the transaction, etc., to ascertain the sense in which it was mutually used. And the court's decision would rest on the facts shown to it that the language used could be given no other meaning than that contended for by the party who set up the claim of mistake in the contract.

If the language in an instrument, say an order or contract to manufacture and sell, is susceptible of more than one meaning, the parties are bound by the sense in which it was mutually used. But proving this point

presents, ordinarily, a legal issue, a fight in the courts. Recognized standards, accepted and approved in the chemical trades and industries, would in the main wipe out litigation of this kind. Certainty of this kind would first prevent any honest mistake in meaning of the parties at the time they enter into any arrangement, and it would prevent dishonest parties, for an advantage gained, later to set up a claim of mistake of meaning.

With regard to the meaning of words as used by parties in expressing their agreements, the popular or common standard controls on the face of things, but such is always open for proof to the contrary. Where a word or phrase is ambiguous, but was used and accepted by both parties to a contract in undertaking to express in writing the terms of the agreement actually made, they thereby have set up a mutual standard of their own and will be bound thereby. But such offers ground for litigation. The rule as to mutual standards in most states is subject to the modification that a clear and unambiguous meaning will not be overthrown by resort to oral or outside evidence to determine what the parties actually intended. (See Wigmore on Evidence, vol. 4, page 3475.)

Of the great mass of litigation clogging the courts throughout the country, only a small number comparatively reach the courts of appeal. Following are cases that have been brought up from the trial courts to appellate courts and often to the courts of last resort, where in some instances the litigation is finally and fully determined, while in others the cases are remanded and sent back to the original trial courts where the machinery of the courts is again set in motion—perhaps to be continued up by appeal or other proper procedure to the courts of last resort again.

The cases selected are those touching upon the quality, properties or specifications of the products, showing where a lack of standard makes it impossible not only to know in advance what is being bought and sold but prevents buyer and seller from referring to an accepted authority to settle their disputes.

LACK OF STANDARDS CAUSES PATENT LITIGATION

Lack of standards enters into the inventive or patent litigation. An inventor describing his process and stating his claims names the chemicals employed, agents and factors used in producing a result. Others exploring along the same or similar lines are not informed by the patent with such precision as to steer them clear of the process patented. Employing chemicals as called for by the patent, they do not obtain the results claimed, and proceed in a search to improve the process or discover a true solution. In one noted case a learned scientist testified that he used the chemical factors called for by a process patent, but did not obtain the product of the inventor. He had used chemicals with certain impurities, according to the testimony of other scientists who had obtained the desired results with chemicals of a different standard. (*Matheson vs. Campbell*, 69 Fed., 597.)

This lack of proper standards for chemicals confused the users of the patent and there developed a useless competition and infringement. By making certain tests of the chemicals employed and using only those up to a certain necessary requirement or standard, the users of this process testified, they obtained the product of the patent. Those using the same chemicals in kind but of a different standard of purity were misled by the patent

claims, and believed that they were untenable. Here the court held that the use of "nitrate" of sodium for "nitrite" of sodium in the specifications of a patent relating to the manufacture of a coloring compound from coal-tar products was not such a misuse of terms as would invalidate the patent; it appearing that no one skilled in the art would be misled thereby and that the use of "nitrate" for "nitrite" was common in the earlier patents relating to the particular art. Here, too, the court defined "chemically pure" to mean absolutely pure, and "technically pure" as used in reference to substances employed in chemical processes to mean pure in the ordinary acceptance of the terms of the art.

RIGHT TO INSPECT GOODS BEFORE ACCEPTANCE

The case of the Imperial Products Co., Inc., vs. Capital Chemical Co. involved the question of inspection of the product sold (176 N. Y. S., 49). The buyer of the product demanded the right to inspect the goods upon delivery and before payment. In such a case with known standards and an agreement based thereon, the matter of delivery would ordinarily be of small moment, as an acceptance of delivery could not be shown to establish the quality of the product or be taken as an acknowledgment that it conformed to the specifications or other descriptions of the agreement.

The law involved in this case is to the effect that under the personal property statute of New York a buyer is entitled to inspection of goods purchased, before delivery and acceptance, unless there are terms to the contrary; that a carrier of the goods is bound to permit of this inspection unless the sales agreement is that shipment should be made "collect on delivery."

Under the New York law, where no terms of payment are specified delivery and payment are concurrent obligations, and the buyer has the right of inspection to ascertain whether the goods are in conformity with the contract, when the seller tenders delivery, before he is required to accept and pay for the goods. But the court says this is very different from payment of the purchase price by sight draft with bill of lading attached. Here payment is a condition precedent to delivery and hence inconsistent with the right of inspection.

SELLER LIABLE WHEN HIS GOODS RUIN PRODUCTS MANUFACTURED BY THEM

In the case of James K. Thompson Co., Inc., vs. International Compositions Co., Inc. (181 N. Y. S., 637), the Thompson company brought suit to recover the purchase price of a quantity of copper oxide. The amount contracted to be sold was 11,862 lb., which at 33c. a lb. amounted to \$3,914.66. There were three deliveries of this oxide. After the third delivery the defendant returned 2,907 lb. and the plaintiff, Thompson company, received it and gave defendant a credit therefor. The balance due for the oxide not returned and accepted was \$2,955.15, and plaintiff recovered a judgment for this sum.

On appeal the Appellate Division of the New York Supreme Court reversed the judgment and granted a new trial. It appears that the copper oxide was sold for a specific purpose—for making a high-grade anti-fouling marine paint. It was admitted that the first two deliveries of the oxide were up to the standard required by the defendant. But there was evidence to show that the third delivery was not up to the standard required by the paint manufacturer and not in conformity with

requirements of the contract and with the standard of article known by the seller to be necessary for the buyer's uses. Before discovering the defect in this article, however, the buyer had used a part of the third shipment, and in making paints therefrom, it made paint which was utterly useless and which was returned by its patrons, and the buyer claimed to have suffered damages by reason of the loss of other materials that were used in the paints, which were then rendered unsalable by reason of this defective copper oxide. Therefore against the seller's total claim for oxide delivered the buyer set up a counterclaim for damages thus suffered in the amount of \$5,267.66.

In defining the rules of law which govern the plaintiff's right to recover the court said that if the plaintiff had knowledge that the defendant required a certain quality of copper oxide for the use of the paint as it was manufactured, then it was bound to furnish that quality under the contract, and that the burden of proof was upon it to show that quality was furnished. On the counterclaim of defendant the court stated that the defendant had the burden of proof, in establishing its counterclaim, to prove that the goods were not of the quality required by the contract, and required by the knowledge that the seller had of the buyer's requirements and the damages that were suffered therefrom.

ADVANTAGE OF HAVING KNOWN STANDARDS

In the case of *E. I. du Pont de Nemours & Co. vs. Robinson & Son*, 204 Ill. App., 529, an advantage of having known standards and quality is presented. Here it was held that although the buyer was given opportunity to examine the product delivered and although it was subsequently used by the buyer, such did not constitute an admission by the buyer that the quality of the product was satisfactory and that it conformed to the contract. For, under the facts in this case, a mere examination by the buyer of the boxes and their contents would not necessarily inform the buyer of the quality of the product, says the court. But where may the complaining party go for proof of what he bought? To his contract. But to what standard and what reference may each of them go in case of dispute as to contract, or better still, in drawing up the contract in regard thereto?

BUYER'S RIGHT TO A PARTICULAR BRAND ORDERED

Of course no standards or other precautionary acts of parties entering into a contract may prevent frivolous defenses and claims being made where litigants are so disposed to fight. All that this forward step can do would be to reduce the difficulties to a minimum and make the results of a suit in equity or an action at law more certain, with the facts or evidence and the proper benefits available to the rightful party or parties.

Again, where one contracts for a particular brand of product he is legally entitled to the brand, though the standard is the same as another substituted. In the case of *Coff-Garrod Co., Inc., vs. Dodwell & Co., Ltd.*, there was a contract for the sale of Monsanto or Heyden brand saccharin of a specified grade or standard. The product was sent in boxes of the American Condiments Co., a subsidiary company of Heyden Chemical Co. The evidence was that the parties were contracting for goods of a certain character and quality, and not labels, and that "Heyden brand" and "Heyden make" of saccharin meant the same thing. Therefore, since the complaining

party obtained a product of the standard contracted for and of the proper manufacture he could not set up a defense of improper trademark or brand. (170 N. Y. S., 615.)

SALE BY DESCRIPTION CANNOT BE TRANSFORMED INTO A SALE BY SAMPLE

In the case of *American Aniline Products, Inc., vs. Mitsui & Co., Ltd.*, there were three sales contracts for dyes for export. The buyer claimed samples of dyes were submitted with the offer of sale, and it was agreed deliveries of dyes under orders would be equal in quality, strength and all other respects to the samples submitted. The orders showed a sale by description, being "Amacid Blue Black K N" and the court said the obligation of the seller was merely to deliver goods to that description of merchantable quality. To attempt to transform a sale by description into one by sample is to attempt to vary the obligation of the seller as to the quality of the article to be delivered, which could not be done. And the evidence as to the sample submitted prior to giving the written orders was not admitted in the case. However, the court held that upon trial either party would be at liberty to define by word of mouth the term "Amacid Blue Black K N." Such evidence does not vary the meaning of the writing, but discloses the full meaning of the parties. The Supreme Court of New York and the Appellate Division were called upon to decide these points.

DELIVERY OF ONE GRADE WHEN BUYER THOUGHT HE CONTRACTED FOR HIGHER GRADE

In the case of the *Independent Trading Co., Inc., vs. E. Fougere & Co., Inc.* (183 N. Y. S., 431), plaintiff brought an action to recover damages for alleged breaches of written contracts for the sale of potassium guaiacol sulphonate, c.p., white. Defendant admitted the contracts but defended on the ground that it never understood that it was agreeing to deliver to the plaintiff the quality of the chemical called for in the contract and which plaintiff claims the defendant agreed to deliver. Upon trial the sole question presented was of a mutual mistake respecting the identity of the article in suit.

Upon this proposition it was claimed that there were two grades of potassium guaiacol sulphonate recognized by the trade. One of these grades was claimed to be in powder form, known as calcine, the other being a crystalline form of perfectly white crystals. The calcine was at time of the sale of the value of \$10 per lb. and the crystalline form was of the value of about \$30 per lb.

The seller understood that the article called for by the contract was the calcine or powdered form then being sold as the commercial product. This product was being manufactured by the Lister Chemical Co. It was not the same article called for in the contract. On the part of the seller it was shown that another product known as "thiocol" was on the market, which contained the same chemical ingredients as potassium guaiacol sulphonate. Thiocol, however, was a trade name belonging to its manufacturers, the Hoffman-LaRoche Co. And the testimony for the seller that it had sold the cheaper article, and that it was customary to use the term "thiocol" or the term "crystal white" in describing the crystalline form was not supported.

In its opinion the court says it is convinced that no mistake was made by either party; that the seller was endeavoring to sell to the trade an inferior product and

deliberately intended to deliver, under the contract, an article known to be inferior; and the seller, having made the contract in question which used the terms well understood in the trade, should be held to a strict performance thereof.

On the question of mutual mistake as to the identity of the product in suit, the court said even though the evidence supported the seller's claim that it did not understand the effect of the contracts which it made, and did not know that it thereby agreed to sell and deliver the crystalline form of the commodity, there was no mistake on the part of the purchaser. It knew what it wanted and what it bargained for—namely, "potassium guaiacol sulphonate, chemically pure, white." What this product was, as established by the trade, could not be denied by the seller.

A standard and knowledge in the trade as to the product in dispute dispensed with the more intricate questions that might have arisen had there been no standards for reference and proof. Putting over an inferior product, as the majority believed was attempted here, might become an easy matter with unscrupulous dealers.

QUALITY OF STEEL QUESTION FOR JURY

In the case of Griffin et al. vs. Metal Product Co. (107 A., 713) defendant purchased from plaintiff certain high-speed steel. The buyer acknowledged receipt of the steel, that it appeared to be in good condition, but alleged that upon use it was valuable only as scrap steel. The question as to the quality of the product was presented to the jurors, who decided from the evidence that the steel was high-speed steel and gave judgment for the defendant buyer. But the Supreme Court of Pennsylvania has reversed this judgment and granted the defendant a new trial.

Under the uniform sales act providing that on sale of an article under its patent or other trade name there is no implied warranty as to its fitness for any particular purpose, a "trade name" is a name given by a manufacturer to the particular product made by him, and the generic name of an article made by several is not a trade name. The Supreme Court holds that speed-steel is not a trade name but a name common in the trade and where sold for use by the buyer for a use known to the seller there is an implied warranty of quality suitable for the purposes intended.

KIND OF GOODS DELIVERED A QUESTION FOR JURY

In the case of Samuel and others vs. the Delaware River Steel Co. (107 A., 700) the Supreme Court of Pennsylvania said the kind of goods delivered under the sales contract was a question for the jury to determine from the evidence submitted. There was an appeal in this matter from the trial court to the Pennsylvania Superior Court, thence to the Supreme Court, where it was finally remitted to the Court of Common Pleas for a new trial.

It appears that the defendant purchased from the plaintiffs, brokers in steel and iron products, two carloads of a commodity known to the trade as "roll scale." Upon unloading the material the Steel company discovered, as it alleged, that the contents of one of the two cars contained largely mill cinder, a product of less value than roll scale. The buyer used the product in dispute, but refused to pay on the basis quoted for roll scale. The seller contended the product delivered was

roll scale, and further, that if it were not such product, the buyer, by accepting and using the product, waived the right to object that it was not the article ordered.

INTENTION OF PARTIES DETERMINE—WHERE AMBIGUOUS WORDS ARE AGAINST PARTY USING

In the case of Fletcher vs. Interstate Chemical Co., the question was the construction of the contract. (110 A., 709.) The Supreme Court of New Jersey here said the cardinal rule in the construction of all contracts, sales included, is that the court must, if possible, ascertain and give effect to the mutual intention of the parties, as far as that may be done without the violation of legal principles. And where a contract is ambiguous it will be construed most strongly against the party preparing it or employing the words concerning which doubt arises. This case was appealed from a judgment of the trial court to the Supreme Court, where judgment against defendant was affirmed.

STRICT READING OF CONTRACT ENFORCED

In the case of Filling Machine Co. vs. United Smelting & Aluminum Co. (107 A., 619) the sole question involved was whether "rod aluminum" meant pure aluminum. The jury in the case was instructed by the trial judge to determine whether the words in the order given "to be drawn to our specifications" had any distinct well-known meaning in the trade, applied to both size and composition or to size only, and whether plaintiff knew or ought to have known that the words were used in such special sense. On appeal this instruction to the jury was held error by the Supreme Court of Errors of Connecticut.

This court said the sale being of specific goods designated as "rod aluminum" in the written contract as completed and in the written negotiations leading up to the contract, it was the duty of the seller to furnish "rod aluminum" as that term was ordinarily used in the trade.

GOODS MUST BE SUITABLE FOR USES REQUIRED

In the action by Smith, DeMacedo & Co., Inc., vs. Swift & Co. (110 Atlantic, 141) it appears that Swift & Co. sold the plaintiffs 34 tons of oleo-stearine which was represented to be suitable for the same purposes or uses and to comply with the specifications set forth for stearic acid. This product was to be resold and exported to Portugal for use there. Upon arrival there it was found that the article did not conform to specifications, the plaintiff's customer declined to accept the shipment, and it was necessary because of shipping conditions to sell the product in Lisbon at a loss to the best bidder.

Smith, DeMacedo & Co., Inc., brought suit to recover damages for failure to deliver goods answering the warranty that they would be suitable for the uses required. This case was carried to the Supreme Court of Pennsylvania and a judgment for the plaintiff was sustained.

REPRESENTATIONS BY SELLER AMOUNT TO WARRANTY

In the case of Swift & Co. vs. Meekins et al. plaintiff sued to recover for the price of fertilizer and acid phosphate. Defendants set up a counterclaim for breach of warranty as to quality of the fertilizer. The sale consisted of 10 tons of acid phosphate and 40 tons of fertilizer analyzing 5-7-0. Meekins testified that

sellers' agent, at time of the sale, stated the fertilizer was as good as any of the same analysis sold to be used for cotton and corn and was as good as any on the market. The case was carried from the trial court to the Supreme Court of North Carolina when the court held these statements amounted to a warranty in law. The positive representation, without any intention to deceive, by a seller that the article sold possesses a certain value and certain qualities amounts to a warranty and the purchaser may set up the breach of warranty to reduce the sum claimed.

GOODS NOT UP TO SPECIFICATIONS

In the case of Grasselli Chemical Co. vs. City Ice Co. (75 So., 920) action was brought to recover the price of certain shipments of anhydrous and aqua ammonia. Defendant claimed that plaintiff warranted all anhydrous ammonia perfectly pure and dry and all aqua ammonia sold to be absolutely 26 deg. aqua ammonia, which warranty was breached, causing a resulting damage to it of \$7,500. The Chemical company contended that it sold all of the ammonia by description only; that the aqua ammonia was sold as 26 deg. at 60 deg. F., and was merchantable; that the anhydrous ammonia was merchantable dry anhydrous ammonia; and each was so warranted. It further charged that defendant's trouble in its use of the product was due to its machines and not to the chemicals employed. An adverse judgment was rendered against the Chemical company and it appealed to the Supreme Court of Alabama, where the judgment was affirmed.

CONTRACT PROVIDING FOR SETTLEMENT OF DISPUTES

The case of Home Guano Co. vs. International Agricultural Corporation involves the sale of 21,600 tons of sulphuric acid. This case was decided by the Supreme Court of Alabama. (85 So., 713.) While there is no controversy over the quality, kind or properties of the goods sold, the contract covers these matters so well that it is given here. Contracts are usually loosely drawn, and never cause any difficulty as long as both parties are satisfied in their dealings, but when dissatisfaction crops up the terms and provisions of the contract become important. The contract provisions here given show how the parties provided for disputes as to the product sold:

"It is understood that seller is privileged to deliver acid of greater or lesser strength than 60 degree Bé., but not less than 57 degree Bé. nor more than 62.50 degree Bé. For any excess in such acid above or below 60 degree Bé. a proportionate reduction shall be made in the price per ton according to the per cent of 60 degree acid contained in such acid of higher or lower degree, as set forth in the table of the Manufacturing Chemists' Association. Approximately at the end of each month seller shall reimburse buyer for additional freight which buyer may have paid or incurred liability for by reason of the shipment of acid of weaker strength than 60 degree Bé., and buyer shall pay to the seller the amount of freight charges saved to the buyer by reason of the shipment of acid of greater strength than 60 degree Bé. Settlement shall be made for each and every shipment upon the basis of 60 degree Bé., as determined by the producing company, at Copperhill, Tenn., whose test shall be the basis of the settlement. In case of dispute as to the accuracy of such analysis, sample of the carload in question, as

drawn by the producing company at Copperhill, shall be submitted to analytical chemists, Ledoux & Co., 99 John St. New York, for analysis, whose determination shall be final."

HOW STANDARDS MAY BE ESTABLISHED

In Penn Steel Castings Co. vs. Wilmington Malleable Iron Co. (41 A., 236) wherever an order was to be carried out with quality "up to standard" it became necessary to prove the standard. In attempting to define the contract meaning of the term the court says a standard implies a measure or test which has the general concurrence and recognition of the class of persons engaged in the particular business or trade under consideration.

Now long and continued usage may develop and determine standards in any field. Considering how long-established and widely known has been the particular business involved in the steel industry, the court thought it was not unreasonable for it to presume, until the contrary be shown, that some well-known standard was generally recognized in that business or trade.

Thus standards may grow slowly through a mass and haze of difficulties with all the attending losses and lessons of experience, or they may proceed in an orderly march, being established in an exact and scientific manner, agreed upon in advance, recognized and approved by the trade.

All these transactions and matters are affected through the factor of evidence in controversies or disputes. When parties dispute the facts, dispute the quality or properties of the subject of contract agreement, where shall they go for aid? What is the mean or standard of measurement that may be brought in to determine the truth and facts in the evidence? What, itself, may be the evidence? With established standards the facts and truth as to matters in evidence may be readily arrived at in a manner satisfactory to all concerned, preventing at the same time dishonest transactions which are now possible.

ADVANTAGES OF ARBITRATION LAWS

Some states have enacted what is known as an arbitration law, notably New York and Illinois. These laws offer much promise to business men, but, being a new departure, have not been availed of to any great extent.

Where contracts contain the proper provisions for arbitration of the differences arising thereunder, in states having these laws it appears that the quality of products and other similar grounds of dispute may be more readily determined, the facts more properly found by referring to an arbitrator or a board of arbitrators—all skilled or educated in the field of inquiry.

I am of the opinion that many of the difficult questions arising in the chemical and allied industries can best be met by an acceptance of such new laws as offer the opportunity of arbitration in disputes and by making use of them. This last is a very necessary and vital thing—the making use of the principle. Skilled and experienced men should be designated as arbitrators, perhaps by the various industries in advance, to whom parties to a contract may look in case of disputes arising. Boards of arbitrators may, in the future, take the place of and do much of the work of courts, unlearned in the particular fields of inquiry. But arbitration will require no little effort for its firm establishment.

Chicago, Ill.

Eliminating Waste and Nuisance in Smoke, Fume and Gas

Suppression of Industrial Waste Byproducts Is Essential Not Only to Avoid Economic Loss but to Abate Nuisance in Residential Localities—Methods Originally Developed for Metallurgical Processes Find Application in a Wide Variety of Industries

By P. E. LANDOLT

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WITH the rapid growth of industry in the past twenty years, we have been confronted with the necessity of waste elimination for conservation or as a public necessity. Waste elimination is truly economic, benefiting industry directly in many cases and ultimately the public. A phase of the industrial waste and nuisance problem that has had a pronounced effect on the industries and the surrounding localities is that of so-called smoke nuisance. In some instances it was allowed to increase to a point where local damage was extreme, and later during its abatement many interferences and delays to industries resulted. Frequent abandonment of large industrial plants followed, and the economic losses, both public and private, were very great. Much of the smoke nuisance has been tolerated or ignored by the public, either accepted as inevitable or essential to industry. Moreover, it has been borne with sullen indifference or accepted as a commonplace like the weather, etc.

SOLUTION IN NO ONE METHOD

The solution of these problems of smoke nuisance or air pollution cannot be effected by any one method, because our industries are essential to the progress of civilization, and therefore careful consideration must be given to every phase of any one problem to be certain that real improvement has been made. If other wastes as great in magnitude as the original one result, then nothing has been gained. All of these problems, therefore, require broad treatment by industrial specialists and by engineers, so that the benefits obtained may be of lasting value.

Prevention is a first consideration; but frequently it is found quite impossible, at least impractical, to prevent such loss or nuisance due to waste gases. Sometimes it is found desirable to carry off materials in waste gas currents and recover such materials later, separated from other materials with which they were originally associated. Moreover, after such materials are removed from a gas, it may be useful for other purposes where it would be useless if not free of such suspended matter.

Many schemes have been used for the removal of suspended matter from gases and under certain conditions have proved satisfactory. In general these consist of mechanical devices for settling dust by gravitation, centrifugal action, baffling or change in gas velocity; washing with water or other liquids, as a fine spray or over packed towers; filtering by means of cloth bags, screens or layers of finely divided or fibrous substances. All of these methods have fairly well-defined limitations, such as temperature, corrosion, power requirements, replacement costs; the quantity and composition, both physical and chemical, of the

material to be removed; water consumption or disposal of the collected material.

ELECTRICAL PRECIPITATION

The development of electrical science has added to the foregoing another method—namely, electrical precipitation—which has been developed commercially during the past fifteen years, and which has been shown to have a wide range of practical operation, particularly where corrosion and high temperature are factors or large-volume treatments are essential. The equipment required for the operation of the Cottrell electrical precipitation processes has been gradually standardized to make these processes readily adaptable to a wide range of industrial problems. The monetary value of metallurgical smoke recovery, for example, has been tremendous, but the resultant applications developed constantly increase the field of usefulness of these processes and promise even greater value in the future as an essential part of other new processes and industries.* The diversity of these applications is shown by the following summary:

I. Non-ferrous Metallurgical Fume and Dust: Recovery of copper, lead, tin, zinc, silver, gold, bismuth, etc. Operations: Sintering machines, reverberatory furnaces, blast furnaces, converters, roasters, driers, etc.

II. Acid Problems: *a.* Sulphuric acid—concentrators (new, spent and sludge acid), parting kettles. *b.* Nitric acid—nitrating operations. Phosphoric acid—phosphate rock reduction. Hydrochloric acid—roasting operations, pickling, etc. *c.* Miscellaneous—Recovery of chlorine, bromine, etc.

III. Smoke, Soot and Cinder: *a.* Boiler plant gases. *b.* Engine roundhouses. *c.* Lamp black from oil. Carbon black from natural gas.

IV. Cleaning of Gases Containing Sulphur Dioxide: *a.* Hot gas (pyrite burners)—sulphuric acid manufacture. *b.* Cold gas (pyrite burners)—sulphuric acid manufacture; (sulphur burners)—sulphite liquor production.

V. Combustible Gas Cleaning: *a.* Iron blast-furnace gas cleaning. *b.* Hot producer-gas cleaning. *c.* Tar recovery from producers, illuminating gas, coke ovens, low-temperature carbonization (fractionation), wood distillation.

VI. Air Cleaning: *a.* Small capacity installations—foundries, machine rooms, etc. *b.* Large volume installations—slate crushing, etc.

VII. Miscellaneous Applications: *a.* Dust and fume from industrial operations: 1. Potash from cement

*For the purpose of this presentation no direct reference will be made to the theory and description of these processes. For complete details of same the reader is referred to the selected bibliography at the end of this paper.

kilns. 2. Large electric furnaces. *b.* Dust and fume from miscellaneous chemical plant operations. *c.* Organic materials—spray drying, milk, fruit juices, etc.

IN THE METALLURGICAL INDUSTRIES

The metallurgical industries have contributed most largely, if not entirely, to the commercial development of these processes. The early efforts of Sir Oliver Lodge in England, Dr. Moeller in Germany and Dr. F. G. Cottrell in the United States led to final accomplishment. Dr. Cottrell was greatly aided in his early work by the co-operation of local industries, primarily E. I. du Pont de Nemours & Co., at Pinole, Cal., and the Selby Smelting & Lead Co. at Vallejo Junction, San Francisco Bay.

Copper Industry.—Many large copper-smelting plants have been equipped with Cottrell precipitators, making recoveries of copper, silver, gold, zinc, lead, arsenic, etc., that have paid from 15 to 50 per cent net per annum on the installation investment after deducting all operating charges, depreciation, interest, repairs, etc. In addition all damage to the surrounding country has been eliminated or minimized. The total investment in Cottrell installations in copper smelters is approximately \$5,000,000, and with a net return on investment of 20 per cent on such installations, this represents a net saving in copper alone of at least 5,000,000 lb. per annum, and a total of at least 8,000,000



FIG. 1. ELECTRICAL PRECIPITATOR FOR RECOVERING LEAD, TIN AND ZINC FUMES FROM REVERBERATORY FURNACES HANDLING DROSSES

cu.ft. of gases have been so "treated" per minute (400,000 to 500,000 tons per twenty-four hours).

Lead Smelting.—Many lead-smelting plants have installed Cottrell precipitators, and the net recoveries compare favorably with those in the copper industry. At least \$3,000,000 has been invested in these installations, with a corresponding net saving of at least 15,000,000 to 20,000,000 lb. of lead per annum.

Tin Smelting.—Numerous secondary metal plants and a primary tin smelter have been equipped with Cottrell precipitators and have paid a net return per annum on their investment of at least 50 per cent (in some cases nearly 100 per cent) after making all deductions, fixed charges or operating expenses. The total investment in these installations is nearly \$400,000, and

the consequent net saving is at least 2,000,000 lb. of tin per annum.

Silver Refining.—The large silver refineries (whether from copper- or lead-smelting sources) are equipped with Cottrell installations. The total investment in them is not over \$300,000, but the total recoveries in silver alone are at least 500,000 oz. per annum. Considerable gold is also saved in addition.

IN THE CHEMICAL INDUSTRIES

The development of the chemical industries has given further opportunity for the application of these processes.

Sulphuric Acid.—Sulphuric acid mist is well recognized as difficult to catch by ordinary means. Dr. Cottrell first applied electrical precipitation to sulphuric acid mist and found the mist was "condensed" or precipitated electrically with the greatest ease.

During the war maximum operation of sulphuric acid-concentrating plants made the acid mist nuisance quite pronounced. Various scrubbing devices used were a failure, were impractical, or rendered this recoverable acid a complete loss. Cottrell installations for this purpose during the war period from 1917 to 1919 made an acid saving, besides abating a serious nuisance, of at least 10,000 tons (66 deg. Bé.) acid per annum. Further development of these processes at that time would have avoided far greater wastes.

Applied to the recovery of sludge acid from oil-refining operations in conjunction with approved sludge acid concentrators, more or less recently developed, these processes serve as a useful part of such equipment. The Cottrell precipitator collects practically all of the acid discharged with the waste gases, returning it to the system at an appreciable concentration. The total acid losses in such a combined system are reduced to a minimum. Acid problems usually mean property damage, and even where the plant is isolated the elimination of acid gases is justified for the saving of wear and tear on plant buildings, roofs, products, etc.

Phosphoric Acid.—These processes are being utilized in connection with the direct reduction of phosphate rock in electric or other furnaces. Phosphoric acid is recovered directly and is used to saturate phosphate rock, giving a superphosphate of high P_2O_5 content, saving the use of sulphuric acid and extra freight on the transport of acid or a phosphate product of less value per ton.

ELIMINATION OF SMOKE AND SOOT IN POWER PLANTS

Smoke and soot from large power plants have been decreased in most cases to an almost negligible amount, but an ever-increasing problem of cinder and ash dust being carried out of the stacks is a serious one. The former problem is being solved largely by preventive methods (improved mechanical firing equipment, control of fuels, etc.), but the latter problem of cinder and ash appears to be soluble only by supplementary collection. Here the material collected is almost if not entirely valueless, the gas volumes are very large, and the duty is extremely severe. Such plants, being operated to their maximum ratings, require close draft adjustment and practically no draft interferences. Schemes have been tried and have succeeded to a large extent in improving stack conditions for such power plants. In the main, therefore, Cottrell installations have not been justified for such conditions, but the

development of apparatus for electrically cleaning such gases at very high velocities (2,000 to 3,000 linear feet per minute), together with the development of powdered fuel combustion for power plants, promises to create a real need for such equipment on a basis that will be sound economically.

THE NUISANCE OF THE ENGINE ROUNDHOUSE

The large engine roundhouses in cities present a problem that constitutes a real nuisance. Owing to the corrosive nature of the gases from such roundhouses, washing equipment is costly to install and maintain.

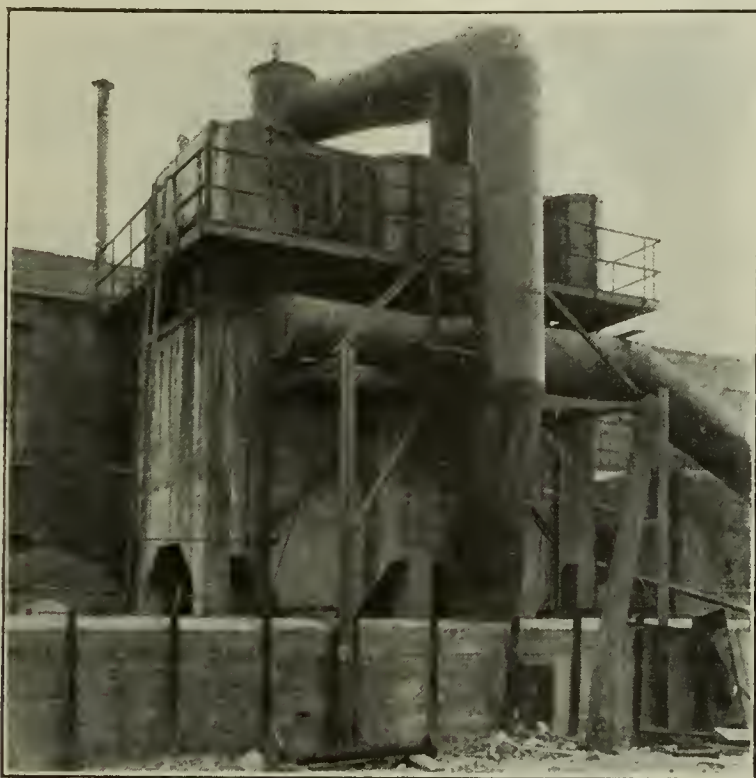


FIG. 2. ELECTRICAL PRECIPITATOR FOR RECOVERING LEAD, TIN AND ZINC FUMES FROM REVERBERATORY SMELTING FURNACES TREATING DROSSES

Electrical cleaning (dry) has been tried and a large installation has been under construction for some time. Unfortunately severe depression in the railroad industry has prevented the completion and operation of this installation. Here, again, the material is of little or no value, but the nuisance is probably not preventable. Earnest efforts have been made by the railroads to minimize such nuisance.

Much has been written on the indirect cost of black smoke nuisance, but for the purposes of this paper a review of all these public "losses" will not be attempted. The reader is referred to official reports of the cities of London and Birmingham, England, and Pittsburgh and Chicago in the United States.

WASTE IN CARBON BLACK AND LAMP BLACK MANUFACTURE

Studies of the smoke and soot ultimately called attention to the problem of waste in carbon black and lamp black manufacture. Present methods of production and recovery are quite inefficient. In carbon black alone less than 1 lb. of black is produced per 1,000 cu.ft., natural gas containing at least 33 lb. carbon in the form of hydrocarbons. These finely divided carbon particles can be readily precipitated electrically, and the electrical precipitator may be readily adapted to conform with other processes devised to increase the yield of such carbon black or lamp black. The next five years should accomplish rather radical changes in this industry, if developments at present under way are ultimately a commercial success. For an equal

production of carbon black the investment saving will be easily one-half, the cost of production per pound will be one-half, and the natural gas consumption one-quarter (or less) of present methods.

ELIMINATION OF WASTE IN SULPHURIC ACID PLANTS

Referring again to the chemical industries, the cleaning of hot sulphur dioxide gases from the roasting of pyrites for the production of sulphuric acid is an example in which the elimination of waste is indirect. The saving in this case is mainly one of labor and maintenance—power also to some extent. In chamber acid plants there would also be a saving of niter. In contact acid plants, cleaning of subsequent equipment would be less frequent. A total saving in production cost of, say, 25c. per ton acid produced amounts to a large sum annually in a relatively small plant.

After such sulphur dioxide gases are cooled another problem presents itself in contact acid manufacture—namely, purification. Here again a saving can be made by introducing an electric precipitator, obtaining practically perfect removal of all suspended acid mist or other suspended impurities, thereby increasing the life of the catalyst, or at least eliminating the necessity for frequent replacement of expensive filter media or the inclusion of large and expensive filter boxes or towers. In actual commercial operation, over 99.5 per cent removal of such suspended matter has been obtained continuously, using electrical precipitation.

ADAPTATION OF PROCESS TO COMBUSTIBLE GAS CLEANING

Considerable development has been necessary to adapt these processes to combustible gas cleaning, but a



FIG. 3. ELECTRICAL PRECIPITATOR FOR RECOVERING TIN FUMES FROM REVERBERATORY, CALCINING AND BLAST FURNACES HANDLING TIN ORES

marked degree of success has followed these efforts. Here also the waste eliminated is primarily a labor waste, both in operation and maintenance, as well as a power waste. The dry hot cleaning of iron blast-furnace gases presented several features important from a waste standpoint—labor saving in operation and maintenance, water waste and stream pollution, fuel and power saving and, during the war, potash

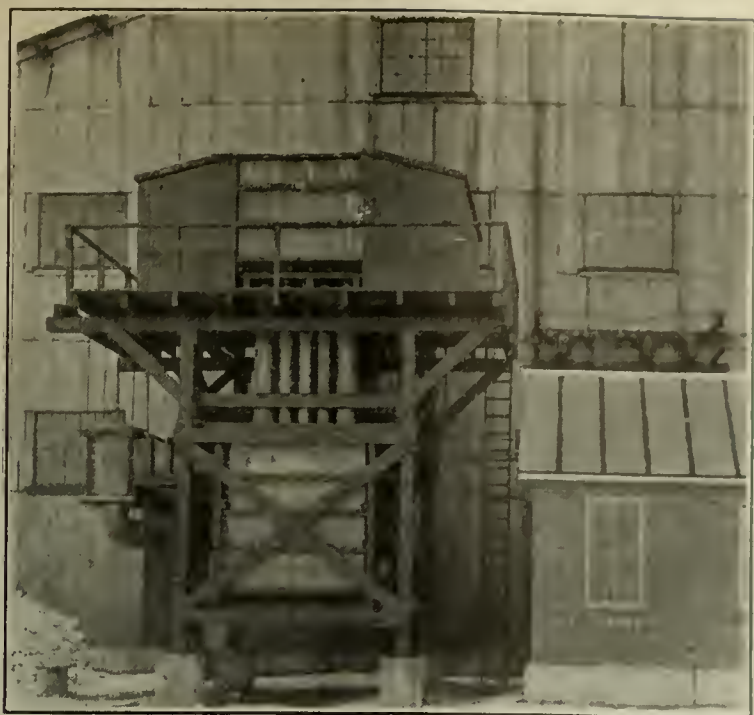


FIG. 4. ELECTRICAL PRECIPITATOR FOR RECOVERING SULPHURIC ACID MIST FROM EXIT GASES FROM A 50-60-TON O. V. CONCENTRATOR

recovery. Two installations built in the United States indicate the possibilities in this field and have shown at the respective plants considerable labor saving on hot stove maintenance, together with appreciably higher stove temperatures. It has been shown by actual statistics that the blast furnaces of the United States could easily produce an amount of potash sufficient for all usual peace-time purposes. It is not the purpose of this paper, however, to discuss the potash situation, which is a complex one. Factors such as transportation rates, availability, first importance of related operations of an especially severe nature, etc., must be carefully studied to determine the final safe economic procedure. Suffice it to state that some potash can be and is being readily obtained in this way and that the isolation of blast-furnace potash by electrical precipitation could be utilized in an emergency. Potash from cement kilns was produced in large quantity during the war, and several large cement plants were operated primarily for their potash recovery with the cement as a byproduct. Rotary kiln treatment of various potash-bearing shales and slates, with electrical precipitation of the volatilized fumes, has also been shown to be feasible and a means of obtaining an economical production of potash. Should imported potash remain at a low figure indefinitely the work done on potash recovery has not been lost, having served a valuable purpose during the war and demonstrated the practicability of "concentration by volatilization," which finds uses in metallurgical and other fields.

ANOTHER FIELD FOR ELECTRICAL PRECIPITATION

The removal of dust and tar from gases of distillation of coal or from producers has offered another large field for electrical precipitation. Fuel and labor saving can be effected thereby, depending on a wide range of operation of such equipment. By temperature control fractional condensation may be obtained, saving certain redistillation operations, securing better grade byproducts, etc.

Examples could be given ad infinitum of possibilities and of accomplishment through the introduction of the Cottrell processes into industry, but the intent of this review is to give a perspective of the extent of the problems encountered, and the trend of thought and

effort directing the development of such processes as a useful instrument in the control of industrial waste. It has been shown in the investigations of various "smelter smoke" commissions, mainly the Selby Commission and the Salt Lake Commission, that if noxious gases are first cleaned to remove their suspended matter and then discharged at a high elevation and at an appreciable temperature above atmosphere, such gases will be dissipated more readily than uncleaned gases and will not do appreciable damage to vegetation. Here again the Cottrell process plays an important part, cleaning the gases without appreciable interference with natural stack draft.

Development of engineering design for electrical precipitation, with or without previous research work, must follow the trend of general industrial progress, and to the end that duplication of effort be avoided and the greatest progress made, there is quite close co-operation and collaboration among all those interested in its development throughout the world. Standardization of design for specific applications tends toward simplification of equipment requirement. Design has therefore largely followed practical commercial results, and has been almost purely empiric, but rational methods must obviously follow, indicating what limitations may be expected in miscellaneous additional applications that may be presented.

SOME FIGURES AS TO COST

Owing to the wide range of application and size of Cottrell installations, it is well-nigh impossible to give any individual set of figures on the investment necessary or the cleaning cost. The following figures, however, will serve to show what may be expected. They are compiled from plants actually built and operated during the past five years:

Complete installation investment per cu. ft. treated per minute (at temperature of treatment)	\$0.30 to \$3.75
Capacity of installations, cu. ft. per minute	200 to 3,000,000
Power consumption, kw.-hr. per 100,000 cu. ft. per hr.	1 to 2
Labor cost per 100,000 cu. ft. cleaned per hr.	\$0.007 to \$0.02
Space occupied by precipitator per 100,000 cu. ft. per hr. cleaned	500 to 1,000 cu. ft.
Precipitation efficiency obtained in commercial plants	90 to 99 + per cent

The table on page 432 illustrates the actual capacities of individual installations.



FIG. 5. VIEW WITH "POWER OFF" OF PRECIPITATOR FOR REMOVING SULPHURIC ACID MIST FROM EXIT GASES FROM O. V. CONCENTRATOR

CAPACITIES OF INDIVIDUAL COTTRELL PROCESS INSTALLATIONS

	Metallurgical Dust and Fume (Large Installation)	Metallurgical Fume	H ₂ SO ₄ and Precious Metals	H ₂ SO ₄ Mist	Precious Metal Fume and Dust	Metallurgical Fume and Dust	Air Cleaning (Gold Dust)	Metallurgical Dust	Metallurgical Dust	Pyrite Burner Dust	Producer Gas (Tar)
Investment per cu.ft. gas treated.....	\$0.50	\$2.38	\$3.75	\$3.75	\$2.85	\$2.50	\$0.95	\$1.50	\$0.67	\$3.75	\$3.00
Cleaning cost per 100,000 cu.ft. gas treated per hr.....	\$0.03	.13	.22	.25	.23	.175	.08	.08	.03	.155	.15
Temperature of gases treated.....	250- 300°F.	600- 700°F.	150°F.	200°F.	650°F.	600- 700°F.	70°F.	400- 500°F.	300- 400°F.	900- 1,000°F.	70°F.
Power consumption, kw.-hr. per 100,000 cu.ft. gas treated per hr.....	0.3	1.6	2.8	2.0	2.4	2.0	1.0	1.0	0.2	0.1	1.25
Cleaning costs per 100,000 cu.ft. gas treated at 70 deg. F.....	\$0.05	\$0.26	\$0.25	\$0.30	\$0.48	\$0.35	\$0.08	\$0.14	\$0.04	\$0.50	\$0.15
Weight of gas treated in tons per hour, approximately.....	4,000	50	26	8.4	8.0	14.4	53	66	270	18	5
Efficiency of removal of suspended matter	85-90%	98+%	99+%	99+%	99+%	97+%	95+%	95%	91%	99%	99%
Weight of precipitate in lb. (av.), per 100, 000 cu.ft., approx.....	6	16	5-15	125	3	8-10	1.0	40-50	.....	7.5	15

NOTE.—Gas volumes taken at temperature of treatment, except where otherwise specified.

The foregoing outline indicates in general what has been done in the past few years, and can be done to an even greater extent in the future, toward the curtailment of industrial waste in the field of gas cleaning (for use in various operations) or for the prevention of atmospheric pollution. Close attention to all of the various factors entering into the solution of these problems is essential to ultimate success both technical and

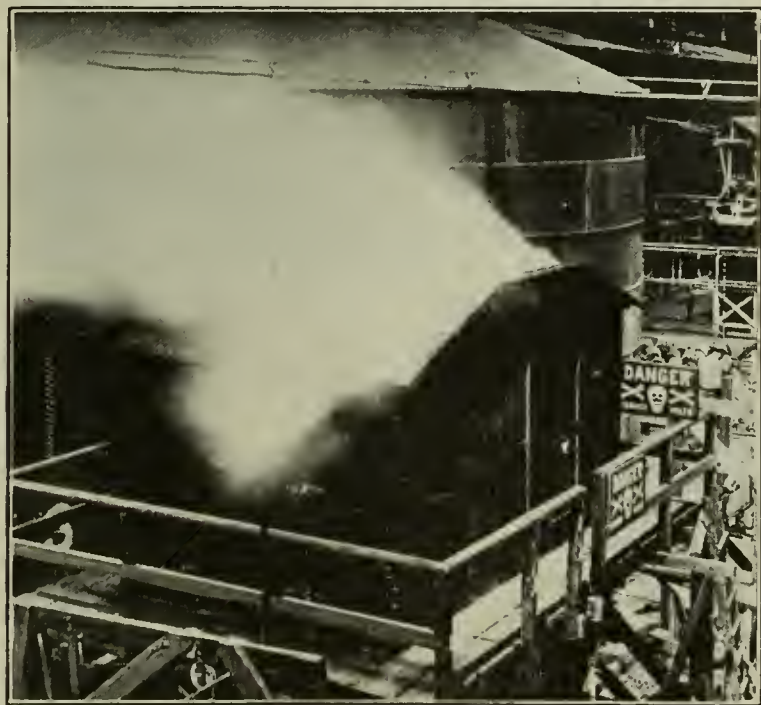


FIG. 6. VIEW WITH "POWER ON" ILLUSTRATING THE EFFECTIVENESS OF ELECTRICAL PRECIPITATOR FOR REMOVING SULPHURIC ACID MIST FROM EXIT GASES FROM O. V. CONCENTRATOR

economic. By conservative consideration of these problems as they arise much good may be accomplished, reacting favorably on the industry affected, creating new processes, making certain commodities more readily available, or assisting in the general betterment of public health and property to the end that the needs of our modern civilization may be cared for and even anticipated without appreciable detriment to anyone—the industries, the workers, or the public. Progress in this direction will therefore be slow, but if properly directed should be continuous.

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Waste and Inefficiency in the Industries

A Series of Short Articles by Industrial Leaders Featuring the Outstanding Causes of Waste in More Than a Score of Industries—Frank Confessions of Inefficiency Due to a Wide Variety of Causes

EDITOR'S NOTE: It is not often that technical executives will speak frankly regarding the weak spots of their industries. They may recognize them clearly and work assiduously to eradicate them, but they are apt to prefer not to talk about them, at least for publication. Accordingly the series of short articles presented herewith assumes a degree of importance that is not likely to be overestimated. Men fully familiar with the industries whereof they speak and fully cognizant of the necessity for eliminating waste and inefficiency have frankly laid bare the conspicuous weak spots. The reader will be struck by the variety of causes assigned by different writers. Lack of statistics, rule-of-thumb operation, lack of team work, lack of technical men and their engineering knowledge, poor management in high places—these are a few of the causes assigned.

A careful reading of the entire series will prove valuable to every chemical engineer regardless of the industry in which he is engaged. He has before him, in effect, brief reports of competent investigating committees whose findings may be accepted at their face value because in some instances they are the butt of their own criticisms.

The Wastes Caused by Carelessness

BY PHILIP DEWOLF
Davison Chemical Co.

If a job is done exactly right, which, of course, means that there are no mishaps of any kind, the result will be 100 per cent of the possible. That does not mean a 100 per cent yield in any chemical process, because chemical reactions go only to equilibrium anyway; also the last few per cent may cost more than they are worth, so cannot be considered within the limits of commercial possibility.

But the greatest enemy of the proper yield is lack of thoroughness. We all make mistakes; we all forget, and the only way to get the yield the greatest number of times is to cultivate the habit of thoroughness. It can't be taught—it must be learned.

CONSPICUOUS WASTES DUE TO LACK OF THOROUGHNESS

Let me give a few examples of troubles from this cause that have come within my experience.

During the war at a munitions plant oil-of-vitriol lines were put into service with bewildering rapidity, and each one started off and ran well until the very last one. And when the pumps were started in it every member of the crew was burned—not a wrench had been put on the flange bolts of the acid lines in the absorber house—someone had not been thorough.

A copper smelter was built 11,600 ft. above the sea, in the mountains of Peru. It was designed by an engineer who had built six large and successful smelters,

and, while of moderate size, was supposed to be the last word. The river furnished just sufficient power to operate the machinery provided. When the metallurgist started to figure his charges he couldn't get them to come out right—the designer had forgotten that at 11,600 ft. the barometer stands at 19 and 50 per cent more air, by volume, is necessary. That meant a new power plant further down stream—pretty costly lack of thoroughness.

This same smelter, owned by one of the largest and most successful copper companies in the world, was fed by many small mines, and before the last power house was finished a flaw in a group of titles was found, and the company abandoned its \$2,000,000 investment—a high price to pay for a careless lawyer.

One of the big munitions plants decided to use marl for neutralizing its wash water before releasing it to the river. One large body of marl was available, soft enough to be a steam-shovel proposition, but it had the drawback of roundabout transportation. So another "marl" deposit was found and bought. It was in rock form, so an expensive crushing and distributing system was installed at the plant. The first few hopper-bottomed cars arrived; the pieces of rock were so large they would not discharge through the hoppers and had to be unloaded by a crane, and were so hard that every crusher tried was broken. So without getting one pound of "marl" into the river this \$150,000 plant was abandoned because the engineer had satisfied himself as to transportation and chemical composition, but had paid no attention to physical condition nor to crushing facilities at the quarry.

THOROUGHNESS PAYS IN THE CHEMICAL PLANT

One very much used war chemical was bought by the Government at 50c. a lb. One of the large manufacturers made it at 19c. a lb., but some smaller contractors, without the technical skill available to the larger one, could not make it for 50c. So a "flying squadron" of good men was organized by the big maker, and was sent around to the smaller plants to cut costs and help production. In almost every case the trouble was found to be insufficient washing, and in every case costs were cut well inside the 50c.

At the 15,000-hp. boiler plant of one of our big chemical companies steam costs 26c. a thousand pounds, while at the best of the boiler plants of a still larger company it is 90c. To be sure, the larger company has no very large individual plants, but neither does it begin to pay the same attention to water softening, proper combustion of fuel, or other smaller but in the aggregate by no means unimportant items. The first company's thoroughness pays.

Examples could be given almost without end, but they would all point to the same thing—viz., how much it costs not to be thorough.

Baltimore, Ohio.

Dye Industry Lacks Business Knowledge

BY "INSIDER"

The manufacture of coal-tar intermediates and dyes is just like any other business, and suffers from the same business diseases. The great variety of products, coupled with an uncommon complexity of manufacturing practice, complicates the symptoms and intensifies ordinary business troubles to a degree not met in the usual industry. This is, however, merely an intensification, and nothing new or mysterious.

"WE DON'T KNOW OUR BUSINESS"

The principal cause of waste in the dye industry today is lack of knowledge of the business by those engaged in it! Horrible confession, we don't know our business, but it's true! This lack of knowledge is monopolized by no one group, but is common to all.

Beginning with the financier, we find a startling lack of appreciation of the risks of the business to which he pledges his resources and the normal ways of minimizing them. Common gambling would represent a true definition of his activities in most cases. Next, of red tape artists suppliant before a mysterious scientist we have had plenty, but the understanding organizer is still absent. Chemists of good training are ever present, but their dyestuff experience is attested by the prevalent low yield figures. Lack of plant discipline is indicated by a watch at our plant sewers—it's an even chance that the operating man either lets the batch by, or finds it desirable to dump it. As for the dyestuff engineer, he is still a dream. Witness our hodgepodge plant equipment and the primary failure to utilize expensive manufacturing equipment and buildings for manufacture rather than for storage. Again, where is the counterpart of the time study of the metal industry?

This view may be called extreme, but space does not permit amplification. One ever-present fact is very indicative—in no branch of the business can a full answer be given to a question without an extensive investigation, not only into the subject matter of the question itself but also into the underlying fundamentals. Commonplace knowledge of the latter is unavailable to most in this business; how then can we be said to know it?

In the past, circumstances have been largely to blame for this lack of knowledge, but we ourselves will be entirely at fault if we fail to correct it in the near future. Some companies have made a considerable advance already, but it is believed the picture here given is true of the average organization.

FINANCIAL, EXECUTIVE AND TECHNICAL PERSONNEL NEEDED

Assuming that we obtain from the public an indication of probable continued support, we must attract to the industry broad-gaged financial men to head our companies, who are willing to lay out a long-time manufacturing program and who are able to back it, even if it means waiting several years for returns. These men must further attract broad-gaged executives who are willing to learn the business and who realize that it takes time and money to build up an art. Chemical engineering, operating and commercial research must be undertaken in a systematic manner, and if the industry is to progress, this research must be undertaken by permanent employees of the companies involved. Letting the other fellow experiment, and if

he goes bankrupt, buying his results at a discount; or, if he succeeds, stealing his men, must cease. Freer interchange of general technical information between companies is an important desideratum. The perfection of organization and methods compelling the quick seizure and immediate utilization of the results of this research is essential. A policy of encouraging and assisting in the development of subsidiary industries, such as chemical machinery manufacture, should be practiced. Finally, we must welcome any methods which will tend to rob the industry of its mystery and thereby render available to it the recognized standard practices of other industries.

Thus can we be sure that we have learned our business, and thus only can we rid ourselves of the charlatan, the mysterious alchemist, the get-rich-quick schemer, the possessor of fake processes and the bribe-giving salesman. And when we have learned our business we will not be afraid to think of next year, and spend perfectly good money *now* preparing for it.

The Rubber Industry Learns Its Lesson

BY ANDREW H. KING

When the topic of waste is first mentioned, one usually thinks of some small insignificant dribble which if allowed to continue will eventually consume a large share of the profits. There is, of course, this type of waste in the rubber industry. However, through the work of alert salvage departments this loss is kept at a minimum.

But unfortunately there is such a thing as "saving at the spigot and wasting at the bung." For waste exists in high places as well as in the low. It is of waste in the high places that I wish to call your attention.

DISREGARDS THE WARNINGS OF THE ECONOMIST AND STATISTICIAN

In common with several other industries, rubber is now recovering from a very serious attack of indigestion, which in the business world is known as overproduction or overexpansion. Losses have reached almost incredible heights. A number of firms have gone into receivers' hands, while others have been forced to undertake plans of reorganization, which in one or two instances could hardly have been more rigorous.

As mentioned in the beginning, the writer feels that the severity and extent of the disaster were largely due to waste in high places. The first and probably the most unpardonable sin was the almost wholesale disregard of the opinions of the economists and statisticians. For at least a year before the "flood" one prominent financial intelligence organization was crying: "*Beware, the end is at hand.*" Few listened, but the majority kept right on with their overproduction and overexpansion as if nothing could ever happen that would puncture their soap bubble of prosperity. They were drunk with their own success.

WANTON SPENDING WITH NO EYE TO THE FUTURE

The second mistake was that very few firms laid by a rainy day fund. And such that did found their estimates wholly inadequate. Perhaps they thought it would never rain. Throughout the period of prosperity there was very poor control of spending. Purchases of all kinds, contracts for future delivery, new build-

ings, new machinery and new equipment were authorized with almost no check as to their need. The executives who should have been on the job were asleep.

Not only was there no respect for statistics as to general business conditions but there were no authentic statistics relative to their own business. Years ago a writer estimated that the average car consumed five new tires per year. This figure misled many who should have known better from their own experience if from nothing else. The estimate above mentioned was made when all tires were "fabrics." Today they are nearly all "cords" and the mileage has been multiplied by at least two and in many cases three or more.

Then again the art of repairing tires has made wonderful progress within the past few years. Today an accident to a tire no more spells its funeral than an accident to a car. New parts are placed in each.

The severe retrenchment which followed has brought once more a healthy condition to the rubber industry. It is hoped that the lessons have been well learned.

New York City.

Technically Trained Men, the Need of the Food-Preservation Industries

BY W. V. CRUESS

Assistant Professor of Fruit Products, University of California

Many companies engaged in food preservation spare no expense for up-to-date equipment and buildings. Often their sales and advertising departments are given the fullest support. Yet these same companies all too frequently intrust the management of production to men who have had no scientific training and who in many cases are opposed to the application of science in the plants under their control. In other cases a small amount of money is appropriated for a laboratory and for a chemist who is expected to return several thousand per cent on the investment at once; or the chemist becomes merely an unimportant adjunct to the advertising department. Both of these viewpoints are wrong.

CHEMISTS AND BACTERIOLOGISTS FOR THE CANNING INDUSTRY

The food-preservation industries are above all else badly in need of scientifically trained and experienced plant managers. Of almost equal importance is the need of well-equipped laboratories manned by high-class research and control chemists and bacteriologists. The National Canners Association has been of immense value to the canning industry. The value of the research work and control measures accomplished by Dr. W. D. Bigelow and his associates cannot be overestimated. Yet in the canning industry itself we have need for hundreds of university-trained men in production, research and control, if the canning industry is to come into its own.

The need is even greater in the pickling, beverage and fruit drying industries. That investment in scientific training and skill pays has been amply proved by such organizations as the H. J. Heinz Co., the Campbell Co. of Campbell's soup fame, the Van Camp Co. and others that could be mentioned.

MUST START AT THE BOTTOM

The food-preservation industries are not entirely to blame for the present condition. Too few of our university graduates are willing to enter the plants at the "bottom of the ladder." It will be necessary in many

cases for them to don a pair of overalls, learn present factory methods and strive for the superintendency or management of the plants. Observation has shown that such men usually advance rapidly. Once this pioneer work of establishing technically trained men in industry has been done, research and plant control will come quickly and naturally, to the great benefit and advancement of the industries concerned.

Berkeley, Cal.

Industrial Waste of Food Products

BY G. A. MENGE

Libby, McNeill & Libby

Considering industrial waste from the standpoint of failure to conserve and utilize byproducts to the best advantage, the food industry in general is perhaps less deliberately guilty than some other industries, considering that it is still largely based upon rule-of-thumb methods. Perhaps the broadest opportunity in the food field for waste of this kind exists in the great meat-packing industry, but whatever just indictments may be found against that industry it is a well-known and very generally recognized fact that indifference to industrial waste is not one of them.

IMPORTANT FOOD PRODUCTS WASTED

In other branches of the food industry, however, the total aggregate waste resulting from failure to conserve and utilize most efficiently such valuable material as skim milk and buttermilk in the operation of creameries, whey in the operation of cheese factories, sound culls and other discarded material of like nature in the food-canning industry in general and in the fruit industry in particular would undoubtedly reach staggering proportions. More or less numerous and intensive studies now in progress on some of these problems will doubtless result eventually in much greater conservation and more effective and economic utilization of such waste materials than is true today.

If, however, we apply to our text sufficiently comprehensive interpretation to include waste or losses resulting from avoidable spoilage of manufactured food products, the food industry becomes involved in a tremendously serious indictment.

WASTES THROUGH MISMANAGEMENT

If my experience in the food industry is typical and my observations accurate, waste through preventable spoilage in this industry is often directly traceable to inefficient management in one or more or all of the major functions of the industry, from central administration to selling, including manufacture and distribution as well as all functions incidental to these. Lax and inefficient management at any major point in the industrial path, especially in central administration—the hub of the industrial wheel—is almost inevitably reflected, generally in aggravated form, at all other points. Conversely, a high degree of efficiency in any one major function, especially in central administration, will surely induce favorable reaction all along the line. Obviously the scientific development of a strong organization, with sharply defined and closely co-ordinated functions, adequately controlled and checked and under the responsible leadership of thoroughly qualified men, is the remedy for waste through mismanagement.

Perhaps the largest proportion of preventable waste through spoilage in the food industry is due to rule-

of-thumb or unscientific methods of manufacture. To the extent that this is true such waste, in my judgment, can be very largely prevented by drawing more generally and more intelligently upon thoroughly qualified technical and scientific service, with capable, efficient and responsible representation in the administrative organization. It is my firm conviction, the opinion of most so-called practical men to the contrary notwithstanding, that the personnel of every food-manufacturing plant should include a man of such thorough technical training, in scope and degree, as to qualify him to recognize the sources of danger, often very subtle and insidious, to prescribe and apply proper and adequate protection when possible and to give competent scientific advice and help in the various technical phases of plant operation with respect to the food product involved. Such service in such degree, in my judgment, expresses the principle of proper scientific control in the food industry in its simplest terms. Elaboration of it may be indicated with great advantage in specific cases.

Disastrous experiences of an economic nature now and then in the food industry have gradually forced some degree of application, as well as recognition of the value, of scientific methods and control as a means of insuring safety, improving quality and greatly reducing waste of manufactured food products, but we still have a long road to travel before this development is complete.

Chicago, Ill.

Causes of Waste in the Textile Industry

BY ONE WHO KNOWS

One of the most apparent reasons for the waste that occurs in the textile-manufacturing industry is the status of intermittent operations which obtain in practically all divisions of this trade. In the majority of plants this spasmodic activity is caused by seasonal conditions which make for an abnormal rush during certain periods and equally abnormal idleness at others. The result is that manufacturers are not able for the most part to figure on 100 per cent capacity in calculating their costs, but must take into consideration the overhead of idleness.

This condition leads naturally to more or less discontent on the part of operatives, who cannot be assured of year-around employment, with the consequence that labor turnover is thereby increased and cost enhanced. To this may be added the liability of labor difficulties, which are more or less recurrent in the textile industry and which frequently last for a protracted period.

It is also apparent in the textile trade that there is a lack of planning ahead in the various operations of the mill. This produces a certain amount of idle machinery that could be utilized to advantage if plans were made to provide a continuous process from one step to the next. This lack of foresight also increases overhead.

BETTER COST METHODS, TECHNICAL RESEARCH AND ECONOMIC DISTRIBUTION NEEDED

It must be admitted that the textile industry shows no general inclination to adopt up-to-date or standardized cost methods. Naturally there are exceptions to this statement, but those manufacturers who are content with methods long discarded are sufficiently numer-

ous to characterize the industry as being decidedly backward in this respect. The effect of this apathy is far-reaching and accounts in a measure at least for much of the speculation and wide range of prices which is frequently noted in the selling markets. Another feature that is not complimentary to this industry is the small amount of technical research work that has been done in the past, though it must be admitted that more attention is being paid to this subject, and the hope for increased efficiency through better technical knowledge of materials and processes is widely entertained.

The uneconomic methods of distribution might be touched upon, though this is going somewhat afield in a strict discussion of waste in the manufacturing industry that goes no further than the production of the fabric. The passage of manufactured product through many hands means an accumulation of profits for each handler and an enhancement of cost which is an economic waste to the ultimate consumer. Here also, however, the tendency is apparent of a more direct contact between the manufacturer and the consumer of his product.

Inefficiency in the Leather Industry

BY JOHN ARTHUR WILSON

Chief Chemist, A. F. Gallun & Sons Co.

The most conspicuous cause of inefficiency in the leather industry is ignorance of the basic principles of tanning. As many as fifty distinct operations may be employed in converting the raw material into finished leather, when perhaps less than half of the enormous amount of labor and materials involved would yield a better leather, if only the relation of each operation to the entire process were sufficiently understood.

UNNECESSARY INCREASE IN TANNING OPERATIONS

Present methods of leather manufacture are largely the result of centuries of hit-or-miss juggling. By chance someone would discover that the introduction of a new operation caused an improvement in the final leather, but little realizing that the new operation merely counteracted the bad effects of some other operation that was either unnecessary or improperly conducted. It is like using alkali at one stage and an equivalent amount of acid at another when a neutral solution is desirable at all stages. Eliminating acid or alkali alone would cause trouble, whereas time, labor, materials and an improved product would be gained by eliminating both acid and alkali. The new operation might cause an improvement in some respects and introduce difficulties in others, requiring the introduction of still further operations for correction. Thus the tendency has always been to increase rather than decrease the total number of operations, and chiefly through ignorance.

ADDING SOLUBLE MATTER AND THEN REMOVING IT

A glaring example of this sort of thing is found in a certain manufacture of heavily greased leather where a tanner treats the hides in the final stages of tanning with very concentrated liquors to get an increase in weight. The large amount of soluble matter now present prevents the greases from penetrating the leather. His method of overcoming this difficulty is then to remove the excess of soluble matter by a scouring operation instead of ceasing the practice of loading the leather with concentrated liquors. He does not appre-

ciate the fact that the concentrated liquors caused the trouble nor that the scouring operation corrects it by removing the excess of soluble matter.

MUST RECOGNIZE VALUE OF CHEMICAL TECHNOLOGY

Incorrect beam-house methods necessitate corrective operations in or prior to tanning, just as crude systems of tanning increase the number of operations required in connection with fat-liquoring, stuffing and coloring. Often costly materials are wasted because their functions are imperfectly understood or because it is not known how to strengthen a used liquor so as to give it the properties of a fresh one.

The ultimate cure for this state of affairs lies in an intensive study of the nature of the interactions between and the physical and chemical properties of proteins, enzymes, tannins, emulsions, dyestuffs and electrolytes, followed by an intelligent application to tannery processes. Unfortunately the industry as a whole has not yet awakened to the value of such study and apparently still doubts that an increased knowledge of chemistry will result in any great increase in the efficiency of the tannery. Some will probably sleep until it is too late to meet competition.

Milwaukee, Wis.

Meat-Packing Industry Contributes Too Much to Fertilizer

BY L. M. TOLMAN

Chief Chemist, Wilson & Co.

The meat-packing industry has been noted for its attempt to utilize in some way every byproduct of the animal, and to a very great extent this has been done especially by the larger companies. It has, however, been realized for some time that a great deal of the material going into fertilizer could be utilized in some more valuable form—particularly is this true of the nitrogenous waste. At the present time it might be said that the most outstanding waste in this industry, if it may so be termed, is the material which goes into fertilizer. This material if it had been handled in the proper way might be made into either food products or into certain technical products, such as gelatine and glue.

BETTER UTILIZATION OF BLOOD

An example of the proper utilization of nitrogenous material could be well illustrated in the handling of blood. Blood consists of serum and red blood corpuscles, which can be separated to produce, in the case of the serum, a product known as blood albumen, which is of great value as a water insoluble glue and finds important uses in the textile industries. The red blood corpuscles consist largely of hemoglobin, which has been found to be of value in medicine. So it is that two valuable products can be made from a material which was formerly used almost entirely as dried blood for fertilizer. Moreover, it is undoubtedly a waste not to use blood for human food.

FAULTY HANDLING DEGRADES VALUABLE MATERIALS

Tankage should be considered similarly. Here we have a material carrying from 40 to 60 per cent protein. At one stage in its handling it was largely an edible product (except where it came from animals which were condemned on account of disease), and it was only the faulty handling that has degraded tankage into an inedible fertilizer substance.

In a general way it might be said that the greatest waste now apparent in the packing industry is that

which is brought about by spoilage or so degrading high-grade edible or technical materials until they are only useful as fertilizer.

Recent developments in the field of medicine have indicated that many valuable medicinal substances can be prepared from the glands and organs. Undoubtedly the developments of the future will be along the lines of utilization of all of these substances and their manufacture into the very highest grade of pharmaceutical preparations.

Chicago, Ill.

Waste in the Glass Industry

BY E. WARD TILLOTSON, JR.

Assistant Director, Mellon Institute of Industrial Research

Some years ago a writer aroused the indignation of glass manufacturers by stating that, despite much excellent management and notwithstanding the use of many ingenious machines, the main policy of the glass executive was to be described by the slogan, "Save at the spigot and waste at the bung." This expression, derived from a defunct industry, may divert the attention of the present reader from the main theme of this contribution and to some, in fact, the analogy may be quite unintelligible. The thought to be conveyed was that the manufacturer failed to recognize the necessity for obtaining certain essential information the lack of which often resulted in the loss of production for a considerable period of time or at least in the manufacture of an inferior product. The loss of a tank of glass due to the use of materials the unsuitability of which would have been indicated by chemical analysis was a case in point.

GLASS MANUFACTURER REQUIRES FACTS

The same thought has been expressed recently to the writer by a prominent and successful glass manufacturer, who, speaking of the industry at large, says:

We neglect facts; we reach decisions and take action without the readily available facts which bear on the matter in question or else we do nothing because the facts which would stimulate to action are not at hand. This is true not only of such information as physics or chemistry or mathematics can supply, but also of the facts which a study of simple records would reveal in the individual plant.

WASTES DUE TO MANAGEMENT AND OPERATION

Waste in the glass industry is of two sorts: The first type of waste results from the lack of proper management and is represented by poorly planned factories, inadequately constructed buildings which provide unpleasant and in some cases unhealthful working conditions, carelessness on the part of the workman, the improper selection of raw materials and the lack of standards for them, and the use of cheap labor for important operations such as the care of the gas producers and the regulation of the furnaces. As an instance, the owner of a small factory states that the systematic reading of gas meters and the constant checking of the proportions of gas and air entering the furnaces have resulted in a daily saving of 150,000 cu.ft. of gas.

WASTES DUE TO MATERIALS

The second kind of waste is due to fundamental limitations of materials, particularly of the refractories, which necessarily are employed. No really satisfactory substance is available for manufacturing those parts of the furnace which come in contact with

the melting glass or for the "crown" and other parts of the furnace. The refractories not only are dissolved slowly by the molten glass but also have a softening temperature only slightly above that of the furnace. Indeed, if the whole mass of the refractory block were to be heated uniformly to the temperature of the furnace, it would soften sufficiently to allow the structure to collapse. Consequently it is impossible to conserve fuel by insulating the furnace; but, on the other hand, it is necessary to increase the radiation (which amounts to around 40 per cent of the total fuel) by cooling the exterior by artificial means. Much of the product which is rejected, the "shrinkage," is discarded because of faults which may be traced back, either directly or indirectly, to the construction or operation of the furnace. Excessive loss of product also is caused, at times, by an occasional use of unsuitable batch materials and by a lack of control of the temperature in the leer.

TO PLACE THE GLASS INDUSTRY ON A SCIENTIFIC BASIS

The glass industry, certain branches of which owe their present status to engineering, will eventually meet its problems in waste through the infusion throughout the industry of the principles of science, not only in the way of research and control from the standpoints of chemistry and physics but also in considering questions of hygiene (including the prevention of contagion, poisoning and injuries) and in placing the several operations and, in fact, the entire organization on a scientific basis. That the more successful glass manufacturers maintain intensive investigations of these and other problems is significant.

Pittsburgh, Pa.

Improvements to Be Realized in the Cane Sugar Industry

BY C. E. COATES

Dean Audubon Sugar School, Louisiana State University

The manufacture of sugar from sugar cane when carried out properly in the most modern plants is exceptionally free from waste. The cane is weighed, the juice is weighed, the resulting sugar and molasses are weighed, and there is a loss unaccounted for of only a fraction of 1 per cent. From a mechanical standpoint, the steam pipes are insulated, the furnaces are provided with suitable gages and there is a heat recovery considerably above the average. The engine work is good, mills are efficiently run, the evaporation is carried on in triple and quadruple effects, graining is done in insulated pans and every effort is made to conserve heat by economizers and the like. Where any of these twentieth century devices are lacking or inadequately provided for, loss in both sugar and in heat is bound to occur.

On the whole, the greatest waste is in the mechanical end, because the economy of high-grade and therefore expensive mechanical engineers is not thoroughly appreciated. The chemist, on the other hand, is generally considered indispensable, and waste from inversion or from molasses of too high purity is not usual. The bacteriologist, however, is just beginning to be appreciated and considerable avoidable loss occurs from lack of consideration of his possible services. Fermentation frequently does more damage to the sugar house itself than is ordinarily known and finished raw sugars lose

materially in transit, because of inversion due to a number of different avoidable fermentations.

NEED OF BETTER UTILIZATION OF BAGASSE AND MOLASSES

Perhaps the greatest waste occurs in the utilization of the byproducts, which are bagasse from the fresh cane and molasses.

Bagasse is ordinarily burned. As a fuel a ton is worth about one-fourth as much as a ton of coal. It would have a considerably higher value if made into building board or paper stock. It is also possible to separate it chiefly into pith and fiber and from the pith plastics could readily be made. The economies have been effected only in isolated instances. Molasses can be fermented into industrial alcohol, and from this motor spirit can be made. This industry is at present quite promising. Molasses may also be used as a cattle feed, and this is done to a large extent. There seems to be no reason, however, why final cane molasses can not be made of such a quality that it would be also fit for human consumption. Comparatively little attention is paid anywhere to quality at this point.

The real waste in the cane sugar industry, and it is a waste of great magnitude, lies in the fact that much cane sugar is made by a rule-of-thumb method, with little consideration given to the teachings of applied science.

Baton Rouge, La.

Basic Technical Information Needed by the Edible Oil Industry

BY JOHN C. INGRAM

Development Engineer, Morris & Co.

An article dealing with the elimination or minimizing of waste in any industry is essentially a dissertation on the basic problems of that industry, and these are naturally receiving some attention from all those actively engaged in the industry. In the edible oil industry the precipitous decline of prices without any possibility of a corresponding decline in costs has brought about so-called economies which have tended to interrupt somewhat the progress being made in the solution of its fundamental problems. Work on the accumulation of basic technical information seems to have been indefinitely postponed and only those problems which promise immediate financial reward are being given any considerable attention.

From a host of pressing problems the following may be selected as typifying the trend of the present-day effort toward the elimination of waste in the several principal processes of this industry.

PROBLEMS OF CRUSHING

About 85 per cent of the edible oils of the country are produced primarily by the cottonseed crushers, who are confronted with the difficult problem of reducing the idle time of their numerous plants. The operating time of cotton-oil mills varies with their location and with the seasons, approaching six months as a maximum, while some have been known to operate but six weeks out of a year. The widespread distribution of oil mills throughout the cotton belt enables the producers to handle between 60 and 75 per cent of the total production of seed, but the capital outlay required is non-productive for the greater part of each year.

The reduction of overhead charges by increasing the

operating time of plants is the most pressing problem before the crushers today, and a number of solutions have been offered. A brief outline of several of these solutions together with a few comments are given below.

REDUCTION IN NUMBER OF MILLS AND STORAGE OF SEED

There can be noticed at present a tendency toward fewer mills of larger capacity, centrally located. The perfection of methods for the drying of cotton seed and the provision of adequate storage facilities promise some relief from the handicap of seasonal production. Part of the saving in freight on dried seed would be used to increase the mill's profitable working radius and the remainder to defray the expenses of drying and storage. Preliminary surveys indicate that the saving thus effected is distinctly worth while.

SUPPLY OF RAW MATERIALS OTHER THAN COTTON SEED

During the era of high prices an appreciable quantity of peanuts and soya beans were handled profitably by the mills, but under present conditions it is doubtful whether the working of these materials contributes much toward the solution of the dormant season problem.

The development of an adequate supply of foreign oil seeds and nuts gives promise of furnishing some relief to those mills which are favorably located. For some time certain importers have been offering small lots of these materials for experimental work with the view of developing these projects should the results prove favorable. It is well recognized by the leaders in the edible oil industry that the most likely source of supply is toward the south—in Mexico, Central and South America—and the materials which look most promising at the present time are sesame seed, cohune nuts and palm kernels.

LOSS IN SOAPSTOCK AND IN FULLERS EARTH

Like the proverbial cat, our old problem—the oil retention of soapstock—has returned with the era of comparatively low-priced oil, the war solution being no longer attractive when all cost factors are considered. This foots, or soapstock, selling around 1½c. per lb. still contains 20 to 26 per cent of 6 to 7c. oil. The refining process is in crying need of considerable study from the standpoint of colloidal chemistry.

Approximately 25,000 tons of fullers earth is used each year by the edible oil industry. The spent earth contains anywhere from 15 to 40 per cent of retained oil, depending on the type of earth. Some efforts are being made to recover the oil and some organizations are attempting to re-use the earth, but as yet no process has proved of sufficient financial interest to be universally adopted, and this material is still a liability.

EFFICIENT DEODORIZATION

This process, developed through decades of cut-and-try experimentation, is essentially the removal of odor bodies by distillation in steam. As such, the main item in its cost is steam, and attempts at cost reduction in this phase of the industry are very likely to aim at higher steam efficiency.

The main problems in deodorization are not connected with direct savings in the process, but with the elimination of waste, through the improvement in keeping qualities of finished oils.

Chicago, Ill.

Cement Industry Needs More Chemical Engineering

BY JOHN GODFREY DEAN
Chemical Engineer

The cement industry has suffered from many of the so-called industrial ills such as overcapitalization, excessive promotion, poor locations, lack of systematic cost accounting, poor management, local overproduction, unreasonable competition, poorly designed plants, lack of 'safety first' provisions, excessive power and fuel consumption, loss of dust and waste heat, etc., to the end of the chapter. Many of these disorders were general, some were more or less epidemic, and a very few were exceptional.

When we consider the rapid expansion that has taken place in this industry during the past twenty years, it is not at all surprising that it has suffered from the usual disorders of youth and inexperience.

CO-OPERATION DISPLACES SELFISH METHODS

By certain processes of elimination, foreclosure and consolidation many of the above-enumerated abuses have been overcome. During the past few years, by a process of education fostered and encouraged by the Portland Cement Association, the industry has become nationalized to a certain extent and a real spirit of co-operation has taken the place of former selfish business methods. This has resulted in a mutual exchange of ideas and experiences. The elimination of waste and inefficiency of manufacturing, marketing and business management has been discussed openly and candidly with great benefit to the industry. In particular, the educational work and propaganda carried on in the interests of "safety first" and the statistical work of the association should be mentioned as being of special service to the industry.

In spite of the many improvements that have been made in machinery and manufacturing methods there remains a great deal to be done, especially in increasing kiln production and efficiency, a better understanding of the essentials of fine grinding, elimination and collection of dust, conservation of heat, reduction of power and labor requirements, and the recovery of byproducts from the stack gases, to mention a few of the more important problems.

CEMENT PROBLEMS ARE CHEMICAL ENGINEERING PROBLEMS

It is my opinion that one of the essentials in the solution of these problems is the recognition of the fact that they are largely chemical engineering problems. In fact very few operations connected with the process of cement manufacturing are entirely mechanical or chemical, and it seems that in many instances proper consideration has not been given to the latter phase of the subject. In order to handle the large tonnage of material satisfactorily and economically the mechanical operations and equipment must necessarily be of a high order of excellence. However, since the ends attained by the various mechanical operations are so largely chemical, the chemical considerations should be of equal importance.

Many companies employ routine chemists and testers who have been recruited largely from the ranks with very little chemical training outside of what has been gained in the plant laboratories. The excellent practical experience of these men cannot be denied and on account of their more or less restricted responsibilities they have been able to meet the requirements. In order

to meet the requirements of the larger field of chemical opportunities better trained technical men are manifestly needed.

It quite often happens that a few degrees variation in the temperature of the drier atmosphere or a slight change in the physical condition of the materials or some other scarcely appreciable variation will materially affect the output and quality of the product. Again, certain methods of operation or certain types of machinery will give excellent results in one plant, while in a neighboring plant the same operations and machinery under practically the same conditions will be quite unsatisfactory.

These problems and many others of similar nature, and particularly the whole field of kiln operation, call for careful investigation and intelligent supervision by well trained chemical personnel. This, in my opinion, would hasten the solution of many of the problems peculiar to this industry and would play an important part in the elimination of waste and inefficiency.

Parma, Mich.

Wasteful Methods of the Naval-Stores Industry

BY V. R. CROSWELL

Naval Stores Division, Hercules Powder Co.

The naval-stores industry of the United States produces about 25,000,000 gal. of turpentine and 834,000,000 lb. of rosin, with an approximate value of more than \$40,000,000. About 90 per cent of this is produced from the living trees (the Southern long leaf yellow pine) by gashing the trunks and collecting in cups the oleo-resin (gum) which flows from the wound. The remaining 10 per cent is obtained from dead wood and stumps of the same tree by destructive distillation or by chipping up the wood, driving out the turpentine by use of steam and extracting the rosin by the use of a solvent.

SEVENTEEN CAUSES OF WASTE

The principal wastes in this industry may be summed up as follows:

1. Working young saplings. Government investigation has shown that the tapping of any tree less than 10 in. in diameter is a loss to the operator regardless of the market value of his products.

2. Poorly placed cups and aprons. On some workings as high as 20 per cent of the gum never reaches the cup due to improper condition or arrangement of the aprons and cups. This particular loss might conservatively be placed at 5 per cent of the gum for the whole industry.

3. Loss of volatiles through exposure of the gum. Probably more than 7 per cent of the turpentine evaporates from the gum before it is worked at the still.

4. Contamination of the gum. Dirt, bark, chips and needles falling into the cups (besides staining the gum and reducing the grade of rosin) will absorb a certain amount of this gum which is never recovered, although the foreign material is strained out at the still.

5. Loss of fresh gum through heavy rains. Fresh gum floats on water. After losing some of its volatile oils, it sinks in water. Heavy rains fill unprotected cups and occasion considerable loss in the fresh gum.

6. Improper chipping. Because of the character of their lease or their ignorance of the technical side of their work, operators often turpentine trees "to death"—a practice which materially reduces the amount of gum obtainable from the tree. Work done by the Forest Products Laboratory indicates that increased yields

might be obtained by even shorter chipping than is generally considered good practice at the present time.

7. Coloring matter from poor cups. Metallic stains from cups lower the grade of rosin produced.

8. Improper distillation. It is the rule rather than the exception to run the still and worm condensers hot, and to use uncovered receivers for the turpentine. Much loss through evaporation is the result. Careless or unintelligent handling of this operation may cause the contents of the still to foam up through the condenser and start a fire.

9. Character of containers. The container constitutes 20 per cent of the weight of a barrel of rosin, which results in excessive freight charges for producers and consumer. No better container has been devised.

10. Unstable market. The naval-stores market is particularly subject to fluctuations. This condition of affairs increases speculation, encourages working young saplings and turpentine "to death," excuses profiteering to make a "killing," encourages low wages, discourages employment of technical men.

11. Method of financing. The factor backs the producer, the producer "stakes" his men on the future. Both take heavy risks and necessarily charge heavily to protect themselves.

12. Forest fires. The Southern pine forests suffer from this calamity as do our other forests.

13. Destructive distillation. In destructive distillation no attempt has ever been made to utilize the volatile gases.

14. In the steam-distillation process the spent chips are burned for fuel, although they could be made into paper after being expensively ground up and chemically treated.

15. Only about 70 per cent of the resinous material in the wood is extracted by the present solvents. The residual resinous material is, however, dark, and special uses would have to be found for it.

16. Solvent losses in the steam-distillation process are excessive.

17. The cost of gathering stump wood is increased 20 per cent by the general practice of taking downwood off the land at one time, and later returning to gather the stumps.

Gulfport, Miss.

Production Wastes in the Ceramic Industry

BY R. H. MINTON

General Superintendent, General Ceramics Co., Plant No. 2

The principal causes of waste in the ceramic industry may be ascribed to the following sources in the order named: Fuel waste, absence of technical control, inefficient workmanship, lack of standardization, and ignorance of costs.

IMPROVE FIRING METHODS TO SAVE FUEL

The ceramic industry consumes an enormous amount of fuel in its operations, and the question of efficiency is of great economic importance. Until the war the cost of coal was so low that there was little effort made to improve the methods of firing kilns. When it is considered that heat balances made on various types of periodic kilns have shown that only 5 to 10 per cent of the fuel heating value is used in actually firing the ware, it can be realized that the mechanical means of firing are very far from theoretical efficiency.

The fuel cost is such a large item that the present high prices have stimulated efforts to develop more economical firing methods and more efficient kilns. The

principal trend is in the direction of the railroad tunnel kiln, where the ware travels through a kiln under continuous fire. Large sums of money are being expended to install and perfect this type of kiln. When successful, it has shown a fuel saving of from 25 to 60 per cent as compared with the old periodic kilns. It is still a long road to perfection, but the tendency is in the right direction.

ABSENCE OF TECHNICAL CONTROL

Many branches of the clay-working industry involve art as well as science, and it is impossible to manufacture these wares along strictly mechanical lines. On account of variations in the raw materials true scientific control is impossible. This makes it even more necessary that every available means of technical control be employed. One of the greatest sources of loss is through lack of knowledge of the raw materials used and the loose methods of uncontrolled manufacture in which too much is left to the human element. Great strides have been made in this direction within the past ten years and the future offers great possibilities along this line.

INEFFICIENT WORKMANSHIP CAN BE ELIMINATED THROUGH CO-OPERATION

Much of the higher grades of ceramic wares is partly hand made and its quality and uniformity depend almost entirely upon skilled workmen. The war played havoc with the morale of these workers and their utter lack of interest is today one of the great trials of the manufacturer. Manufacture is carried on under restriction of union shop rules which largely prevent efficient production. This is a problem of management and only better co-operation between management and labor will result in the elimination of many avoidable losses.

EVIDENT LACK OF STANDARDIZATION

The very essence of efficient manufacture is standardized production. On account of the wide prevalence of the raw materials used in the manufacture of many kinds of clay products it is comparatively easy to start a plant. This has resulted in many small units springing up everywhere. Many of these grow by a sort of accretion and the final result is anything but an engineering product. The tendency of modern plants is to adhere to good engineering designs and to accentuate mechanical equipment in every way possible in order to standardize methods at the expense of labor.

In the highest grade wares mechanical standardization is possible only to a limited extent. Here the element of art enters and plays an important part. It is this combination of art and science, together with the difficulties and uncertainties of the processes involved, that makes the industry so fascinating to all connected with it.

WIDESPREAD IGNORANCE OF COSTS

Perhaps in no other great industry is the knowledge of costs so limited. On account of the long period of time required in the production of a given unit the average cost system becomes so involved and produces such unreliable figures as to discourage its use. The lack of cost figures results in many articles being sold at a loss, while others may be out of line, prices depending largely upon competition. As compared with many other products it is really astonishing at what

low figures many ceramic wares are sold when one considers the skill required and the risks and losses involved in the ordinary course of manufacture. The advantages of the use of a uniform system of cost-accounting in the different branches of the industry is recognized and will undoubtedly result in placing the industry upon a much more stable basis commercially.

Metuchen, N. J.

Wastes and Inefficient Practices in the Petroleum Industry

BY W. A. HAMOR

Mellon Institute of Industrial Research, University of Pittsburgh

Certain wastes and inefficient procedures are observable in the great petroleum industry, particularly in the production of crude oil. It is recognized, for example, that greater supplies of petroleum can be obtained through increased recovery from our oil fields, resulting from the development and application of more effective operating methods, and especially from the elimination of wastes. There is, in fact, a many-sided movement to effect a more rational production of petroleum by scientific study, and there have been begun investigations on the determination of the capacities and characteristics of oil sands, the proportions of petroleum not recovered by present methods of production, and the laws governing the expulsion of petroleum from these sands. But little information exists on this subject, and it will be impossible to interpret data and to evaluate various production procedures until the underlying geochemical laws are better understood. Methods for stimulating production and increasing the recoveries of petroleum from strata, including the effects of vacuum pumping, the employment of compressed air or gas, and the use of water flooding, are receiving more and more research attention; and it will be contrary to experience if some of these efforts are not fruitful in the coming years. At present, geology, the real foundation of a study of production, is insufficiently applied or understood by the average producer, and consequently much of the production is accidental.

Wastes in production also result from the formation of emulsified petroleum in oil wells. Probably all emulsions in wells are formed after the oil has left the sand, and their formation often can be prevented. The broad study of methods for excluding water from oil wells, of the effect of water on production, and of related casing and tubing problems, would likewise lead to economies.

Other wastes in the domain of production engineering include losses of oil in storage, through evaporation, leakage, etc., and losses through fires at the wells and tanks.

HOW BETTER TO UTILIZE THE NOW AVAILABLE CRUDE PETROLEUM

From an economic standpoint, a better utilization of the crude petroleum now available can be accomplished by the pyrolysis of oils now used as fuel into gasoline. Less than one-half of the petroleum produced receives an ideal separation into products. Indeed, the output of gasoline may be doubled or more without increasing the production of crude petroleum.

Pyrolysis is the leading potentiality in petroleum refining, but the ideal pyrolytic or piezopyrolytic process is not a *fait accompli*. Among the common defects of the processes in use are the loss of oil as fixed or

permanent gas, low yields, the formation of undesirable impurities, and the accumulation of carbon. In this connection it is important to note that not enough work is being done in a systematic way to show how to economize in the use of gasoline when made.

Other wastes in refinery operations result from insufficiency in fractionation, chemical treatment and storage. Certainly there should be no abatement of research on the increase of the efficiency of tower stills, condensers and heat exchangers. And then a familiar problem in refining is the chemical treatment of lubricating oils in such a manner as to prevent the emulsions which result when sulphuric acid is employed, and to minimize other losses due to its use. The most economic utilization of the residues from the acid and alkali treatments remains an open field for research; it is surprising, in fact, that these have attracted so little investigational attention and that, even in well-directed plants, they usually are used for fuel. However, in time much of the acid and soda treating will be eliminated from refinery practice.

Pittsburgh, Pa.

Preventable Losses in Petroleum Refining

BY JOSEPH E. POGUE

Consulting Engineer, New York

The petroleum-refining industry represents an estimated investment of between \$1,500,000,000 and \$2,000,000,000 and in 1920 turned out upward of 20,000,000,000 gal. of products valued at close to \$3,000,000,000. The degree of efficiency attained assumes special importance in an industrial activity of this magnitude.

The petroleum-refining industry may be divided roughly into two overlapping parts: one comprising the large, complete, usually long-established plants, making a reasonably full separation of the raw material into the products in commercial demand; the other including the smaller, newer refineries, called skimming plants, that effect a very superficial extraction of values, recovering merely gasoline and kerosene, and lumping together the remaining products as fuel oil. The efficiency of the second type of plant is necessarily less than that of the first.

The preventable losses involved in the refining of petroleum are of three general types:

(a) Physical losses of material as a result of improper or incomplete installations, controllable in part by the refiner.

(b) Imperfect separation of products resulting in the recovery of more valuable components in a less valuable form, caused in part by faulty processing but in part the result of economic conditions over which the individual refiner has no control.

(c) Financial losses arising from idle equipment as a result of excessive installations, controllable in part by better planning.

ANALYSIS OF THE PREVENTABLE LOSSES

The physical losses of oil in refining, according to statistical records, total about 4 per cent of the crude run to stills. Part of this loss is inevitable, but upward of half represents gasoline vapor included in the still gases, recoverable by methods already in use for extracting gasoline from natural gas. Such methods for some time have been commercially applied in the more progressive refineries and these could be profitably extended to other plants. The fuel consumption in most

refineries is also unduly high; proper insulation, the installation of heat interchangers and other improvements would lead to a gain on this score.

The separation of crude petroleum into its maximum range of values is effected in only a few refineries. Full attainment under this head is not commercially possible under present conditions, but many plants could install with advantage fractionating towers that would enlarge their output of gasoline by recovering the portion that is normally left in admixture with the heavier products. The Bureau of Mines has estimated that the average efficiency of gasoline recovery runs from 75 to 95 per cent and that the country's output of gasoline could possibly be augmented as much as 10 per cent by greater effectiveness in distillation. The further extension and development of cracking may also be expected to enlarge the gasoline yield.

The petroleum-refining industry as a whole is carrying the burden of an excessive equipment. For several years the volume of oil run to stills has averaged close to 70 per cent of the installed capacity. Assuming a valuation of \$1,500,000,000 for the equipment directly and indirectly concerned with oil refining, the annual cost of this idle equipment, with money at 8 per cent, approximates \$36,000,000.

The proficiency of petroleum refining on the whole is not equal to the attainments of many other chemical industries. Such an outcome, however, is an inevitable result of the rapid growth of petroleum output in advance of a balanced set of demands. The discount from full efficiency is largely the result of a bountiful and cheap supply of raw material. With a stringency in raw material an ultimate eventuality, improvements in refining efficiency may confidently be expected.

Need of Technically Trained Men in Salt Manufacture

BY W. L. BADGER

Director, Evaporator Experiment Station, University of Michigan

It is difficult to point out wastes in the salt industry, because the whole industry is in a state of technical ignorance and disrepair. It is easy to see why this condition exists. Salt was so long a byproduct of the lumber industry and made with waste steam which cost nothing that the idea of applying engineering principles to its manufacture never occurred. The story is told of an engineer who went into a salt plant in Michigan not many years ago and pointed out methods by which steam could be saved. The owner's comment was: "I don't want to know how to save steam. I have too much of it. I want to know how to use more." In too many cases men who were brought up in this atmosphere are still managing salt plants.

WASTES DUE TO LACK OF TECHNICAL CONTROL

The most striking single source of waste is the lack of application of engineering principles to the utilization of heat. The grainer process still makes a very large proportion of the total output. While there are certain uses for which the type of crystal which the grainer makes is better suited, there are many cases where grainer salt is used merely because of prejudice or habit. Much of the grainer salt now made might well be replaced with vacuum salt, thereby substituting for single-effect steam economy triple-effect economy or better. In addition to this it would amaze the average engineer to see the lack of application of ordinary engi-

neering principles in many salt plants. Heat-condensed water is thrown away and boilers are fed with cold raw water. Piping systems are many times as extensive as they need be and are seldom properly covered. The application of very ordinary precautions would result in remarkable saving of heat.

Raw material is so cheap that a certain amount of waste here is entirely justified. In most plants, however, a very little care would result in the saving of many tons of salt a day which are now lost through preventable leaks. It is a question whether any system of accounting to keep track of salt entering and leaving the plant will ever be justified.

A third source of waste is the almost complete absence of labor-saving machinery. Salt is still largely handled in wooden carts, pushed by hand. Belt and package conveyors are conspicuous by their absence.

There are many other minor sources of waste which might be enumerated. The remedy for all, however, is the same—adequate technical control. Most salt plants do not need a large technical staff. One good chemical engineer who understood the handling of materials, the handling of heat, the operation of a boiler room and how to make a few simple analyses when the occasion arose would work wonders in the average salt plant.

The industry must come to recognize the need of technically trained men, or most of the smaller plants will find themselves helpless to compete with the one or two concerns that first see the light.

Ann Arbor, Mich.

Efforts to Eliminate Wastes in the Glue Industry

BY T. R. TENNANT

United Chemical & Organic Products Co.

Having recently passed through the greatest era of wastefulness the world has ever known, there is little wonder that as a nation and as individuals we are experiencing a reluctance to coming back to a normal and sane basis of business transactions. The logical beginning of such a transition is the elimination of waste.

Our province in this discussion is the glue industry, which itself is based on the recovery of waste. Although in this industry waste from various other industries is converted into a valuable commercial product, the process of conversion has not been free from the practice of wastefulness.

SAVINGS OF LABOR AND MATERIALS

As in other industries, savings have been made in labor and material in the last few years: savings in labor by the installation of various machines and rearrangement of equipment to facilitate flow of material through the various processes in the plant; savings in material by closer and more intelligent supervision of materials at each stage of manufacture. This control not only serves a very important part in preventing waste through decomposition, with consequent loss in yields, but has a direct bearing on improvement in quality.

The chemist has played a very important part in the glue industry, particularly in the last few years, and it is through his efforts that intelligent and systematic savings have been and are continuing to be made. There is still work for the chemist, however. The field is interesting and fertile enough to produce rich rewards for both the chemist and the industry.

One point at which a large amount of waste may be

eliminated is at the source of the raw material supply. Such raw materials for glue manufacture as are produced at packing houses and tanneries are merely by-products in these institutions and as such are not given the same consideration that the main products receive. To the glue maker it is a different story. These same byproducts are his raw material, and he is therefore vitally interested in their history and method of handling before they are received by him.

In many instances the improper handling of these materials at the source is due to lack of knowledge of proper methods. The glue maker is in a position to supply the necessary information, and in the interests of conservation is in duty bound to arrange for co-operation with whomever he is dealing. This has been done in isolated cases very successfully, and if the policy were carried out universally it would tend to eliminate waste and be a financial benefit to all parties concerned.

Chicago, Ill

Outstanding Causes of Waste in the Glue Industry

BY R. H. BOGUE

Industrial Fellow, Mellon Institute of Industrial Research

No single condition for waste in the glue industry stands pre-eminent, but three conditions prevail which, if eradicated, would constitute a seven-league stride in the direction of industrial economy.

LOSSES CAUSED BY POOR TECHNOLOGY

On the manufacturing side, the greatest losses arise through a careless disregard of certain principles that are known to constitute the most advanced practice in glue-house technology. Delay between the processes of boiling, evaporating and drying is most disastrous. The liquefying bacteria and molds which develop with awe-inspiring rapidity may bring the grade down sharply in only a few hours. The difference between the grade that should be attained with a given stock under the most favorable conditions and the grade as actually obtained should appear on the books as a technical loss, but this is not commonly done. Such a practice would furnish the most accurate index of plant efficiency. If the losses were necessitated through insufficient equipment, evaporator capacity or the like, there would be indicated in terms of dollars and cents the exact returns that an investment for such needed equipment would be expected to furnish.

CONSUMER OFTEN IGNORANT OF FUNDAMENTAL PROPERTIES OF GLUE

The wastes incurred by the consumer of glue through carelessness or an ignorance of the fundamental qualities of the material are of greater moment and are more to be deprecated than those committed by the manufacturer. The list of unsound glue-room practices is long. The measuring of glue rather than weighing may be fatal upon different lots of glue. The optimum concentration of glue for application upon different kinds of woods has not been sufficiently studied. Soaking is often carried on for too short a period; the upper portions are often dry; the soaking water is often so warm that bacteria injure the product. The temperature of melting is usually higher than necessary, and the melted glue is kept hot for many hours. Experiments show that a glue may lose in joining strength as much as 1,000 lb. per sq.in. by heating for twelve hours at 80 deg. C., or 5 per cent of its original strength per hour of heating. If maintained at a lower tempera-

ture (40 deg. C.), the bacterial decomposition will likewise result in a great weakening of joint strength. And unless the utmost precaution is used to keep all glue utensils perfectly clean, the liquefying bacteria that develop may become a most serious cause of joint failures. Higher joining pressures, evenly maintained, would result in the production of much stronger joints.

STANDARDIZATION AND SPECIFICATIONS BOUND TO COME

A standardization of the methods employed for the evaluation of glue and the expression of these tests in absolute terms is one of the most urgent of the present-day needs in the glue industry. Such a standardization could result only in good for the entire trade. The manufacturer could again enjoy a reputation based upon mutual rather than upon paternalistic confidence. The consumer would for the first time in history know just what he wanted and know when he received it. Glue would be ordered and sold upon a system of concise specifications, and a designated grade would refer to exactly the same thing, whether addressed to one company or to another. Manufacturers are reluctant to abrogate their long precedent of secrecy and competition through the art of salesmanship to an open competition based solely upon the quality-price basis; but public opinion and men of science are making the demand, and standardization is now a question not of whether it shall come, but of when it shall come.

Pittsburgh, Pa.

Wastes in Paint and Varnish Oils

BY OTTO EISENSCHIML
Manager, Scientific Oil Compounding Co.

All of the paint and varnish oil industries undoubtedly contribute their share of industrial wastes, but there are two representative industries which are particularly worthy of study. The first of these, the chinawood oil industry, is characterized by appalling transportation losses.

MUCH CHINAWOOD OIL LOST IN TRANSIT

Chinawood oil to a large extent is barreled in China and arrives at the Coast in the original cooperage. The waste on the boats due to leakage and breakage is enormous. Anyone that has received a shipment of chinawood oil has been perturbed at one time or another by the consistent discrepancies in the original gross weights and those that were marked on the barrels at the port of entry before the goods were re-shipped into the United States. On top of this, it is mighty seldom that a barrel load of this commodity arrives at its final destination without further serious damage. The writer has seen cars of chinawood oil arrive in Chicago time and time again with as many as ten and even twenty barrels completely broken in transit.

To make matters worse, a certain amount of soakage into the staves of the barrels takes place during the months that elapse between the barreling and the consumption of the oil. This waste amounts to from 2 to 11 lb. per barrel.

What a terrific overhead expense this means on the price of chinawood oil!

MANY LINSEED OIL PLANTS STAND IDLE

The second industry is the production of linseed oil, in which the greatest waste, it seem to me, lies in

excessive plant capacity. There are about three times as many flaxseed crushing plants as there are needed to take care of the linseed oil requirements of this country. The result is that most plants stand idle a great deal of the time, thus adding very considerably to the cost of production.

The remedy in the case of chinawood oil seems to be within reach. Elimination of wooden containers and more care in transportation, perhaps with a premium for those train crews whose cargoes suffer the least damage, should help matters greatly. At the present moment union rules are an obstacle to the last-named proposition.

So far as linseed oil is concerned no suggestion can be made. Repeated consolidations have failed in this respect and the permanent closing down of linseed oil mills has always been followed by the erection of new ones.

Chicago, Ill.

Improving the Paint and Varnish Industry

BY ROBERT S. PERRY
President, Perry & Webster, Inc., New York

The paint and varnish industry in Civil War times consisted of a few small factories for linseed oil, white lead and mixed paint.

Since the Civil War a continent has been occupied and a hundred million people across the far-flung miles have housed both a nation's families and a nation's activities.

To protect and decorate these new buildings of the great national expansion the paint and varnish industry grew with equal rapidity to enormous proportions.

As for the nation, so also for the paint and varnish industry, the half century of expansion prior to the World War was a period of effort toward increased profit from volume of output rather than from elimination of waste or possible savings in cost. The feverish activities of the World War period marked the definite end of this period for the paint and varnish industry. Maintained and increased success for any concern will now mean concentrated effort to improve commercial service, enhance quality of product and eliminate wastes.

FACTS TO BE CONSIDERED IN THE PAINT INDUSTRY

Waste savings must include investment cost in plant for a given output, as well as in labor, power and material. Better design for new factories, and careful engineering design, survey for reassemblage in present factories, are inevitable to meet the problems of investment, of labor and of power.

The recent developments and savings by leaders in the industry in finer grinding of tinting colors must be carried further and must be followed by those who have not yet availed themselves of the consequent better quality and conservation of these expensive materials. Standardization of colors like yellows will save great wastes.

Increased knowledge in colloidal chemistry and physics, and in the characteristics of paint as a plastic solid, as contrasted with its former study solely from the standpoint of a viscous liquid, directs us to question the possibility of ultimately transporting it from factory to consumer in a wrapper instead of in the expensive package of today.

We are now faced with the stupendous sums involved

in the present delivery to and destruction by the consumer of this container, which represents so large a percentage of the cost of the product. The white lead industry, with its use of about 99 per cent of all raw materials, is an example of the possibilities of waste conservation for the rest of the industry, and this high efficiency resulted from dust recovery as a sanitary measure.

RECENT IMPROVEMENTS IN THE VARNISH INDUSTRY

The heavy fume losses in varnish manufacture have now yielded to accurate knowledge of their nature and value, and about twenty leading manufacturers are now engaged in their recovery and use. The control and recovery of fume have led to control of fire risk and a new type of plant.

The new type of plant, the control of fire risk and the recovery of fume products have decreased varnish plant investment, cost of insurance and cost of product.

This new development of the past three years is rapidly transforming the varnish industry from a great waster to a highly economic and efficient industry.

New York City.

The Waste of the Soap Industry

BY J. H. CHESTER

Considering the manufacturing phase of the soap industry, the lay observer finds the waste extremely small. The processes are chemically controlled at every point and raw materials are purchased on absolute conformance with specification. In the factory, the nigger, or dark-colored material collecting at the bottom of the first-quality soap kettle, is drawn off and re-treated with the second quality batch. The nigger from this in turn passes through the laundry soap process, and the final residue from the laundry soap enters washing powders and cleansers. Washing powders, such as Gold Dust and Old Dutch Cleanser, were originally developed as an outlet to use up the foots from the cottonseed oil industry. They have a legitimate use in the household and serve the industry in the elimination of material wastes.

Manufacturing establishments are well located. Chicago, one of the principal centers, has the supply of fats from the packing houses and is sufficiently near the alkali supply from the Niagara district and mid-western sources. Principal centers east of the Mississippi River are economical locations for soap production and marketing. There is some economy of location on the Pacific Coast, where one or two plants have recently been established.

MATERIALS WITHOUT SOAP VALUE ADDED TO PLEASE THE PUBLIC

The salient waste in this business, however, is created through competition, where each producer, endeavoring to market his own particular product, has educated the public to desire transparent soap, perfumed soap, oatmeal, peroxide, witchhazel and other so-called medicinal soaps for the toilet. Embossed and lithographed art packages add to the expense. The production of transparent soap involves the incorporation of sugar, glycerine and sometimes castor oil. With one exception of foreign manufacture all transparent toilet soaps are cold made and require these substances, which are relatively very expensive and without detergent value.

Perfumery in soap is likewise cheapening in its use and sold at absurdly high prices. So a double waste is incurred with the purchaser paying a higher price for an article having no added soap value for the increased weight. The medicinal soaps do not contain enough of the constituent to warrant so branding and lead to a sense of false security. No germicide incorporated in soap can be as efficacious for removal of bacteria as can mechanical friction on the skin.

There is no distinct line of demarkation between toilet and laundry soap, since one merges into the other by nature of the manufacturing process. Many laundry soaps are put on the market heavily weighted with inert fillers, such as starch, silica and clays, which have no scouring or detergent value. Of course where silica is incorporated admittedly for scouring purposes there is no imposition on the public. The price paid for transportation cost on inert materials mounts to a large figure in the United States each year. On the contrary, white soaps having alkali fillers like soda ash or silicate of soda perform a function in softening the water.

PURE SOAP LAW WOULD PROVE BENEFICIAL

The best possible compound for soap is made by processing high-grade fats with first quality alkali. But toilet and laundry soaps should be purchased on the guaranteed soap value. Where it is necessary to soften hard water the soda ash or other alkali should be added separately. Were an act similar to that governing pure food and drugs enforced for soap products, it would work an economic benefit alike to users and reputable manufacturers.

There is no excuse today for low titer oils not being used, because they may all be hydrogenated to any degree of hardness desired. One form which research is now taking deals with the possibilities of the saponification of mineral oils. There will no doubt be discoveries from research laboratories which will permit of even better and cheaper methods of manufacture and treatment of raw materials, but after all is said and done, the greatest waste lies in the misleading of the public by the manufacturer overanxious to outstrip his competitor in the disposal of products.

How the Fertilizer Industry Can Prevent Wastes

BY CHARLES H. MACDOWELL

President, Armour Fertilizer Works

In common with all commercial ventures, the fertilizer industry has many opportunities for waste and often makes the most of them. It is a heavy chemical industry, manufacturing and selling plant food on a guaranteed analysis. It receives no pay for overruns and is docked for under-analyses. The old-time superintendent was sure he could determine the analysis of a variable material by looks and taste. He was wrong, but there are some old timers still at the helm. They refuse to adopt chemical control. Study of state inspection reports shows many costly overruns and comparatively few underruns. The industry gives away millions of dollars of plant food above reasonable safety provisions.

STRICT CHEMICAL CONTROL NEEDED

Plant losses begin with incoming material purchased on an average-lot-analysis basis. The values contained in one car often differ from those of another. This variation should be known. Shrinkage in weight in

handling and manufacturing starts at once. Average shrinkage should be ascertained and figured. Sulphuric acid yields may be good or bad, with niter consumption high or reasonable. The relation of iron to alumina in phosphate rock affects the availability and mechanical condition of acid phosphate. Fine grinding has much to do with obtaining low insolubles. Different rocks require varying quantities of sulphuric acid to obtain lowest costs and highest availability. Knowledge of what's going on in a factory can be obtained only by a strict chemical control.

In formulating mixtures a procedure based on careful weighing of ingredients of known analysis through mixing, and check analyses after mixing, including further balancing if needed, is the big enemy of waste in the mixing department and the good friend of profits. Again chemical control is the answer.

ACCURATE WEIGHING AND CAREFUL INSPECTIONS PAY

In handling incoming ingredients and outgoing finished product the man at the scale, if he is careless, makes dents in black figures during good years and increases the red in bad ones. Under normal conditions the industry fills 90,000,000 sacks of product. An overrun of a pound to the bag (and an over-industrious worker filled with speed mania can easily accomplish this) would mean giving away 45,000 tons of product worth fully \$1,350,000.

Avoiding waste in manufacturing comes from knowing what you sell as well as what you pay for, keeping fully informed as to your work and yields, careful inspection of machinery to avoid breakdowns and to save power consumption, accurate weighing, avoiding false motions in labor handling and keeping your superintendent advised as to costs on differing outputs that he may cut his cloth properly.

POOR COST-ACCOUNTING DISCREDITS THE INDUSTRY

As to cost-accounting: Like the overcoat in the expense account, all cost items get into the ledger some time and often too late for safety. Known costs are checked out daily, but unless deposits are annually made for hidden items of cost the unwelcome "no funds" notice comes to hand too soon for pride or for financial comfort. Often charges for interest on investment, or on stocks, are not taken into consideration in plant-accounting. Buildings, machinery and outside equipment are subject to heavy depreciation, and charges should be spread over the life of the plant to take care of these costs. Obsolescence is an item few makers consider. Depreciation reserves figured annually should be set up for the unusually heavy replacement year.

Companies that do not figure these items properly are fooling themselves and are apt to accept business on a basis of actual loss when they think they are making a profit. Such sales demoralize markets and discredit the industry. Steps are being taken by the National Fertilizer Association to work out a rational cost-accounting system which should show up much of the waste of manufacturing. This, together with chemical control and rigid plant and process inspection, should do away with many losses and tend to stabilize conditions. Do the thing right, know that it is being done right, know what it costs to do it and many present-day ills will disappear.

Chicago, Ill.

The Lumber Industry—A Flagrant Waster

BY EARLE H. CLAPP

Assistant Forester, U. S. Forest Service

American industry and the American public in their use of forest products have been and still are as prodigal as Nature herself. Not more than one board foot appears in finished lumber for every four cut in the woods. Two of the four are left in the woods or fed into the sawmill burner or are lost in seasoning before the stage of rough-seasoned lumber is reached. The third foot disappears during the manufacture of the finished product.

Even greater waste in manufacture is not uncommon. The hickory-handle maker buys two tons of lumber and sells 400 lb. of handles. In many furniture and chair plants unskilled labor plus unskilled supervision net only 70 or 50 or 35 per cent of the lumber received. Similar wastes characterize most all the other wood-utilization industries.

ENORMOUS WASTES DUE TO MISUSE AND TO FOREST FIRES

The question may be approached from another standpoint. The building trades alone use annually \$200,000,000 worth of timber in general construction where strength is a factor, and have only begun to consider working stresses. Much of the railroad claims bill of \$100,000,000 for damaged or lost goods should be charged to faulty containers. Fifty million dollars may cover the annual loss from poor seasoning of lumber. The development and use of preservatives in timbers exposed to decay could be made to save an enormous drain, equal to the annual loss from forest fires. Fire retardants and better construction could likewise largely reduce the \$200,000,000 annual bill for fire losses in buildings.

Our losses from forest fires have for the past ten years averaged 1,000,000,000 cu.ft. Furthermore, we allow 81,000,000 acres of forest land to remain an idle waste year after year and even add to it annually something like five to eight million acres. We are satisfied with one-fourth of the easily obtainable growth on 237,000,000 acres additional of cut-over and burned lands.

Much of this enormous waste is pure prodigality. When we have so much, why worry about waste? There is more money in wasteful than in careful use. We have not yet spent our inheritance and we will not go to work until we feel the pangs of hunger. Many seem to think it will be time enough then, provided that Yankee ingenuity has not found substitutes for wood by that time. Excessive waste in the forest industries has first, therefore, resulted from the very wealth of our resources.

BETTER KNOWLEDGE OF THE PROPERTIES OF WOOD A SURE REMEDY AGAINST WASTE

The second outstanding cause is our ignorance of wood and its products. Wood has been taken as a matter of course—nothing more has been thought necessary than the rules of thumb handed down from generation to generation. Only during the last decade has there been any real perception of the fact that we are dealing with a complex and variable substance, and of what this means practically. We are beginning to learn that knowledge of the strength properties of wood makes possible great economies, even in so elementary a matter as the making of boxes, for example. Knowledge of the physical properties of wood will solve

our seasoning problems. And finally, we can make the chemistry of wood assist in the utilization of vast quantities of material now waste, not only for pulp and paper, alcohol and other familiar products, but also for purposes now undreamed of, as is exemplified by the recent discovery of a method for converting sawdust into stock feed.

Washington, D. C.

More Pulp Per Cord of Wood—Why Not?

BY JOHN D. RUE

In Charge, Pulp and Paper Section, Forest Products Laboratory

The pulp and paper industry stands seventh in the list of great American industries. In 1920 over 7,000,000 tons of paper was produced in the United States, in the manufacture of which 6,114,072 cords of wood were consumed. This wood cost the manufacturers over \$116,000,000. One of the prominent examples of waste and inefficiency in this country is found in the present methods of handling and utilizing our forests. The pulp and paper industry is a large contributing factor in the production of this waste, since 8 per cent of the annual cut of timber goes into the manufacture of paper. Each cord of wood cut contains a certain quantity of potential paper-making material. When manufactured into ground wood pulp, all but the water-soluble portion, or approximately 96 per cent of the wood, exclusive of the bark and knots, could become paper. When manufactured into chemical pulps, probably between 55 and 60 per cent of the wood could become paper. Anything less than these amounts really constitute a waste. Let us consider the causes for such wastes and how far they might be avoided.

It is comparatively easy to point out the location of the losses, but, unfortunately, the methods of measuring the wood used and the pulp produced, especially the former, are so inadequate that no real knowledge of percentage yields can be obtained. Such information is most essential, however; for an accurate knowledge of existing conditions is prerequisite to improving these conditions.

WASTE CAUSED BY DECAY DURING STORAGE

If we start our consideration with the pulpwood after it has been cut, we will find our first source of loss in decay during storage. A certain amount of decay in the wood as received must be expected, for the pulp industry cannot compete with the lumber industry for the finer grades of wood. Lack of proper care in handling and storing is responsible, nevertheless, for large decay losses. The wood loses in weight, causing a proportionate loss in the possible yield of ground wood pulp as well as a loss in the quality of the product. Furthermore, the destructive organisms have a selective action on the cellulose, so that the potential yield of chemical pulp is reduced. Losses from the decay of pulpwood and wood pulp are estimated at at least \$5,000,000 per year, and could to a large extent be prevented, provided more were known about proper methods of handling and storing the various species, and more of that which is known were put into practice. Investigations of preservative treatments for ground wood pulp have already indicated most encouraging results in the prevention of decay during storage.

In the grinding of wood losses are met with on account of the production of excessive amounts of fine wood flour and of large slivers. More efficient control, as well as improvements in the quality of the stone and

in its care during operation could do much to lessen these losses, which amount to over 5 per cent, or 75,000 tons per year, valued at \$3,000,000.

IMPROVING THE METHODS OF PULP MANUFACTURE

The fundamental object in using chemical processes in the manufacture of pulp is to produce a pulp of greater durability and of higher quality than is possessed by ground wood pulp. Approximately 55 to 60 per cent of the weight of the pulp consists of cellulose, and it is reasonable to expect that it should be possible to obtain this amount of a white pulp product. Higher yields should be obtained when a less pure product will suffice. As a matter of fact, in practice less than 45 per cent of the wood is obtained as high-grade pulp, or less than 75 per cent of the potential yield. In other words, the wood consumed during 1919 should have produced 600,000 tons more than the 2,000,000 tons actually obtained, which on a very conservative estimate would represent a value of \$30,000,000. It would not be fair to the pulp manufacturers to estimate that this loss is entirely or even largely due to inefficient methods of operation, although it is true that through a more thorough system of technical control much saving could be realized both through improved yield and through improved quality of product. It is fair, however, to charge the industry with a large portion of this loss, because it has failed to prosecute vigorously the scientific investigations necessary to unfold the underlying principles of the processes. Such knowledge is fundamental to the rapid improvement of pulp manufacturing processes and to the design of efficient plants and equipment.

It is a regrettable commentary on the industry that the past fifty years has seen so few changes in the pulping processes. With the exception of an increase in the size of units and in the rapidity of production, pulp manufacture today stands practically where it stood during the last quarter of the nineteenth century. There are evidences, however, of an awakening to the need for intensive investigations along these lines which give promise of greater progress in the future.

MORE FAVORABLY LOCATED SPECIES MUST BE USED IF POSSIBLE

Any discussion of the inefficient utilization of wood in pulp and paper manufacture would not be complete without emphasizing at least one other factor, a factor which when fully appreciated is most startling. Fifty-six per cent of all the pulp wood consumed is spruce. If we include with spruce hemlock and balsam fir, these three species constitute 77 per cent of the entire pulpwood consumption. The significance of these facts becomes evident when we realize that the supply of these species comes almost exclusively from the northeastern section of the United States, and that it is estimated that this supply constitutes only 3 per cent of the entire wood supply of the country. The drain on this limited number of species is causing their rapid depletion. Pulp mills which were a few years ago in the heart of their pulpwood supply are now forced to haul their wood long distances and in many cases past large stands of available timber, which, however, are considered undesirable for pulping. This state of affairs means lower profits to the manufacturer and higher prices to the consumer. Here again intensive investigation and research are needed to point the way to economic means of utilizing more favorably located

species. In a field of such wide application and universal interest the highest degree of co-operation in such investigations is desirable, if not imperative.

NORTHERN PINES THE MOST PROMISING POSSIBILITY

Species that are to meet satisfactorily the demands for pulpwood must be favorably located with respect either to present mills or to the pulp markets. An increased supply of spruce, hemlock and fir can be found only in the far West; too far from present mills and too far from present pulp markets to warrant the extensive building of new mills.

A goodly supply of hardwoods is available especially in the Central and Southern States, but the shortness of their fiber greatly limits their field of usefulness. The pines, however, still remain as an important possibility. If the Northern pines could be satisfactorily used, the supply of pulpwood to the mills now using spruce, hemlock and fir would be immediately doubled. Five times as much more pine is available in the Central, East Central and Southern States. These localities would be within range of pulp markets and the supply of pulpwood could be obtained without undue competition with the lumber industry. Here again the one outstanding need is for intensive research to blaze the trail to successful utilization.

Sins of omission are quite as grave as those of commission. The fact that the industry has failed to provide for an early solution of these problems does not relieve it one whit from the responsibility for the inefficiencies and waste which this failure involves. It is a matter for great encouragement that the leading organizations of the industry are turning their attention to these problems. The need is urgent, and procrastination spells catastrophe.

Madison, Wis.

The Lack of Team Work in the Wood- Distillation Industry

BY FRANK J. ROOT

So much has been published on the huge loss of sound wood in form of forest waste and mill waste that one may now merely call attention to the fact that it is one of our foremost extravagances.

In the manufacture of wood-distillation products in the United States good body wood in the form of cord wood has been used at an average rate of over a million cords annually for the last twenty years. This cord wood has been so increasingly expensive and hard to obtain that many makers have curtailed an otherwise profitable production, while some have entirely suspended operations.

USE OF MILL WASTE RETARDED BY LACK OF CO-OPERATION

The major problem during these twenty years has been to find a method whereby the vast quantity of mill waste might be made to replace the disappearing cord wood. This effort has indeed been a battle royal, with three chief participants: (1) The mill owner; (2) the wood-distillation operator, and (3) the technical man. There seems to exist every economic reason why these three should work in entire harmony, but instead they treat one another with suspicion and do not seem able to speak the same dialect. The sawmill owner pleads he is not a chemical man and hence will have none of it. He also holds his waste at prohibitive figures. The wood-distillation men as a class stand

aloof from advancement, not only refusing to aid but insisting that their own antiquated methods cannot be improved. This is humorous in view of the fact that their yields per unit of wood carbonized have been steadily declining until they are now 30 per cent below the good yields of twenty years ago. Their sporadic attempts at improvement have been for the most part ill-advised repetitions of well-known mistakes.

CAUSES OF FAILURE SHOULD BE STUDIED

What, then, is the answer? Suppose a case in which John Doe spends \$80,000 or \$100,000 in an attempt at betterment, which fails utterly and the plant passes to the scrap heap. A little later Richard Roe (who does not know John Doe) feels the urgency of improvement and begins a similar campaign, carefully avoiding any contact with the lamented John or his history, which he dismisses with the terse term, "failure." Roe proceeds until he, too, is in deep water, only to find he has in effect repeated John's error.

Obviously, this economic waste may be avoided by properly compiled records which shall include failures as well as successes. It may not be pleasant to work in a morgue, nevertheless the resulting knowledge of how the patient died may save the next case. The only way the so-called human race progresses is by beginning where the other chap quit. Refusal to do this results in some of the difficulties from which this industry suffers.

THE SAVING FROM BETTER RECOVERY OF WOOD-DISTILLATION PRODUCTS

Another phase of this interesting history may serve to illustrate the lack of team work: Each cord of wood carbonized yields as an unavoidable byproduct, 12,000 to 15,000 cu.ft. of gas. When leaving the retort this gas carries with it all the liquid values, including the wood alcohol. To reclaim these values from the gas an ordinary water-cooled surface condenser alone is employed. This serves to remove a large portion of the liquids, but unfortunately not nearly all. The gas mass, still saturated to its dew point with both alcohol and acetic acid, goes directly to the fireboxes and is burned as fuel.

About twenty years ago a method was worked out whereby these liquids were reclaimed from the gas and at the same time the vapor tension on the retorts was accurately controlled, the net saving amounting to a 10 per cent increase in products made. This work was done on a commercial scale and installed in a small group of plants, where it continued to make its regular 10 per cent saving year after year.

With a record like this one might expect to see every plant similarly equipped, but sad to relate the number so equipped has never been materially increased.

The loss so incurred may perhaps be best visualized if stated in terms of trees: each year the industry thus unnecessarily cuts 5,000 acres of good standing timber. In the twenty years under discussion it has cut 100,000 acres.

This protracted sacrifice appears to the writer to be in the same class as the drain on the productive land of India by the keeping of vast herds of "sacred" cattle which produce nothing. We condemn the Indian's attitude. What shall we say of the American parallel situation? A small amount of team work by the parties interested would soon correct this waste and avoid another twenty years of extravagance.

Chicago, Ill.

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Defenseless in War

And Laggards in Peace

THE present is a historic moment in American chemistry. True, the meeting of the American Chemical Society, now in session in New York, is incidental inasmuch as it is a semi-annual occasion and the exposition is established as an annual affair. But never before was there so much at stake for chemistry in America. The reason for this is because we are momentarily weak in the weakest link of our chain.

As a nation we are a lazy people. Nearly every Yankee invention from the sulky plow to the sewing machine was designed originally to make less work and that easier. We'd rather sit down than stand up and when we search our hearts we find that most of us aspire first of all to wealth for the purpose of ease. We have let the wish become father to the thought and, having grown rich as a nation, we have, rich and poor alike, adopted luxurious habits of mind. We think hard only once in awhile; the rest of the time we let things drift until the miseries bank themselves up against us. Then we have to hustle when it is almost and sometimes quite too late. It was so with the Civil War, with the German war, with free silver, with American shipping, with the petroleum industry of which we are losing the leadership, and we are now at the parting of the ways in chemistry.

A number of signs that everyone can recognize point to this danger. The widespread devastation of research laboratories by incompetent administrators of chemical industries is one of them. Chemical industry differs from all others in that it cannot be permanently standardized. The standard of today may well spell failure tomorrow. Research must always be years—sometimes even a dozen years—ahead of the game. Unless not only administrators but even stockholders understand this, chemical industry cannot thrive.

The effort to kill the U. S. Chemical Warfare Service was another close call. We have to thank the enlightenment and the perseverance of a very few Senators and Representatives in Congress that this leading feature of national safety was not utterly destroyed. It has now been reduced to such a skeleton that only by the greatest intelligence in leadership can it be maintained. The removal of General FRIES and the appointment in succession of someone of the unscientific type of mind of General PEYTON C. MARCH, for instance, competent soldier though he may be in other respects, would destroy it in short order.

The dye industry is the bulwark of organic chemistry. Chemists and textile manufacturers and dyers and finishers all know that the price of dyes themselves has the least bearing on the cost of finished goods. They know that every dye that makes for fastness against light, wash, bleach, wear and perspiration that was available before the war is available today

by direct purchase on the market or by importation under license. They know that the bulk of the costs of dyeing and finishing is in labor and time and not in dyes. And yet we find on all sides, repeated *ad nauseam*, the deliberate lie that improperly dyed goods are inferior because American-made dyes are not good. This is not true and manufacturers know it. When the coloring is inferior, it is because with the high cost of labor in American dye and finishing houses, it is cheaper to make it so. That is the sole reason. The cost of the dye itself is negligible. At the same time Congress has thrice refused to provide for the continuance within our borders of this industry, which is as essential to our national defense as the United States Artillery. If Congress does not learn this fact before the end of the year, the industry will be lost.

We could continue the enumeration of these danger signals at greater length if we were so disposed, but we shall merely add the note that the Employment Bureau of the Chemists' Club is overwhelmed with applicants for positions, whereas there are but few vacancies to fill. The applicants include men of splendid attainment and capacity. The very time when they might be doing the kind of work that reduces the cost of production or improves the quality of products they are sent away. We know of one great chemical works that let about 500 of its laborers go because there was no market for its goods. It was in the same boat as other manufacturers. But it kept its research laboratory in more intensified activity than before. "Bad times have hit us," said the president, "but we need our chemists. We need them more than we need our accountants, and we shall not close our research laboratory until after we close our office." Incidentally it may be said that the products of this plant bear an enviable reputation for quality.

Perhaps with the spread of the doctrine of relativity we may gain a larger sense of what time is. Our present disposition is to think that "any time will do." But any time will not do. We must do some things now, today, or the opportunity will pass. We must change a number of our ways. We must reorganize research by re-establishing it, not only where it has been given up but elsewhere. We must hearten the chemists engaged in their work. We must enlarge and spread chemical understanding and sense in the offices of works and among their boards of directors. We must teach our legislators the meaning of chemistry and its amazing ubiquity, from the farm to the fireside. These are our tasks today, tomorrow, next week, next month, before the year is over. We are indeed at the parting of the ways. We must conserve chemistry in America. It is the gospel of industry and the protector of nations. Without the pure science we cannot apply it and without applied chemistry we shall be defenseless in war and laggards in peace.

The Electric Furnace and Sound Castings of Pure Silver

THE introduction of the electric furnace into the United States Mint and into precious metal foundries is in itself a notable event; and it seems likely that due to the high efficiency of the operation and the excellence of its products the electric furnace will attain supremacy in this as well as in other branches of non-ferrous metal melting. In changing from crucible melting to electric-furnace melting it was necessary to take into account the natural properties of silver, particularly pure silver. The latter in the molten state will occlude, absorb or combine with 22 volumes of oxygen, giving rise to the familiar phenomenon of "spitting" or "sprouting" due to the escape of the imprisoned gas as the metal cools. Whether the oxygen is combined, as MUSPRATT believed, or merely occluded has never been settled; however, metallurgists have resorted to various expedients to eliminate "sprouting," as otherwise it is impossible to make sound castings fit for rolling or stamping. Accordingly it has been common practice to use an air-tight covering of molten salt or a covering of charcoal. There are, however, serious objections to coverings of this kind.

In introducing the electric furnace into the silver foundry steps were taken to eliminate all coverings and reduce the metal losses to a minimum. The successful culmination of tests to this end are recorded by Mr. HERLENIUS elsewhere in this issue and will be presented also by Mr. DEFRIES next week. The interesting and novel feature of the work consists in the introduction of an iron block into the silver bath. This practice serves a double purpose: First, that of a heat equalizer; and second, that of an oxygen "sponge." The idea is so simple, and therefore the more valuable, that one wonders that it was not suggested long ago. But with the empirical results well in hand, it is possible to offer some thermochemical comparisons. The specific heat of iron throughout the temperature range of melting and casting silver is twice that of the precious metal. Again, the heat of combination of iron with oxygen is about ten times that of silver with oxygen. Furthermore, the iron oxides are very stable, whereas the silver oxides are very unstable.

The metallurgist may see in the principle of the iron sponge process a certain parallelism with the Parkes process of silver refining. It will be recalled that in this process advantage is taken of the fact that freezing zinc and lead are mutually insoluble, or very nearly so, while silver at the same temperature has a decided affinity for zinc and only a slight affinity for lead. Similarly, in the iron sponge process, molten silver has little affinity for iron, while oxygen has a decided affinity for iron and only a slight affinity for silver. The iron sponge process is so extremely simple and has given such excellent results in the case of silver that it seems likely the underlying principles may be applicable to the making of sound castings of other metals—for example, copper. 'Tis true that the old Lautenthal foundry used to place a wrought-iron ring on the molten silver to prevent the spattering of the silver sulphate during the Roessler refining process. Others have employed iron rods to stir the molten silver. But no one, we believe, has ever before introduced metallic iron into the molten bath, as a stabilizer of heat and an absorber of "noxious" gas. They even have told us that oxygen is insoluble in iron!

Wastes in the Iron and Steel Industry

IT IS only about twenty years ago that a steel mill was abandoned, having separate foundations for the shafts and cylinders of some of the engines. Less than thirty years ago a Corliss engine was considered far too delicate a machine to be used in a rolling mill. The industry has made wonderful progress in the past quarter century, more rapid progress than in any previous period. The best practice today is not far from the best practice it is now possible to propose. The best practice is not universal, but where it is not followed the cause is lack of capital rather than lack of knowledge or desire. There is little to criticize or suggest as to the individual manufacturing interest.

The iron and steel industry considered as a unit, however, presents cases of tremendous losses. The losses referred to are due to distributed ownership of facilities that should be under one ownership and management. One great loss is due to the existence of what are known as "merchant" blast furnaces. Another loss is due to the use of the beehive coking process instead of the byproduct process. The merchant furnaces make between 25 and 30 per cent of all the pig iron. As a rule it is not feasible for them to operate a byproduct coking plant, on account of the smallness of the operation; that is one loss. The furnace, if it has reasonably good practice, uses economically all of its gas that it needs and wastes the rest; that is another loss. A third loss arises from the furnace being idle a very considerable percentage of the time. If the steel mills, which consume between 75 and 80 per cent of all the pig iron made, should make all the pig iron, they could conveniently stock malleable, forge and foundry grades in dull times. It is disadvantageous for them to stock such iron as they use themselves, since they lose the advantage of "direct" or molten metal. With one or two interesting exceptions, all the merchant iron now made is delivered cold, so that it is iron that could readily be stocked. Steadier operation of blast furnaces would result. The recent past has given an impressive lesson of the desirability of finding an operation for steel works blast furnaces in dull times, as well as an excuse for operating attached byproduct ovens. At some steel works in the past six or eight months there has been a painful accumulation both of byproduct coke and of pig iron, partly because blast furnaces had to be operated as gas producers. The gas was needed, the pig iron was not needed.

It is a debatable question whether an economy would be represented by the steel-making industry carrying its products to a greater degree of finish. The fact that some steel makers have gone farther while others have not shows that the matter is debatable, and it is easily seen that there has been no uniformity of counsel. One steel company builds freight cars. Another, and larger, company has kept away from freight cars but makes well derricks. Another steel interest does not fabricate the sheets it rolls but does make railroad spikes. As a rule steel mills have tended to avoid fabricating their rolled products, because they wished to avoid the appearance of competition with their natural customers, but in order to "expand" have added new lines of rolled material instead of following the original line to a greater degree of finish. On the ground of economy many products could be fabricated much better by the mill than by the mill's customers.

Would the ZR-2 Have Been Saved by Helium?

SOME authorities answer this question "Yes." Some say "No." Others express a noncommittal "Perhaps." But however the question is answered, anyone who knows the facts admits that there has never been enough helium produced to have filled the ship even if all of it could have been assembled for use in the fatal trial flight.

Industrially the question of real importance is, "What is the influence upon our national helium program of this much regretted disaster? It is immaterial whether it was a failure of framework, an explosion of gas, or a gasoline fire which was the original cause of the crash. All contributed to the final result, but if helium had been present instead of hydrogen at least one element of the disaster would have been eliminated. In other words, as expressed by one Government scientist, "The disaster is another argument for the advancement of the helium program."

At present there is available for helium studies from Army appropriations a quarter-million dollars. The Navy appropriation, which is made in one general fund for several projects, will provide an additional \$400,000 if it is prorated according to the original requests for funds. However, this sum can be augmented if the Secretary of the Navy should deem the helium work of greater relative importance than the other projects which must be cared for from this general fund. But it is unlikely that helium will be considered sufficiently important to increase the allotment for it to a total of \$1,600,000, which is the sum requested by the Helium Board. This would practically stop other essential work in the lighter-than-air service. It seems certain, therefore, that the Government work will progress much less rapidly than was deemed desirable by the Army and Navy officials who prepared the estimates unless Congress should come to their relief.

Helium is a typically American resource. Numerous natural gas fields are known by the Bureau of Mines where recoverable quantities of helium could be obtained by a process which is already a demonstrated success in the plant at Fort Worth, Tex. No other nation has such helium reserves. Therefore, so long as helium production does not result in export, America will have exclusive advantage of this non-flammable balloon gas. Indeed, this element of exclusiveness is one of the most convincing arguments for the further development of our helium projects, expensive though they be.

It is too soon to say what the official conclusions will be on the question whether increased impetus shall be given to the helium program or not. Officials of the Army, the Navy and the Bureau of Mines all wish to reserve judgment in the matter a bit longer in the hope that we can learn more of the causes and the significance of the catastrophe. However, certain fundamental facts can be clearly set forth at once. These are most strikingly given by R. B. MOORE, chief chemist of the Bureau of Mines, who from the first has been intimately associated with the development of the helium resources and is still in charge of much of the most effective work being done by the Government in this field. He says in effect:

"For the price of one battleship it would easily be possible to maintain and operate permanently six of the most modern helium-filled dirigibles which the best

talent of America could design. Included in this program would be adequate provision for reserves of helium-bearing natural gas, adequate facilities for generation of the needed helium, its recovery and repurification, and generous allowance for needed fundamental research in physics, chemistry and engineering. The question therefore is, 'Which will contribute most to American security and defense, one additional modern first-line battleship or an elaborate program in the field of non-flammable, lighter-than-air craft of wide-cruising radius, tremendous powers of offense and almost unrivaled ability in defensive observation?'"

It is too much to expect that the Government will provide thus extensively at once. The first requirement is to obtain and conserve in adequate degree the most important fields where high percentage helium-bearing natural gas is found. Fortunately this means saving gas which is generally least valuable for commercial sale, because high helium content means also high nitrogen content and low heating value. Second in importance is the support of small-scale research, particularly the work of the cryogenic laboratory at the Bureau of Mines and the corresponding activities which logically will supplement that work. In the third place, one must then ask for plant-scale research, including perhaps the necessary investigations to make the Petrolia plant using the Jeffreys-Norton process a success, if this proves feasible. Next will be the provision for plant operation on a large scale and large-capacity storage of the gas. Finally will come the time when construction of the several airships for use with helium can be undertaken with the surety that adequate supply of gas will be at hand for their regular operation. In the meantime, of course, much work on design of these vessels and a limited amount of experimentation on their construction would be expected. Unfortunately progress on this extensive program is likely to be slower than all of us would wish, but so long as definite progress is constantly being made, and along right lines, every encouragement should be given to the Government in its helium projects. That the progress will be along the right lines seems assured, for Army, Navy and scientific bureau specialists are co-operating closely through the Helium Board and no chance for constructive criticism and advice is being ignored by any of these agencies.

And AGAIN.

What Is a Chemist?

THE question will not down, and sometimes out of the mouths of babes and sucklings come—side-lights. In the New York office of a large heavy chemical manufacturing concern there is a lad of fourteen who shows originality, although it is scarcely of the type that indicates the possession of the research mind. One morning not long ago he appeared with great, horn-rimmed spectacles. He was asked if he was having trouble with his eyes, and he replied that he was not. "I am studying," he explained, "to be an acid expert."

If we are "very much what we think we are," then this cheerful youngster is doubtless already "very much" of an acid expert. And yet even this does not fully answer a question which has been teasing us for a considerable time and to which we can get no satisfactory answer. It has become a chronic conundrum. Why can we not get general trade specifications for heavy chemicals? Every effort thus far has been unsuccessful.

Readers' Views and Comments

The Constitution of Gas Atmospheres in Aluminum Alloy Melting Furnaces

To the Editor of Chemical & Metallurgical Engineering

SIR:—On page 60 of your issue of July 13, 1921, in an article by Robert J. Anderson and J. H. Capps, entitled "The Constitution of Gas Atmospheres in Aluminum Alloy Melting Furnaces," there appears some discussion with regard to the toxicity of gases emanating from electric furnaces used for this purpose.

Carbon monoxide is, of course, extremely poisonous, and if all of the carbon monoxide produced in such a furnace were to be discharged unchanged into the foundry atmosphere, a serious condition would probably result. As a matter of fact, such carbon monoxide as does leave the furnace through various vents is at an extremely high temperature in the case of arc furnaces particularly and, as a result, burns to carbon dioxide as soon as it strikes the air. This is obvious to anyone who has watched the operation of an electric arc furnace for any length of time, whether this furnace is melting steel, brass, aluminum or any other metal whatsoever. I believe that any user of electric arc furnaces will agree that it is practically impossible for any appreciable amount of carbon monoxide to escape from his furnaces into the atmosphere of the foundry.

With respect to cyanogen the situation is, of course, somewhat different, but the authors state in this same article that they have been unable to detect cyanogen by chemical methods even in the atmosphere of the furnace itself where it would be most concentrated. Although it is occasionally possible to detect the odor of cyanogen in the neighborhood of an electric furnace melting aluminum, this gas is evidently present in such exceedingly small quantities that no unpleasant results are to be expected. As a matter of fact, as the authors state, there is absolutely no record of injury to health from electric-furnace gases in any commercial installation despite the fact that electric furnaces have been in use for many years in the melting of both steel and brass.

H. M. ST. JOHN,
Service Manager.

Detroit, Mich.

Culture in Technical Education

To the Editor of Chemical & Metallurgical Engineering

SIR:—Your editorial on "Culture in Technical Education" in the number for July 20 overlooks one important element in the problem under consideration. At the end of any four-year course the father of the boy taking it has had frequent reminders of the fact that college courses are expensive. In very many cases the family resources have been strained by reason of this. To add two more years to the total would in not a few cases make such a course impossible for some of the best men applying. I think this has had much to do with the present condition of things, and I know of one case where this was the controlling thought.

Given a student who has enough perseverance to give six years to such a quest, there can be no doubt that six years are better than four. It seems to me, however, that it may be worth consideration whether some of the additional courses desired may not come into the

college preparatory course. I cannot rid myself of the impression that too much of the pre-college time is poorly applied, and, in some instances, almost entirely wasted.

It is also true that much time in college is wasted. Not a few college professors are extremely poor teachers; in some cases men remarkable for work as investigators have shown an utter lack of teaching ability. I have come to think that college professors should be classified as teachers and investigators, and that the first class should be required to take normal school courses before teaching. Some college professors I have known have failed to understand that there is such a thing as psychology. The appeal to reason is their only appeal, and this is very seldom effective.

Lafayette College,
Easton, Pa.

EDWARD HART.

Studies in Colorado Shale Oils

To the Editor of Chemical and Metallurgical Engineering

SIR:—In reading the interesting article by A. J. Franks, in your July 13th number, on "Studies in Colorado Shale Oils," we were rather surprised that after he had discontinued the use of the cumbersome Waters method for the determination of sulphur in his samples of shale oil, he turned to the use of the Parr sodium peroxide bomb.

In Technical Paper 26 of the Bureau of Mines the results of an investigation of the various methods of sulphur determination of oils are shown. The Bureau went into this matter very carefully and they found that the use of an oxygen bomb gave a method for sulphur determination of oils and combustible materials which was "accurate, rapid and reliable."

The Parr oxygen bomb, made of the so-called illium alloy, is particularly adapted to this work and if one does not care to secure the bomb manufactured for the calorific determinations, there is a smaller size which is turned out especially for sulphur determinations.

We believe that Mr. Franks would have saved himself considerable work and time had he used an oxygen bomb for his sulphur determinations.

Roxana Petroleum Corporation,
Wood River, Ill.

RALPH R. MATTHEWS.

To the Editor of Chemical & Metallurgical Engineering

SIR:—In reply to Mr. Matthews' comment I wish to bring to his attention the fourth and eighth paragraphs of my paper, in which he will find, among other relevant statements, the following sentences: "Since it is beyond the scope of this paper to discuss the relative merits and defects of different methods for determining sulphur, only the two which were actually tried will be given consideration." "Since a complete discourse on this subject would be too long to be included here, only the main points will be considered briefly, a fuller and more detailed discussion being reserved for a later paper."

My paper dealt primarily with the amounts of sulphur in shale oils and their fractions, not with methods for determining sulphur. A comprehensive discussion

of the latter subject would have required much valuable space. Such a discourse could not have been justly included. I reserved it for a later paper which has been in preparation for some time. Hence I did not choose to present all the data I had, nor any but very general and brief reasons for adopting the sodium peroxide fusion method. Under these circumstances I do not feel that anyone is justified in making critical suggestions or remarks concerning the methods I used. It is entirely sufficient that the results given in my paper are accurate.

Mr. Matthews' letter conveys the impression that I am not aware of the fact that there is such an apparatus as the Parr oxygen bomb for sulphur determinations and that there are advantages attending its use. I can say with pride that I am a former pupil of Prof. Parr, and am very well acquainted with the virtues of all standard apparatus of his design.

Although I expect later to discuss the subject in detail in a special paper, I will defend my choice with a few brief remarks, since the wisdom of my decision has been questioned. Permit me to repeat the requirements which a method must meet in order to serve satisfactorily for the large number of determinations which we were called upon to make in the course of our research:

1. The cost of the apparatus should not be great.
2. The results must be dependable and as accurate as possible.
3. The determinations should require a minimum amount of time.

If analyses are to be made economically, at least two bombs are required. The cost of a single oxygen bomb and the necessary accessories is far in excess of that for two peroxide bombs. Hence where expense is a factor the use of the former is out of the question.

In so far as accuracy is concerned the peroxide bomb method is superior or at least equal to the oxygen bomb. As evidence of the truth of this contention and the lack of agreement between three series of determinations made with the latter instrument by reputable laboratories on three oils, C. E. Waters (U. S. Bureau of Standards Tech. Paper 177) presents these data:

	Per Cent Sulphur
Mexican oil	1.52 to 1.90
Red oil	0.39 to 0.53
Vulcanized oil	0.89 to 1.22

He also states: "One laboratory alone reported five determinations on the red oil which ranged from 0.42 to 0.53 per cent, while eight results for the vulcanized oil varied from 0.89 to 1.19 per cent." There are differences of 20 to 27 per cent between the above results for the same oil. Differences between results reported in my paper seldom exceed 1 or 2 per cent. Since accuracy is the chief consideration in such research, there is no occasion for criticism because of the time element.

But let the question of accuracy and expense be neglected for a moment and only the factor of time be considered. In spite of Mr. Matthews' opinion to the contrary, the peroxide fusion method does not require more time and energy than the oxygen bomb method. It is at least as rapid as if not more rapid than the latter, and is less awkward. The peroxide bomb can be charged, closed, ignited, cooled and the contents removed with greater speed and ease than can the oxygen bomb. From here on the operations are practically identical in each case. If the oxygen bomb is equipped with a lead gasket, an additional quarter to half an hour

will be required to convert any lead sulphate, which might have been formed, to soluble sulphate. Where then does the saving of time come in through the use of the oxygen bomb? Since it is more expensive than the peroxide bomb and the results it gives are no more accurate than the peroxide bomb, I fail to recognize Mr. Matthews' suggestion as being either useful or illuminating.

ARTHUR J. FRANKS.

Department of Chemistry,
Colorado School of Mines,
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Multiple Effect Evaporation

To the Editor of Chemical & Metallurgical Engineering

SIR:—On pages 110 to 115 of your number of July 20, 1921, appeared an article by Burton Dunglinson, entitled "Multiple Effect Evaporation." There are certain statements in this article which Mr. Dunglinson apparently gives without careful study or knowledge of the subject, and we would therefore ask you kindly to make the following corrections:

No Kestner evaporator up to 12,000 sq.ft. heating surface per body built in this country or to our knowledge in Europe has ever developed any "mechanical difficulties such as sagging of the tube due to its weight and consequent strain of the top tube plate with the result that leaks will develop."

The extremely large time of contact in the 20-ft. or rather 23-ft. Kestner tube does not exceed one-half the time the liquid is in contact with the Multiplex tube.

The average scouring effect produced in the Kestner tube due to the velocities is at least four times greater than that in the Multiplex tube.

The limiting height of the Kestner evaporator is the same as that of the Multiplex—namely, the height of a barometric condenser.

The floor space required for Kestners of such small sizes as the superimposed Multiplex is adapted to depends upon the space required for the auxiliaries, and in a Kestner installation is, therefore, no greater than in a similar sized Multiplex. In the larger sizes the Kestner evaporator requires less floor space than does the Multiplex, owing to the necessarily larger diameter steam belts in the shorter tube Multiplex body.

In fact, not one of the claims of superiority advanced for the Multiplex as an improvement in the art, but is equaled or surpassed by the older Kestner type.

KESTNER EVAPORATOR CO.,

Philadelphia, Pa.

RALPH MELLOR, President.

More on the Tellurides and Selenides

To the Editor of Chemical & Metallurgical Engineering

SIR:—Referring further to the subject of selenides and tellurides, concerning which I published a short note in your issue of Aug. 17, the sodium and potassium compounds are also interesting.

I first ran into these in an ill-advised attempt to produce metallic tellurium by direct reduction of the oxide, using sodium carbonate as a flux. The result was sodium telluride. The compound gives a beautiful solution if kept away from air, the color being very like that of potassium permanganate. Both the selenide and telluride decompose very readily from the oxygen of the air setting free metallic tellurium and metallic selenium with formation of sodium hydroxide. I believe that this reaction was made the basis by A. E. Knorr of a process for the recovery of these metals.

New York City.

DONALD M. LIDDELL.

Electric Furnaces for Silver, Gold and Metals of Low Melting Point

Points to Be Considered in the Electric Melting of Silver, Gold and Metals of Low Pouring Temperature and Their Alloys — Selection of Appropriate Furnaces — Results Obtained

By JONAS HERLENIUS

FOR many reasons the use of electric furnaces has lately been widely extended and will eventually include every industry, as soon as electric current is available at a reasonable price. Practically every known method of generating heat electrically has been utilized in the electric furnace art and it should therefore seem possible to select the proper furnace suitable for a particular purpose. The choice of furnace, however, requires a study of all the details connected with each individual melting problem in order to decide upon the type that will, as much as possible, answer all requirements.

UNDEVELOPED FIELD FOR ELECTRIC FURNACES

For the refining of steel and the melting of copper, nickel, aluminum, brass and bronze the electric furnace is now in use so extensively that the prospective user has a large field for practical investigation. Furthermore, there is ample literature available covering operating conditions, together with accurate figures on the results obtained. However, in the melting of some other metals, notably silver, gold, lead, zinc and tin, the electric furnace is in only limited use and for certain reasons its introduction is progressing very slowly. It should be only a question of time, nevertheless, until the merits of using electric furnaces for these metals will also be fully recognized, as it requires a type of work where the electric process is distinctly adaptable. Secrecy and limited use are the contributing reasons why so very little as yet has been published concerning the results obtained and other operating data from furnaces melting these metals. It must also be borne in mind that the part of this article dealing with the possibilities of electric furnaces in this new field is based on conclusions drawn from theoretical calculations or from the comparison of analogous conditions which occur during the melting of other metals.

ADVANTAGES IN THE USE OF ELECTRIC FURNACES

The electric furnace has the following main advantages over fuel-heated furnaces:

1. A more perfect temperature control.
2. Less loss by oxidation due to a neutral or reducing atmosphere.
3. A higher efficiency.

These three points are of such importance that it may safely be expected that any heating problem will ultimately be handled electrically when adequate furnace types have been developed. The prevailing high price of current in many districts, however, has greatly hampered the introduction of electric furnaces, mainly because the prospective user fails to understand that an eventual increase of his fuel cost will generally be

fully offset by a better quality of the product and by a higher efficiency of the melting equipment.

According to the method of heat generation, electric furnaces may be divided into the following main classifications:

1. Direct arcing furnaces, where the heat is generated in arcs between electrodes and the material charged, using it as a part of the circuit.

2. Free-burning arc furnaces, where the heat is generated independently of the charge, in arcs drawn between the tips of electrodes located above the metal.

3. Carbon resistor furnaces having special heating units located along the sides of the hearth, from which the heat is radiated to the charge, either directly or reverberated.

4. Induction furnaces, where the heat is generated in the metal itself by induction from primary coils suitably located; the furnace being constructed so that the metal charge forms a secondary closed circuit.

5. High-frequency induction furnaces, where the heat is generated in the metal charge or its container by eddy currents induced by current coils surrounding the crucible.

6. Wire-resistance furnaces, having special heating units in the form of wire coils located outside of the crucible containing the metal, from which the heat is conducted through the crucible wall.

The first class—i.e., direct arcing furnaces—which have found such extensive use in the melting and refining of steel, are not suitable for metals with low melting points. An excessive loss by volatilization is inevitable on account of the high temperature developed by the arcs in direct contact with the charge. This group of furnaces for that reason will not be considered here, while all the other furnace types will show important applications.

POINTS TO BE CONSIDERED IN THE MELTING OF SILVER

Silver has a melting point of about 1,760 deg. F. (about 960 deg. C.), has no low volatile oxide and can therefore be exposed to the air even at high temperatures without any danger of loss through oxidation. Silver, however, in the molten stage has the property of absorbing gases, especially oxygen, to a large extent. These gases are partly liberated on cooling, but partly retained in solid solution, giving rise to brittleness rendering the metal unfit for rolling. It is therefore necessary to exclude all air draught to avoid agitation of the metal, and to maintain a slightly reducing atmosphere in any furnace used for silver melting.

The boiling point of silver is about 3,550 deg. F. (about 1,950 deg. C.); some volatilization is supposed to occur at about its melting temperature. The loss

by volatilization is, however, very small as long as the liquid metal is not superheated to any great extent, but electric arcs close to or in direct contact with the metal are out of the question.

The pouring temperature of sterling or fine silver should be from 2,360 to 2,380 deg. F. (about 1,295 to 1,305 deg. C.), and if possible further superheating should be avoided. In pouring at a higher or lower temperature the metal is apt to crystallize coarsely upon solidifying, making it extremely brittle. An accurate temperature control in the furnace is therefore highly desirable in order properly to regulate the pouring temperature.

Any sudden chill in handling the molten metal, as for instance an excessive loss of time in transporting it from the furnace to the molds, will cause brittleness. For this reason lip-tilting type furnaces will best answer the purpose and usually specially designed pivoted pouring spoons are attached directly underneath the spout. The molds are located in front of this spoon to permit direct pouring, and care should be taken to preheat the spoon to incandescent heat and have it closed by a suitable cover.

Another important feature in silver melting is to prevent as much as possible the absorption of the metal in the lining. If crucibles are not used, the bottom should be tamped in with utmost care, using gannister or a suitable mixture of carborundum and fireclay. The rest of the furnace should be lined with either silica or a good grade of firebrick.

To summarize what is stated above, the following features are essential for a furnace to be employed in the melting of silver:

1. The furnace should produce enough heat in order that a sufficiently high pouring temperature may easily be reached and a quick melting down accomplished.
2. A proper application of the heat developed in the furnace must be provided for to avoid excessive local superheating and consequent loss by volatilization.
3. An efficient temperature control of the furnace is essential in order that the charge may be poured at the proper temperature and thereby avoid brittleness of the metal.
4. The furnace must be tight so as to exclude any air draught.
5. A suitable working door should be provided to allow for the introduction of slag-building material and to be able to work or stir the metal if necessary.
6. The furnace should be of the tilting type, preferably lip-tilted, to assure quick and efficient pouring.

VARIOUS TYPES OF FURNACES USED FOR MELTING SILVER

The Rennerfelt electric furnace, which is of the free-burning arc type, has been employed extensively for melting silver both in this country and abroad and seems to be especially adaptable for this purpose.

At the U. S. Mint in Philadelphia a 1,000-lb. capacity furnace operated continuously for several months, remelting 3,142,000 lb. of silver dollars into bullion. This furnace was taking off about twenty-two heats per twenty-four hours, with an average power consumption of 177 kw.-hr. per net ton. The total loss amounted to 0.75 oz. per 1,000 oz. and was due partly to volatilization, but mainly to absorption of metal by the lining, which later was recovered. The net loss after deducting the recovery was approximately 0.20 oz. per 1,000 oz. The actual melting time for a 1,000-lb. heat was fifty minutes.

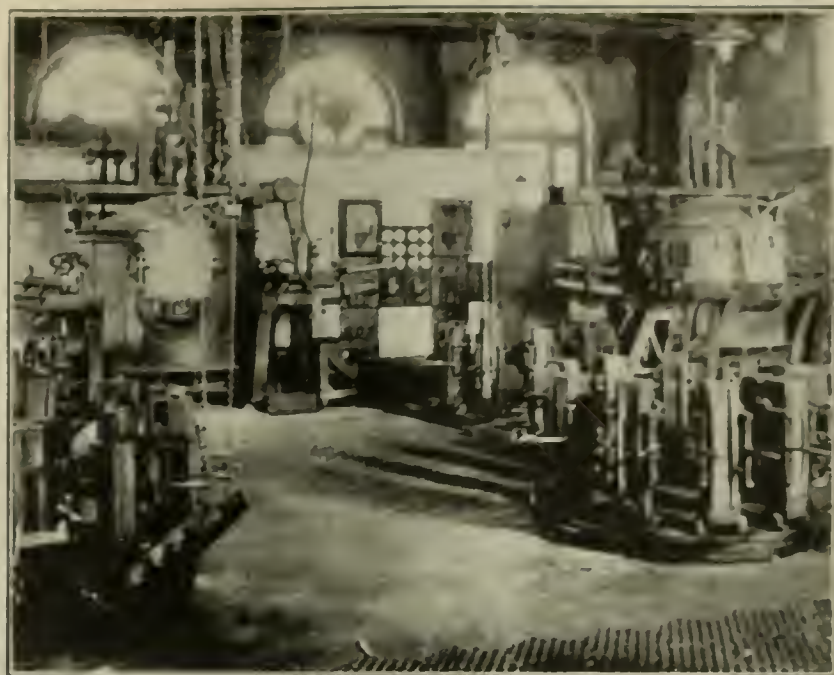


FIG. 1. RENNERFELT ELECTRIC FURNACE INSTALLATION AT U. S. MINT, PHILADELPHIA, PA.

This furnace has a 150-kva., 40 deg. C. transformer bank, and is equipped with a two-electrode General Electric automatic electrode control. It is of the lip-tilting type and is tilted by means of a small 1½-hp. electric motor.

At another plant a 500-lb. 100-kva. Rennerfelt furnace is in operation on sterling and fine silver. This furnace is turning out about one heat per hour, with an actual power consumption of 250 kw.-hr. per net ton and an additional 80 kw.-hr. for preheating the furnace in the morning. The melting loss is practically negligible and amounts to only 4 oz. per heat of 5,000 troy ounces.

In practice the Rennerfelt furnace is preheated to at least a light yellow incandescent heat before charging the silver. After the metal is melted some powdered charcoal is generally scattered all over the bath and a slightly reducing atmosphere is maintained in the furnace. Too much charcoal, however, has been found injurious. With the metal there is often charged a small piece of wrought iron, which in practice seems to have very important advantages. The iron serves as a heat equalizer and furthermore will absorb to a great extent the oxygen present in the liquid silver.

Usually no slag building material is required except when it is necessary to remove zinc when the metal is slightly contaminated by german silver. An aluminum silicate slag is then built up of fireclay, which will bind the zinc as ZnO, although part of the metal will be eliminated in volatilization during melting down.

In order to ascertain the pouring temperature, spoon tests are generally taken from the furnace and poured into water. If the metal sticks to the spoon, it is far too cold, and a sufficient temperature is not reached until the silver granulates in the water and the spoon empties clean.

The variation in operating results with the Rennerfelt furnaces referred to is due to difference in practice and capacity and to the quality of the metal melted. The silver dollars are only remelted into bullion and the pouring temperature is therefore considerably lower than is otherwise required; this accounts for the lower power consumption.

In the furnace melting sterling and fine silver utmost care must be exercised in order to obtain sound castings and to make the metal fit for rolling and stamping.

This necessitates a considerably higher pouring temperature.

Only one carbon resistor furnace has been installed for the melting of silver—i.e., a Baily furnace at the William A. Rogers Co., Ltd., in Niagara Falls, N. Y. This is a pit type crucible furnace, used for recovering the silver from the company's electrolytic process for plating. The furnace is rated 30 kw. and accommodates two crucibles holding approximately 500 oz. each. These crucibles are lifted out for pouring; the metal is cast into anodes.

This Baily furnace has been in operation since 1914 and has given very satisfactory results in comparison with the oil furnace previously used. A great improvement was obtained especially in uniform heating and temperature control, which made it possible to pour the silver at a lower temperature and still obtain a more homogeneous metal. A slow, soaking, well-distributed heat and an accurate temperature control are very important advantages of the Baily furnace, which account for its great success in various metallurgical fields.

The pouring temperature of the metal melted at the Rogers company is estimated to be about 2,200 deg. F., although no pyrometer is used. This temperature is sufficiently high for a fluid metal when no complicated castings are poured or when the silver does not have to be rolled. Eight heats per day of 1,000 oz. each were poured with practically no loss. The average time for charging, pouring and melting of one heat was about one hour and seven minutes.

The power consumption with this furnace, however, was very high in comparison with other furnaces herein described. This, of course, is due to the fact that the metal is heated indirectly in crucibles.

It is a question whether it would not be more practical, especially in larger scale production, to melt the silver in the Baily furnace directly on the hearth instead of in crucibles. The excellent results obtained with free-burning arc furnaces in silver melting tend

to indicate that it ought to be feasible, even if the metal loss increased slightly.

Other carbon resistor furnaces, for instance the General Electric and the electric reverberatory types, will surely melt silver commercially either directly on the hearth or in crucibles similar to the Baily type used by the Rogers company. It is a fact, however, that the efficiency of all furnaces built on the principle of radiated resistor heat will be considerably less than for direct arcing types. Whether the employment of crucibles will compare favorably with open-hearth melting, due to lower metal loss and improved quality of the castings, can be determined only after further trials on a larger scale.

The ordinary horizontal ring induction furnace is not suitable for silver melting, because of "pinch" troubles due to the high electrical conductivity of the metal. Even the vertical ring induction furnace—for example, the Ajax-Wyatt—although used extensively in brass foundries, has not proved to be a successful type for silver melting. It is true that in this furnace the hydrostatic head of the molten metal will oppose the "pinch" force, but silver has so high an electrical conductivity that the efficiency of the furnace is considerably decreased. All induction furnaces, furthermore, require continuous operation or a liquid charge for starting, which naturally is a distinct objection in the handling of any precious metal, since the silver melting plants usually operate on but one shift.

HIGH-FREQUENCY FURNACES

The only high-frequency induction furnace on the market is the Ajax-Northrup type, which is manufactured in sizes up to 60 kw. power rating. Four of these furnaces are in operation at the U. S. Mint in Philadelphia for coinage silver and one at the plant of Handy & Harmon in Bridgeport, Conn., for sterling silver. The results obtained have been very gratifying. For this reason its operating conditions will be described in detail.

As stated above, silver has too high electrical conductivity to be melted with any satisfactory efficiency by direct induction. In order to overcome this obstacle, the Ajax-Northrup furnace is equipped with a crucible of molded carbon or graphite to replace or to fit into the crucible of non-conducting refractory material usually supplied. The heat is thus generated in the walls of this carbon crucible and transmitted to the metal contained by conduction or radiation.

The furnaces installed at the U. S. Mint in Philadelphia, Pa., are stationary, single-phase units, specially constructed to answer local conditions and to change the existing practice as little as possible. Two of these furnaces have been in operation for over one year on fine silver and gold for rolling and stamping. They have a power rating of 8 kw. each and hold two small crucibles, which are lifted from the furnace and poured. The two other furnaces are rated 16 kw. and accommodate one crucible each, from which the silver is dipped or ladled out until about 200 oz. remain, which are removed by withdrawing the crucible and pouring it out. Recently either one of the larger furnaces is operated two-phase, using 32 kw. power input, which corresponds to the total power that was originally intended for both units. This has considerably increased the efficiency and the two furnaces are now run alternately twenty-four hours.

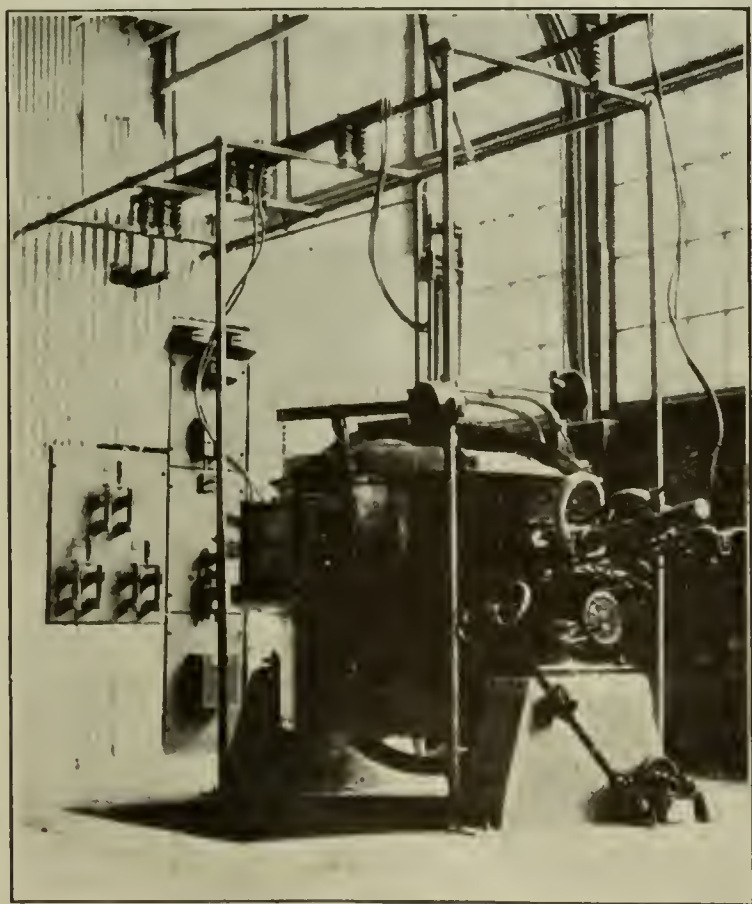


FIG. 2. RENNERFELT ELECTRIC ARC FURNACE, STANDARD 500-LB. TYPE

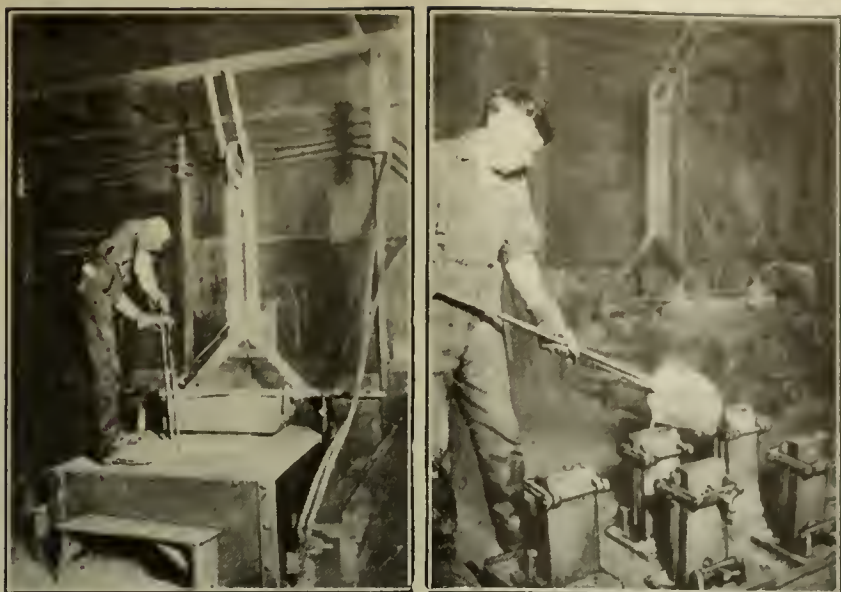


FIG. 3. BAILY PIT TYPE ELECTRIC CRUCIBLE FURNACE AT WM. A. ROGERS CO., NIAGARA FALLS, N. Y.

In a trial run with one of the larger furnaces at the U. S. Mint four charges, constituting 13,490 oz., were melted in seven hours' time, with a power consumption of 156.5 kw.-hr. This is equal to 5.9 lb. per kw.-hr., or 340 kw.-hr. per net ton. The average load was $12\frac{1}{2}$ kw. per phase, or a total of 25 kw., and the metal loss was almost negligible.

The furnace at Handy & Harmon's is lip-tilted and pours directly into the molds without intermediate ladles or pouring spoons. It is a three-phase installation, which absorbs 60 kw. from the supply line, 30 to 40 per cent of which is lost in the high-frequency converter. This makes an actual power rating of the furnace crucible of about 40 kw.

The furnace has a capacity of about 600 lb. of silver per melt. One day's operation shows a production of 36,558.50 oz. of sterling silver melted in eight hours and fifteen minutes, including preheating, and uses about 317 kw.-hr. This makes an average of 7.95 lb. of silver per kw.-hr. for the entire time consumed, or a power consumption of approximately 252 kw.-hr. per net ton.

The Ajax-Northrup furnace consequently shows remarkable efficiency in the melting of silver and in case the mechanical defects are overcome, this furnace should answer most of the requirements for silver melting on a smaller scale. The life of the conducting crucible will have to be established from further trials and there still remains the question as to whether this part of the furnace will meet all requirements in general commercial operation. A distinct advantage of this high-frequency type is that in melting in a closed crucible the metal is prevented practically from absorbing any gases. On the other hand, the removal of zinc, in case the silver is contaminated by german silver, is not possible. The practice of inserting a piece of iron into the metal bath of this furnace would materially disturb the induction. There is less need for a deoxidizer, however, and no heat equalizer is required in a furnace where the heat distribution is so nearly perfect.

Wire-resistance furnaces do not produce sufficient heat to melt silver and are consequently not applicable.

POINTS TO BE CONSIDERED IN THE MELTING OF GOLD

Gold is always alloyed to a certain extent with some other metal, especially copper, silver or platinum. It has a melting point of about 1,950 deg. F. (about 1,065 deg. C.), begins to volatilize around 2,010 deg. F.

(about 1,100 deg. C.) and volatilizes four times as fast at 2,280 deg. F. (about 1,250 deg. C.). The pouring temperature should therefore be slightly above its melting point and excessive superheating must be carefully avoided in order to prevent any loss by volatilization of this precious metal.

Gold should only be melted in crucibles and the main requirements of a suitable furnace are an accurate temperature control and a uniform heat distribution. Gold is so expensive that low loss handling is paramount, while the efficiency of the melting equipment ranks next in importance, but does not have the same bearing from the standpoint of economy.

Arc furnaces are not suitable for heating crucibles, on account of insufficient temperature control and subsequent danger of superheating. Carbon resistor furnaces may be applicable and especially the previously described Baily pit furnace used at the William A. Rogers Co., Ltd. This type has a slow, soaking heat and possesses excellent means for an accurate temperature control.

Other furnaces belonging to the same group, especially the General Electric and the electric reverberatory types, could probably be adapted if constructed for the purpose. Thus far, however, no furnaces of these types have been employed for melting this metal.

Gold has too high electrical conductivity to be melted by direct induction. Such furnaces are consequently not suitable, with the exception of the Ajax-Northrup, where a conductive crucible is used as described under silver melting. Some small furnaces of this type have been installed for gold melting, using a graphite crucible, and the performances have been very satisfactory. In a 6-in. crucible with a net volume of 53 cu.in. 37 lb. of gold can be melted in eight minutes at a rate of 14 lb. per kw.-hr. consumed. The crucible is coated with a special refractory material which will cohere to the graphite and withstand a high temperature in order to prevent the crucible from being oxidized by the air.¹

If the gold is alloyed with platinum, a metal which has a very high resistivity, the resultant electrical

¹See CHEM. & MET. ENG., June 22, 1921. Footnote on p. 1099.

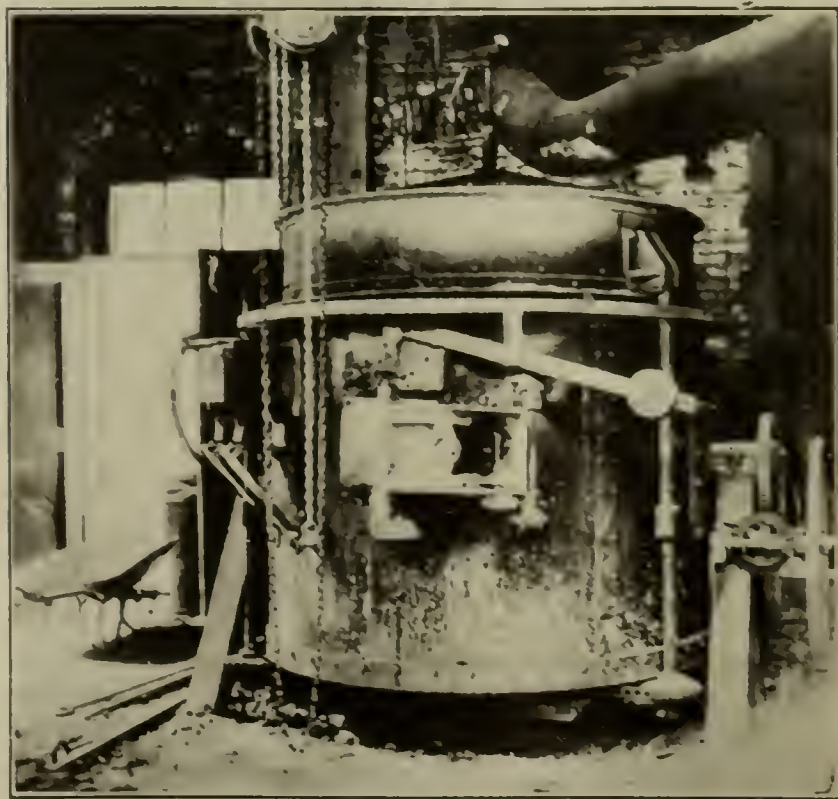


FIG. 4. STANDARD BAILY ELECTRIC FURNACE AT THE LUMEN BEARING CO., BUFFALO, N. Y.

conductivity may be decreased sufficiently so that the alloy can be melted by direct induction in a clay or magnesite crucible. This is of great importance in the melting of gold-platinum alloys, due to the fact that any contamination by carbon is to be avoided and a more homogeneous metal can be produced, due to the stirring action caused by the currents induced in the bath.

In a test recently carried out 50 troy ounces of an alloy containing 85 per cent fine gold and 15 per cent pure platinum were melted in a No. 5 clay crucible which was washed inside with electrically sintered magnesia. In six minutes the charge was melted and considered sufficiently fluid for pouring. The ingot cast was rolled out and found to be free from platinum streaks, which frequently appear when using gas- or oil-fired crucibles.

There are many reasons why the high-frequency induction furnace may be considered particularly well adapted for melting gold and platinum. It enables the melting of very small quantities of metal with comparatively high efficiency. The furnace also possesses an accurate temperature control and a uniform, well-distributed heat. Furthermore, the stirring action which is an inherent feature with direct induction furnaces is an important advantage in alloying gold and platinum.

POINTS TO BE CONSIDERED IN THE MELTING OF ZINC, TIN AND LEAD

When melting metals of very low pouring temperature, only such furnaces should be employed as possess either suitable means for accurate low-temperature control or where the source of heat is limited to a certain temperature equilibrium. This concerns practically all metals or alloys that melt below 1,000 deg. F. (540 deg. C.) and include zinc, tin and lead and their alloys

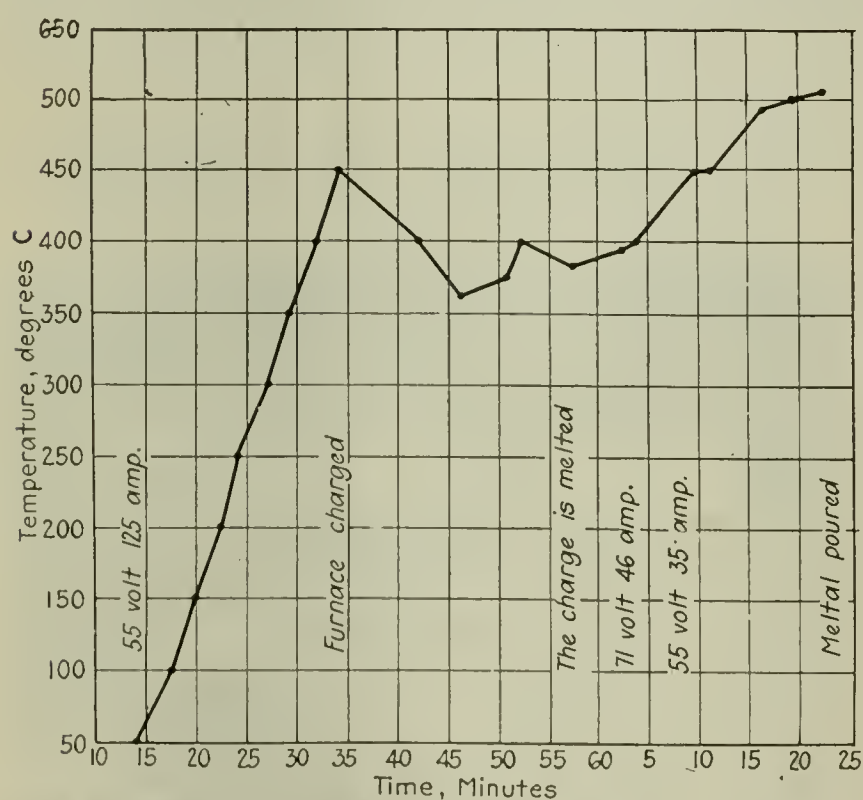


FIG. 5. MELTING CHART OF A LEAD ALLOY HAVING A MELTING POINT OF ABOUT 370 DEG. C.

and certain other important alloys of these metals with copper, bismuth, antimony and cadmium. It is feasible to melt any of these metals or alloys electrically if adequate furnace types are employed, and a very rapid development of electric melting in this new field of metallurgy may be expected in the near future. This

is a very comprehensive subject, however, and the limits of this article preclude any detailed account.

All arc furnaces produce too much heat and are therefore not suitable for metals of low melting point.

Resistance radiating furnaces have a close temperature control and should therefore be well suited under certain conditions. For large-scale production, demanding furnaces in tonnage capacities, this type is so far the only one available. One Baily furnace is in operation at the Lumen Bearing Co., in Buffalo, N. Y., melting "Lumen" metal, which is an alloy of 85 per cent Zn, 10 per cent Cu and 5 per cent Al. It is a 105-kw. tilting type furnace of 1,000-lb. capacity producing about one heat per hour, with a power consumption of from 200 to 240 kw.-hr. per net ton. The metal is poured at a temperature of about 1,300 deg. F. (about 705 deg. C.), and the metal loss varies between 2½ and 3½ per cent.

As all these metals have rather low electrical conductivity, it should be possible to melt with direct induction, in case 24-hr. operation can be established and the composition of the alloy is not changed too frequently. The high thermal efficiency and the circulation in the metal bath are features of great advantage with this type of furnace.

The Ajax-Northrup high-frequency induction furnace employs an iron crucible as a container for lower melting metals and alloys. The heat is developed in the iron by induction, which can be done with high efficiency and almost perfect temperature control. Using a 10-in. crucible, 25 lb. of zinc can be melted in six minutes at a rate of 13 lb. per kw.-hr.; 25 lb. of tin and 39 lb. of lead are melted in two and one-half minutes at the rate of 30 and 50 lb. per kw.-hr. respectively.

Wire-resistance furnaces are very well qualified for any kind of low-temperature work, because the temperature is under perfect control by changing the connection of a number of the heating elements surrounding the crucible. The heat input is furthermore limited so that excessive superheating is rendered impossible, and after the desired temperature is reached by adjusting the power input this temperature is maintained by a constant heat supply. The furnace works slowly but with comparatively high efficiency and is particularly well adapted when it is desired to keep a metal liquid at a constant temperature for a long time. This principle of electric heating should therefore be used to advantage in heating soldering pots, lead baths for annealing purposes, melting stereotype metal, etc. A series of trial runs with a small furnace of this type have been submitted by Hamilton & Hansell, Inc. The variation in temperatures in one of these runs is represented by the curve shown (Fig. 5) and refers to a lead alloy having a melting point of about 700 deg. F. (about 370 deg. C.).

The furnace was preheated empty to about 840 deg. F. (about 450 deg. C.) in twenty minutes, using about 2½ kw.-hr. and afterward charged with 176 lb. of lead. The metal was melted in twenty-five minutes, superheated in an additional twenty-five minutes and poured at about 960 deg. F. (about 515 deg. C.). The average power input was about 55 volt, 125 amp. d.c. or 6.9 kw. The total consumption of power was 6½ kw.-hr., of which 4 kw.-hr. was actually consumed for melting. This is equal to 27 lb. of metal per kw.-hr. covering all the time used, or 44 lb. per kw.-hr. excluding the preheating.

Studies in Evaporator Design—V

Experimental Data for Horizontal Tube Evaporator Showing Relation Between Hydrostatic Head, Temperature Drop and Heat Transmission—Ratio of Corrected Coefficients for Two Different Temperature Drops Is Constant for All Levels*

BY W. L. BADGER

THIS paper presents two curves showing the relation between hydrostatic head and heat transmission in a horizontal tube evaporator. These two curves were determined at the same boiling point, but with a different steam temperature for each curve; thereby furnishing means for determining the relation between hydrostatic head, temperature drop and heat transmission.

So far as the writer has been able to determine, no systematic experimental work has been done on horizontal tube evaporators. There are scattered tests of horizontal tube evaporators available, but they are all reports of isolated tests on evaporators in actual plant operation, and are therefore not available for systematic study. The previous literature regarding the effect of hydrostatic head on heat transmission and regarding the effect of temperature drop on heat transmission has been discussed elsewhere.¹

DESCRIPTION OF APPARATUS AND METHOD OF PROCEDURE

These tests were run in the horizontal tube evaporator of the Evaporator Experiment Station at the University of Michigan, which has been described in detail.² Briefly, the evaporator body is 25 $\frac{3}{4}$ in. wide inside and, in these tests, it was 8 ft. high inside. It was equipped with 156 steel tubes $\frac{7}{8}$ in. in outside diameter by $\frac{1}{8}$ in. wall, with an effective length of 46 $\frac{1}{4}$ in., making a net heating surface on the wet side of 0.883 sq.ft. per tube. The total heating surface was therefore 137.75 sq.ft., or 12.795 sq.m. The arrangement of the tubes is shown in Fig. 1. In calculating the heating surface, no allowance was made for the tube sheets, which are of cast iron, 1 $\frac{1}{4}$ in. thick. The tubes are secured in these tube sheets by the standard Swenson tube packing plate (see Fig. 2). When tubes of this size with their centers 1 $\frac{5}{8}$ in. apart are so secured, the pressure of the packing plate results in a spreading of the gaskets until they unite in a practically continuous sheet of rubber, perhaps $\frac{1}{8}$ in. thick. The packing plates themselves are 1 in. thick and form a continuous sheet. This combination of 2 $\frac{1}{4}$ in. of cast iron and $\frac{1}{8}$ in. of rubber offers so much resistance to heat transmission as compared to the $\frac{1}{8}$ in. of steel in the tubes proper that it was considered reasonable to omit the tube sheets entirely. In this experimental evaporator the tube sheets are very large, and consequently in this set of experiments a large part of the tube sheet was blanked off. In blanking off holes not in use, the same gaskets and packing plates were used

as were used in securing tubes, so that there is no need to consider the upper part of the tube sheets as being a part of the heating surface.

Air was vented from the top of the front steam chest into the vapor space; and from the bottom of the front steam chest through the condensate receiver and back to the vapor space. Condensed water was taken from the front steam chest only.

When the evaporator was boiling smoothly and conditions seemed uniform, at a signal from the recorder the level of condensate in the receiver was marked, and readings of all temperatures and pressures were begun at once. Readings were taken every two minutes until a sufficient amount of condensed water had accumulated; or in the case of runs at high ratings, until at least ten or twelve sets of readings had been taken. At a signal from the recorder the time was again noted and the amount of condensed water again marked. The evaporator was connected to another receiver, and as soon as conditions had become uniform the next run

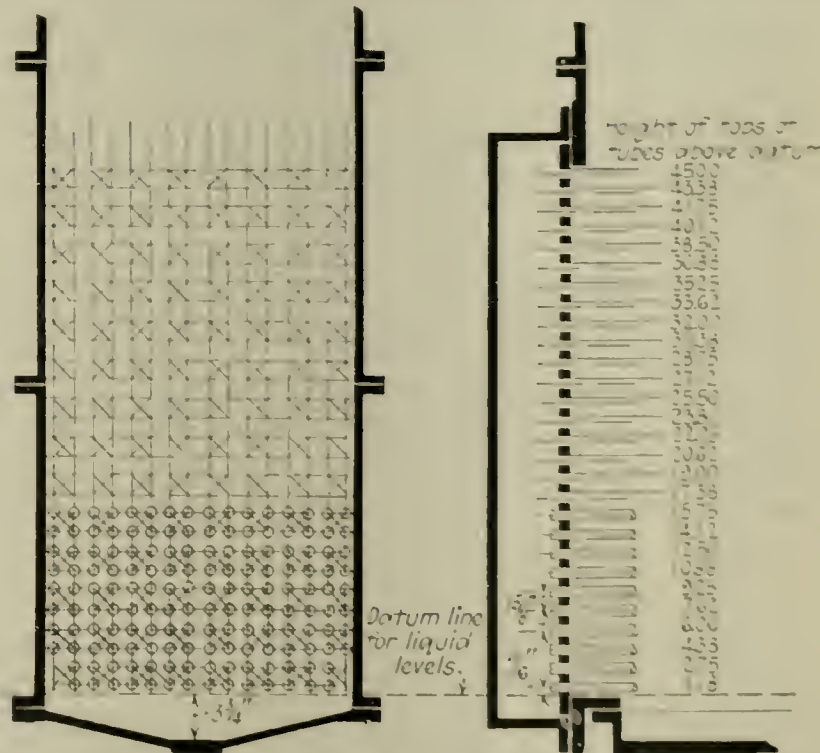


FIG. 1. ARRANGEMENT OF TUBES IN EXPERIMENTAL EVAPORATOR

was started. This usually involved a lapse of five to seven minutes, during which time the evaporator was kept boiling and the conditions kept as constant as possible. In series T there was but one break. Runs 128A, 151B and 259 were made without a shutdown, and then runs 129A, 152B and 260 were also made consecutively. In series U runs 130A-I, -II and -III were made consecutively. There was then a break until the next day, when runs 153B, 154B, 261 and 262 were made consecutively. There was another break, and runs 155B, 156B and 131A were made.

*Read before the American Institute of Chemical Engineers at New Orleans, Dec. 7, 1920.

¹"Studies in Evaporator Design"—I, II, III and IV, CHEM. & MET. ENG., vol. 23, Nos. 6, 7, 9 and 12, pp. 237, 281, 390 and 569, Aug. 11, 18, and Sept. 1 and 29, 1920.

²CHEM. & MET. ENG., vol. 23, No. 4, p. 159, July 28, 1920.

METHODS OF MEASUREMENT AND ACCURACY OF RESULTS

Time was measured with an ordinary watch, and it is probably correct to within ± 2 seconds. The vacuum was controlled by the automatic vacuum regulator described in a previous paper³ and usually did not vary over ± 2 mm. during a test. Therefore the probable error of the average for a test is very small (less than ± 0.1 mm.). Temperatures of the vapor space were not read systematically, but when read they came so near to the temperature calculated from the vacuum as to indicate no constant error in the manometer

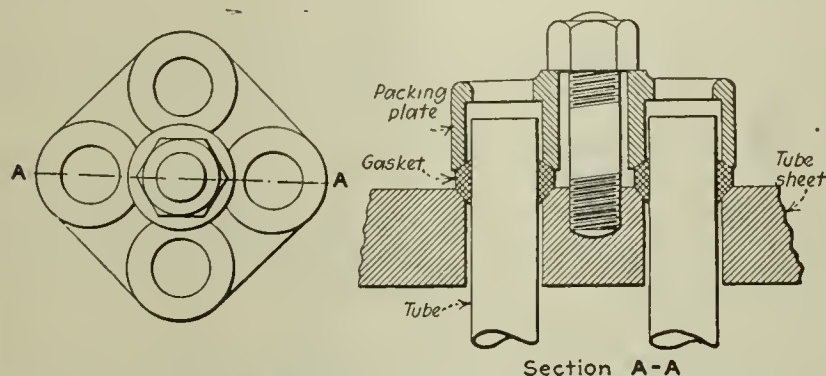


FIG. 2. TUBE PACKING PLATE SHOWING METHOD OF SECURING TUBES

greater than ± 1 mm. (or ± 0.13 deg. C. at 60 deg.). In a previous paper⁴ there is a discussion of the reasons for preferring temperature calculated from vacuum as the temperature of the boiling liquid rather than temperature determined by a thermometer inserted into the machine. It should be noted that in calculating on the basis of the temperature corresponding to the vacuum the results are in terms of apparent temperature drop and are therefore apparent coefficients.

Steam pressures were measured by mercury manometers attached directly to the steam chests. Long ex-

TABLE I. STEAM TEMPERATURES IN BACK AND FRONT STEAM CHESTS DURING SERIES T

In Degrees Centigrade							
Run No.	Back Steam Chest			Front Steam Chest			Drop in Satn. Temp. VII
	Temp. from Therm. I	Temp. from Press. II	Super-heat III	Temp. from Therm. IV	Temp. from Press. V	Super-heat VI	
128A I.....	115.82	100.07	15.75	101.85	100.08	1.77	-0.01
II.....	115.80	100.04	15.76	103.26	100.06	3.20	-0.02
III.....	114.18	100.01	14.17	104.77	100.07	4.70	-0.06
151B I.....	112.35	99.91	12.64	103.13	99.94	3.19	-0.03
II.....	112.91	100.01	12.90	103.48	100.38	3.10	*-0.37
III.....	114.08	100.08	14.00	103.39	100.06	3.33	+0.02
129A I.....	113.64	100.14	13.50	102.23	100.12	2.11	+0.02
II.....	114.88	99.96	14.92	102.81	100.02	2.79	-0.06
III.....	114.45	100.00	14.45	102.85	99.95	2.90	+0.05
259 I.....	111.10	100.01	11.09	103.23	99.99	3.24	+0.02
II.....	111.28	100.00	11.28	103.25	99.99	3.26	+0.01
III.....	110.52	100.04	10.48	103.32	99.98	3.34	+0.06
152B I.....	114.21	99.95	14.26	102.29	99.93	2.36	+0.02
II.....	115.69	100.03	15.66	102.39	100.02	2.37	+0.01
III.....	115.89	100.05	15.84	102.52	100.03	2.49	+0.02
260 I.....	116.80	100.07	16.73	102.55	100.01	2.54	+0.06
II.....	115.55	100.03	15.52	102.28	100.00	2.28	+0.03
III.....	115.62	100.03	15.59	101.35	99.98	1.37	+0.05
Average.....	114.16	100.02	14.14	102.79	100.01	2.78	+0.01

* Omitted.

NOTE.—Column III = Column I - Column II. Column VI = Column IV - Column V. Column VII = Column II - Column V.

TABLE II. STEAM TEMPERATURES IN BACK AND FRONT STEAM CHESTS DURING SERIES U

Run No.	Back Steam Chest			Front Steam Chest			Drop in Satn. Temp. VII
	Temp. from Therm. I	Temp. from Press. II	Super-heat III	Temp. from Therm. IV	Temp. from Press. V	Super-heat VI	
261 I.....	108.13	89.96	18.17	91.40	89.96	+1.44	0.00
II.....	108.73	89.95	18.78	91.39	89.86	+1.53	+0.09
262 I.....	107.48	90.15	17.33	91.32	89.97	+1.35	+0.18
II.....	107.82	89.91	17.91	91.07	89.93	+1.14	-0.02
154B I.....	110.73	89.99	20.74	91.15	89.95	+1.20	+0.04
II.....	110.15	89.94	20.21	91.64	89.95	+1.69	-0.01
130A I.....	111.15	90.03	21.12	90.47	90.05	+0.42	-0.02
II.....	111.26	89.81	21.45	91.75	89.75	+2.00	+0.06
III.....	110.84	89.99	20.85	92.02	90.01	+2.01	-0.02
131A I.....	105.60	89.99	15.61	90.06	90.04	+0.02	-0.05
II.....	104.97	89.85	15.12	89.89	89.93	-0.04	-0.08
155B I.....	104.16	89.81	14.35	88.88	89.69	-0.81	+0.12
II.....	104.01	90.03	13.98	89.43	90.01	-0.58	+0.02
156B I.....	104.23	90.01	14.22	89.83	90.01	-0.18	0.00
153B I.....	109.81	89.90	19.91	89.99	89.88	+0.11	+0.02
Average.....	107.94	89.95	17.99	90.69	89.93	+0.76	+0.02

NOTE.—Column III = Column I - Column II. Column VI = Column IV - Column V. Column VII = Column II - Column V.

eters on an instrument board. A special brass stuffing box was screwed into a tapped hole in the steam chest covers. Glass manometer tubes were made with the end of one arm bent horizontal to enter this stuffing box. Water slowly accumulated in the steam side, but it was measured at each reading and allowed for in the calculations. The average of the manometer readings is probably accurate to less than 1 mm. This is equivalent to ± 0.04 deg. on the saturation temperature for series T, and ± 0.05 deg. for series U.

Steam temperatures, because of the accessibility of the steam chests of a horizontal tube evaporator, can be ascertained much more satisfactorily than in the vertical type evaporator. Four calibrated thermometers were inserted in each steam chest, distributed over the part opposite the ends of the tubes in use. The averages of these thermometer readings are given in Tables I and II. (The "back" steam chest is the one in which the steam enters.) The probable error of the average temperature in the back steam chest was about ± 0.3 deg. Condensate temperature was measured in the condensate line about 3 ft. from the steam chest. The error of this reading may have been ± 0.2 deg.

HEAT AVAILABLE

It will be seen from the data of these tables that there was considerable superheat in all the runs. This is because high-pressure steam was used and throttled at the evaporator. The heat transmitted through the heating surface per kg. of steam condensed is, therefore: (1) Heat given up as superheat in cooling to saturation temperature. (2) Latent heat of condensation. (3) Sensible heat given up by condensed water in cooling from saturation temperature to the temperature at which it left the evaporator. (4) Heat given up in cooling from the temperature of the back steam chest to the temperature of the front steam chest, by steam bled through vents or condensed by radiation in condensate lines and condensate receivers. Of these, No. 4 may be omitted as too small to consider. The other items may be readily calculated. In this respect the work on the horizontal tube evaporator is more definite than on the vertical tube evaporator. The superheat may be in error by ± 0.15 cal.; the latent

perience with metal piping (both ordinary iron pipe and fittings and seamless copper tubing) has led us to distrust manometers for steam which are any great distance from the point at which the pressure is to be measured. We therefore abandoned the idea of manom-

³CHEM. & MET. ENG., vol. 23, No. 4, p. 161, July 28, 1920.

⁴CHEM. & MET. ENG., vol. 23, No. 6, p. 241, Aug. 11, 1920.

heat by ± 0.03 cal.; and the sensible heat by ± 0.2 cal. Since the total heat given up per kg. of steam condensed was about 550 cal., the greatest probable error would be ± 0.4 cal., or 0.08 per cent.

It is interesting to note that the temperature drop from the back steam chest to the front steam chest (calculated from pressure) was of the order of a few hundredths of a degree. In most cases the drop is toward the front steam chest, as would be expected. In series T, the pressure drop in 151B-II is evidently in error. Omitting this, there is no difference between the two steam chests over 0.18 deg. in either series. The average difference is $+0.01$ deg. in series T and $+0.02$ deg. in series U.

CALCULATION OF APPARENT TEMPERATURE DROP

In calculating the apparent temperature drop there are complications due to the presence of superheat. In order to handle the calculations it will be assumed that the processes are as follows: First the steam is cooled to the saturation temperature, giving up its superheat. Next it is condensed to a liquid at a temperature corresponding to the mean of the pressures in the front and

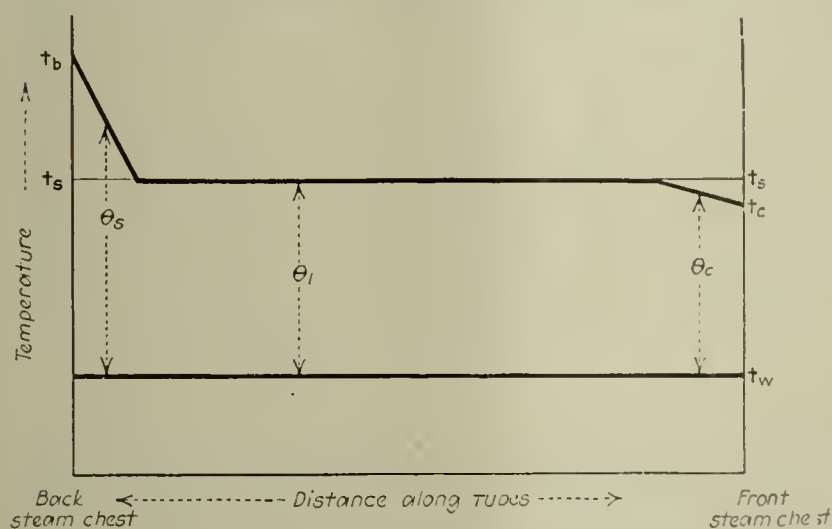


FIG. 3. TEMPERATURE GRADIENT IN THE HORIZONTAL TUBE EVAPORATOR

- t_w = temperature of boiling liquid.
 t_b = temperature of superheated steam entering tubes from back steam chest.
 t_s = temperature of saturated steam in tubes.
 t_c = temperature of condensed water.

back steam chests. Finally, the condensate is cooled from this temperature to the temperature at which it leaves the evaporator. Under these assumptions the following formulation holds: (See Fig. 3.)

- t_b = temperature of back steam chest from thermometers.
 t_f = temperature of front steam chest from thermometer.
 t_s = temperature of saturated steam corresponding to mean of the pressures of front and back steam chests.

t_c = temperature of condensed water.

t_w = temperature corresponding to vacuum.

θ_s = mean temperature difference during transfer of superheat.

θ_l = mean temperature difference during transfer of latent heat.

θ_c = mean temperature difference during transfer of sensible heat of condensate.

H_s = Heat as superheat in cal. per kg.

H_l = latent heat in calories per kg.

H_c = sensible heat recovered from 1 kg. of condensate.

θ_m = mean apparent temperature drop.

$$\text{Then } \theta_s = \frac{(t_b - t_w) + (t_s - t_w)}{2} \quad (1)$$

$$\theta_l = t_s - t_w \quad (2)$$

$$\theta_c = \frac{(t_s - t_w) + t_c - t_w}{2} \quad (3)$$

$$\theta_m = \frac{\theta_s H_s + \theta_l H_l + \theta_c H_c}{H_s + H_l + H_c} \quad (4)$$

In equations 1 and 3 the arithmetical mean has been

used instead of the logarithmic mean. This is because H_s and H_c are so small that the error so made in θ_s and θ_c is without significance in the final result.

The above method of calculation was applied to a number of runs. The results of a few, selected because they represent extremes, appear in Table III. As will be seen, H_s and H_c are so small in comparison with H_l that they are not significant. In view of the amount

TABLE III. CALCULATION OF MEAN APPARENT TEMPERATURE DROP (θ_m)

Run	Series T			Series U		
	128A I	259 III	260 I	130 A I	261 II	155B III
t_b	75.02	75.08	75.10	75.20	74.96	74.98
t_f	115.82	110.52	116.80	111.15	108.73	104.01
t_s	100.08	100.01	100.04	90.04	89.91	90.02
Superheat	15.74	10.51	16.76	21.11	18.82	13.99
t_w	7.66	5.12	8.15	10.15	9.04	6.72
θ_s	538.65	538.69	538.68	544.88	544.96	544.89
θ_l	0.34	0.19	0.20	0.71	0.90	1.01
θ_c	546.65	544.00	547.03	555.74	554.90	552.62
θ_m	32.93	30.18	33.32	25.40	24.36	22.03
t_c	25.06	24.93	24.94	14.84	14.95	15.04
t_w	24.89	24.83	24.84	14.46	14.50	14.54
H_s	252.24	154.52	271.56	257.81	220.21	148.04
H_l	13,498.57	13,429.54	13,434.68	8,086.02	8,147.15	8,195.15
H_c	8.46	4.72	4.97	10.28	13.85	14.69
$H_s + H_l + H_c$	13,759.27	13,588.78	13,711.21	8,354.11	8,380.41	8,357.88
θ_m	25.17	24.96	25.07	15.03	15.10	15.12
$\theta_m - \theta_l$	+0.11	+0.05	+0.13	+0.19	+0.15	+0.08

of calculating saved, θ_l has been used in all the data of this paper instead of θ_m . The total heat available from 1 kg. of steam condensed was, however, determined by taking the sum of H_s , H_l and H_c . Hence the values used for θ may be in error by not over ± 0.2 deg. due to this method of calculation. As stated above, t_w has an error of ± 0.13 deg., and $t_s = 0.05$ deg. Therefore the final values for θ may have a maximum error of ± 0.4 deg. or ± 2.6 per cent, in series U and ± 1.6 per cent in series T.

In all cases temperatures were read to tenths of degrees and pressures to millimeters of mercury. In all calculations temperatures were carried to hundredths of degrees and pressures to tenths of millimeters. The final results were rounded off to the nearest whole number for the values of K and U . So far as the probable error of any of the determinations goes, the final result is probably accurate to 1 to 2 per cent. However, the possibility of systematic errors makes us doubtful whether we should assign a greater accuracy than ± 50 to any figures for K . Duplicates can be obtained closer than this.

RESULTS

The data for the two series are given in Table IV and are plotted in Fig. 4. From the data of these tables it would seem that in runs 131A, 155B and 156B, there was not enough venting from the front steam chest, so that some air accumulated at that point. In series T steam pressures throughout were above atmospheric pressure and therefore it was easy to keep the steam chests free of air.

EFFECT OF SUPERHEAT

The question on the effect of the presence of superheat is one which has been discussed many times in the literature. A few scattered tests are available to show the effect of superheat, but as a general thing they are not systematic and lead to contrary conclusions. In no case have tests been carried out where the total heat transmitted was entirely or even largely superheat.

TABLE IV. HEAT TRANSMISSION DATA OBTAINED IN SERIES T AND U

						Series T								
	Run	Level	Time Min.	Abs. Vac.	Corres. Temp.	Abs. Steam Press.	Corres. Temp. Steam	Actual Temp. Steam	Superheat	Cond. Temp.	Cond. Lb.	θ	K	T
128A	I	6 03	10.0	289.3	75.02	762.1	100.08	115.82	15.76	99.74	457.7	25.06	2,123	434.8
128A	II	5 92	16.0	289.4	75.03	761.3	100.05	115.80	15.75	99.79	740.5	25.02	2,150	440.3
128A	III	6 00	15.0	290.3	75.11	760.2	100.01	114.18	14.17	99.56	546.1	24.90	2,138	437.8
151B	I	12 41	16.0	290.5	75.12	758.5	99.94	112.55	12.61	99.65	719.1	24.82	2,100	430.0
151B	II	12 93	14.0	289.4	75.03	770.5	100.38	112.41	12.03	100.07	650.4	25.35	2,124	434.9
151B	III	12 25	16.0	289.9	75.07	761.9	100.07	114.08	14.01	99.85	731.6	25.00	2,123	434.8
259	I	18 10	16.0	289.9	75.07	760.1	100.00	111.10	11.10	99.79	694.4	24.93	2,016	412.8
259	II	17 87	16.0	290.0	75.08	759.8	99.99	111.28	11.29	99.79	698.1	24.91	2,028	415.2
259	III	18.03	16.0	290.0	75.08	760.2	100.01	110.52	10.51	99.82	700.2	24.93	2,031	415.9
129A	I	23 80	18.0	289.7	75.06	763.5	100.13	113.64	13.51	99.89	672.7	25.07	1,729	354.1
129A	II	23 97	16.0	289.4	75.03	759.8	99.99	114.88	14.89	99.87	599.9	24.96	1,745	357.4
129A	III	24 10	20.0	290.2	75.10	759.5	99.98	114.45	14.47	99.89	756.8	24.88	1,766	361.6
152B	I	35 90	20.0	289.4	75.03	758.4	99.94	114.21	14.27	99.72	675.0	24.91	1,575	322.5
152B	II	36 23	20.0	289.6	75.05	760.7	100.03	115.69	15.66	99.71	684.0	24.98	1,592	326.1
152B	III	36 03	20.0	289.3	75.03	761.2	100.04	115.89	15.85	99.80	688.2	25.01	1,600	327.6
260	I	47 97	16.0	290.2	75.10	761.1	100.04	116.80	16.76	99.84	482.2	24.94	1,406	287.9
260	II	48 05	20.0	290.8	75.15	760.4	100.01	115.55	15.54	99.92	604.9	24.86	1,414	289.5
260	III	48 18	16.0	287.8	74.90	760.1	100.00	115.62	15.62	99.92	483.2	25.10	1,398	286.3
Average			.....	289.7	75.06	.....	100.04	.....	.....	.....	.....	24.98	.....	.....

Series U														
153B	I	6.17	24.0	290.7	75.14	523.8	89.90	109.81	19.91	88.73	438.0	14.76	1,461	299.2
154B	I	9.00	20.0	288.9	74.99	525.1	89.96	110.73	20.77	89.13	400.9	14.97	1,582	324.0
154B	II	9.28	18.5	284.9	74.66	524.8	89.95	110.15	20.20	88.97	370.7	15.29	1,549	317.1
130A	I	12.10	20.0	291.4	75.20	526.6	90.04	111.15	21.11	89.33	378.5	14.84	1,508	308.8
130A	II	11.95	20.0	288.8	74.98	521.4	89.78	111.26	21.48	89.02	379.5	14.80	1,516	310.5
130A	III	12.00	20.0	293.5	75.37	525.9	90.00	110.84	20.84	89.47	413.9	14.63	1,671	342.2
261	I	17.87	20.0	289.6	75.05	525.0	89.96	108.13	18.17	89.12	340.0	14.91	1,345	275.4
261	II	17.97	20.0	288.5	74.96	524.0	89.91	108.73	18.82	89.01	342.4	14.95	1,351	276.7
262	I	23.97	20.0	288.0	74.92	525.7	89.99	107.48	17.49	89.16	340.4	15.07	1,190	243.7
262	II	24.08	24.0	285.9	74.74	524.2	89.92	107.82	17.90	88.93	368.7	15.18	1,194	244.5
155B	II	35.95	21.0	286.4	74.76	520.8	89.75	104.16	14.41	88.69	270.1	14.99	1,009	206.7
155B	III	35.95	20.0	288.8	74.98	526.2	90.02	104.01	13.99	89.01	230.2	15.04	899	184.2
156B	I	35.97	20.0	287.2	74.85	527.8	90.10	104.23	14.13	89.02	239.9	15.25	925	189.4
131A	I	48.08	24.0	290.5	75.12	524.9	89.95	105.60	15.65	88.98	255.6	14.83	845	173.1
131A	II	49.30	24.0	289.4	75.03	522.2	89.82	104.97	15.15	88.68	231.6	14.79	768	157.3
Average			.....	288.8	74.98	.....	89.94	.....	.....	.....	.....	14.96	.....	.....

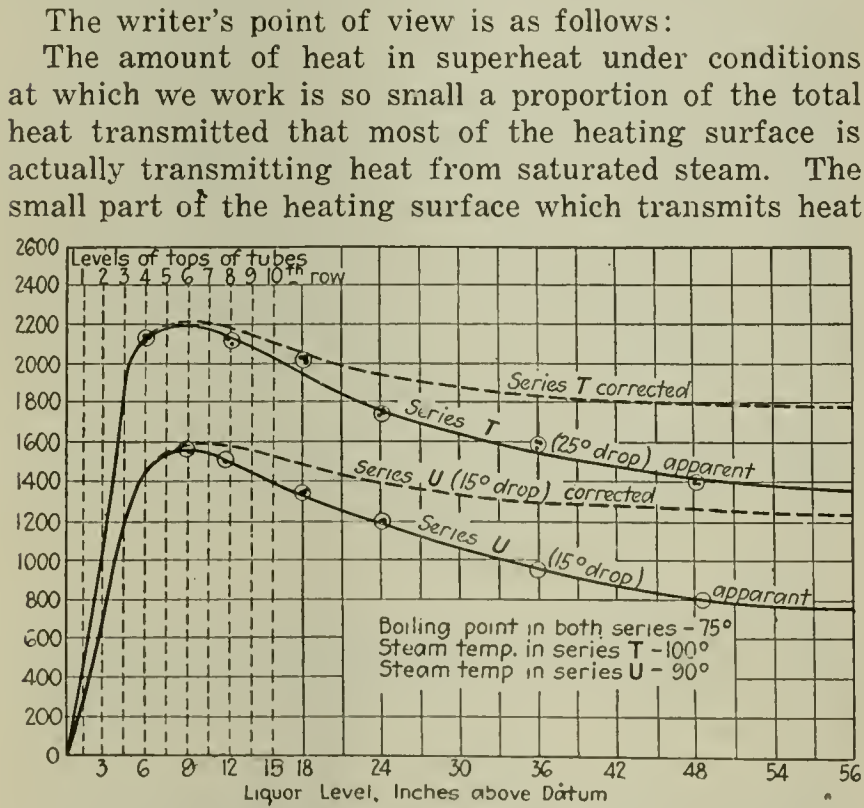


FIG. 4. APPARENT AND CORRECTED HEAT TRANSMISSION COEFFICIENTS FOR TWO DIFFERENT TEMPERATURE DROPS (SERIES T AND U)

from superheated steam may be working at a rate which is relatively very low, but this part of the surface is too small to affect the results appreciably.

It will be noted that these statements are purely qualitative. For the present we prefer not to attempt to deal in numerical statements. By a rearrangement of the steam lines in the experiment station it is now

possible to operate the horizontal tube evaporator on steam of pressure low enough so that there is no appreciable superheat, even in the steam chest. By a comparison with the runs here reported we hope to confirm the above qualitative statements with quantitative data in the near future.

The data of Table IV are apparent heat transmission coefficients—that is, they are determined by dividing the total heat transmitted by the apparent temperature drop. They may be corrected for effect of hydrostatic head by the following method. (See Fig. 5.)

In addition to the nomenclature given above under

TABLE V. CALCULATION OF HYDROSTATIC HEAD CORRECTIONS FOR SERIES T AND U

Level	Series T		Series U	
	6 In.	12 In.	6 In.	12 In.
H_a	7.874 sq.m.	2.6247	7.874	2.625
H_b	4.9213	10.171	4.920	10.169
t_b	75 90	76 77	75 84	76 81
t_2	24 14	23 27	14 12	13 23
θ_2	24 56	24 12	14 54	14 10
θ_{mh}	24 82	24 30	14 80	14 27
Apparent K	2,140	2,125	1,425	1,500
Correct K	2,153	2,182	1,440	1,573
$t_s = 100.04^\circ\text{C.}$ $t_w = 75.06^\circ\text{C.}$ $\theta_1 = 24.98^\circ\text{C.}$				
$t_s = 89.94^\circ\text{C.}$ $t_w = 74.98^\circ\text{C.}$ $\theta_1 = 14.96^\circ\text{C.}$				

Levels Above Top of Tubes							
Level	18 In.	24 In.	36 In.	48 In.	18 In.	24 In.	36 In.
t_b	77 64	78 45	80 01	81 49	77 53	78 36	79 92
t_2	75 39	76 27	77 95	79 53	75 32	76 20	77 89
θ_2	22 40	21 59	20 03	18 55	12 41	11 58	10 02
θ_3	24 65	23 77	22 09	20 51	14 62	13 74	12 05
θ_{mh}	23 53	22 68	21 06	19 53	13 52	12 66	11 04
Apparent K	1,930	1,765	1,550	1,400	1,345	1,190	960
Correct K	2,049	1,940	1,840	1,792	1,488	1,406	1,302

the calculation of temperature drop, the following are needed:

- p_v = absolute pressure in vapor space.
 p_h = hydrostatic head on bottom of heating surface.
 p'_h = hydrostatic head on top of heating surface.
 p_b = total pressure on bottom of heating surface.
 p_t = total pressure on top of heating surface.
 t_b = temperature corresponding to p_b .
 t_t = temperature corresponding to p_t .

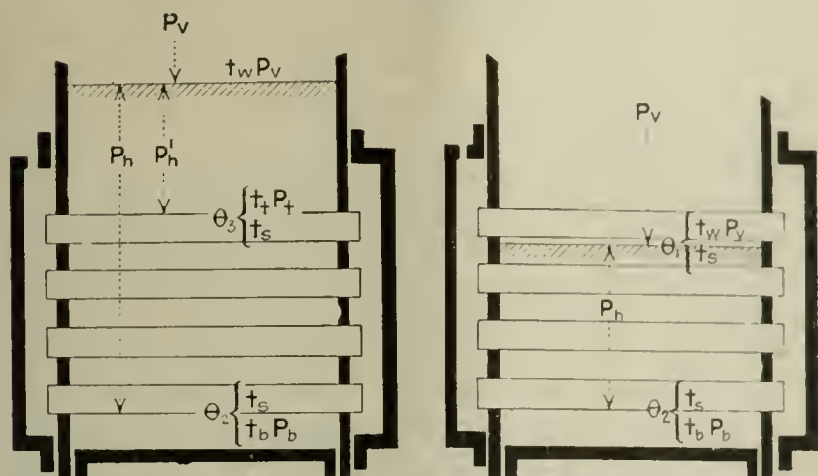


FIG. 5. ILLUSTRATION OF METHOD OF CORRECTING HEAT TRANSMISSION COEFFICIENTS FOR EFFECT OF HYDROSTATIC HEAD

For those cases where the liquid is above the top of the heating surface we have the following:

- θ_1 = apparent temperature drop = $t_s - t_w$.
 $p_t = p_v + p'_h$.
 $p_b = p_v + p_h$.
 $\theta_2 = t_s - t_b$ = temperature drop at bottom of heating surface.
 $\theta_3 = t_s - t_t$ = temperature drop at top of heating surface.
 θ_{mh} = mean temperature drop corrected for effect of hydrostatic head = $\frac{\theta_3 + \theta_2}{2}$

For those cases where the liquor level is below the top of the heating surface the formulation becomes:

- $p'_h = 0$, hence $t_t = t_w$.
 $\theta_2 = t_s - t_b$ = temperature drop at bottom of heating surface.
 H_a = heating surface above liquor level.
 H_b = heating surface below liquor level.
 $\theta_4 = \frac{\theta_1 + \theta_2}{2}$ = mean temperature drop over submerged part of heating surface.
 $\theta_{mh} = \frac{H_a \theta_1 + H_b \theta_4}{H_a + H_b}$

There are certain errors made in the above corrections of which the writer is aware but which do not introduce enough error to be significant. In particular, the mean temperature drop is, of course, not the arithmetical mean of the temperature drops at top and bottom of heating surface, but is determined by some other function which involves the relation between the

series T, is at once evident; and some search was made for a quantitative relation. Table VI showing the ratios of the corrected values in the two series indicates at once a very useful relation—namely, that if the ratio of heat transmission coefficients for different temperature drops is determined for a given evaporator at any one liquor level, the same ratio may be used for other liquor levels with an accuracy far greater than that now involved in any other part of the design.

CONCLUSIONS

The following conclusions must for the present be considered as indicating tendencies only, and must be applied with caution to evaporators differing much in design from the one in which they are determined.

1. In horizontal tube evaporators the maximum capacity occurs when the tubes are from half to two-thirds submerged.
2. The maximum capacity is reached at levels nearer the top of the heating surface as the apparent temperature drop becomes smaller.
3. The maximum apparent heat transmission coefficient is 105 to 108 per cent of the heat transmission coefficient where the liquor level is at the top of the heating surface.
4. The ratio of corrected heat transmission coefficients for two different temperature drops is constant for all levels above the optimum.

All of the work reported in this paper was done with funds supplied by the Swenson Evaporator Co., to which the writer wishes to express his indebtedness for permission to publish the result.

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Pronounced Benefits From Preliminary Impregnation of Pulpwood Chips*

Impregnating pulpwood chips with cooking liquor under pressure before the cooking action has commenced has been found decidedly advantageous in the soda and sulphate processes of pulping. The required pressure is obtained by pumping cooking liquor into the digester after it has been completely filled and closed. The amount of pressure necessary, duration of treatment and other factors vary with the type of cooking process, kind of chips used and quality of paper sought.

Laboratory cooks of treated chips on a 50-lb. scale showed greater uniformity of cooking, increased yields, reduced bleach consumption, increased concentration of the cooking liquor and reduced time for cooking.

Mill trials of the improved method on a 3-ton scale resulted in increased concentration of the cooking liquor, reduced time for cooking, a reduction of the steam required for cooking from 9,000 to 6,000 lb. per digester charge and an increase in the concentration of black liquor from the digester from 15 to 18 deg. Bé.

The saving in time required for cooking was estimated to be sufficient to offset the time required for impregnation. The saving in steam consumption made possible an increase of from 12 to 20 cooks per day from a 250-hp. steam boiler. The increase in the density of the cooking liquor was estimated to make possible an increase of 25 per cent in the output of the recovery house.

*From U. S. Forest Products Laboratory Technical Notes.

TABLE VI. RATIO OF CORRECTED VALUES, SERIES U, TO CORRECTED VALUES, SERIES T

Level, In.	Ratio U : T
10	0.721
12	0.721
18	0.725
24	0.724
36	0.708
48	0.712

vapor pressure of water and temperature. Averages obtained by graphic integration of the vapor pressure curve for water over the pressure ranges involved in these hydrostatic head corrections showed differences from arithmetical mean of only 0.02 to 0.03 deg.

The great similarity of the curves, series U and

Legal Notes

BY WELLINGTON GUSTIN

Nitric Acid With Sulphuric Acid Added to Prevent Corrosion Not Subject to Duty

The Supreme Court of the United States has upheld the judgment of the Court of Customs Appeals in the proceedings on protests of the Aetna Explosives Co. against assessments of duty on imported goods. (41 Sup. Ct. R. 513.)

The imported merchandise was nitric acid to which 20 per cent by weight and 5 per cent according to value of sulphuric acid had been added for the sole purpose of preventing corrosion of steel tank cars necessary for transportation of the nitric acid in large quantities. The court below found that the sulphuric acid was added solely for transportation purposes and that the result was not a product merchantable as such for use in the United States. Hence it held that no duty should have been demanded, and the Supreme Court affirms this decision.

In the 1913 tariff act, paragraph 387, including nitric and sulphuric acid in the free list, and paragraph 5, imposing a duty of 15 per cent ad valorem on all chemical and medicinal compounds, preparations and mixtures, nitric acid, to which sulphuric acid amounting to 20 per cent by weight and 5 per cent according to value has been added solely to prevent corrosion of the steel-carrying tank cars, is not subject to duty as a "preparation" or mixture.

The merchandise was not a commercial mixture contemplated by the statute. It was susceptible of no use other than as nitric acid, which must be treated again before use. The court said the mixing of this minimum amount of sulphuric acid should be treated as a means of and part of the shipment, and as an act as essential in the importation of nitric acid as would have been the proper packing of glassware or other goods designed for shipment by rail.

Cyanide Pond Owners Liable for Death of Live Stock

The case of Williams Estate Co. vs. Nevada Wonder Mining Co., 196 Pacific, 844, involves the liability of the mining company for loss of cattle from drinking cyanide solutions discharged from its mill, located at Wonder, Nev. It appears that the solutions flowed down a slope for a mile or so and there were collected in a pond. This pond was situated for the most part on mining ground owned by the mining company but extended over onto the public domain. These cyanide solutions are highly poisonous, but as they resemble water are attractive to cattle and other live stock. The mining company kept the pond fenced with barbed wire and posted notices warning owners of live stock of its dangerous contents. The company generally kept two men to impound these cyanide solutions, and on the day of the loss for which suit was brought the solutions broke through the levee of the pond and flowed outside the fence.

Plaintiff's cattle coming from the open range were attracted to the spot, drank the solutions and died.

A judgment was rendered for the loss of the cattle in the District Court and the Supreme Court of Nevada

has affirmed this decision. Nevada has no law requiring stockmen to keep their stock within inclosures, and they may lawfully permit such to roam at will and graze over the public ranges and also over unfenced land of private owners. In fact, a herder of horses or cattle upon public and other uninclosed lands is unknown to the stockmen in Nevada, says the court, and a mine owner creating a cyanide pond in proximity to and in open view of the public range, with knowledge of the poisonous nature of its contents and its attractions for cattle, is required to exercise reasonable care to prevent access to it by live stock.

Ordinarily one is not bound to keep his uninclosed premises in safe condition to avoid liability for injury to trespassing stock, but he is not permitted negligently to leave on his premises poisonous substances which will attract passing animals.

Nuisance in Storage Crude Petroleum

In an action brought by H. A. Lutes et al. against the Great Northern Refining Co., plaintiffs were awarded damages through defendant's erection and maintenance of an oil tank shipping rack in close proximity to their residence. It was charged that crude petroleum was being constantly pumped through the tank to the cars for shipment and that the gases and fumes escaping from the crude oil were so offensive, disagreeable and injurious as to constitute a nuisance and so as to make their residence uninhabitable. It was further alleged that because the oil was impregnated with gas and was highly flammable they were in constant danger of having their property destroyed by fire. (227 S.W., 795.)

The Court of Appeals of Kentucky reversed the Circuit Court's judgment for an error on the trial and a new trial was ordered. This court lays down the law that the storage of oil upon one's premises is not *per se* a nuisance. A lawful business cannot be a nuisance *per se*, but the character of the business, the manner in which it is conducted and its proximity to other buildings and the surrounding circumstances may be such as to create a nuisance. It is not every annoyance that will give a right of action to the complaining party. A nuisance is that which offends the olfactory nerves of an ordinary man, and not those of an individual with sensitive and delicate nostrils.

Further, the court says, every one who brings or stores oil on land must confine it securely in pipes, tanks or reservoirs, or at least not permit it to escape onto the land of another, whether by flowing over the surface or percolating through the soil, and if one does not, even though guilty of no negligence, he will be liable for whatever damage is suffered by the oil escaping. This is true, although the refining of oil is a perfectly legitimate business. Nor is the owner of property, injured by the operation of oil wells or works, confined to instances where the oil actually enters upon his premises, as he may recover because of noxious odors occasioned by their operation rendering his premises unhealthful or objectionable to live upon.

However, the court said, the question of prospective damage from fire should not have been submitted to the jury. It was too problematical. Ordinarily the mere anticipatory loss by fire because of the possibility that the tank might be struck by lightning or fired by a spark from a locomotive does not form a basis for a legal recovery. It might never happen; and if it did, and the owner was negligent, there would be a proper remedy.

Preliminary Summaries of 1919 Census of Manufactures

Tabulated Statistics for Chemicals, Drug Preparations, Natural Dyes and Extracts, Fertilizers, Gas, Leather, Paper and Wood Pulp, Petroleum Refining, Rubber Goods, Soap, Brass, Bronze and Copper Products, Pig Iron, Industrial Power and Fuel Consumption in Superpower Zone

PRELIMINARY statements of the general results of the 1919 census of manufactures with reference to a number of chemical and metallurgical industries have been issued by the Bureau of the Census. Comparative statistics for 1919 and 1914 are summarized in the following tables, figures for 1919 being subject to such change and correction as may be necessary from further examination of the original reports.

CHEMICAL INDUSTRY

The chemical industry is subdivided for establishments primarily engaged in the manufacture of (a) chemicals in general; (b) coal-tar chemicals; and (c) sulphuric, nitric, and mixed acids; and the figures are based upon returns from 811 establishments, with products valued at \$603,555,400. In addition chemical products were reported by 563 establishments primarily engaged in other lines of manufacture, to the value of \$91,087,600, making a total of 1,374 establishments and \$694,643,000 in value of products.

At the census of 1914 there were in the aggregate 754 establishments, with products valued at \$200,195,800, showing an increase of \$494,447,200 or 247 per cent.

CHEMICAL INDUSTRY, 1919 AND 1914

	1919		1914	
	No. of Establishments	Value	No. of Establishments	Value
Total.....	1,374	\$694,643,000	754	\$200,195,800
Chemical industry.....	589	436,602,800	395	158,053,600
Coal-tar products industry.....	183	135,482,100		
Sulphuric, nitric and mixed acids industry.....	39	31,470,500	32	15,215,500
Subsidiary chemical products, other industries.....	563	91,087,600	327	26,926,700
	Quantity	Value	Quantity	Value
Acids (a).....		\$78,117,800		\$30,516,600
Acetic and pyroligneous, lb.....	46,821,000	2,816,300		
Acetic, glacial, lb.....	5,050,000	869,200	70,617,600	1,272,300
Acetic anhydride, lb.....	1,213,200	578,600		
Boric (boracic), lb.....	14,454,100	1,754,600	8,584,300	589,000
Citric, lb.....	3,163,700	3,047,400	2,657,800	1,516,300
Hydrochloric, tons.....	147,130	4,312,300	85,440	1,348,800
Hydrofluoric, lb.....	5,675,400	440,200	5,373,700	325,600
Mixed (sulphuric, nitric) tons.....	48,430	4,426,600	42,725	2,204,500
Nitric, tons.....	19,440	2,976,100	14,685	1,591,600
Oleic, lb.....	44,350,600	6,548,600	21,932,700	1,301,400
Phosphoric, lb.....	13,379,500	1,711,100	12,420,200	680,200
Stearic, lb.....	16,969,900	3,796,400	14,351,400	1,242,500
Sulphuric (basis 50 deg.), tons.....	3,296,270	35,638,200	2,338,280	15,395,100
Lactic, lb.....	5,054,500	781,500		
Oxalic, lb.....	2,103,500	545,600		3,049,300
Tartaric, lb.....	5,313,000	4,262,400		
Other, lb.....		3,612,500		
Sodas and sodium compounds.....	90,913,100		32,594,800	
Bicarbonate, tons.....	141,560	3,695,400	90,170	1,439,000
Borax, tons.....	21,435	4,622,300	20,500	2,071,800
Caustic soda, tons.....	319,490	20,494,800	212,540	6,657,500
Salsoda, tons.....	71,830	2,102,200	106,590	1,510,500
Soda ash, tons.....	1,033,480	31,195,200	935,305	10,937,900
Sodium bichromate, tons.....	22,990	5,337,400	11,820	1,125,400
Phosphate, tons.....	22,350	2,438,900	15,400	853,500
Silicate, tons.....	286,790	6,052,300	169,050	1,648,900
Sulphate (glauber salts), tons.....	37,390	843,500	34,540	427,800
Salt cake, tons.....	175,010	2,084,300	90,440	841,900
Sulphides, tons.....	35,180	2,316,300	20,260	516,600
Other.....		9,730,500		4,564,000
Potash and potassium compounds.....		16,409,500		7,219,900
Bitartrate (cream of tartar), lb.....	2,854,550	2,620,400	12,646,120	3,125,000
Caustic potash, lb.....	12,625,000	2,163,400		
Potash from original sources, tons.....	106,000	7,110,100		4,094,900
Other.....		4,515,600		

	Quantity	Value	Quantity	Value
Alums, tons.....	327,070	\$16,677,600	156,860	\$3,468,000
Ammonia and cyanogen compounds.....		46,549,000		8,065,000
Anhydrous ammonia, tons.....	27,350	10,861,600	8,330	3,140,900
Aqua ammonia, tons.....	16,680	3,245,400	17,770	1,412,200
Ammonium chloride, tons.....	6,060	1,426,100	5,760	641,100
Ammonium sulphate, tons.....	294,880	22,638,600	(b) 4,423	(b) 211,300
Other ammonium salts.....		2,476,300		260,800
Cyanides.....		5,901,000		2,398,700
Leaching compounds.....		10,582,800		5,302,400
Chlorine, lb.....	34,391,800	1,425,900	12,217,000	472,900
Hypochlorite, lime, tons.....	88,570	3,418,500		
Hypochlorite, sodium, tons.....	37,860	1,362,800	155,190	2,916,200
Peroxide, hydrogen, lb.....	31,515,000	2,257,300	32,595,000	1,303,600
Peroxide, other.....		449,100		
Sodium bisulphite.....	38,717,000	948,700		609,700
Other sulphur bleaches.....		129,300		
All other.....		592,200		
Coal-tar products.....		133,340,900		8,839,500
Finished products, lb.....	82,532,400	84,515,500		
Dyes, lb.....	63,402,200	67,598,900		
Color lakes, lb.....	7,569,900	4,180,000		
Photographic chemicals, lb.....	325,500	1,059,300		
Medicinals, lb.....	6,778,000	7,883,100		
Flavors (saccharine, etc.), lb.....	610,800	1,318,600		
Perfume materials, lb.....	41,400	164,300		
Synthetic phenolic resins, lb.....	3,094,600	2,311,300		
Crudes and intermediates.....		48,825,400		
Compressed and liquefied gases.....		33,154,200		4,484,000
Carbon dioxide, lb.....	59,771,400	6,574,200	50,445,780	2,320,700
Nitrous oxide, gal.....	22,376,000	515,200	17,838,000	213,100
Oxygen, M.cu.ft.....	1,173,400	16,577,400	104,700	1,829,400
Other.....	(c) 9,487,400		(d) 120,800	
Plastics.....		77,477,000		13,895,800
Pyroxylin.....		30,169,000		8,876,500
Rubber substitutes.....		1,456,000		428,600
Viscose, collodion and other.....		45,852,000		4,590,700
Chemicals produced by the aid of electricity.....		67,543,800		29,661,900
Not elsewhere included (aluminum, calcium carbide, abrasives, ferro-alloys, phosphorus, etc.).....		48,297,900		24,614,600
Included in other groups (duplication).....		19,245,900		5,047,300
Aldehydes-formaldehyde, lb.....	19,663,800	3,938,300	8,426,200	655,200
Other.....		1,794,300		(e)
Esters:				
Amyl acetate, lb.....	704,600	350,600	1,300,000	465,700
Ethyl acetate, lb.....	2,251,000	340,000		(e)
Ethyl chloride, lb.....	248,100	166,200		(e)
Other.....		1,114,400		(e)
Ethers:				
Ethyl (sulphuric), lb.....	4,111,800	1,103,700	2,120,000	278,800
Other.....		22,600		(e)
Ketones:				
Acetone, lb.....	6,045,900	767,000	10,425,800	1,099,600
Methyl ethyl, lb.....	1,158,000	167,700		(e)
Other.....		225,100		
Misc. organic chemicals:				
Carbon tetrachloride, lb.....	9,811,800	803,600		(e)
Chloroform, lb.....	1,677,600	516,600	1,334,000	295,300
Glycerine, refined, lb.....	64,342,800	20,724,000	58,810,400	10,779,200
Glycerine, crude (for sale), lb.....	21,304,300	2,961,600	16,568,900	2,279,000
Vanillin, lb.....	134,700	1,365,900	120,600	525,200
Other.....		18,813,900		(e)
Metals salts, n.e.s. (Salts of):				
Antimony, lb.....	4,045,600	1,190,000		(e)
Arsenic (other than lead arsenate).....		1,290,800		(e)
Barium sulphate (blanc fixe) lb.....	13,626,000	256,100	18,278,000	257,400
Barium, other salts.....		1,422,300		103,200
Bismuth, lb.....	502,300	1,235,500		(e)
Calcium acetate, lb.....	152,634,000	2,682,200	163,522,000	2,138,900
Calcium chloride, lb.....	149,397,000	1,043,300		(e)
Calcium phosphate, lb.....	43,910,000	4,709,200		(e)
Calcium, other salts, lb.....		427,500		(e)
Chromium.....		1,192,340		(e)
Cobalt.....		104,970		
Copper sulphate (blue vitriol), lb.....	35,288,000	2,825,550	37,152,000	1,598,900
Copper, other salts.....		410,200		14,380
Gold, oz.....	14,844	143,070	28,817	291,660
Iron sulphate (copperas), lb.....	119,611,000	1,046,900	92,479,000	352,770
Iron, other salts.....		1,694,700		839,000
Lead arsenate, lb.....	11,465,800	2,090,300	8,641,900	511,700
Lead acetate, lb.....	4,183,600	552,400		474,430
Lead, other salts.....		335,500		
Magnesium sulphate (epsom salts), lb.....	58,696,600	1,497,000	29,265,000	297,000
Magnesium oxide (calcined), lb.....	9,031,600	1,176,860		(e)

	Quantity	Value	Quantity	Value
Magnesium carbonate (precipitated), lb.	2,064,700	\$85,700	(e)	(e)
Magnesium, other salts		788,600	(e)	(e)
Mercury, lb.	1,143,800	1,775,000	605,700	\$518,000
Nickel, lb.	1,059,800	640,200	409,500	157,150
Silver nitrate, oz.	3,017,900	2,184,000	2,563,200	846,060
Silver, other salts		257,700		(e)
Strontium, lb.	529,450	319,400		(e)
Tin chloride, lb.	8,999,200	2,986,500	8,291,200	2,028,500
Tin oxide, etc., lb.	1,352,600	900,240		
Zinc chloride, lb.	74,089,000	4,349,100		
Zinc sulphate, lb.	7,325,500	267,000	40,786,900	1,130,960
Zinc, other salts, lb.		785,540		
Radium, mg.	25,381	2,743,670		
Cerium, titanium, thorium and uranium		900,550		1,388,480
Other chemicals, n.e.s.		7,014,110		23,568,300
Chemical byproducts and residues		25,108,000		4,407,600
Other byproducts and contract work		9,514,700		3,890,800

(a) Coal-tar acids included with "coal-tar products."
 (b) Not including ammonium sulphate product of byproduct coke and gas plants—88,490 tons, value \$4,830,786.
 (c) Includes acetylene, hydrogen, nitrogen, argon, etc.
 (d) Not including acetylene in containers 121,696 M.eu.ft.; \$2,317,605; which was included in the manufactured gas industry.
 (e) Figures not available.

DRUGGISTS' PREPARATIONS, PATENT MEDICINES, PERFUMERY AND COSMETICS

Three related industries—druggists' preparations, patent medicines and compounds, and perfumes and cosmetics—are treated in the following table:

DRUGGISTS' PREPARATIONS, PATENT MEDICINES, AND PERFUMERY AND COSMETICS, 1919 AND 1914

	Number of Establishments		Value of Products	
	1919	1914	1919	1914
Total			\$409,769,800	\$176,747,000
Druggists' preparations—industry	524	416	\$114,596,900	\$48,009,700
Subsidiary products from other industries	42	....	13,344,300	5,353,600
Patent medicines and compounds, industry	2,468	2,903	212,185,700	102,463,400
Subsidiary products from other industries	151	....	6,878,100	3,202,000
Perfumery and cosmetics—industry	570	496	59,630,100	16,899,100
Subsidiary products from other industries	61	....	3,134,700	819,200

Classified Products		Quantity		Cost	
		Lb.			
Alkaloids and derivatives	1919				
Production, lb.	481,056				
Made and consumed, lb.	23,160				
For sale, lb.	457,896			15,416,000	16,231,500
Biological products (serums, vaccines, toxins)	94	98	15,876,400	6,223,500	
Tinctures, fluid extracts, medicinal syrups	406	347	38,679,500	13,900,400	
Pills, tablets, powders, etc.	403	281	37,790,900	10,903,000	
Pharmaceutical metals and their salts and synthetic preparations (a)	28	130	825,500	2,117,300	
Patent and proprietary medicines containing opium, codein, heroin, morphine or cocaine	231		2,951,100		
Not containing any of said narcotics	1,909	2,460	159,520,800	83,455,300	
Patent and proprietary compounds	1,030	1,075	46,376,600	16,514,300	
Perfumery and cosmetics and toilet preparations	938	932	69,470,400	19,160,400	
Flavoring essences and extracts			5,241,500		
All other products			17,621,100	8,241,300	

(a) Includes synthetic preparations in 1919—4 establishments; value \$404,585; 1914—75 establishments; value, \$1,384,996.
 (b) Figures not available.

NATURAL DYES AND EXTRACTS

The total production of natural dyestuffs in 1919 as reported by all manufacturing establishments was valued at \$4,689,000, as compared with \$1,862,200 in 1914, and the total production of tanning materials was

valued at \$32,625,300 in 1919, as compared with a production of \$7,898,700 in 1914. In addition the establishments reported the manufacture of mordants to the value of \$1,218,700, assistants valued at \$2,845,300 and sizes to the amount of \$11,580,500.

NATURAL DYESTUFFS AND EXTRACTS, 1919 AND 1914

	1919		1914	
	Quantity, Lb.	Value	Quantity, Lb.	Value
Total		\$57,233,000		\$21,382,700
Natural dyestuffs and extracts: industry		54,063,000		*20,620,300
Subsidiary products of other industries		3,170,000		762,400
Natural dyestuffs		4,639,000		1,862,200
Logwood extract	32,727,000	3,292,500	28,990,000	1,312,000
Fustic	3,896,000	355,000	4,510,000	222,800
Quercitron	6,746,000	303,400	3,845,000	113,000
Brazilwood and other red woods	1,553,000	246,400		
Cutch	525,000	66,500		214,400
Other	896,000	425,200		
Tanning materials		32,625,300		7,898,700
Oak extract	27,726,000	1,390,100		
Chestnut	444,735,000	17,287,700	328,198,000	4,130,100
Hemlock	19,706,000	879,400	18,978,000	340,400
Sumac	3,507,000	253,100	4,512,000	129,600
Quebracho	71,412,000	7,123,800		
Gambier	1,006,000	87,200		
Spruce, myrobalans, dividivi and gallnuts, (chiefly spruce)	81,811,000	804,300		3,298,600
Other vegetable extracts	34,805,000	3,124,200		
Other tanning materials, including chrome tanning and ground bark		1,675,500		
Mordants		1,218,700		392,400
Assistants		2,845,300		1,537,000
Sizes		11,580,500		3,052,900
Dextrine	49,329,000	3,791,400	18,914,000	705,600
Rosin	57,056,000	2,888,600	20,717,000	373,200
Gums other than rosin	8,672,000	634,600	3,832,000	205,300
Other sizes, starches, glue, etc.		4,265,900		1,768,800
All other products		4,274,200		*6,639,500

* Includes artificial dyestuffs to the amount of \$5,252,600 included in the industry in 1914.

FERTILIZER INDUSTRY

In 1919 the establishments in the fertilizer industry proper, 599 in number, were located 144 in Georgia, 50 in South Carolina, 45 each in Maryland and North Carolina, 44 in Virginia, 40 in Alabama, 31 in Pennsylvania, 24 in Florida, 21 in Ohio, 19 in New Jersey, 16 in California, 13 in Indiana, 12 in Illinois, 10 each in Maine and Tennessee, 9 each in Mississippi and Texas, 7 in Delaware, 6 each in Connecticut, Louisiana and New York, 4 each in Kansas and Kentucky, 3 each in Missouri, Oregon and Washington, 2 each in Arkansas, Colorado, Massachusetts and Nebraska, and 1 each in Iowa, Michigan, Montana, Nevada, New Mexico, Rhode Island, and West Virginia.

FERTILIZER INDUSTRY, 1919 AND 1914

	Number of Establishments		Production	
	1919	1914	1919	1914
Total for all establishments	818	1,238	\$303,238,000	\$169,017,000
Fertilizer industry	599	784	\$278,609,000	\$153,196,000
Subsidiary products, other industries (a)	219	454	\$24,629,000	\$15,821,000
Fertilizers, tons			8,291,000	\$8,432,000
Value			\$280,288,000	\$153,260,000
Complete and ammoniated, tons	530	898	4,696,000	5,612,000
Value			\$196,343,000	\$121,676,000
Superphosphates, tons	250	218	2,340,000	1,693,000
Value			\$44,956,000	\$14,779,000
Concentrated phosphates, tons	15	18	117,000	68,000
Value			\$3,755,000	\$1,367,000
Other fertilizers, tons	434	461	1,138,000	1,059,000
Value			\$35,234,000	\$15,438,000
Fish scrap, tons	51	55	48,600	62,900
Value			\$3,240,700	\$1,915,500
Oil, gals.	50	48	2,132,300	2,445,000
Value			\$1,850,000	\$778,300
Bone black, pounds	8	5	44,598,000	41,055,000
Value			\$2,227,100	\$1,413,000
Sulphuric acid (basis 50 deg. Baume), tons			309,300	129,100
Value			\$3,639,000	\$768,800
Other acids and chemicals			\$711,800	\$400,600
Glue	5	12	\$2,171,100	\$1,131,200
Grease (soap stock, etc.)			\$2,162,200	\$1,209,300
All other products			\$6,947,600	\$8,140,200

(a) Includes 100 cottonseed oil mills, 51 slaughtering and meat packing plants, and 68 establishments in other industries producing waste of fertilizing value.

GAS INDUSTRY

The figures are based on returns from 1,020 establishments, with products for the year valued at \$328,851,000. At the census of 1914 there were 1,244 establishments with products valued at \$217,920,000, an increase of \$111,931,000, or 50.9 per cent. The decrease in number of establishments is chiefly in the small town and village plants of the acetylene or gasoline groups, there being but 37 acetylene and 22 gasoline (cold process) plants in 1919 as compared with 125 and 112 respectively in 1914.

The total production of gas for sale in 1919 was 307,913,000,000 cu.ft., valued at \$281,865,000, an average value of 91.5c. per thousand feet. In 1914 the production was 203,517,500,000 cu.ft., valued at \$172,748,000, or an average unit value of 84.9c. The increase in quantity was 104,395,500,000 cu.ft., or 51.3 per cent, and in value \$109,117,000 or 63.2 per cent.

GAS, MANUFACTURED, 1919 AND 1914

Products*	1919		1914†	
	Quantity	Value	Quantity	Value
Value of products.....		\$328,851,000		\$217,920,000
Gas for sale, M. cu.ft.....	307,903,000	281,865,000	203,517,500	172,748,000
Coal gas.....	8,029,500	10,496,400	10,509,900	10,726,500
Carburized water gas....	90,656,300	83,663,400	90,017,700	74,516,500
Mixed coal and water gas.....	179,877,500	161,199,700	86,281,300	72,012,000
Oil gas.....	15,420,300	18,747,500	16,512,300	15,044,500
Acetylene (distributed through mains).....	5,200	59,600	14,900	194,000
Gasoline (cold process gas).....	20,400	41,200	181,400	254,700
Other (enrich. nat. gas)...	13,903,800	7,647,200		
Coke, for sale, tons.....	2,458,200	17,822,900	2,281,800	8,719,900
Made and consumed.....	1,820,400		1,300,700	
Tar, for sale, gal.....	120,550,400	4,661,300	125,938,600	3,252,900
Made and consumed.....	47,639,500		27,372,600	
Ammonia, liquor, gal.....	30,148,500	1,677,200	50,737,800	1,235,400
Ammonium sulphate, lb....	5,073,900	205,000	6,216,500	134,200
Other products.....		5,265,300		20,851,800
Receipts from lamps and appliances.....		17,354,300		10,977,800
Materials	Quantity	Cost	Quantity	Cost
For gas making:				
Coal, anthracite, G.T....	1,307,400	11,326,300	6,116,700	20,872,500
Bituminous, N.T....	6,193,500	32,412,300		
Oil, gals.....	879,320,800	50,624,900	715,418,600	24,721,000
Coke, purchased, N.T....	1,335,300	11,781,900	964,900	4,500,300
Made and used in generators, N.T.....	663,300		‡	
Other materials§.....		84,600		339,700
Gas purchased, M.cu.ft....	82,020,000	22,578,500	28,351,100	8,883,000

* In addition six establishments in 1919 and five in 1914, primarily in other lines of manufacture, distributed gas through mains—1919—64,200 M.cu.ft.; value \$112,480; 1914—51,898 M.cu.ft.; value \$61,405.

† Not including forty establishments without mains, included in report for gas industry in 1914 (product compressed gas in cylinders—121,696 M.cu.ft., value \$2,317,600).

‡ Figures not available.

§ Includes benzene, benzine, gasoline, naphtha and calcium carbide.

GLASS INDUSTRY

The preliminary report for the glass industry during 1919 was published in CHEMICAL & METALLURGICAL ENGINEERING, vol. 24, p. 1017, June 8, 1921.

LEATHER INDUSTRY

Reports were received from 681 establishments, having a total output valued at \$928,668,200. In 1914 there were 767 establishments with a total value of products amounting to \$367,201,700. Of the 681 establishments reported for 1919, 131 were located in Massachusetts, 94 in New York, 92 in Pennsylvania, 73 in New Jersey, 30 in Illinois, 28 in Michigan, 25 in Wisconsin, 24 in Ohio, 21 each in California and Virginia, 18 in Delaware, 17 in West Virginia, 11 in North Carolina, 10 each in Kentucky and Tennessee, 9 each in Indiana and Maine, 7 each in Connecticut, Maryland, Missouri and New Hampshire, 6 in Minnesota, 5 in Oregon, 3 each in Georgia and Texas, 2 each in North Dakota, Rhode Island, Vermont and Washington, and 1 each in

Alabama, Colorado, Louisiana, South Dakota and Wyoming.

COMPARATIVE SUMMARY FOR THE LEATHER INDUSTRY
1919 AND 1914

	1919	1914
Number of establishments	681	767
Value of products	\$928,668,200	\$367,201,700
Leather, value	\$848,038,500	\$341,796,400
Sole leather, sides	19,715,800	18,075,500
Value	\$218,829,900	\$116,188,000
Hemlock, sides	1,731,500	5,626,700
Value	\$16,179,600	\$31,007,400
Union, sides	7,314,900	6,588,800
Value	\$79,917,900	\$42,457,800
Oak, sides	10,086,200	5,267,900
Value	\$117,522,100	\$38,384,100
Chrome, sides	583,200	592,000
Value	\$5,210,300	\$4,333,800
Belting, butts	1,483,070	647,200
Value	\$32,777,000	\$8,369,600
Harness, sides	2,677,200	2,777,300
Value	\$24,171,000	\$20,969,200
Upholstery, value	\$31,916,700	\$14,328,400
Cattle side, upper (other than patent), sides	16,709,500	8,246,000
Value	\$120,897,300	\$32,939,100
Upper, skins	79,811,900	66,268,800
Value	\$266,725,000	\$83,009,200
Horse, sides	2,913,200	965,300
Value	\$16,181,400	\$2,881,900
Fancy, skins	1,783,500	7,486,300
Value	\$5,687,100	\$6,406,000
Patent, value	\$26,754,400	\$15,590,800
Glove, value	\$16,004,900	\$3,286,400
Finished splits, value	\$16,501,700	\$8,547,200
Case, bag, and strap leather, value	\$11,880,800	\$5,383,300
Skirting and collar leather, value	\$5,998,700	\$2,083,000
Bookbinders', value	\$3,463,800	\$1,362,700
Sold in rough, value	\$3,712,700	\$4,495,000
All other leather, value	\$46,508,600	\$15,956,600
Amount received for work done for others	\$51,913,800	\$12,270,900
All other products	\$28,715,900	\$13,134,400

PAPER AND WOOD PULP INDUSTRY

Returns were received from 713 establishments engaged in the industry in 1919, with products to the value of \$789,548,000. Of the total number, 481 establishments manufactured paper only, 61 wood pulp only, and 171 both paper and pulp. At the census of 1914 there were 718 establishments with products valued at \$332,147,000. At the census of 1919 the production of paper amounted to 6,124,000 tons, valued at \$682,043,000, as compared with 5,269,000 tons valued at \$291,588,000 in 1914, an increase of 16.2 per cent in tonnage and 133.9 per cent in value.

Products	Quantity (Tons of 2,000 lb.)		Value	
	1919	1914	1919	1914
Wood pulp produced (including that used in mills where manufactured), total	3,519,000	2,893,000		
Ground, tons	1,519,000	1,294,000		
Soda fiber, tons	412,000	348,000		
Sulphite fiber, tons	1,420,000	1,151,000		
Sulphate fiber, tons	12,000	52,000		
Screenings, mechanical, tons	12,000	12,000		
Screenings, chemical, tons	36,000	36,000		
Total value of products*			\$789,548,000	\$332,147,000
Newspaper, in rolls and sheets	1,324,000	1,313,000	\$98,560,000	\$52,943,000
Hanging papers	69,000	97,000	6,043,000	4,489,000
Poster, novel, tablet, lining, etc.	80,000	†8,000	7,273,000	†491,000
Book paper:				
Plain	819,000	787,000	118,271,000	58,496,000
Coated paper	132,000	117,000	24,010,000	11,606,000
Plate, lithograph, map, etc.	10,000	9,000	1,556,000	588,000
Cover paper	40,000	22,000	9,531,000	2,809,000
Fine paper	325,000	248,000	87,741,000	34,055,000
Wrapping paper, including bag paper	932,000	882,000	114,936,000	49,373,000
Tag stock (rope, jute, etc.)	27,000	29,000	5,460,000	1,936,000
Boards:				
Wood pulpboard	180,000	116,000	14,888,000	4,227,000
Strawboard	228,000	175,000	12,230,000	4,270,000
Newsboard	89,000	128,000	4,604,000	3,502,000
Binders', trunk and press boards	43,000	61,000	3,788,000	2,664,000
Cardboard, bristol board, card middles, etc.	85,000	83,000	11,104,000	5,376,000
Leather board	28,000	27,000	2,263,000	1,177,000
Chip board	714,000	‡	37,749,000	‡
All other	518,000	701,000	37,464,000	23,652,000
Tissue paper	191,000	115,000	40,696,000	11,536,000
Blotting paper	13,000	14,000	3,209,000	1,458,000
Building paper	195,000	244,000	17,737,000	9,476,000
All other paper	82,000	93,000	16,461,000	7,464,000
All other products, including wood pulp manufactured for sale			113,974,000	40,559,000

* In addition, in 1919, five establishments engaged primarily in the manufacture of other products produced paper and pulp to the value of \$1,064,772, and in 1914, nine such establishments manufactured \$2,767,407 worth of paper and pulp.

† Reported as poster paper in 1914.

‡ Included in all other boards in 1914.

PAINT AND VARNISH INDUSTRIES

The figures are based upon the returns from 601 establishments primarily engaged in the manufacture of paints with products valued at \$256,714,300, and 229 establishments in the manufacture of varnishes with products valued at \$83,632,400. In addition, paints and varnishes to the value of \$41,559,300 were manufactured by 56 establishments included under other classified industries.

At the census of 1914 there were 585 establishments in the paint industry with products valued at \$112,408,700, 215 in the varnish industry with \$33,215,000, and 57 establishments in other classified industries, making paint and varnish to the amount of \$3,549,700.

PAINTS AND VARNISHES, 1919 AND 1914

	1919		1914	
	No. of Establishments	Value of Products	No. of Establishments	Value of Products
Total	886	\$381,916,000	857	\$149,173,400
Paint industry	601	256,714,300	585	112,408,700
Varnish industry	229	83,632,400	215	33,215,000
Paint and varnish subsidiary products of other industries	56	41,569,300	57	3,549,700
	Quantity	Value	Quantity	Value
Colors (pigments)		\$72,457,300		\$17,450,500
Natural:				
White lead, dry: production, lb.	240,052,000		279,269,800	
For sale, lb.	80,455,000	6,318,500	71,643,800	3,697,700
Made and consumed, lb.	159,597,000		207,626,000	(a)
Zinc oxide, lb.	279,321,000	24,082,300	(a)	(a)
Lithopone, production, lb.	154,622,300			
For sale, lb.	151,200,700	9,757,600	48,972,000	1,857,500
Made and consumed, lb.	3,421,600		(a)	
Lead oxides, production, lb.	165,106,700		61,335,300	
For sale, lb.	162,474,200	12,748,400	58,642,600	3,281,700
Made and consumed, lb.	2,632,500		2,692,700	
Iron buff and other earth colors, lb.	189,347,000	3,657,900	92,897,000	797,800
Chrome yellow, lb.	2,307,700	612,300	6,747,300	641,500
Orange or green, lb.	2,985,700	666,700	8,024,400	677,300
Prussian blue, lb.	627,200	457,500	1,239,400	387,100
Ultramarine, lb.	2,800,000	630,000	2,698,600	222,800
Vermilion (true), lb.	327,500	237,800	322,760	200,100
Fine colors (n.e.s.), lb.	3,881,200	1,754,100	4,215,900	690,300
Other dry colors, lb.	78,259,000	5,984,300	142,537,000	3,942,400
Pulp colors, sold moist, lb.	30,084,300	3,262,300	22,110,500	1,054,300
Synthetic:				
Chrome yellow, orange or green, lb.	4,138,470	802,400		
Iron, buff and other iron colors or dyes, lb.	12,834,500	121,000	(b)	(b)
Prussian blue, lb.	317,450	187,700		
Other mineral colors, lb.	38,264,000	1,176,500		
Paints in oil		168,525,400		70,582,400
In paste form: White lead	237,358,700	25,606,600	281,417,600	18,141,500
Other paints, lb.	160,910,000	23,576,600	138,594,500	10,896,700
Mixed for use, gal.	59,646,800	119,342,200	40,745,600	41,445,300
Varnishes and japans		86,814,800		36,142,200
Oleoresinous varnishes, gal.	28,116,200	40,044,900	17,801,440	18,762,400
Spirit varnishes, not turpentine, gal.	2,974,100	8,105,500	2,964,170	3,080,400
Damar and similar turpentine and benzine varnishes, gal.	6,356,400	10,273,800	3,297,370	2,865,300
Pyroxylin varnishes, gal.	500,060	923,500	852,570	1,308,800
Drying japans and driers, gal.	5,940,970	5,558,900	6,560,400	3,015,900
Baking japans and lacquers, gal.	5,375,220	5,877,600	4,888,800	2,960,800
Other, gal.	11,318,200	16,030,600		4,148,600
Fillers		6,551,600		3,239,200
Liquid fillers, gal.	2,605,280	1,835,600	965,640	670,100
Paste or dry fillers, lb.	16,981,500	1,551,800	49,587,550	1,318,700
Putty, lb.	66,681,500	3,164,200	69,828,000	1,250,400
Water paint and kalsomine		5,351,900		2,202,300
Dry or in paste, lb.	106,797,920	4,549,100	61,904,260	2,055,200
Mixed for use, gal.	359,130	802,800	297,170	147,100
Other products:				
Bleached shellac, lb.	8,799,190	5,955,700	8,654,510	1,806,800
Boiled linseed oil, gal.	611,130	1,044,800	572,560	306,600
All other products		35,214,500		17,443,400
Principal materials:		Cost		Cost
Pig lead, short tons	147,012	17,241,730	150,762	11,488,110
Alcohol, grain, gal.	2,985,740	1,724,100	1,061,300	436,500
Alcohol, wood, gal.	244,560	304,000	987,450	422,100
Linseed oil, gal.	26,385,230	42,660,000	24,481,620	12,049,200
Chinawood, soya and other oils, gal.	17,770,380	17,199,400		
Turpentine, gal.	6,081,900	6,962,000	(a)	(a)
Benzene, gal.	1,665,600	400,200		
Ro in, lb.	85,886,500	5,409,300		
Shellac, lb.	7,785,300	4,653,600	48,902,000	4,797,900
Other gums, lb.	35,352,200	5,123,400		

(a) Figures not available. (b) Not separately reported; included above.

PETROLEUM REFINING

With reference to the petroleum refining industry reports were received from 318 establishments with products for the year valued at \$1,632,354,000. At the census of 1914 there were 176 establishments with products valued at \$396,361,400, an increase of \$1,235,992,000 or 312 per cent.

The phenomenal increase is the result of increase in quantity production and in higher unit values. The output of gasoline in 1919 was 3,637,045,000 gal., valued at \$679,775,500 as compared with 1,195,412,000 gal., and \$106,140,200 in 1914, an increase of 204 per cent in quantity and 540 per cent in value, and in unit value from 8.8c. to 187c. Likewise in fuel oils: the output in 1919 was 7,979,868,000 gal. valued at \$318,082,700 as compared with 3,734,092,000 gal. valued at \$84,017,800 in 1914, an increase of 114 per cent in quantity, and 277 per cent in value, and in unit values from 2.25c. to 4c.; and in illuminating oils the production in 1919, 2,304,850,000 gal. valued at \$235,617,500 was an increase of 191 per cent in quantity and 143 per cent in value over that of 1914, with an increase in unit values from 5c. to 10.2c.

The refineries used 357,686,000 bbl. of crude petroleum (domestic 319,626,600 bbl., foreign 38,059,400 bbl.) in 1919, costing \$866,265,000, as compared with 191,262,700 bbl. (185,027,479 domestic and 6,235,245 foreign) and \$249,728,000 in 1914, an increase of 87 per cent in quantity and of 247 per cent in cost, and in increase in unit values from \$1.31 to \$2.42 per bbl. The marketed production of crude petroleum in 1919 was 377,719,000 bbl., and in 1914, 265,762,535 bbl. Thus the refinery consumption was equal to 84.6 per cent of the domestic production in 1919 as compared with 69.6 per cent in 1914 and 65.9 per cent in 1909.

The gasoline product of the refineries does not include casing-head gasoline made at the wells, except to the extent that it was purchased and used as a material (6,952,200 bbl.). The ranking states, those with products in excess of \$100,000,000, are New Jersey, with 9 establishments; Texas, 38; California, 45; Pennsylvania, 53; and Oklahoma, 66.

Comparative data for the industry in 1919 and 1914 are tabulated in the following table:

PETROLEUM REFINING 1919 AND 1914

	1919		1914	
Products	Quantity 1,000 Gal.	Value \$1,632,354,000	Quantity 1,000 Gal.	Value \$396,361,400
Naphthas and lighter products	4,190,276	765,914,500	1,460,038	121,919,300
Gasoline	3,637,045	679,775,500	1,195,412	106,140,200
Naphtha	392,257	65,077,900		
Benzine	64,491	10,015,900	264,626	15,779,100
Other	96,483	11,045,200		
Illuminating oils	2,304,850	235,617,500	1,935,275	96,806,500
Fuel oils:				
Distillates	635,900	36,548,100	457,492	15,999,300
Gas oils	1,259,943	76,383,500	755,558	22,805,300
Residual fuel oils	6,084,025	205,151,100	2,521,042	45,213,200
Lubricating oils	818,953	196,242,400	517,839	55,812,100
Pale or paraffin	123,373	28,238,300	93,422	8,084,600
Red or neutral	210,516	44,583,100	116,353	12,426,000
Cylinder	235,436	59,036,500	102,949	13,703,800
Other	249,504	64,384,500	205,115	21,597,700
Liquid asphaltic road oils	97,037	4,480,700		
Residuum or tar	29,163	1,533,500	134,844	4,018,000
Partly refined oils sold for re-running	428,347	29,268,900		(a)
Grease		11,896,700		3,536,500
Petroleum, mineral jelly, etc.	10,230	3,750,000	6,078	1,243,400
Lubricating greases	12,599	6,043,800	4,980	1,625,000
Axle greases	5,318	2,102,900	2,948	668,100
Paraffin wax	69,361	28,348,400	57,539	8,897,000
Candles		2,939,500		1,403,000
Asphalt other than liquid	(b) 927,151	12,500,200	(b) 465,157	4,867,200
Coke	(b) 798,180	3,928,300	(b) 213,777	818,900
Reclaimed acid sold (66 deg.)	(b) 136,320	687,300	(b) 89,792	491,400
Acid oil		992,900		
Other special products		6,813,600		8,508,000
All other products		13,106,900		5,265,700

Materials	Quantity (Bbl. 42 Gal.)	Cost	Quantity (Bbl. 42 Gal.)	Cost
Crude petroleum.....	357,686,000	\$866,265,000	191,262,700	\$249,728,000
Penn. grade.....	29,838,500	126,182,000	21,197,000	50,020,000
Lima—Indiana.....	1,737,800	5,031,600	2,564,700	4,286,600
Illinois.....	15,580,000	33,469,300	17,672,300	30,138,000
Mid-continent.....	171,704,500	495,812,200	92,462,600	121,188,500
Gulf.....	16,399,600	28,918,800	5,787,300	6,080,900
California.....	71,529,700	106,360,500	41,901,700	30,157,000
Rocky Mt. and other U.S.	12,836,500	21,666,000	3,441,900	2,088,700
Foreign (Mexican, etc.)....	38,059,400	48,824,600	6,235,200	5,768,300
Distillates purchased and re-run.....	30,465,400	98,757,000	9,455,300	24,395,500
Casing-head gasoline purchased.....	6,952,200 1,000 cu. ft.	58,592,000		(a)
Casing-head gas.....	16,671,322	1,254,400		(a)

PRODUCTION OF PETROLEUM IN THE UNITED STATES, 1919
(U. S. Geol. Survey)

Total, bbl.....	377,719,000	Mid-continent.....	196,891,000
Appalachian (Penn. grade) ..	29,232,000	Gulf.....	20,568,000
Lima—Indiana.....	3,444,000	California.....	101,564,000
Illinois.....	12,436,000	Rocky Mountain.....	13,584,000

(a) Figures not available.
(b) Tons (2,000 pounds).

RUBBER GOODS INDUSTRY

Reports were received from 475 establishments in the rubber goods industry having a total value of products of \$1,138,216,000. In 1914 there were 342 establishments with a total value of products of \$300,994,000. Of the 475 establishments reported by the rubber industry in 1920, 96 were located in Ohio; 73 in New Jersey; 56 in Massachusetts; 43 in New York; 32 in Pennsylvania; 26 in Connecticut; 22 in California; 21 in Illinois; 16 in Indiana; 10 in Rhode Island; 9 each in Iowa and Wisconsin; 8 each in Missouri and Oklahoma; 7 in Michigan; 6 in Texas; 4 each in Colorado and Washington; 3 each in Georgia, Kansas, Missouri and Nebraska; 2 each in Maryland, North Carolina, Oregon, West Virginia and Delaware; and 1 each in Louisiana, Kentucky and Maine.

RUBBER GOODS INDUSTRY, 1919 AND 1914

	1919	1914
Number of establishments.....	475	342
Value of products (a).....	\$1,138,216,000	\$300,994,000
Tires:		
Pneumatic:		
Automobile:		
Casings, number.....	22,727,000	8,022,000
Value.....	\$485,904,000	\$105,679,000
Inner tubes, number.....	39,700,000	7,908,000
Value.....	\$199,305,000	\$20,101,000
Motoreycle and bicycles:		
Casings, number.....	3,422,000	.....
Value.....	\$11,892,000	3,728,000
Inner tubes, number.....	1,393,000	(c) \$6,906,000
Value.....	\$2,904,000	.....
Solid:		
Truck, number.....	1,620,000	.....
Value.....	\$43,917,000	.....
All other, number.....	6,635,000	(c) \$13,736,000
Value.....	\$9,005,000	.....
Boots and shoes:		
Rubber boots, pairs.....	9,208,000	4,025,000
Value.....	\$26,067,000	\$12,648,000
Rubber shoes and overshoes, pairs.....	66,195,000	57,212,000
Value.....	\$64,713,000	\$37,858,000
Canvas shoes with rubber soles, pairs.....	19,896,000	.....
Value.....	\$25,177,000	(b)
Heels (includes only those sold as such or on hand), pairs.....	126,572,000	.....
Value.....	\$14,238,000	(b)
Soles, including composition or fiber, pairs.....	18,437,000	.....
Value.....	\$4,321,000	(b)
Rubberized fabrics:		
Automobile and earriages, yards.....	14,429,000	.....
Value.....	\$10,697,000	(b)
All other, yards.....	17,630,000	.....
Value.....	\$13,712,000	(b)
Belting, value.....	\$22,436,000	\$7,989,000
Hose, value.....	\$26,998,000	\$16,854,000
Packing, value.....	\$7,317,000	\$3,508,000
Clothing, value.....	\$10,450,000	\$6,799,000
Druggists' and stationers' sundries, value.....	\$13,834,000	\$7,512,000
Hard rubber goods, value.....	\$34,230,000	(b)
All other manufactures of rubber, value.....	\$80,720,000	(d) \$40,133,000
Reclaimed rubber (produced and sold as such or on hand), pounds.....	121,795,000	(b)
Value.....	\$23,716,000	\$11,135,000
All other products, value.....	\$6,663,000	\$10,136,000

(a) In addition, in 1919, products to the value of \$7,574,000 were reported by establishments assigned to other classifications, and in 1914 to the value of \$752,503.

(b) Not reported in 1914.

(c) Not segregated in 1914 (number of solid tires not shown).

(d) Includes scrap and old rubber (sold or on hand).

SOAP INDUSTRY

Returns were received from 349 establishments which manufactured soap valued at \$317,163,000. In addition soap products to the value of \$21,140,000 were produced as subsidiary products by 90 establishments in other lines of manufactures, making a total of \$338,303,000. At the census of 1914 there were 371 establishments with products valued at \$127,942,000 and 142 establishments with subsidiary soap products to the value of \$7,362,000, a total of \$135,304,000. Although the industry shows a decrease in the number of establishments for 1919 as compared with 1914, the increase in the value of products for all establishments was \$202,999,000 or 150 per cent, primarily due to higher prices.

SOAP INDUSTRY, 1919 AND 1914

	1919	1914
Number of establishments.....	439	513
Soap industry.....	349	371
Subsidiary soap products, other industries.....	90	142
Value of products.....	\$338,303,000	\$135,304,000
Soap industry.....	317,163,000	127,942,000
Subsidiary soap products.....	21,140,000	7,362,000
Hard soaps, lb.....	2,322,185,000	2,064,228,000
Value.....	\$227,439,000	(a) \$104,465,000
Toilet soaps, lb.....	179,256,000	169,926,000
Tallow soaps, lb.....	945,414,000	938,447,000
Olein soaps, lb.....	110,785,000	42,524,000
Powdered soaps, lb.....	466,341,000	367,744,000
Soap chips, lb.....	182,738,000	97,746,000
Foots soap, lb.....	16,191,000	.....
Dye soaps, lb.....	21,710,000	447,841,000
Other hard soaps, lb.....	399,550,000	.....
Soft soap, lb.....	75,307,000	57,002,000
Value.....	\$3,962,000	\$1,697,000
Liquid soap, lb.....	10,025,000	.....
Value.....	\$1,254,000	.....
Special soap articles, value.....	\$3,568,000	\$833,000
Lye, lb.....	16,301,000	23,346,000
Value.....	\$1,789,000	\$891,000
Glycerine:		
Crude, lb.....	18,258,000	12,745,000
Value.....	\$2,483,000	\$1,817,000
Refined, lb.....	44,377,000	32,674,000
Value.....	\$11,461,000	\$5,776,000
Perfumery and toilet preparations, value.....	\$12,635,000	\$6,804,000
All other products, value.....	\$73,712,000	\$13,021,000

(a) Value of hard soaps 1914, not distributed by kind.

SUGAR INDUSTRY

Figures for the beet and cane sugar industries during 1919 were given in CHEMICAL & METALLURGICAL ENGINEERING, vol. 24, p. 1017, June 8, 1921.

BRASS, BRONZE AND COPPER PRODUCTS

Of the 1,119 establishments which reported the manufacture of brass, bronze and copper products during 1919, 213 were located in New York, 125 in Ohio; 122 in Pennsylvania; 88 in Illinois; 80 in Michigan; 75 in Connecticut; 72 in Massachusetts; 67 in New Jersey; 44 in California; 36 in Wisconsin; 31 in Indiana; 21 in Missouri; 20 in Maryland; 18 in Rhode Island; 16 in Washington; 10 in Minnesota; 9 each in Kentucky and Colorado; 7 in Texas; 6 each in Louisiana and New Hampshire; 5 each in Iowa and Maine; 4 each in Alabama, Delaware, Georgia and Oregon; 3 each in Nebraska and West Virginia; 2 each in Montana, Tennessee, Utah and Virginia; 1 each in the District of Columbia, Florida, Kansas and Vermont.

BRASS, BRONZE AND COPPER PRODUCTS, 1919 AND 1914

	1919	1914
Number of establishments.....	1,119	992
Value of products.....	\$487,707,000	\$162,199,000
Ingot and bars.....	30,490,000	4,792,000
Plates and sheet.....	102,898,000	41,655,000
Refrs.....	40,705,000	17,189,000
Tubing.....		
Seamless.....	37,531,000	10,269,000
Brazed.....	4,603,000	3,646,000
Wire.....		
Plain.....	33,933,000	13,487,000
Insulated.....	3,694,000	846,000

	1919	1914
Castings and machinery fittings.....	\$130,736,000	(a) \$5,288,000
Lamps.....	1,559,000	561,000
Electrical supplies.....	7,927,000	1,127,000
Other hardware and trimmings.....	38,396,000	1,524,000
Other manufactured products.....	15,400,000	19,430,000
All other products.....	33,961,000	47,385,000
Amount received for custom work and repairing....	5,874,000	(b)
(a) Includes aluminum castings only in 1914.		
(b) Included with "all other" products in 1914.		

PIG IRON INDUSTRY

The following figures for the pig iron industry are based upon the returns from 195 establishments with products valued at \$794,466,600. In addition pig iron to the value of \$6,595,800 was produced by 5 establishments included under other classified industries, making a total of 200 establishments, and \$801,062,300 in products. At the census of 1914 there were 160 blast-furnace establishments with products valued at \$317,654,000.

PIG IRON INDUSTRY, 1919 AND 1914

Number of establishments.	1919		1914	
	(a) Quantity, Gross Ton	200 Value	Quantity, Gross Ton	160 Value
Products				
Total value.....		\$801,062,300	(b)	\$317,654,000
Blast furnaces—Pig iron industry.....		794,466,500		317,654,000
Subsidiary pig iron products, other industries.....		6,595,800		
Pig iron.....	30,543,167	785,960,400	23,269,731	312,761,600
For consumption in works of company producing...	21,687,376	523,533,000	15,495,004	209,263,400
For sale.....	8,855,791	262,427,400	7,774,727	103,498,200
All other products.....		15,101,900		4,892,400
Pig iron by fuels:				
Coke.....	30,097,220	770,101,200	22,787,890	304,234,200
For consumption.....	21,686,861		15,436,921	
For sale.....	8,410,359		7,350,969	
Bituminous coal and coke..	35,745	1,385,600	118,632	2,704,100
Ant. and ant. and coke....	94,465	2,975,500	87,919	1,256,600
Charcoal.....	315,737	11,498,100	275,290	4,444,700
Pig iron by grades:				
Basic.....	14,597,535		9,465,853	
Bessemer.....	9,374,950		7,577,792	
Low phosphorus.....	289,726		305,738	
Foundry.....	4,792,961		4,325,100	
Malleable.....	1,090,344		730,910	
Forge or mill.....	287,529		488,172	
White, mottled and mise..	56,418		32,202	
Direct, castings.....	53,704		14,384	
Delivered molten to steel works, etc.....	18,138,453		11,936,791	
Machine cast.....	7,746,656		6,007,417	
Sand cast.....	3,970,309		4,681,867	
Chill cast.....	634,045		629,272	
Direct castings.....	53,704		14,384	
Materials		Cost		Cost
Iron ore.....	56,333,358	310,981,100	43,326,817	150,855,700
Domestic.....	55,792,776	306,623,000	41,556,642	141,276,700
Foreign.....	540,582	4,358,100	1,770,175	9,579,000
Scrap, mill cinder, etc.....	3,436,851	23,273,400	2,168,092	6,651,100
Fluxing material, net tons...	15,599,824	25,722,400	11,499,685	11,184,400
Fuel for smelting.....		229,111,300		85,436,500
Coke, net tons.....	34,605,700	223,250,600	26,883,082	83,499,400
Charcoal, bushels.....	31,931,134	5,684,200	29,083,978	1,683,100
Anthracite.....	25,153	104,300	38,874	158,400
Bituminous coal, net tons..	23,568	72,200	60,337	95,600

(a) Includes 5 establishments in other lines of manufacture (ferro-alloys, etc.) producing 265,876 tons of pig iron, valued at \$6,595,800.
(b) Includes ferro-alloys (329,580 tons) not included in the pig iron industry in 1919.

INDUSTRIAL POWER AND FUEL CONSUMPTION
IN SUPERPOWER ZONE

A preliminary statement with respect to power equipment and fuel consumption of plants in the Superpower Zone has been prepared by the Bureau of the Census in collaboration with the Superpower Survey of the United States Geological Survey.

The Superpower Zone embraces the North Atlantic area from Maryland to New Hampshire and includes in entirety, Connecticut, Massachusetts, Rhode Island, New Jersey, and the District of Columbia; the southern portion of New Hampshire (Cheshire, Hillsboro, Merrimac and Rockingham counties); the southern portion of Vermont (Bennington and Windham coun-

ties); Kent and New Castle counties in Delaware; Anne Arundel, Baltimore, Baltimore City, Cecil, Herford, Kent, Prince Georges and Queen Annes counties in Maryland; the eastern portion of Pennsylvania extending west to York, Dauphin, Northumberland, Montour, Columbia, Luzerne, Wyoming and Susquehanna counties inclusive; and the southeastern portion of New York, extending west and north to Broome, Delaware, Otsego, Oneida, Herkimer, Fulton, Saratoga, Warren and Washington counties. The superpower project contemplates the development of available water powers to supplement and equalize power requirements, and effect economies in fuel consumption.

The figures are based upon returns from 95,984 establishments. Of these 76,277 or 79.4 per cent used power, the same including 73,694 manufactories, 1,563 laundries, 939 mines and quarries and 31 governmental institutions. The power equipment of these 76,227 establishments aggregated 9,069,471 hp., comprising the following factors:—33,379 steam engines of 4,255,868 hp., 2,115 steam turbines of 1,171,061 hp., 6,246 internal-combustion engines of 279,040 hp., 4,708 water-wheels of 541,033 hp., 506,907 electric motors of 5,336,627-hp. rating (of which 361,961 of 2,770,715 hp. were operated with purchased energy and 198,946 of 2,565,912 hp. by current generated by the establishment), and 51,754 hp. of purchased power other than electric.

The net total is 9,069,471 hp. of rated power equipment, primary and purchased, of which 5,336,627 hp. or 58.8 per cent is represented, as utilized, by electric motor equipment. These establishments consumed 20,910,000 long tons of anthracite, 34,669,000 short tons of bituminous coal and 5,661,000 tons of coke.

INDUSTRIAL POWER AND FUEL CONSUMPTION
IN SUPERPOWER ZONE, 1919

A—Power equipment, by types:

Class	Number of Units	Horsepower
Aggregate.....		9,069,471
Prime movers.....		6,247,002
Steam engines.....	33,379	4,255,868
Steam turbines.....	2,115	1,175,061
Internal combustion engines.....	6,246	279,040
Water wheels.....	4,708	541,033
Operated by purchased energy.....		2,822,469
Electric motors.....	361,961	2,770,715
Other.....		51,764
Electric motors, total.....	560,907	5,336,627
Run by current generated in establishment.....	198,946	2,565,912
Run by purchased current.....	361,961	2,770,715

B—Horsepower and fuel, by industries:

Industries	No. of Estab- lish- ments Using Power	Horsepower		Pur- chased Energy	Fuel	Bituminous
		Aggre- gate	Prime Movers		Anthra- cite Coal, Long Tons	Coal and Coke, Short Tons
Total.....	76,227	9,069,471	6,247,002	2,822,469	20,909,865	40,330,352*
Manufactories:						
Textiles and their products.....	18,442	1,914,722	1,440,495	474,227	1,763,425	5,121,985
Iron and steel....	6,362	1,745,755	1,175,504	570,251	1,311,943	10,224,543
Paper and printing	8,291	706,429	489,775	216,653	765,259	1,967,594
Chemicals and al- lied products....	2,109	523,849	390,558	133,291	3,304,186	9,923,865
Metals, non-ferrous	3,423	405,249	245,774	159,475	883,861	1,545,733
Food and kindred products.....	11,465	385,184	232,084	153,100	1,515,826	1,793,073
Stone, clay and glass.....	2,204	345,018	229,351	115,667	556,984	3,176,078
Lumber and its re- manufactures....	4,710	280,533	206,405	74,128	86,481	356,122
Leather and its products.....	2,707	178,081	104,461	73,620	147,355	650,396
Railroad re- pair shops.....	316	119,906	68,549	51,357	435,866	835,468
Liquors and bever- ages.....	1,303	113,934	101,762	12,172	345,088	401,199
Vehicles.....	3,862	95,380	28,222	67,158	107,669	238,864
Tobacco.....	567	15,334	8,773	6,561	39,529	40,915
Miscellaneous....	7,933	1,071,524	546,110	525,414	844,982	3,142,086
Laundries.....	1,563	55,087	44,371	10,716	178,569	239,132
Mines and quarries	939	1,010,757	857,273	153,484	8,598,467	266,118
Governmental insti- tutions.....	31	102,729	77,534	25,195	24,375	407,181

* Bituminous coal 34,669,324 tons; coke, 5,661,028 tons.

Microscopic Examination of Iron and Steel

A COMMITTEE on metallography, appointed by the American Society for Testing Materials, has proposed the following tentative methods for testing iron and steel. Criticism of the methods is invited; it should preferably be addressed to G. F. Comstock, Titanium Alloy Manufacturing Co., Niagara Falls, N. Y.

LOCATION OF TEST-PIECES

The location of the test-piece for microscopic examination is of prime importance. In the case of a casting of steel or cast iron, the section ought to be cut perpendicular to the surface so as to show the variation of structure from the outside to the interior. In the case of forged and rolled metal both cross and longitudinal sections should be examined, their location being determined by the nature of the forging, etc. For crankshafts definite locations are given with reference to the tensile test specimens. For guns, tangential specimens are required and for microstructure these should be cut parallel to the axis, etc. No one specimen is of necessity representative. The usual method of taking a cross-section from rods and bars, while showing segregation of the constituents, fails to reveal the usual lamination, for which a longitudinal section is necessary.

In defective material, the sample should be cut adjacent to the fracture or defect. When necessary the fracture can be protected during grinding and polishing by coating it with a heavy deposit of electrolytic copper, molten lead-tin solder or a mixture of litharge and glycerine. For hardened steel and other material likely to be tempered, fusible metals such as Rose's or Wood's alloys may be used.

METHOD OF POLISHING

The method used for polishing specimens will depend primarily on the material to be examined and on the polishing equipment. In general, samples should not be over 1-in. square and their thickness should be less than the smallest dimension of the polished surface; otherwise there is a tendency to round off the edges.

The softer material can be cut with a saw, while harder metal may be cut with an emery disk or broken off with a hammer. A flat surface is at first obtained either by rubbing on a file held in a vise or by grinding on an emery wheel. In both cases it is necessary to avoid tearing the surface of the metal or causing it to flow. Perfectly smooth surfaces can be obtained by commercial surface-grinding machines.

Having obtained a flat surface in this way, the sample is next rubbed down on a series of emery papers, usually starting with No. 00 Commercial followed by Nos. 0 and 00 French Emery. (Of course, other similar papers of domestic manufacture are also available and suitable for this purpose.) These papers may conveniently be mounted on revolving disks. Rubbing on one paper is stopped as soon as the scratches from the last operation have been taken out. From the No. 00 French Emery the specimen may be taken to a revolving disk covered with broadcloth, preferably running in a horizontal position at such a speed that the polishing powders are not unnecessarily thrown off. For ordinary work, two such disks will be sufficient, the first armed with well-washed carborundum, 65 or a similar grade, while the second may be armed with well-washed alumina. This is cleaner and better than rouge.

To obtain a fine polish it is a mistake to try to save time by hurrying through the papers because if this is done when the specimen is etched innumerable fine lines will be revealed in the ferrite. In some cases the appearance of the ferrite is actually blurred because the metal distorted in the grinding and by the coarse grades of emery has not been subsequently removed. Under no conditions should buffing be tried, because this causes an actual flow of the metal.

For material of small size, such as sheet and wire, numerous methods of mounting have been devised. For wire, various mounting media such as wax, a mixture of litharge and glycerine, fusible metals and the like can be used in a small brass container. For sheet metal, a pack can be built up of pieces of the sample with alternate layers of red fiber board, bakelite or other resistant material, the whole held together by two brass end pieces and two screws.

METHODS OF ETCHING¹

The sample ought to be examined as polished in order to show up the non-metallic inclusions as well as cracks and other defects. In order to show up the structure of the metallic matrix various etching reagents have been used depending on the material being examined. The accompanying list gives the best of these reagents. For general work a 4 per cent solution of picric acid in ethyl alcohol is recommended. This darkens the pearlite in steel and leaves the ferrite or cementite bright as the case may be. Long etching with picric acid in alcohol will develop the grain structure in very low-carbon steel and in wrought iron. This may be done more rapidly with a 2 to 4 per cent solution of nitric acid in ethyl alcohol (95 per cent). For showing up pearlite alone, picric acid in absolute alcohol is best.

To distinguish between ferrite and cementite in high-carbon steels the usual method is to boil in the sodium picrate solution, which darkens the cementite.

For hardened and tempered steel, picric acid may be used, but after etching, washing under the tap and flooding with alcohol, the specimen should be dried by an air blast or if this is not available by shaking it in air. If the usual method of mopping on a soft towel be tried, the etching film will be spoiled.

For the study of hardened and tempered steels under high magnifications other reagents have been devised, such as those of Kourbatoff.

For distinguishing between cementite and phosphide of iron in cast iron, either heat tinting or boiling with sodium picrate may be used, as recommended by Matwieff. This attacks the iron phosphide, but leaves the cementite unattacked.

For revealing the segregation of the phosphorus in steel, various reagents have been used depending on the deposition on copper from a copper chloride solution, as given in the accompanying list of reagents.

In many cases after etching, the ferrite or cementite may be found to be more or less stained or colored. This can often be remedied by a light repolish on a chamois-skin pad. While this brightens up the ferrite or cementite, as the case may be, it markedly alters the appear-

¹Sauveur, "Metallurgy and Heat-Treatment of Iron and Steel," 1920, pp. 42 and 62. Tiemann, *Iron and Steel*, 1919, p. 286. Hoyt, *Metallography*, vol. 1, p. 63 (1920). Wawrzyniok, "Handbuch des Materialprüfungswesens," p. 497. Czochozalski, *Stahl und Eisen*, 11, p. 1073, p. 1129 (1915). List of reagents, p. 1132. Goerens, *Metallography*, p. 134. Kerns, Foundry Data Sheets, June 1 and 15, 1920; Etching Solutions for Iron and Steel. Kourbatoff, *Revue de Metallurgie*, vol. 2, p. 169 (1905); Contribution à l'Etude Metallographique des Aciers Trempes. Kourbatoff, *Revue de Metallurgie*, vol. 3, p. 648 (1906). Pamphlet No. 403, U. S. N. Bureau of Ordnance, October, 1916.

ance of the pearlite, giving it an abnormal structure, and therefore when this method is used, photographs should be so marked.

REAGENTS FOR NORMAL IRON AND STEEL

Picric Acid (Igevsy): Solution (a), 4 g. picric acid in 95 c.c. absolute ethyl alcohol. Solution (b), 5 g. picric acid in 100 c.c. 95 per cent ethyl alcohol.

Nitric Acid: 5 c.c. concentrated HNO_3 in 95 c.c. 95 per cent ethyl alcohol.

Iodine: 1.25 g. I, 1.25 g. KI, 1.25 c.c. H_2O in 100 c.c. alcohol.

Hydrochloric Acid, recommended by Martens and Heyn (1904) especially for hardened steel: 1 c.c. HCl of specific gravity 1.19 in 100 c.c. alcohol. This may be diluted with 500 c.c. water for electrolytic etching with a very weak current.

KOURBATOFF'S SOLUTIONS FOR HARDENED STEEL

Solution A: 4 c.c. HNO_3 in 96 c.c. amyl alcohol, acting five minutes, will color troostite brown, austenite yellow, martensite white.

Solution B differentiates the various constituents. It consists of 1 volume of saturated solution of ortho-nitrophenol in alcohol, and 2 volumes of 20 per cent HCl in amyl alcohol.

Solution C: Mix just before using a solution of 4 per cent HNO_3 in acetic anhydride with three times the volume of a mixture of equal parts of amyl, ethyl and methyl alcohols. It colors troostite and troostite-sorbite.

Solution D: 1 volume of 4 per cent HNO_3 in ethyl alcohol plus 3 volumes saturated solution of nitrophenol in ethyl alcohol; immersion of ten minutes colors troostite and martensite needles.

Solution E for troostite: 2 parts methyl alcohol, 2 parts ethyl alcohol, 2 parts amyl alcohol, 1 part butyl alcohol, 3 parts of 4 per cent HNO_3 in acetic anhydride.

Solution F: 4 per cent HNO_3 in methyl alcohol to which $\frac{1}{10}$ of its volume of 4 per cent picric acid in ethyl alcohol is added. Colors austenite, martensite and troostite differently.

Solution G: 1 volume of HNO_3 in alcohol and 3 volumes of saturated solution of nitraniline. Colors troostite, troostite-sorbite and martensite needles.

Benedicks' Solution: 5 per cent meta-nitrobenzol sulphonic acid in alcohol. Darkens martensite more than austenite after immersion of fifteen seconds.

SOLUTIONS FOR CARBIDES

Kourbatoff: 2 g. picric acid, 25 g. NaOH, 75 c.c. water. Cementite will be colored after boiling five to ten minutes. Ferrite and tungsten carbide (WC) are unattacked. Various other compounds, such as Fe_nW and $\text{Fe}_2\text{W}_2\text{C}$, are colored.

Matwieff: Boil specimen twenty minutes in a neutral solution of sodium picrate, and wash thoroughly. Iron phosphide is attacked, but cementite is not.

Yatsevitch: Tungsten carbide in high-speed steel is darkened by immersing ten to twelve minutes in a fresh mixture of 10 c.c. commercial H_2O_2 in 20 c.c. of a 10 per cent water solution of NaOH.

Hilpert and Colver-Glauert: Non-pearlitic steels and pig iron may be etched for from seven seconds to one minute in 3 or 4 c.c. saturated aqueous solution of SO_2 in 100 c.c. alcohol or water.

Murakami: Carbide and tungstide in high-speed and tungsten steels may be distinguished by a hot solution of 10 g. potassium ferricyanide, 10 g. KOH and 100 c.c. water.

SOLUTIONS FOR ALLOY STEELS

Austenitic nickel steels may be etched in 5 g. Fe_2Cl_6 , 50 c.c. HCl and 100 c.c. H_2O .

Stellite and high-chromium steels may be etched with a very weak electric current in a 0.5 per cent NaOH solution.

On 110-volt circuit use two 4-cp. lamps in series, connected with two-wire terminal (platinum wire preferable). Flood surface of specimen with solution, and make contact with one wire at side and dip the other in the solution, moving it around to obtain uniform etch.

METHODS FOR IDENTIFICATION OF NON-METALLIC INCLUSIONS

Stead² uses 30 per cent H_2SO_4 . Bubbles arise from sulphides, but none from silicates or oxides.

Law³ uses an acid solution of lead or cadmium salt in gelatine. The sulphides form deep brown or yellow stain of cadmium or lead sulphide. Oxides or silicates unaffected.

MEANS FOR THE IDENTIFICATION OF NON-METALLIC INCLUSIONS

As Polished	
FeS.	Brownish yellow.
MnS.	Slate blue, smooth.
FeS_xMnS_y	Slate blue to brown, may show duplex structure.
FeO.	Slate blue, rough, a little darker than MnS.
MnO.	Similar.
Mn-silicate.	Greenish tinge, smooth and greasy.
Fe-silicate.	Black and greasy.
Al_2O_3 .	Tiny hard rounded grains, never elongated by rolling, etc.
Sand grains.	Angular form, convex side, greasy appearance standing in high relief.
Titanium nitride or cyanonitride.	Pink or yellow cubic crystals.

He also recommends as an electrical etching solution consisting of distilled water with 0.002 per cent ammonium chloride or caustic potash, used boiling. After a few minutes wash and dry with alcohol. Results: MnS unaltered. FeO and FeO_xMnO_y is reduced, but MnO unaffected.

Matwieff⁴ uses hydrogen or steam at 600 deg. C., or organic acids to distinguish oxides, silicates and sulphides as follows:

	Oxides	Silicates	Sulphides
Hot hydrogen	Reduced	Unaffected	Unaffected
Hot steam	Attacked	Unaffected	Unaffected
Organic acids	Unaffected	Unaffected	Attacked
2% HF in absolute alcohol ⁵ .	Unaffected	Darkens	Darkens

Iron oxide may be distinguished from manganese oxide by repolishing the sample reduced by hot hydrogen, and etching with dilute solution of FeCl_3 in alcohol. If colored feebly, the inclusion is FeO; if colored deeply, it is MnO with some FeO; MnO alone is not reduced. Iron sulphite is colored by tartaric acid, while MnS is very feebly colored.

SULPHIDES

Rohl⁶ recommends a 1 per cent solution of acetic, citric, oxalic or picric acid in water, noting that picric acid gives the most uniform results on sulphides. FeS is always readily blackened in one minute; MnS is slightly blackened in forty-five seconds. Sulphides also give a dark brown color after a triple etching (a) 4 g. picric acid in 100 c.c. amyl alcohol, (b) 4 c.c. HNO_3 in 100 c.c. amyl alcohol, (c) concentrated hot NaOH. A 2 per cent sodium acetate will give FeS a brownish tint in one minute, whereas MnS is colored but very lightly.

Reduction tests for sulphides: Sulphides are covered by mercury after immersion in HgCl_2 solution. If the sample is lightly repolished, FeS will be found corroded but MnS not. A 3 per cent boiling solution of AgNO_3 will color FeS a uniform violet blue and MnS a slightly darkened dove gray. On repolishing, FeS appears a reddish violet, and MnS a blue gray.

Campbell's method of distinction: A short preliminary etching with 1 per cent picric acid in ethyl alcohol, followed by tempering to dark yellow, changes FeS into a beautiful dark blue to reddish violet, and MnS into dull gray to bright white.

Whitely recommends that 5 g. gelatine be soaked one hour in 20 c.c. water and 15 c.c. gelatine added. Heat till clear, add 0.05 g. tartar emetic in 1 c.c. H_2O , filter, and add 1 c.c. dilute H_2SO_4 . Apply warm. Yellow ring forms around sulphides.

McCance⁷ replaces tartar emetic by 0.1 g. AgNO_3 , when a black stain indicates sulphide.

Comstock⁸ uses boiling alkaline picrate of soda. MnS is blackened and roughened, while silicates and oxides are unaffected.

²Stead, *Iron and Steel*, vol. 9, p. 105.

³Law, *Journal, Iron and Steel Inst.*, vol. 2, p. 94 (1907).

⁴Matwieff, *Revue de Metallurgie*, vol. 7, p. 447.

⁵Reagent due to McCance. Action occurs in three seconds. Another recommended solution contains 8 c.c. HF, 42 c.c. water and 50 c.c. alcohol.

⁶Rohl, *Journal, Iron and Steel Inst. Carnegie Memoir*, vol. 4, p. 28 (1912).

⁷McCance, *Journal, Iron and Steel Inst.*, pp. 1-239 (1918).

⁸Comstock, *Transactions, A.I.M.E.*, vol. 56, p. 553 (1916).

Hardened Rosin and Resin Esters

A Study of the Special Treatment of Rosin for Use in Tung-Rosin Varnishes—Empirical Methods Now in Use Should Be Replaced by Better Technology and Chemical Control—Description of Experiments to Determine Optimum Conditions for the Esterification

BY ALEXANDER MURRAY

WITHIN the last decade or so the art of varnish-making has been completely revolutionized by the extensive introduction of tung or chinawood oil varnishes. Previous to this time much rosin had been used for the adulteration of varnish gums, and, in the form of "gloss oil," as a cheap and deleterious addition to paints and enamels. Gloss oil is a solution of lime-hardened rosin in benzine.

It has been realized for some years that rosin has wonderful adaptability in combination with tung polymers for the production of varnishes of great and varied utility, having remarkable properties and fair durability. The outstanding characteristics of tung-rosin varnishes are extremely pale color, great rapidity of drying, high gloss, waterproof properties and very fair durability. Accordingly rosin has risen from the position of a despised adulterant to a necessary raw material of extensive applicability. Tremendous quantities of these varnishes are used today. Some are simply tung rosin and thinners; others contain proportions of linseed oil or other oils or resins.

Untreated rosin is not satisfactory for this purpose for many reasons. It is too soft, too acid and neither waterproof nor durable. Raw rosin feels sticky or tacky, even in the heat of the hand. Its softening point is about 70 deg. C. The acid number averages about 160. When exposed to moisture it turns milky white, probably due to penetration of moisture with the formation of an emulsion film on the surface. Rosin is a plastic, non-crystalline solid. It has sometimes been called a colloid, though probably on insufficient evidence.

The present paper deals with the special treatment of rosin, in relation to its use in tung-rosin varnishes. It will be seen that even in this one phase of varnish making there is a fascinating field for research. While there has not been an absence of chemists in the industry, they appear to have concentrated most of their efforts on the testing and analysis of varnishes and raw materials, rather than undertaking research with a view to developing a scientific rationale for the manufacture of their products. There is, of course, great opposition from the professional varnish makers, who in general seem to feel that their interests are best served by a policy of secrecy.

UNTREATED ROSIN IN VARNISH

If rosin is dissolved in benzine and this solution then brushed out on some surface and permitted to dry, it will be found that when the thumb is pressed down firmly upon it the film will appear tacky. This tackiness persists when raw untreated rosin is used as a major ingredient in the preparation of a varnish. The latter might appear to dry satisfactorily, especially in cold weather, but in a warm room or on a hot summer day, if one were to be so unfortunate as sit in a chair

that had been finished with it, he would be likely to experience the embarrassing fear that an essential section of his clothing was not coming with him when he started to arise.

The untreated rosin varnish may have a remarkably high gloss when applied, but it becomes dulled rather rapidly. This varnish also gives inferior service outdoors. Gardner has shown that it is entirely unsuitable for concrete and cement paints, because of its very high acid number.

NECESSITY FOR TREATING THE ROSIN

It is apparently assumed by some that a combination occurs between the wood oil and rosin, with the resultant production of a new compound of indefinite composition. There is no real evidence, however, that any such reaction occurs, and, on the contrary, observation indicates that no combination occurs between the rosin and tung polymers other than physical interdispersion, and that the properties of the rosin are not changed in any absolute sense, but only modified or diluted by the presence of the tung oil. The heating to which the colophony is subjected in the cooking of the varnish is insufficient to change its characteristics to any marked extent, and such change, contrary to some opinions, tends actually to soften besides darkening it. In some recent experiments the writer found that after heating rosin for one hour at 300 deg. C. the softening point had been lowered 2 deg. C. and the acid number reduced to 149. Since it is well known that on distillation rosin breaks down into lighter distillates, rosin oil and tar, a lowering of melting point should be expected when it is heated to incipient distillation for any length of time. When the varnish is to be used in conjunction with pigments, there is an additional reason why the rosin acids must be neutralized, since the latter are adsorbed by basic pigments and in time combine with them chemically. (The author hopes to present some evidence for this statement in a future paper.)

EMPIRICAL METHODS FOR HARDENING ROSIN

It is desirable, therefore, to treat rosin for the two fundamental purposes of increasing the melting point and neutralizing it; this can be done either as a part of the varnish-making process or as a separate operation. The expression "hardened rosin" is technically applied only to rosin which has been neutralized with lime. There is much difference of opinion among varnish makers as to the kind of lime to use, and the technique—such as temperature, stirring and method of adding lime. Ask half a dozen expert varnish makers the correct way to harden rosin, and you will get half a dozen different methods.

It was formerly generally supposed, and is today still

affirmed by many, that oyster-shell lime has no equal for this purpose. The investigator constantly uncovers dogmas that might cause in him a tendency to smile, but most fetishes have some foundation in fact, and this one is a good illustration. Oyster-shell lime is weaker in CaO content than a good grade of hydrated chemical lime, but is technically free from iron and magnesia, and of course its composition is reasonably constant. Many commercial limes contain appreciable amounts of iron, which is taken up by the rosin and discolors the product. As for magnesia, its effect is peculiar, due to the fact that solutions of magnesium rosinate have much higher viscosity than solutions of the calcium salt. Very small proportions have a noticeable thickening action, which is highly undesirable, since the tung polymers themselves have great viscosity. The magnesium salt is much less fusible than rosinate of lime, which presents an additional disadvantage if the MgO content is high. A suitable lime should not contain over 1 per cent of MgO, and should be technically free from iron.¹

It will be readily appreciated from the foregoing that the empirical varnish maker, without chemical control, might be very badly impressed by a change from oyster-shell lime to one of unknown composition.

The details of neutralizing would appear to be of the simplest order, but here one is surprised to find frequently that the more complexity and mysticism one can add to the process the better will be the ultimate result. The following is a typical formula: "Melt 400 lb. of rosin in a copper kettle, raising the heat to 500 deg. F.; sift in 32 lb. of oyster-shell lime. Do not stir the mix. Raise the temperature to 550 deg. F. and hold there until the lime is taken up, then remove from fire."

Hot rosin darkens rapidly in contact with the air, and since pale color is ever desirable and since nothing is gained by high temperatures, it should be subjected to only the lowest practicable temperatures for the shortest possible time. This rule should be observed at all times when cooking rosin. It darkens more quickly than heated oils, and therefore it should be added to the batch of varnish at as late a point in the cooking as possible. When using 6 lb. of lime to 100 lb. of rosin, the latter may be heated to 400 deg. F., the lime then added (it need not be sifted) and thoroughly stirred in for about ten minutes, when the operation will have been completed.

PREPARATION AND USES OF PALE HARDENED ROSIN

It is not possible to prepare pale hardened rosin with much less than 30 per cent of free rosin, because of the high melting point of the rosinate, and in order to get even this degree of neutralization it is necessary to cook the rosin with 9 lb. of lime per 100 lb. of rosin at a temperature of 435 to 440 deg. F. for one and one-half hours. In this case one would, of course, keep the kettle covered during the cook.

Rosin can be subjected to a great deal of cooking in covered aluminum kettles without darkening at all, and the rosin acids do not appear to attack the metal to any marked extent. If the hardening is being conducted as an integral part of a varnish cook, the next ingredient is added as soon as the lime is combined;

and if being limed separately, the hardened rosin is ladled into shallow pans to cool, and then broken up and stored for future use. The advantage of liming large batches of rosin at a time is, of course, primarily the saving of labor and fuel, but it also facilitates uniformity, since it is possible for the laboratory to follow the neutralization closely, and make corrections when necessary. In cases in which the oils have to be cooked for an hour or longer it is advisable, from the point of view of the color of the product, to have the rosin already hardened and add it at a late stage of the cooking.

Hardened rosin varnishes are still unsuitable for use in concrete, plaster and cement coatings, since they contain considerable free rosin acids. They also caused serious thickening when used with zinc oxide and some white leads and lithopones before this reaction was better understood. Furthermore, hardened rosin is very brittle and imparts this property to a varnish to an extent proportional to the amount used.

RESIN ESTERS AND THEIR PREPARATION

The preparation of esters of the resin acids has received attention for some time, and glyceryl triresinate is being used extensively. By this method the rosin acids can be completely neutralized if desired.

There are on the market resin esters known as "ester gums," some of which are very pale in color and are said to have been vacuum-distilled. It has been found that some of these darken readily when cooked and that the resulting varnish is not lighter than that prepared from esters made in the varnish kettle in the manner described below.² The latter esters have the additional advantage of lower cost.

The reaction, of course, is well known. The amount of glycerine required by theory is about 10 per cent of the rosin, although the author has found as high as 20 per cent being used in practice. Gardner³ used 55 lb. of glycerine to 100 lb. of rosin, but did not get a triglyceride, as will later be explained. Free glycerine is very undesirable in a varnish, as it reduces the resistance to moisture and causes rapid deterioration of the film, especially with exterior exposure. It is further necessary to use a minimum amount for economic reasons, glycerine being usually the most expensive ingredient in the formulas in which it is used.

OPTIMUM TEMPERATURE

In the writer's experiments to determine the optimum conditions for esterification, temperature received first consideration. When glycerine is added to melted rosin at 150 deg. C., combination is seen to commence immediately, as evidenced by the formation of water in the mixture, which causes some foaming and apparent ebullition. The fused material is clear, but drops removed and cooled will show a milky appearance. The acid number is found to decrease rapidly, but one may cook at 150 to 250 deg. C. for hours and a large part of the rosin will still remain unneutralized, no matter how great an excess of glycerine is used. Now, if the temperature is raised to 290 deg. C., the boiling point of glycerine, the last portion will rapidly combine and an almost neutral ester will result.

It is necessary to keep the batch covered during

¹See also H. A. Gardner, "Lime for the Varnish Industry," Circular 113, Educational Bureau, Paint and Varnish Manufacturers' Association, for a comparative discussion of the properties of many commercial limes.

²The author's work on esters, reported herewith, was completed before the publication of Gardner's paper on "Tunga-resin."

³See "Papers on Paint and Varnish," p. 234. See also p. 214 for patent literature.

esterification, in order to prevent excessive discoloration and loss of the glycerine, which is readily carried off by the water vapor. It is not advisable to use a condenser of course, as the steam must be permitted to escape.

The result is a glyceryl triresinate, which, if carefully prepared, will have an acid number of less than 5. This ester, however, has a somewhat lower melting point than the original rosin, as might be expected from our previous experience with other organic esters. Accordingly the ester is slightly more tacky than the rosin itself. It is the opinion of the author, although he has not yet had sufficient confirmation to state it as a fact, that after the ester has been combined with the tung polymers, its tackiness is not as pronounced as the stickiness of rosin and that the film has a softness that makes it more durable in certain uses, notably in furniture varnishes and exterior coatings. Such a varnish is very elastic and waterproof and practically neutral, and is of value in the preparation of paints for concrete, cement, and plaster surfaces.

The addition of 0.5 per cent of a cobalt drier has been recommended to overcome the tackiness of rosin ester, but this quantity would represent an excess of a powerful drier, to be avoided on general principles, and besides would cause serious darkening of the product. The melting point of rosin ester is raised in practice when desired by the addition of a small amount of lime or some hard resin, such as Congo copal.

TIME OF ESTERIFICATION

After determining the optimum temperature the next factor to be ascertained was the time. In this connection it was found that, esterifying at 555 deg. F., the reaction passed through a peak about fifteen minutes after this temperature was reached. Working with 12 lb. of glycerine to 100 lb. of rosin, a resin ester with an acid number of 5 to 10 was obtained in that time, and if heating was continued there resulted a gradual increase in acidity, due apparently to decomposition of the ester after the excess of glycerine had been consumed. This is analagous to the action of the glyceryl esters of the higher fatty acids, such as those of linseed oil, which decompose under prolonged heating with the accumulation of increasing quantities of free fatty acid. The latter are more stable than the resins. A sample of linseed oil will reach an acid number of about 20 after heating for, say, five hours at 575 deg. F.

It is necessary, then, for the varnish maker, with the aid of his control laboratory, to determine the peak of his esterification and stop cooking at that point. It is desirable not to use sufficient excess of glycerine to neutralize the rosin completely, but to use not more than 12 lb. of glycerine, and when the neutralization has proceeded to the maximum, stir in half a pound of lime and remove the kettle from the fire. The resulting ester will be practically neutral, and the small amount of lime contained will act beneficially as a hardening agent.

The complete procedure can be illustrated by the following example:

Melt 600 lb. of rosin in a copper or aluminum kettle, and when the temperature reaches 400 deg. F. slowly add 72 lb. of glycerine—it is not necessary to stir, as the liquid is strongly agitated by the escaping steam. Increase the temperature to 555 deg. F. and hold it there for about twenty minutes or the exact time that

is found to give maximum esterification, which may vary slightly with different apparatus and materials. Then stir in 3 lb. of lime, remove the kettle from the fire, and ladle the ester into cooling pans.

ADDITION OF CONGO COPAL

We have previously referred to the addition of Congo gum as a hardening and toughening agent. This is a hard fossil resin, melting with partial decomposition at a high temperature and having an acid number of about 133. The esterification of Congo copal presents considerable difficulty, as it will not melt at 555 deg. F., and glycerine cannot be used in unsealed kettles at higher temperatures.

The addition of 10 per cent of Congo to rosin ester was found to improve the latter greatly, adding considerable toughness and hardness. This addition can be accomplished by cooking 90 parts of rosin with 10 parts of Congo, keeping the kettle covered, at 600-610 deg. F. until the Congo is completely dissolved in the rosin. No rosin can be esterified unless it is in a liquid condition. When the Congo is entirely melted, the batch is cooled to 550 deg. and 12 parts of glycerine added. The temperature is then raised to 555 deg. F., and the remainder of the procedure is the same as with pure rosin.

CATALYTIC POLYMERIZING ACTION OF COPPER

Working along the same lines with increased quantities of Congo in a copper kettle, it is found that severe darkening takes place, accompanied by uncontrollable foaming, which increases with the amount of the hard gum used. When a proportion of two parts of Congo to one part of rosin was reached, the mass became very dark and solidified before the glycerine could be combined. This solidification occurred very rapidly at 555 deg. F. and strikingly resembled the polymerization of tung oil. After several unsuccessful attempts to control the reaction in copper the experiment was repeated in aluminum, with the result that foaming and darkening were negligible and the ester remained liquid until the end of the operation and could then be readily poured or ladled from the kettle. It is possible to make esters in aluminum with three parts Congo to one of rosin, using 10 lb. of glycerine per 100 lb. of resins. The resulting ester has a hardness approaching that of Kauri, an acid number of 7.5 or less, and lends itself to the preparation of varnishes which are paler in color than those which can be made from Kauri. As a result of these experiments it is obvious that copper acts as a polymerization catalyst on Congo copal.

In regard to the covering of the kettle while melting and cooking resins, it should be noted that unless the cook is very short, air should be excluded as much as possible to prevent darkening of the product. It is interesting here to contrast the well-known fact that linseed oil shows a maximum darkening if it is cooked in the total absence of air—e.g., in an inert atmosphere—and also darkens considerably if cooked in a covered kettle.

The writer regrets that lack of facilities and time has prevented his accumulating more exact scientific data on the reactions and properties of the materials discussed in this paper, but would suggest that here is a practically virgin field for research of real and immediate value.

Springfield, Mass.

An Improved Type of Filter Press

Comparison of Advantages and Limitations of Various Types of Filtering Apparatus and a Description of a Modified Form of the Plate and Frame Filter Which in Certain Features Appears to Present a Number of Important Improvements

BY CHARLES D. BURCHENAL
Consulting Engineer

THERE is no single type of filtering apparatus which can be used to the best advantage for all classes of filtration work. Although the plate and frame filter press is capable of performing a great many filtering operations, it requires hand labor and is intermittent, so that if conditions permit some other filter which will give continuous operation or a reduction of labor would have certain advantages. These economic advantages, however, should not be permitted to blind one to certain inherent faults in such a filter, and in each filtering problem all conditions should be studied and the proper apparatus determined by a process of elimination.

The following order of considerations is suggested:

First. When the material is of a free filtering nature, containing no heavy particles or any colloidal matter to plug up the pores of the filter cloth, it is obvious that some form of rotary vacuum filter should be used in order to take advantage of continuous operation and the elimination of labor in dumping.

Second. When high pressures are desirable and when the solid matter is not to be recovered in dry form, the rotary pressure filter may prove suitable, and although the operation is no longer continuous and the advantage of automatic discharge is lost, the labor of discharge is less than with plate and frame filter.

Third. When a solid cake is required, no more simple and effective apparatus has been devised than the plate and frame filter, which since its invention fifty years ago has increased in usage and is today the most widely used type of filter.

INHERENT ADVANTAGES OF THE PLATE AND FRAME FILTER

The inherent advantages which are responsible for its popularity are simplicity, ruggedness, cheapness and a compactness that gives the greatest possible filtering area for the size of the machine. Cloths are easily removed and replaced without any sewing or wastage. Cakes, being inclosed, cannot get away from the positive flow of wash water or drying air, which may be supplied at high pressures. There is practically no filtering operation which cannot be accomplished by the plate and frame machine, but it has the disadvantage of requiring hand labor to dump and dress its frames, and it is this that has inspired the design of every attempted substitute.

USE OF THE FILTER PRESS IN THE SUGAR FACTORY

One important use of the filter press has been in the treating of settlings from the raw juice of sugar factories. Here the hot filtrate and hot washings must be recovered with a minimum loss of heat and with as much speed as possible (to prevent inversion of the sucrose) and the cake must be recovered in dry form for use as

fertilizer. Furthermore the material contains cane wax and colloidal matter, which necessitates the frequent removal and washing of the cloths in a laundering machine with hot water. It would appear, therefore, that any filter having its cloths sewed or fastened in place is seriously handicapped for this work.

A decantation system has recently been proposed for this use and installations have been made in a number of foreign countries. However, the element of time required and the possible failure to remove lighter suspended particles have caused the desirability of the scheme to be questioned by some sugar engineers, for these two points are of greatest concern to the sugar boiler—viz., the inversion loss of sucrose through delay in the dilute stage and the presence of impurities in the resulting massecuite, which prevents the recovery of the otherwise crystallizable sugar.

DESIGN OF AN IMPROVED FILTER

Realizing its importance, the writer has made a study of the plate and frame filter for the past few years and has developed a form which eliminates some of its disadvantages and at the same time simplifies the already comparatively simple machine. This improved type of filter press has been given the trade name Duplex, since it employs double inlets, double outlets, and a new method of supporting the cloth which gives (in the early stage of the cycle) practically double the usual filtration rate. Due to a special support for the cloths which allows the free passage of filtrate at all times, cakes may be formed of unusual thickness, thus reducing the labor, since the filter is dumped at less frequent intervals. A double system of washing is provided so that all cakes may be washed (in alternate directions if desired) by

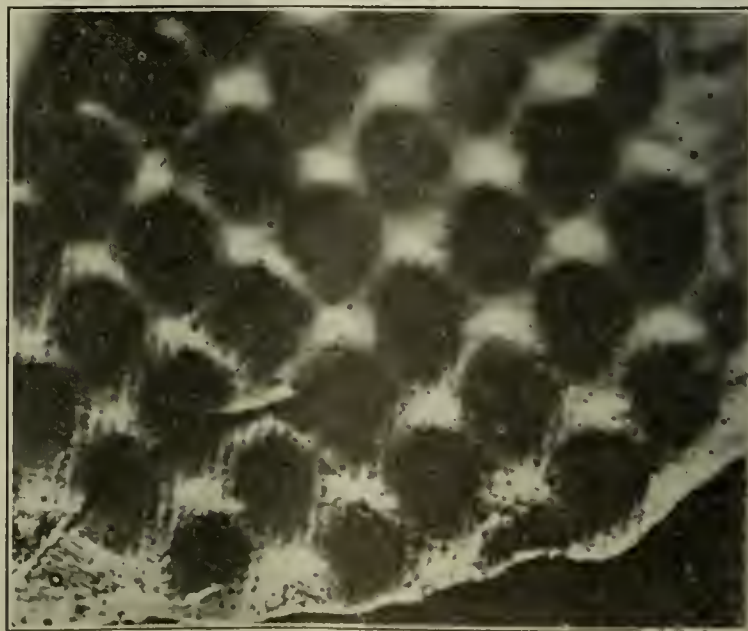


FIG. 1. SURFACE OF CAKE OBTAINED WITH PYRAMID SURFACE. PLATE SHOWING DEPTH OF INDENTATIONS

the manipulation of a single valve. It is not necessary to close drip-cocks on every alternate plate, as is usual in a washing type press, and all plates are exactly alike. Drip-cocks have been eliminated as well as the open drip gutter, yet turbid filtrate from any one cloth can be detected and shut off without stopping the flow from a perfect cloth on the opposite side of the same plate. The absence of drip-cocks simplifies the operation, and

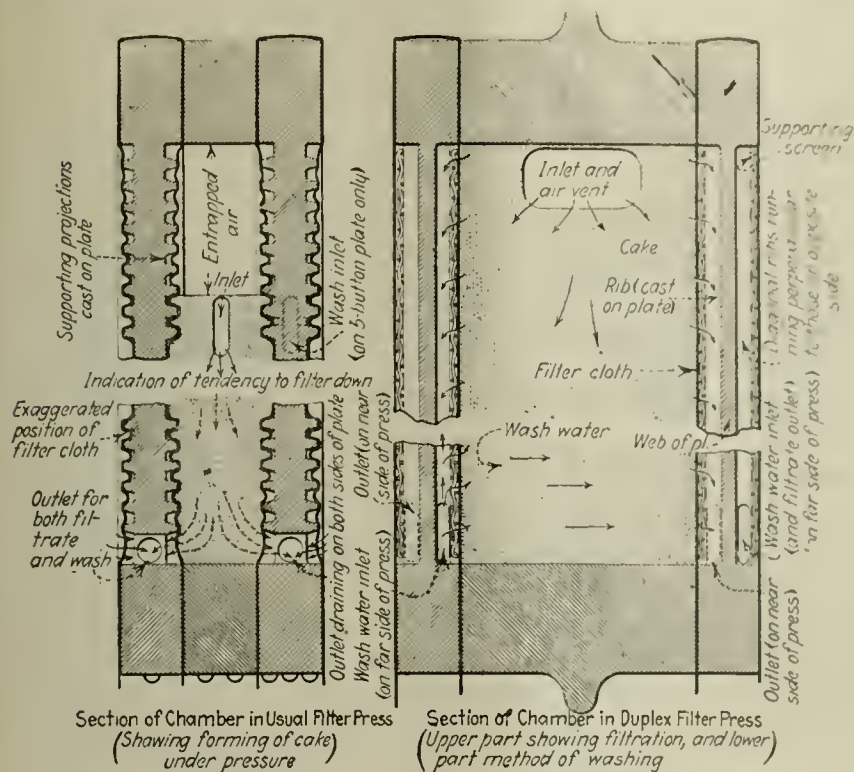


FIG. 2. COMPARISON OF SECTIONS OF CHAMBERS IN USUAL TYPE OF FILTER PRESS AND IN DUPLEX TYPE

the substitution of a closed discharge for the open gutter saves the loss of heat, or loss by evaporation where volatile filtrates are handled. It also enables the operator to stand closer to the press, and in large units permits of mounting the press closer to the floor, giving easier handling and cleaner discharge of cake into floor hoppers.

WIRE SCREEN SUPPORT FOR CLOTHS

In the usual form of filter press the cloths are supported on plate surfaces consisting of corrugations or a series of truncated pyramid projections cast on the plate, and as the cloths become coated and the pressure is consequently increased, they are pressed against the tops of these projections with such force that there may be no flow through the cloth at these points and the effective filtering area is decreased by the aggregate area of these points. As the pressure is further increased, the cloth is stretched and forced down between these points until it tends to lie against the web of the plate itself and actually does so where the pressure is sufficiently high, as can be seen by noting the depth of the corresponding corrugations on a hard cake, such as is shown in Fig. 1. Where the grooves are abnormally deep, actual contact with the web is probably never reached, but the condition is approximated. This condition not only further reduces the effective filtering area at the time when it is most needed but hampers both the run-off of the filtrate which does get through the cloth and the supply of wash water during the subsequent washing operation, since these constantly decreasing "valleys" behind the cloth are the only means of carrying away the filtrate to the drip-cocks and of admitting wash water to the cake surface. It is for this reason that with many materials the filtrate will

cease to flow before a solid cake is formed and the thickness of the frames employed must be made smaller in order to obtain a solid cake.

In the Duplex press the cloths are supported on a special screen of wide mesh double crimp wire, which in turn is carried on widely spaced reinforcing ribs cast on the plate, so that ample space behind the cloth is provided for the fall of filtrate and for the easy access of wash water to the entire surface of the cake. No matter how much the cloth may stretch it cannot come in contact with anything except the surface of the wire, which is small and gives practically no reduction of the effective area.

COMPARISON OF RATES OF FILTRATION

So many variable factors enter into the rate of filtration that values obtained with one material are of little value for comparison with those derived with another in establishing the efficiency of a filter. The rate is constantly changing throughout any single operation and even the fairly definite value of average gallons per square-foot-hour for the cycle may vary on the succeeding run of the same material, in case it is of such a nature as gradually to clog the cloth pores. The graph shown in Fig. 3 is useful for showing comparative rates, only because both types of plates were supplied from the same pump, filtering simultaneously. For this test a single Duplex unit and a single pyramid surface unit were mounted in a press, supplied from a small laboratory triplex pump running at a constant speed with a relief valve set at 40 lb.

The material used was spent filter-cel mixed with bag fiber and other matter filtered from raw sugar washings in the leaf filters of a refinery. These solids settled rapidly and in passing over the large inlet openings to the

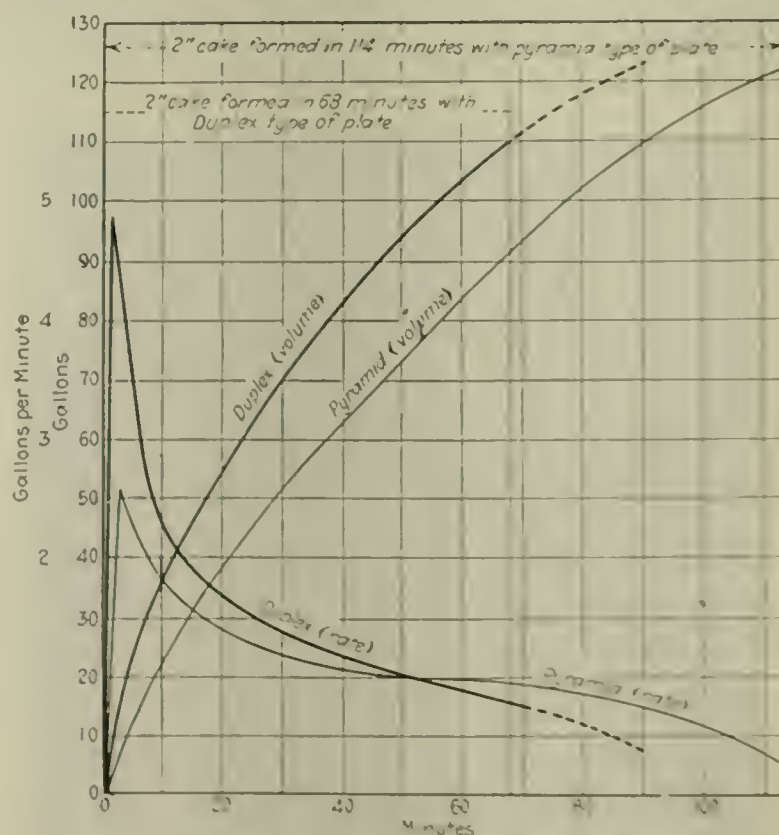


FIG. 3. COMPARISON OF RUN-OFF FROM SINGLE 36-IN PLATES OF PYRAMID AND DUPLEX TYPES FILTERING SLICING FROM SUGAR REFINERY LEAF FILTERS

Areas per plate, 14.6 sq.ft. Vol. per frame, 1.22 cu.ft.

frame nearest the pump settled in this frame enough to give the increase in density shown on the Duplex curve, where it will be noted that the solid cake was formed with the smaller volume of filtrate. These units being supplied from a constant rate pump, the filtration rate

of the Duplex plate could of course never exceed this small rate, so that the higher rate which is possible is not shown, as it would be if a monte-jus or centrifugal pump has been used.

The centrifugal pump is the ideal method for filter supply, as it gives a large volume of filtrate when the resistance is low and automatically increases the pres-

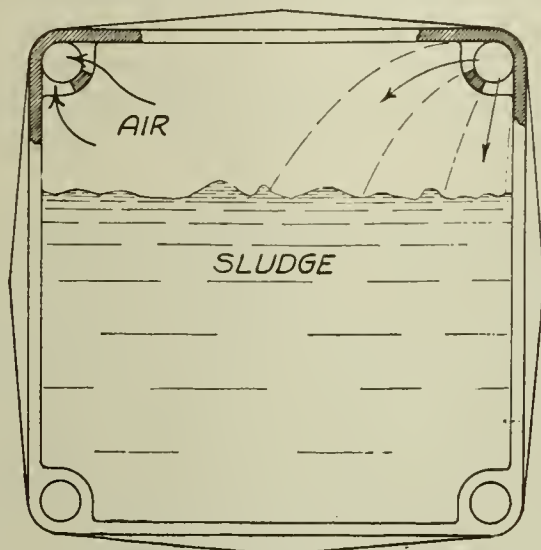


FIG. 4. FRAME SECTION SHOWING FOUR INLET PORTS AND ESCAPE OF AIR

sure as the flow diminishes. It is also free from pulsations which tend to compact the deposit on the cloths and it can never raise the pressure above its characteristic value to a dangerous point by failure of a relief valve. Each press should have its individual pump in order to get the most service from it. Where several presses are served from one pump, the empty press on being connected to the supply line will take most of the flow, as it offers the least resistance, and the other partly filled presses must stand idle until the new press has caught up with them in resistance. The resistance of the fresh press may be equalized by throttling it, but this of

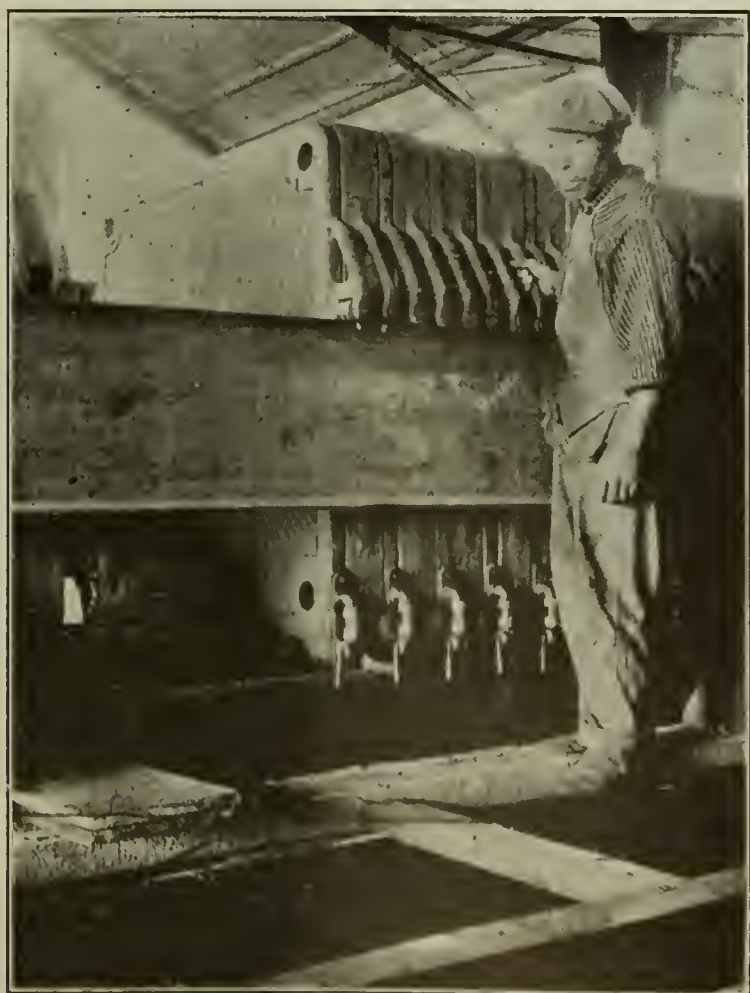


FIG. 5. VIEW OF PLATE SHOWING INCLOSED FILTRATE OUTLETS

course cuts down the higher rate which is possible with the fresh press.

PRECAUTIONS AGAINST BREAKAGE OF PLATES

The breakage of plates is almost invariably caused by a difference of pressure on opposite sides, due to the plugging up of the inlet to the adjacent frame with some fibrous or foreign substance. This is a rather frequent occurrence in the usual type of press when used with material containing fiber, for the inlet to the frame consists of a single slot, which is necessarily narrow on account of the thin frame used.

The wide frames and the use of double feed channels in the Duplex press make it possible to provide four wide, flaring inlet openings to each frame, so that it is impossible accidentally to cut off the pressure in any one frame. Further insurance against breakage is given by the use of a stronger plate, which is obtained without increase in the metal by casting continuous reinforcing ribs diagonally across the plate, those on the back side of the plate running perpendicularly to those on the front side.

The use of two inlet channels in the upper corners has the further advantage of allowing the venting of air through one as it is displaced by the incoming liquid through the other when first filling the press (Fig. 4), thus avoiding the usual air-bound condition at the start. The full area of the cloth is thus used from the very start instead of being held back until the entrapped

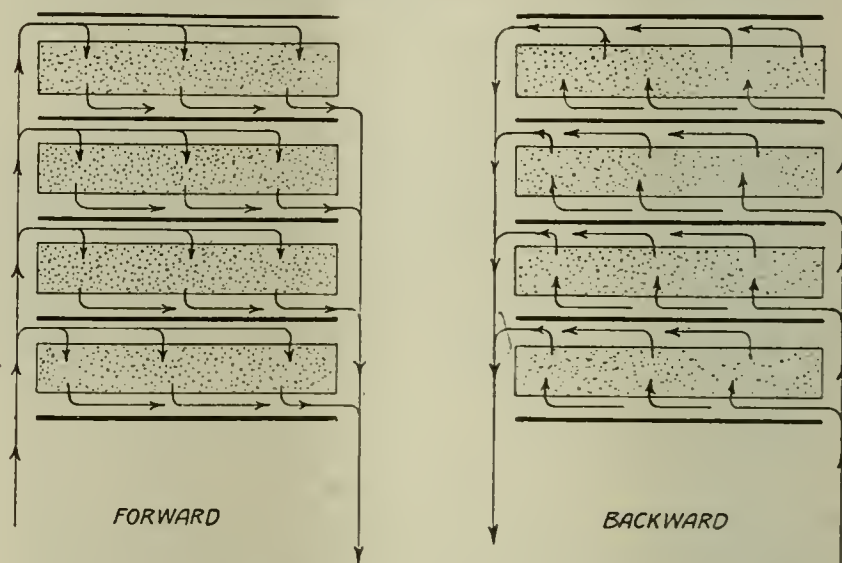


FIG. 6. DIAGRAM OF REVERSE WASHING SYSTEM

air has had time to bubble out of the drip-cocks along with the filtrate or seep through the cloth joint at the top of the press.

The use of two outlet channels at the bottom corners allows an ample area to carry away the filtrate when running at its maximum rate, as each plate, instead of being drained through the usual $\frac{1}{2}$ -in. cock, has two outlets, each equivalent to a $\frac{3}{4}$ -in. cock.

Another novelty of design consists in the way these outlets are connected to the plate faces. The drainage from the front face of every plate is connected to the right-hand channel and to this one only, while the back face of every plate is connected to the left-hand channel only. These individual connections are made by bringing the filtrate out of the press at the edge of the plate through a short sight-glass and back again into the internal channel. In this way any defective cloth may be detected and its flow shut off by means of a stop-cock, while the flow from the cloth on the other side of the same plate may continue if desired.

These stop-cocks are merely a precaution in case of

defective cloths and are never opened or closed except in this emergency. In fact, where this risk is negligible, the stop-cocks and sight glasses may be dispensed with entirely without affecting the operation of the press.

In the usual press with drip-cocks, which is provided with a wash-water channel (opening into every other plate) the shutting off of turbid filtrate at any one cock will force the dirty liquid back into the washing channel, whence it will run out of the adjacent drip-cock. Consequently the whole set of drip-cocks is utterly valueless in this type of press as far as the stoppage of turbid filtrate is concerned. Some manufacturers have gone to the expense of providing a ball-check valve on each wash plate in order to prevent this.

REVERSIBLE WASHING SYSTEM

By admission to the lower left-hand eye, the wash water comes in contact with the entire front surface of each cake, whence it flows straight through the cake and

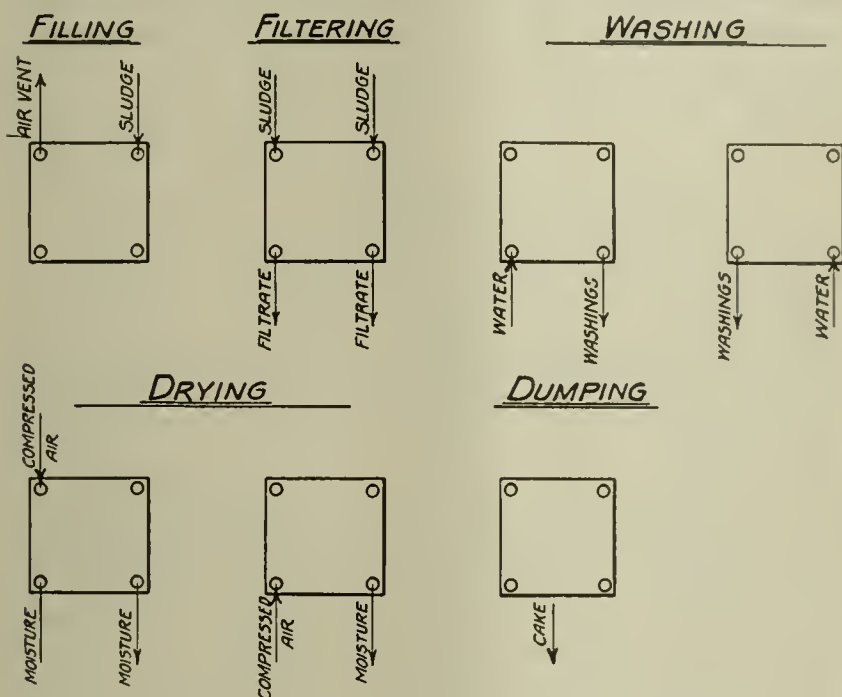


FIG. 7. CYCLE OF OPERATIONS WITH DUPLEX FILTER

out at its back surface into the space behind the cloth which drains into the lower right-hand eye. By admitting water to the left-hand eye and draining from the right, the cakes are all washed in the opposite direction—from back to front. Thus the flow may be reversed as often as desired by the handling of a single valve.

The inlets in the upper corners of the frames may also of course be used for washing, thus making it possible to apply water at all four corners in cases where this is of advantage.

In drying the cake compressed air may be admitted at the upper corners, driving the moisture out at the bottom, or it may be admitted at one of the lower eyes, blowing transversely through the cake and out the other lower eye.

The cycle of operations is shown in Fig. 7.

COMMERCIAL INSTALLATIONS

The original installation of a press of this type was made in a Hawaiian sugar factory and consisted of four hydraulically operated units, each forming forty cakes, 40 in. square of 4 in. in thickness—a capacity of 142 cu.ft. and having a filter area of 848 sq.ft. per unit. (See Fig. 8.)

These large frames are mounted on rollers and may be handled by two men, so that the labor cost is no more than in a small press and the labor per unit of solid is vastly decreased. Since the time of the original instal-

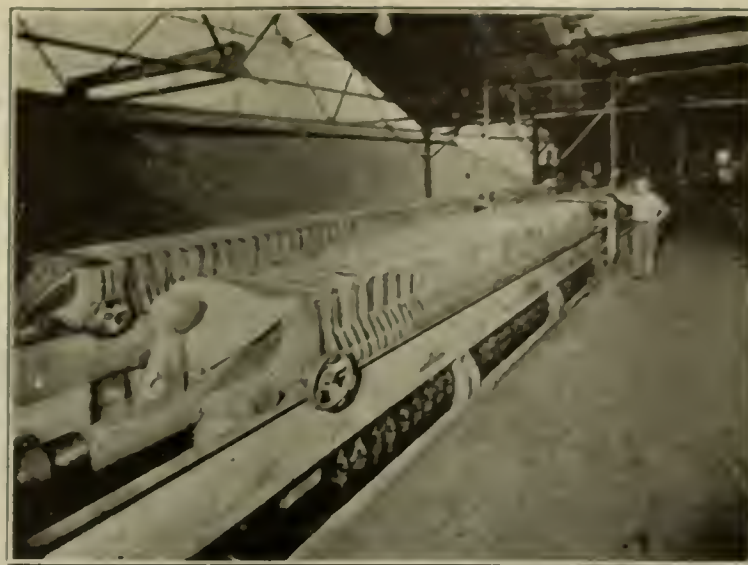


FIG. 8. ORIGINAL INSTALLATION OF DUPLEX FILTER

lation several improvements in the design of the press have been made. The filter is patented and is now being manufactured by T. Shriver & Co., of Harrison, N. J.

The latest installation (July, 1921) has been made by the American Sugar Refining Co. for use on the recovery of spent filter-cel from sluicing of leaf filters. These sluicings contain large amounts of jute fiber from sugar bags, which caused frequent breakage of plates, and it is the prevention of this which makes the machine of special value in this case.

With the perfect joint surfaces and the effective closing device of the modern filter press, the drip from the elements is negligible, but in this installation drip-sheets are provided as a precaution to prevent any drip into the floor hoppers, for the solid must be delivered as dry as possible to save the expense of evaporation in the subsequent retorting operation.

The drip-sheet used is turned up at its lower edge, forming its own gutter, which drains to a small sump at the end of the press. The sheet is split longitudinally

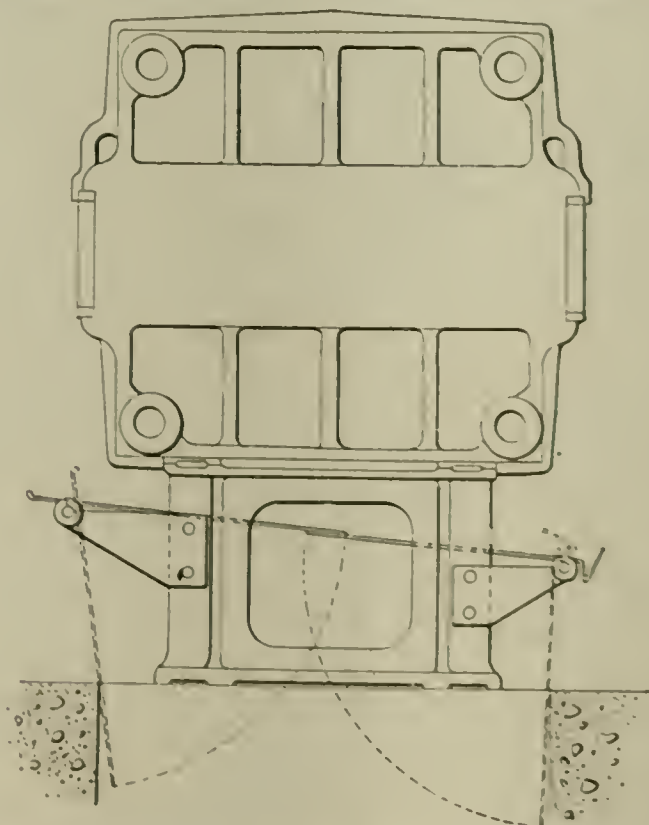


FIG. 9. DIAGRAM SHOWING ARRANGEMENT OF PIVOTED DRIP SHEETS

in two halves, each carried on a shaft running parallel to the axis of the press, turning in bearings on the press legs at either side. This gives a single overlapping joint down the middle when the sheets are in place, and when

not in use these halves swing down into the floor hopper, forming extensions to its sides above the floor line, assisting in the clean discharge of cake and preventing the necessity of the usual removal of the sheet in transverse sections.

It is believed that the use of some decolorizing carbons may be simplified by the application of the Duplex principle, for the liquid may be readily passed and re-passed transversely in alternate directions through large volumes of carbon in the form of abnormally thick cakes. When exhausted, these may be washed and dumped, regenerated and reformed into cakes ready again for treating the liquid to be passed through them. This method is of course applicable only to vegetable carbons having a rapid decolorizing action.

One of the principal points in favor of the Duplex filter is that it has obtained its added efficiency by a simplification, rather than a complication, of the well-known plate and frame apparatus.

New York City.

Book Reviews

GASOLINE AND OTHER MOTOR FUELS. By Carleton Ellis and Joseph V. Meigs. 710 pp., 206 illustrations. New York: D. Van Nostrand, 1921. Price, \$10.

The authors, Ellis and Meigs, have written a book for which there is undoubtedly a very great need. For several years past, processes for the manufacture of gasoline by various novel and usually startling methods have appeared in the newspapers, which have served no other purpose than to separate a few people from good money, and to arouse the idle curiosity of the commuter on his morning train. The authors are well known for their technical contributions and their volume on "Gasoline and Other Motor Fuels" contains admirable chapters calculated to explain what gasoline is, how it is obtained in the usual refinery practice, and how it is refined and tested. There is also an excellent discussion of the relative importance of benzene from by-product coke-ovens and other minor sources. There is also a very excellent discussion of the value of alcohol as a motor fuel and the possibilities in the distillation of oil shale, both of which subjects are bound to become of increasing importance. In fact, the only criticism which the reviewer can make of the present volume is the modesty of the authors in not being more critical of some of the subject matter, particularly the excerpts from the patent literature, which they include. In Engler's ponderous volumes on petroleum, it was evidently attempted to include all matter which found its expression in print and to present it to the reader impartially and without criticism and thus put it up to the reader to discern and select sense from nonsense. This seems to be one method of writing or rather compiling books on technical subjects. In justification of this method, it is sometimes said that an experienced investigator may get valuable ideas from the failures of others. However, it is probable that most persons referring to the work of Ellis and Meigs for information will be confused by a mass of descriptive matter taken largely from the fiction leaflets put through the United States Patent Office. Much material is included which will confuse the novice and needlessly waste the time of the better informed.

Another theory or method of writing on technical subjects is for the author to "Test all things and hold fast to that which is good," in other words, to exercise an editorial function, which he is supposed to be competent to do, of the subject whereof he writes and thus save the reader, who is presumably less well informed than the author, from wasting his time with the bizarre word play of patent lawyers and the often curious imaginings of those who make inventing an indoor sport. However, Ellis and Meigs are perhaps justified in refraining from the exercise of the edi-

torial function since the art of producing gasoline from the higher boiling oils, which is the principal theme of their book, is still in an unsettled condition. Just a few days before the writing of this review, the Burton process, evidently the most successful of any of the processes which have had fair large scale trial, was reported in the press to have caused the death of seven men and the serious burning of about forty others in an explosion at Whiting, Ind. It is, therefore, well to keep in mind that the manufacture of gasoline from higher boiling hydrocarbons is a comparatively new art and that five or ten years from now the best process may be one which has not yet had fair large scale trial. However, it is doubtful if any one will be helped by rather lengthy descriptions of processes, such as the following, to which six full pages are devoted and the character of which may be judged from the following excerpts:

It is asserted that by heating oils which, like many crude petroleum and residua, consist largely of carbon compounds containing from ten to twenty or more carbons in the molecule, with a suitable control of the conditions, a depolymerization of comparatively simple and regulable type and without complex side reactions can be produced. Under proper conditions, it is said, the oil is broken down mainly into gaseous compounds, having two carbon atoms, without deposition of carbon or formation of tar.

The oils best adapted are crude petroleum composed of oils containing hydrocarbons with more than ten carbons.

On exposing such high boiling hydrocarbons in vapor form to temperatures around 700 deg. C. (1,292 deg. F.) and within 50 to 75 deg. C. on either side of that point, a regularly gasifying depolymerization sets in with the production of low molecular gaseous hydrocarbons without any great amount of other synthetical or analytical side reactions as long as vapor of unchanged oil still remains in the sphere of action. Such vapor seems to have, it is stated, a shielding action on the products.

At 800 deg. C. (1,472 deg. F.) breaking down of ethylene, propylene, etc., is apt to begin. Another reason for the limit given is that with chambers of large section it is difficult to prevent stratification—a separation of oil vapors and gas. And a stratum of gas, free of oil vapors, is apt to suffer damage at temperatures which would otherwise be safe.

The composition of the products will vary somewhat with that of the original oil and with the details of operation.

Admixing the gas with air or oxygen and passing over catalyzers such as platinum or palladium, various useful oxidized products may be obtained and condensed or absorbed, leaving the ethane.

In recovering the olefins, instead of chilling the gas, it may be scrubbed with cold concentrated sulphuric acid which is claimed to have but little action upon the olefins proper. The acid solution upon dilution separates polymerized unsaturated aliphatic hydrocarbons.

BENJAMIN T. BROOKS.

* * *

FESTIGKEITSEIGENSCHAFTEN UND GEFUGE BILDER DER KONSTRUKTIONSMATERIALIEN—Von Dr.-Ing. C. Bach und R. Baumann, professoren an der Technischen Hochschule Stuttgart. Zweite, Stark Vermehrte Auflage. Berlin, Germany: Verlag von Julius Springer. Cloth; 8 x 10 in.; pp. 191; illustrated.

The rather unique German book noted above is an illustrated encyclopædia covering the strength of the metallic materials of construction. It presents graphs showing the relations between deformation and loading for a certain steel, for instance. Illustrations are printed alongside showing the typical test-bar, the surface of fracture and the normal microstructure. Many pictures are given of faulty structures and the nature of the breaks, both as seen by the eye and under the microscope. Carbon steels, plain and annealed, special alloy steels, cast iron and steel, malleable iron, brass, bronze, and the principal non-ferrous metals are covered in this manner in 950 illustrations. Apparently most of the material is original with the authors. Typographically the book is excellent, the micrographs being particularly well printed. It would be a good reference book for any control or testing laboratory, especially those working with ferrous metals.

E. E. THUM.

Synopsis of Recent Chemical & Metallurgical Literature

Sulphuric Acid During the War.—The story of the important rôle played by sulphuric acid in the World War is very clearly told in a paper by H. J. Bailey which was printed in the July 15, 1921, issue of the *Journal of the Society of Chemical Industry*. The stringent measures taken in Great Britain for conserving this acid and its principal raw materials are reviewed. Statistical data are presented showing the production and utilization of all acid produced in England during the period 1915-1918 and of the sources and consumption of pyrites, pyrites cinders, spent oxide and sulphur.

The chamber-acid plants of Great Britain reached their maximum output in March, 1917, when they were producing at the rate of 1,307,000 tons of 100 per cent sulphuric acid. In the following table the uses of the chamber acid during 1916, 1917, 1918 and five months of 1919 are summarized. The figures for the latter period show the transition toward normal peace-time practice.

SULPHURIC ACID FROM CHAMBER-PLANTS IN TERMS OF 100 PER CENT H_2SO_4
Summary of Uses

	1916, Tons	1917, Tons	1918, Tons	1919, (5 Mos.) Tons
Explosives.....	352,131	337,765	152,193	5,712
Dyes.....	17,736	9,688	9,143	5,207
Accumulators.....	2,696	3,145	3,075	822
Alum.....	24,854	24,406	26,184	11,233
Bichromates.....	8,433	5,710	5,316	1,863
Bleaching powder.....	70,413	50,302	50,694	10,471
Copper and copper pickling.....	3,360	2,702	1,339	380
Copper sulphate.....	21,705	27,032	30,424	9,540
Drugs and fine chemicals.....	3,098	4,479	4,225	1,308
General chemicals.....	9,203	9,217	9,624	3,734
Chemical warfare.....	39	1,122	1,678	93
Hydrochloric acid.....	71,872	53,510	52,227	26,105
Iron pickling.....	54,523	28,864	28,840	25,406
Metal trades, other than copper and iron.....	3,615	3,263	2,396	1,318
Mineral waters.....	2,421	490	391	1,884
Oil-refining.....	23,690	17,022	14,840	7,238
Paints and antimony colors.....	4,081	3,667	3,684	1,346
Sewage.....	442	307	723	1,613
Soap and glycerin.....	2,608	4,060	3,560	1,906
Sugar-refining.....	925	1,051	1,067	517
Sulphate of ammonia.....	253,340	230,145	231,092	116,144
Sulphates of magnesia and zinc.....	8,347	9,235	8,339	2,783
Sulphites and phosphates.....	10,717	11,009	12,504	5,015
Sundries.....	6,639	5,561	6,006	2,677
Superphosphates and compound manures.....	169,730	212,209	270,597	144,747
Tar.....	13,704	14,946	13,897	3,683
Textile industries.....	23,211	15,987	13,323	13,484
Totals.....	1,163,533	1,086,894	957,381	406,229

Practically all of the fuming acid or oleum was used in the manufacture of explosives, as may be noted from the following figures:

OLEUM (20 PER CENT FREE SO_3)

	1916, Tons	1917, Tons	1918, Tons	1919, (5 Mos.) Tons
Production.....	183,000	367,000	288,000	7,500
Imports.....	5,500	1,500	.....	.....
Total.....	188,500	368,500	288,000	7,500
Consumption—				
For explosives.....	179,000	352,000	276,500	.....
For trade.....	6,500	11,000	18,000	*12,000
For export.....	.....	.....	1,000	.....
Total.....	188,500	363,000	295,500	12,000
Stocks on Dec. 31.....	11,000	16,500	9,000	4,500 (May 31)

* No separate data available.

The following data for the production and consumption hydrochloric acid are of interest:

HYDROCHLORIC ACID

	1916, Tons	1917, Tons	1918, Tons
Production 30 per cent HCl.....	272,633	288,991	263,580
Niter cake used.....	48,085	55,031	47,460
H_2SO_4 consumed (100 per cent).....	111,120	107,431	101,707

CONSUMPTION OF HYDROCHLORIC ACID (30 PER CENT)

	1917 Tons	1918 Tons
Ammonium chloride.....	7,421	9,572
Aniline.....	814	1,083
Barium salts.....	2,446	2,444
Bleaching liquor, powder and chlorine.....	134,453	125,139
Carbonizing.....	2,526	3,071
Drugs and fine chemicals.....	3,574	3,950
Dyeing and bleaching.....	18,143	14,577
Dyes.....	10,330	14,030
Extraction of metals such as gold, platinum, etc.....	3,662	5,285
Foodstuffs and preservatives.....	1,854	1,743
General chemicals.....	2,593	1,867
Glue, size and gelatin.....	4,261	3,295
Leather.....	1,069	932
Metal-pickling.....	58,638	53,314
Paint, varnishes, colors, ink, etc.....	3,279	2,135
Soap and glycerin.....	9,973	8,128
Metallic chlorides.....	20,103	12,145
Chemical warfare and explosives.....	459	1,836
Sundry purposes.....	3,257	2,063
Totals.....	288,915	266,709

The relation of sulphuric acid to the fertilizer industries is given detailed study and statistical tables are included which show production and consumption of superphosphates, mixed fertilizers, basic slag and ammonium sulphate.

Solar Cooker on Mount Wilson.—In a very interesting report of Smithsonian Institution's Explorations for 1920, vol. 72, No. 6, of Smithsonian Miscellaneous Collections, Publication 2619, Washington, 1921, there is a record of a solar cooker designed by Dr. Abbott at the Mt. Wilson Observatory. In this device Mrs. Abbott, who had charge of the experiment, was able to bake excellent bread, cook meat dishes, vegetables and prepare fruits and vegetables for preserving. In short, all cooking operations were easily performed except frying. It consists in a parabolic cylindrical mirror with a polished aluminum surface of about 100 sq.ft. which focuses the sun's rays upon a blackened tube filled with mineral oil which in turn communicates with an iron reservoir of oil in which are two baking ovens. A continuous circulation of the heated oil keeps the ovens hot. It is said that Mrs. Abbott was much envied for her cool kitchen and novel appliance by the ladies of the mountain.

The solar cooker was constructed on Dr. Abbott's plans, largely at the cost of grants for the American Academy of Arts and Science in Boston and the National Academy of Sciences. It has proved successful, although as yet it is somewhat of a luxury and is available for relatively cloudless regions rather than as a generally useful appliance. The device is very simple, the oil pipe being fixed above the mirror, which by a simple clockwork device may be made to follow the sun. The idea suggests itself that the apparatus might well be used as a pre-heater on bright days to the saving of considerable coal. It might also be used in tropical countries for drying fruits and for the preparation of copra. Again, it might be that a kitchen of this sort could be provided with a hearth for artificial heat to be used on cloudy days but with sun heat availed of on days that are bright.

Leather Industry in India.—A recent summary of conditions in the leather industry of India is contained in an article by Sir Henry Ledgard, which was published in the May, 1921, issue of the *Journal of Indian Industries and Labour*. According to this report "there exists in southern India and the Bombay Presidency a great number of tanneries, chiefly small but in the aggregate producing a great quantity of leather (mainly from cow hides and those not fully tanned), also a large number of tanned goat and sheep skins, most of the leather being exported to the United Kingdom. Little or no machinery is used in these tanneries at present. This trade is passing through a period of depression. In the Punjab there are seven or eight tanneries, in most cases designed to tan buffalo and cow hides and skins. At present they are producing much below their capacity, and chiefly buffalo leather; very little machinery is used and the leather is not fully tanned or set out, or rolled to render it solid and wear-resisting as good sole leather should be. This leather finds a market in most towns in northern India in the manufacture of the cheap bazar-made boots and shoes, also in repairing and resoling work. It could be made more valuable if machinery were applied to its preparation."

Recent Chemical & Metallurgical Patents

American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Alloy for High-Temperature Uses.—The need in many metallurgical and chemical operations for an alloy which will withstand exposure to high temperatures without material oxidation or disintegration has prompted the development by Frank A. Fahrenwald, of Cleveland Heights, Ohio, of an alloy which is claimed to be sufficiently resistant for most practical purposes. The alloy consists substantially of 75 to 85 per cent of iron, 10 to 20 per cent of chromium, 2 to 6 per cent of silicon, 0.5 to 1 per cent of each of the metals manganese and titanium, and 0.2 to 2 per cent of carbon. (1,378,941; May 24, 1921.)

Alloys With Degasifying and Deoxidizing Properties.—Patents numbered 1,382,146 and 1,382,147 and issued to Calvin Vos, of New York, describe certain alloys, which because of special degasifying and deoxidizing properties are claimed to be of value in the manufacture of steel. These alloys consist of aluminum within the limits of from 90 to 95 per cent, magnesium within the limits of from 2 to 10 per cent, ferrosilicon within the limits of from 0.02 to 3 per cent and either uranium oxide or zirconium within the limits of from 0.01 to 6 per cent. Sodium fluoride is used as a flux. (June 21, 1921.)

Preparation of Glacial Acetic Acid.—Roland L. Andreau, assignor to E. I. du Pont de Nemours & Co. of Wilmington, Del., has described a process for preparing substantially anhydrous organic acids which is especially applicable to glacial acetic acid. In this process he is able to use sulphuric acid of 100 per cent strength without obtaining the usual decomposing and charring of the acetic acid formed. Briefly stated, the invention consists of carrying on the reaction between anhydrous sodium acetate and the sulphuric acid in the presence of a non-volatile and inert liquid such as paraffin. A double decomposition takes place very smoothly with the formation of substantially anhydrous acetic acid and of sodium sulphate, which remains in suspension in the oil in a finely divided state. There being no caking, the acetic acid is distilled over immediately. The distillate is of about 95 per cent strength or better. (1,381,782; June 14, 1921.)

Process of Producing Phthaleins.—The usual condensation of phthalic anhydride with a phenol for the production of a phthalein—e.g., phenolphthalein—occurs only in the presence of some dehydrating agent such as concentrated sulphuric acid. Most of these condensing agents have the disadvantage of forming tarry byproducts which interfere with the refining of the final product besides giving a yield of only 30 to 60 per cent of the theoretical. A process which has recently been patented substitutes an anhydrous sulphonic acid or a mixture containing such an acid for the usual condensing agent. It is claimed that a yield equivalent to 90 per cent of the theoretical can be obtained in this manner. (1,381,503; Alfred L. Rispler, assignor to Monsanto Chemical Works of St. Louis, Mo.; June 14, 1921.)

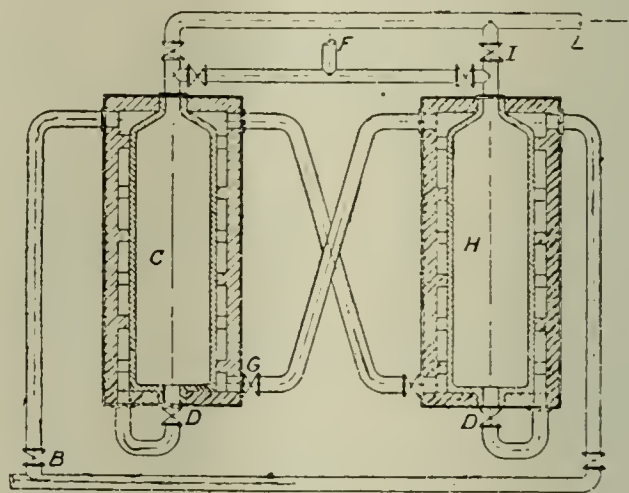
A Basic Sodium Naphtholate.—As a substitute for solid sodium naphtholate in the preparation of naphthol-carboxylic acids, L. F. Chebotaref, a Russian citizen residing in Wappinger Falls, New York, proposes a new substance, which he characterizes as a basic alkali naphtholate. In the case of the sodium salt this is prepared by fusing 15 parts of sodium naphthalene-beta-sulphonate with 11 parts of caustic soda for 2 hours at a temperature not higher than 350 deg. C. The sodium sulphite formed precipitates into the bottom layer; the upper layer when decanted and allowed to cool will congeal into a yellow

crystalline solid, easily soluble in both water and alcohol. Its composition corresponds empirically to $C_{10}H_8O_2Na_2$ and in properties it compares with a substance represented by an addition product of 1 mol of sodium naphtholate and 1 mol of caustic soda. (1,381,280, assigned, by mesne assignments, to National Aniline & Chemical Co., Inc. June 14, 1921.)

British Patents

For complete specifications of any British patent apply to the Superintendent, British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Treatment of Nitrous Gases.—In the absorption of dilute nitrous gases by means of solid absorption agents, and the decomposition of the resulting product to produce concentrated nitrous oxides and nitric acid, the combined process is conducted in retort-like, acid- and fire-proof vessels surrounded by gas-tight jackets capable of resisting comparatively high pressures. The hot gases before actually entering the retorts pass into the space between the jacket and the retort in order to heat the latter and thus enable either absorption or decomposition to take place. The absorbent may be such as is described in specification 137,071, consisting of a mixture of a dry base with one or more metallic oxides and the absorption is advantageously effected at 300-600 deg. C. In one form of the apparatus shown in the



figure, the furnace gases first pass to the vessel C containing material fully saturated with nitrous gases through the valve B, but before entering the inner retort traverse the interstices between the jacket and the retort. To facilitate the decomposition, which is preferably effected at a pressure below that of the absorption, a small portion of the furnace gases is led through the valve D actually into the retort and carries with it the concentrated nitrous gases and nitric acid to the exit F. The greater portion of the furnace gases leaves the vessel C by the valve G and enters the second vessel H containing fresh or denitrated material, after passing through the space between the retort and the jacket. The residual gases freed from nitrous gases escape through the valve I and pipe L. When the material in the vessel H becomes saturated, the circulation of gases is reversed—i.e., the furnace gases enter the vessel H and then pass on to C. The valve D may be shut off entirely, the necessary gases then entering the retort through holes in the retort walls. Alternatively the retort walls may be made porous. Instead of two vessels, a battery connected on the counter-current principle or in any suitable manner may be employed. (Br. Pat. 163,026; not yet accepted. Norsk Hydro-Elektrisk Kvaelfstofaktieselskab, Christiania; June 29, 1921.)

Alloy for Permanent Magnets.—Steel alloys suitable for permanent magnets and other purposes are made by alloying with carbon steel, containing about 0.25 to 1.5 per cent of carbon, about 5 to 19 per cent of cobalt. Tungsten (or vanadium or molybdenum) or chromium, nickel and tungsten (or vanadium or molybdenum) may also be added, and also up to about 1 per cent of manganese. The tungsten may vary up to about 10 per cent and the nickel and chromium up to about 5 per cent each. Cast ingots of the alloys may be heated to about 1,000 deg. C., forged, hardened at about 850 or 900 deg. C., and magnetized. (Br. Pat. 164,039. Sir R. A. Hadfield, Westminster, July 20, 1921.)

Current Events

in the Chemical and Metallurgical Industries

Program, American Chemical Society Meeting

The final program for the sixty-second meeting of the American Chemical Society, New York, Sept. 6 to 10, is as follows:

TUESDAY, SEPT. 6

- 9 a.m.—Registration begins at the Chemists' Club, 52 East 41st St.
 3 p.m.—Council meeting at the Chemists' Club.
 6:30 p.m.—Dinner to the Council at the Chemists' Club.
 9 p.m.—Adjourned meeting of Council, if necessary.

WEDNESDAY, SEPT. 7

- 9:30 a.m.—General meeting, Columbia University gymnasium:
 Address of Welcome, John E. Teeple, chairman, New York Section.
 Response, Edgar F. Smith, president, American Chemical Society.
 "Chemistry and the State," Francis P. Garvan, president, Chemical Foundation.
 "Mustard Gas," Sir William J. Pope.
 "Organization of Industrial Research in Canada," Prof. R. F. Ruttan.
 12:30 p.m.—Society of Chemical Industry Luncheon to British and Canadian visitors.
 2 p.m.—Divisional meetings at Columbia University.
 4 p.m.—Reception and lawn party given by Columbia University on the university green, 120th St. and Amsterdam Ave.
 8 p.m.—Smoker at Waldorf-Astoria.

THURSDAY, SEPT. 8

- 9:30 a.m.—Divisional meetings at Columbia University.
 2 p.m.—Organ recital by Prof. Samuel A. Baldwin in the Great Hall of the College of the City of New York, 139th St. and Convent Ave., followed by
 2:30 p.m.—International meeting:
 "Chemistry and Civilization," Dr. Edgar F. Smith.
 "Science and Civilization; the Rôle of Chemistry," by Prof. Charles Baskerville.
 "Energy; Its Sources and Future Possibilities," by Dr. Arthur D. Little.
 "The Engineer; Human and Superior Direction of Power," by Dr. Leo H. Baekeland.
 "Chemistry and Life," by Sir William J. Pope.
 "Theories and Their Development," by Dr. Willis R. Whitney.
 "Research Applied to the World's Work," by Dr. C. E. K. Mees.
 "Problem of Diffusion and Its Bearing on Civilization," by Prof. Ernst Cohen, of the University of Utrecht.
 "Catalysis; The New Economic Factor," by Prof. Wilder D. Bancroft.
 8 p.m.—Banquet at Waldorf-Astoria.

FRIDAY, SEPT. 9

- 9:30 a.m. and 2 p.m.—Divisional meetings at Columbia University.
 8 p.m.—Public meeting, Columbia University gymnasium:
 Presentation of Priestley portrait by C. A. Browne.
 President's address, "Progress in Chemistry," Edgar F. Smith.

SATURDAY, SEPT. 10

Visits to plants of the following concerns have been arranged by the committee: National Biscuit Co., Ladew Co., Ziegel Eiseman Co., American Tobacco Co., Standard Oil Co. of New York, Standard Oil Co. of New Jersey, Manhattan Rubber Co., Passaic Print and Dye Works, Seaboard Byproduct Coke Co., Liebmann's Brewery.

DIVISIONAL MEETINGS

The following divisions and sections will meet on the days noted:

- Division of Agricultural and Food Chemistry, Wednesday and Thursday, 16 papers to be presented.
 Section of Sugar Chemistry, Wednesday, Thursday and Friday, 24 papers.

Division of Dye Chemistry, Thursday and Friday, 21 papers.

Division of Organic Chemistry, Wednesday, Thursday and Friday, 41 papers.

Division of Biological Chemistry, Wednesday, Thursday and Friday, 40 papers, including a symposium on vitamins.

Division of Physical and Inorganic Chemistry, Wednesday, Thursday and Friday, 48 papers.

Section of Leather Chemistry, Wednesday, Thursday and Friday, 24 papers.

Section of Cellulose Chemistry, Wednesday and Thursday, 11 papers.

Division of Rubber Chemistry, Wednesday, Thursday and Friday, 21 papers.

Section of Chemical Education, Wednesday, Thursday and Friday, 10 papers.

Division of Industrial and Engineering Chemistry, Wednesday, Thursday and Friday, 35 papers, including symposia on filtration and on the chemistry of gases and fuel.

Division of Fertilizer Chemistry, Wednesday and Thursday, 23 papers.

Section of Petroleum Chemistry, Wednesday, Thursday and Friday, 12 papers, including symposium on emulsification problems.

Division of Water, Sewage and Sanitation, Friday, 7 papers.

Division of Chemistry of Medicinal Products, Friday, 13 papers.

Steel Treaters' Convention

An imposing list of seventy-eight papers has been secured for presentation and discussion at the forthcoming convention of the American Society for Steel Treating, held in conjunction with an exhibit of metallurgical equipment at Indianapolis, Sept. 19 to 24, 1921.

Tool steels will be discussed in nine papers by Messrs. Brown, Calkins, d'Arcambal, Green, Marshall, Medwedeff, Nelson, Seidell and Townsend.

Various problems in metallographic research will occupy six papers, by Messrs. Dowdell, Gill and Bowman, Hoffman, Lau, White and Helrigel.

Fourteen papers on general practice in heat-treatment will be presented by Messrs. Blacet, Cowdrey, Cope, Janitzky, Keller, Langstroth, Haywood, Hoyt and Bierman, Lynch, Merton, Priestley, Ward, White and Gaun, while there will be nineteen papers descriptive of new heat-treating furnaces or pieces of miscellaneous equipment.

Management will be discussed in ten papers, by Messrs. Bellis, Blue, Bressler, Langenburg, Pierce, Smart, Woodside, Wood, Millard and Medwedeff.

Properties of carbon and alloy steels will occupy Messrs. French, Grossman, Johnson, McCormick, Styri, Vannick, Bird, Cox, Johnson, Holz and Wild.

Labor Disputes and Wage Reductions in British Chemical Plants

The following developments were reported recently by cable from London:

The Minister of Labor has intervened in the dispute between the chemical companies and their employees and it is expected that representatives of the employers and the men's union will again confer. The dispute affects 30,000 men.

Ninety per cent of the employees of the Brunner-Mond Co. have promised their employers that they will not walk out, even if a general chemical strike is called. (It will be recalled that the company threatened to close down its Winnington works unless sufficient men accepted the reduced wage and agreed to continue at work under the new wage scale.)

A ballot taken by the Scottish shale miners shows that the men agree to a reduction in wages amounting to 3s. 2d. per day.

Decision on Standard of Comparison in Minerals Separation vs. Butte & Superior Suit

Decision was rendered of Friday, Aug 12, by Judge George M. Bourquin, in the Montana U. S. District Court, on the motion of plaintiffs that the court determine a standard of comparison for the guidance of the master in the settlement to be made by the Butte & Superior Mining Co. to Minerals Separation, Ltd., et. al., for infringement upon patents.

Judge Bourquin's decision follows:

Plaintiffs' patent valid and defendant having infringed it (250 U. S., 336), the suit is in the final stage and has been referred to a master to take and state an account.

Therein plaintiffs move the court to determine a standard of comparison for the guidance of the master. The standard they contend for is processes known (1) at the date of patent, or (2) at the date infringement began.

Defendant resists specific and particular instructions to the master as calculated to embarrass the proceedings by vague determinations in respect to evidence before tendered, and maintains the proper standard is processes known at any time so far as subsequent infringement is concerned. The issue of relativity in time of standard and infringement has been exhaustively argued and briefed, and some time to be decided, better be decided now. There is no controlling decision in this circuit, the issue not having been expressly raised and determined in either Supreme Court or Circuit Court of Appeals. In several cases the Supreme Court's language is that the infringer accounts for the fruits of the advantage which he derived from the use of that invention, over what he would have had in using other means then open to the public and adequate to enable him to obtain an equally beneficial result.

The rule of comparison is settled law, and contemplates that the infringer had a choice of processes, chose that of the patent, and gained an advantage over what would have been his had he chosen otherwise. Obviously his choice is made from processes existing at the time of choice, that is, at the time infringement from day to day and as alternative presents itself. He is not limited in fact to the process of the patent and processes existing only at the date of the patent, and the principle of standards does not require nor sanction that he be so limited in theory. For the advantage he actually gains, and which as profits or savings he must render to the patentee, is only that of the invention over other processes he might have chosen in lieu of the invention and did not.

What the infringer thus gains is also what the patentee is presumed to thus lose, so far as accounting for profits is concerned, and equity is done when all such gains are taken from the infringer and given to the patentee; for thus the former loses nothing, he is not penalized, the latter is made whole, and he is not given gratuities nor rewarded beyond his present deserts, as otherwise would be the case. And it seems fairly clear that this is the import of the quoted language of the Supreme Court.

The event to which the court refers is the infringement, and the time to which it refers is "then" at that time, the time of the antecedent event.

In so far as the motion seeks a general and not a particular determination, it is granted. The standard of comparison that will govern the master is any standard (having in mind the distinction between processes and standard) that is duly made to appear, in respect to subsequent infringement.

Australian National Research Council Holds First Meeting

Sir Edgeworth David, first president of the Australian National Research Council, which opened its first session at Melbourne, Aug. 24, declared it was necessary to establish the basic chemical industries in Australia and to work for co-ordination generally, throughout the Commonwealth, of scientific effort.

New British Act Affects Chemical Imports

On Aug. 25 the Board of Trade announced that part 1 of the safeguarding of industries act, dealing with all synthetic and organic chemicals, would come into full operation on Oct. 1. All goods arriving in England on or after that date will be liable to duty regardless of the date when the goods were ordered.

American Ceramic Society at the Chemical Exposition

The American Ceramic Society will be represented at the Seventh National Exposition of Chemical Industries, booth 451. A larger booth than usual has been obtained this year in order that this may form a real headquarters for members at the exposition whether they be visitors or exhibitors. Small committee meetings may be held and appointments made to meet friends. Every member who plans to attend the exposition is asked to register at the booth and use it as his personal headquarters.

Friday, Sept. 16, will be Ceramic Day. In the afternoon a program along ceramic and chemical lines will be given by interesting speakers. In the evening motion picture films on the industry will be shown.

On Thursday and Saturday, Sept. 15 and 17, at 9:30 a.m., a conference will be held at the Hotel Commodore, including the board of trustees, officers of divisions and sections and members of the committees with ex-presidents. This conference has been called by President Pence so that the officers in each group in the organization can counsel together, formulate a general program of activities for the entire society, and discuss methods and policies. Efficiency and methods, definiteness and attractiveness of program, activity and persistency of directing officers and extent to which the individual members in each of the divisions and sections are kept informed and interested will be taken up.

Some of the divisions are growing in numbers and influence, while others are struggling for existence. Some of the standing committees have accomplished a great deal, while others do not know how to get started. Some of the local sections flourish, while others struggle along in indifference. Some of the divisions have co-operative working relations with other technical organizations and with industrial associations, while others have none.

The officers of each division, section and committee are urged to prepare for presentation at this meeting a statement of their activities, present and past, an exhibit of all printed notices and circular letters used at any time; and each division is asked to send at once to Ross C. Purdy, the new organizing secretary, a list of all industrial associations, together with names and addresses of officers, which, directly or indirectly, are or could be interested in the work of the American Ceramic Society. The society is also anxious to receive a list of addresses of all trade, industrial or technical journals and house organs, no matter how remote their interest might be, to which notices of the activities of the American Ceramic Society can be sent. The organizing secretary wants to learn of ways and means of assisting each group in the organization and is interested that everyone should be present at the conference to be opened on Sept. 15.

Annual Meeting of the Societe de Chimie Industrielle de France, October, 1921

The annual meeting of the Société de Chimie Industrielle de France will take place Oct. 9 to 12, 1921, in Paris. The following sections will be represented: Analytical Chemistry; Plant Machinery; Laboratory Apparatus; Gas and Coke Industries; Hydrocarbons, Petroleum; Wood Distribution; Refrigerating Industries; Water; Metallurgy and Electrometallurgy; Precious Metals; Heavy Chemicals; Fine Chemicals; Electrochemistry; Glass, Ceramics and Enameling; Rare Earths, Radio-active Bodies; Pharmaceutical Products; Photographic Products; Powder and Explosives; Essences, Natural and Synthetic Perfumes; Resins, Paints, Lacquers and Varnishes; Rubber and Substitutes; Fatty Materials, Soap, Candles, Glycerine, Cellulose, Paper; Plastic Materials, Artificial Textiles; Bleaching, Dyeing, Printing; Tanning; Fermentation; Sugar; Starch; Milk; Food Products; Agricultural Chemistry, Soils and Fertilizers.

An exposition of the chemical industry, Oct. 7 to 16, will feature this first annual meeting of the society.

Fertilizer Statistics

The National Fertilizer Association is co-operating with the Bureau of the Census in an effort to collect complete statistics on the production of acid phosphate and sulphuric acid.

Temporary Dye Control Extended

No real opposition was encountered in the Senate to the proposal to continue until after the recess the temporary control of imports of dyes. The subject came in for extended discussion, but there was no disposition on the part of any Senator to allow the measure to lapse entirely. Advantage was taken of the opportunity to denounce a permanent embargo. Senator Hitchcock attempted to establish that the War Trade Board, in handling the temporary embargo, had made it almost impossible for an American user to get imports of a dye in time to use it, even when it was not obtainable in the United States. Senator Smoot, in urging the passage of the extension of the control, among other things said:

I am opposed to an embargo on dyestuffs or any other article of common use. I am for the extension of the temporary embargo, for the reason I wish to be fair with the dye manufacturers of the country. I believe we can give ample protection to the dye industry by the regular rates that may be inserted in the tariff bill.

I am investigating conditions of every dye that is manufactured. I am taking the manufacturer's number of that dye. I am trying to find its cost abroad, at least the price for which it is sold when imported into this country and into foreign countries, both before the war and today. I am investigating the American value of those dyes, where they are made in this country. I cannot say today what rate of duty will be necessary. I do know, however, that in my investigation so far there must be two classes of dyes, if not three, and in those classes there will be a great difference in rates.

Senator Pomerene, of Ohio, stated to the Senate that imports of dyes in 1920 aggregated \$5,000,000 in value. During that year dyes to the value of \$29,000,000 were exported. This led Senator Smoot to say that 90 per cent of the exports consisted of a few articles, particularly synthetic indigo and sulphur black. He said that sulphur black has been made in this country for thirty years and that we can compete with nearly every country so far as that dye is concerned. We will not be able to compete with Germany in the manufacture of synthetic indigo, he declared, and just as soon as Germany gets back to quantity production of synthetic indigo that country will take all the markets outside the United States, he said.

In the course of the debate Senator McCumber, an influential member of the Finance Committee, made this significant remark: "Before we get through with the tariff bill, I think we shall have succeeded in getting a measure that will be sufficiently protective without an embargo."

While the general impression in Washington at the time of this writing is that the Senate committee will decline to restore the dye embargo to the tariff bill no decision has been reached and it is very evident that several members of the committee who are not particularly impressed with the embargo policy hesitate to accept responsibility for killing it.

Obituary

PETER COOPER HEWITT, electrical and mechanical inventor and engineer, died in the American Hospital in Paris, Aug. 25. He was born in New York on March 5, 1861, and was educated at the Stevens Institute of Technology and the Columbia University School of Mines. One of his earliest inventions was that of improved machinery in his grandfather's famous glue factory. His greatest success was achieved in the field of electricity—the Cooper Hewitt lamp, the Cooper Hewitt rectifier and other inventions bringing international fame. Because of his scientific attainments, Mr. Hewitt was made first vice-president of the United States Naval Consulting Board during the war and in that capacity he did much valuable patriotic service.

ROSS F. MACMICHAEL, of the United States Gypsum Co., Chicago, was drowned in Lake Michigan on July 10. Born

in 1885, he was educated through private study. After occupying various minor positions he became field engineer for the American Smelters Securities Co. at Asarco, Durango, Mexico. Later he became associated with the Northern Clay Co., Auburn, Wash., carrying on technical problems in chemical engineering. Returning to the American Smelting & Refining Co. at Hayden, Ariz., as construction and experimental engineer, he invented the MacMichael chimney gas tester and the MacMichael viscosimeter. He had just come to Chicago to engage in the design of special machinery for the United States Gypsum Co. He was a member of the American Ceramic Society and the American Association of Engineers.

Dr. FRANK N. SMALLEY, chief chemist of the Southern Cotton Oil Co., died on Aug. 15 at the Homeopathic Hospital, Boston. Death was due to peritonitis, which set in following an operation. Dr. Smalley was born in Westborough, Mass., in 1874. He received his education in Massachusetts and was graduated from the Massachusetts Institute of Technology in 1898. A month later his services were secured by the Southern Cotton Oil Co., and he went to Savannah to enter its employ as one of its chemists. Some years ago he was given full charge as chief chemist for all of the laboratories of the company. Well known and highly esteemed in the cotton oil industry, his research work in his field caused his alma mater to confer on him the degree of doctor of philosophy. Dr. Smalley led an active life and had wide interests. He served as a non-commissioned officer in the United States Army shortly after the Spanish-American War and saw service in the Philippines. He was a member of the Society of Chemical Industry, the American Oil Chemists Society, the American Chemical Society and the American Institute of Chemical Engineers.

GEORGE W. THOMAS, president of R. Thomas & Sons Co., manufacturer of electric porcelain, died recently at his home at East Liverpool, Ohio, at the age of sixty-nine. He was the pioneer producer of high-voltage porcelain in the United States.

Personal

Dr. HOWARD ADLER has recently been made assistant professor of the department of chemistry of the University of Chicago and will also succeed Gerald L. Wendt as managing editor of the *Chemical Bulletin*, organ of the Western Sections of the American Chemical Society.

HOWARD W. AMBRUSTER, formerly general manager of Hemingway & Co., of Bound Brook, N. J., announces that he has opened his own office at 261 Broadway, New York City, for the purchase or sale of chemicals or colors.

R. R. DANIELSON, U. S. Bureau of Standards, Washington, D. C., is making an extended business visit in Chicago.

BURTON DUNGLINSON, formerly with the American Chemical & Sugar Machinery Co., is going to London to represent the Republic Flow Meters Co. of Chicago in the European field.

HERBERT A. HAUPTLI, superintendent of the Sears-Roebuck wall paper and dye plant, Chicago, Ill., is leaving for an extended trip to Europe to investigate methods of manufacture of wall paper, inks and dyestuffs.

J. T. SLEEPER, formerly manager of Ricketts & Co., Inc., and later research analyst for the Testing Laboratories of New York, has resigned from the latter position.

GEORGE OTIS SMITH, director of the United States Geological Survey, returned to Washington last week from London. The primary object of his visit to England was to serve as a member of the organization committee of the International Geological Congress, the next meeting of which is being arranged for August, 1922, at Brussels.

CLYDE E. WILLIAMS has been appointed superintendent of the U. S. Bureau of Mines Experiment Station at Seattle, Wash.

Current Market Reports

Chemical and Allied Industrial Markets

NEW YORK, Sept. 5, 1921.

Very encouraging reports were noted from the heavy chemical trade during the past week. Business seems to be showing a decided improvement and efforts to make this condition permanent are being made throughout the trade. Miscellaneous inquiries for small lots have increased and some sellers have placed considerable business. The volume of business is averaging better than it did a month ago, which is quite a favorable feature to record during the hot vacation period. Importing continues freely and importers find no difficulty in bringing in stocks of most materials at prices ruinous to domestic makers. The final settlement of the tariff question is expected to counter-balance this feature in a large way. Prices in general are fairly steady and are losing their recent softness. In many cases imported materials figure largely, but for the moment importers are holding their prices steady. Paper factories and textile mills have bought freely in certain commodities and inquiries from tanneries and dyers are on the increase. Shoe factories and enamelers are buying with a much better spirit and in larger quantities.

EXPORT SITUATION DISCOURAGING

The most discouraging feature at present is our export trade. Aside from the credit situation, foreign interests are underselling American producers in South America and other countries. Germany seems fully determined to win back her former commercial supremacy, regardless of what it costs. It seems problematical how far Germany can go on this price question, but it is the cause of no little concern to American interests which are not in a position to meet the keenest kind of competition. There were a few who expected a sharp decline in caustic soda. The resisting power and the gradual recovery of prices, however, speaks well for the underlying fundamental position of this chemical. Soda ash has also shown renewed strength and efforts to force the price down have not met with much success. It may be stated in general that the peak of the depression is passing and indications point to a steady improvement.

Advices from steel quarters indicate positive betterment. The decrease in the number of idle freight cars during July in spite of the fact that the greater part of the perishable freight had been moved before the end of the period has amounted to nearly one-third of their number. This fact alone has given a feeling of optimism to both consumer and manufacturers which will go a long way toward bringing better business, and its effects are already seen in the present improvement.

CHEMICALS

Buyers are calling for small lots of *bichromate of potash* and sales are reported at 11½c. per lb. There has been no apparent pressure in the market, but supplies seem sufficient to meet the current extent of inquiries. *Ammonium sulphate* has shown a noteworthy increase among the export and also domestic trade. Business has been very active and prices are named at \$2.40@2.50 per 100 lb. in double bags for steamer New York. Out-of-town soap-makers have taken large quantities of *caustic potash* at lately prevailing prices and reports are heard that the situation is becoming tighter abroad. While some dealers quote 4½c. per lb. for imported 88-92 per cent, other large jobbers are asking above this figure and state that sales have gone through at 4½c. per lb. Producers of *acetate of soda* are asking 4½c. per lb. for this chemical, but would undoubtedly accept 4c. on a firm offer, as recent sales have gone through at this figure. The movement is slow and devoid of particular feature. Trading in small lots of *bichromate of soda* is the best that can be reported at

present. Transactions up to 5 casks are going through at 7½c. per lb., with this figure named by most dealers. Offerings on spot are moderate and the tone is steady. Miscellaneous *caustic soda* inquiries are reaching the market in better volume. It is true that business is only moderately active, but the increased interest displayed seems to forecast expansion in trade in the very near future. It is difficult to place any European business on account of the strong competition existing. There are reports that some foreign producers have advanced their prices. Some South American business is going through and conditions at some points have improved materially. Spot sales are reported by dealers at \$3.85@3.90 per 100 lb. for standard brands. A few odd lots might be purchased at \$3.80. No change from the former selling price of 7½c. per lb. can be reported for *chlorate of soda*. Business is confined to prompt shipments and the volume for domestic use is quite satisfactory. Small lots of *nitrite of soda* have sold at prices ranging from 7@7½c. per lb. on spot, depending upon size of order. It is possible that a slight concession might be granted on a round quantity, although holders of these lots seem to be somewhat tighter in their ideas. Spot prices for *prussiate of soda* are holding steady for the imported and it is doubtful if better than 12c. per lb. could be done in the open market at present. Dealers quote 12@12½c. and report a fair consuming demand for small quantities. The withdrawal of one of the largest low-priced sellers of *bleaching powder* on account of the disposal of output has put the market on a higher trading level. Producers are quoting 2½c. per lb. for large drums at the works and it is doubtful if second hands could shade this figure on any sizeable quantities. Paper mills have placed orders for considerable quantities during the past few weeks. Small drums are quoted at 2½c. per lb. lot works. Spot prime material in large drums is quoted at \$2.85 per 100 lb., ex-store.

Importers of *oxalic acid* report sales at 16c. per lb. Brokers claim to be able to shade this price to 15½c. on odd lots, but dealers quote all the way up to 18c. for the domestic variety. Sales at the works are reported at 16c. per lb. Small-lot trading continues to feature the market. Sales of *zinc carbonate* are reported at 16c. per lb. by producers. On round lots a slight concession might be allowed. The present inquiry seems to be confined practically to small lots. Spot *zinc sulphate* is quoted at 3c. per lb., with occasional sales at \$2.90 per 100 lb. The latter figure is considered an inside price for large-quantity orders. Moderate inquiries are reported from the paint and textile industries. Sales of imported crystal *tartaric acid* have been made at 26¼@27½c. per lb., the prevailing quotation at the close being 27@28c. per lb., according to quantity and seller.

COAL-TAR PRODUCTS

There have been quite a number of orders in the market for quantity lots of intermediates during the past week and in some directions this is taken as an indication of decided improvement. There are some who believe, however, that the recent orders are coming from those who have depleted their stocks which they took on some months ago and that they will not be in the market again for several months to come. In any case the outlook is considerably better, as indications point to improved consuming demand. The uncertainty of the tariff remains a ruling cause for slowness in the market, aside from the long-continued persistency of consumers in staying out of the market. Plants generally are barely moving and many are completely shut down. No large sales of crude material were made during the past week. Intermediates are moving slowly and manufactures are holding their quotations fairly firm, except where sharp competition is noted, as in the cases of *beta naphthol* and *aniline oil*. Resale stocks are greatly reduced on most items. There are only a scant few where prices are declining on account of accumulated resale material on hand. Producers of *benzene* quote 27@33c. per gal., but cannot supply any spot material. In order to take care of the c.p. demand it has become necessary for first hands to notify fuel oil consumers

that they can expect a curtailment of supplies on all new contracts. The greater number of coke ovens are shut down with no signs of any improvement at present. The market on *naphthalene* continues very quiet, with the demand at a virtual standstill. Refiners' prices remain unchanged at 8½@9½c. per lb. for flake, but, resellers are willing to sell even below their quoted figure of 6¾c. per lb. for quantity business. Resale Government *phenol* is to be had at 9@11c. per lb., according to packing and quantity. Government surplus stocks are still offered at 12@15c. per lb. Refiners of natural *phenol* are quoting 15@16c. per lb. for their product.

Business has been going on in routine proportions with the pharmaceutical trade. Resale lots of *beta naphthol* are to be had in good quantity at 32c. per lb. and reports are heard that makers are willing to do 34c., although they still deny it. Competition is keen and prices have been slightly shaded on round lots. The demand is somewhat slow. Makers of *aniline oil* have brought their prices well into line and are now quoting 20c. per lb., although some are still shading higher prices to this level. Resale lots are to be had in good quantity as low as 18c. per lb. Little interest is being displayed by consumers. Producers of *alpha naphthylamine* are quoting lower prices at 35c@37c. per lb. There is very little *alpha* offered by resellers in the spot market, as makers have retained control of stocks. Manufacturers of *dimethylaniline* are quoting 45@50c. per lb. according to brand and are pretty well in line within this range. Reports are current that sales have been made by producers as low as 42c. per lb., and while this seems possible no maker is willing to admit it. Makers' prices for *paranitraniline* rule at 79@82c. per lb., with resale material below this level in very light supply. The demand is rather slow. Producers of *paratoluidine* have brought their prices into better alignment and are now quoting \$1.25@\$1.28 per lb. Demand for small lots only has been noted.

WAXES

There was a moderate inquiry for crude *beeswax*, but the situation underwent no important change. Crude African held around 15@16c. per lb., according to quantity and seller, with the Brazilian at 22@25c. per lb. Pure white closed nominally at 36@42c. per lb. While offerings of *candelilla wax* were not pressing on the market, lack of demand caused prices to hold on the recently reduced basis of 25@26c. per lb. Interest in *carnauba wax* centered in the lower grades, although domestic consumers refused to anticipate their wants and business reported was only of a hand-to-mouth nature, confined almost entirely to small lots. No. 2 North Country held at 25c. per lb. with the No. 3 North Country at 15c. No. 3 chalky settled nominally at 15½c. per lb. Spot offerings of *Japan wax* were firmly held and at the close the market ranged from 19½@20½c. per lb., depending on seller and quantity. Strength at primary centers was the supporting feature. The market for *paraffine* was unsettled, with liberal offerings by large producing interests. The export demand has shown only a slight improvement and competition for pending business has been very keen with the result that price shading continues. Crude scale of 122@124 deg. melting point was available in carlots for immediate shipment at 1¾c. per lb.

The St. Louis Market

ST. LOUIS, Sept. 2, 1921.

In spite of the fact that the month of August has always been looked upon as a dull period for the chemical market, there have been many favorable reports coming in from manufacturers stating that business has increased to a great extent over the past months, and all are very optimistic as to what the future holds. It is the general opinion that there is a tendency for prices to harden, as the majority of the items, especially the major ones, have reached the level where they are consistent with manufacturing cost. The above facts not only cover the drugs, pharmaceuticals and fine chemical lines, but also affect the heavy chemicals, where the demand has increased steadily and has strengthened the market considerably. Not only have declines been halted but in several instances

an upward change has been recorded. It is still true that buyers are very conservative in procuring their supplies and orders are not of large volume, but they are more numerous and frequent and in most instances are placed for immediate shipment. On some of the commodities the foreign material continues to be a disturbing element to the manufacturers. However, they are gradually becoming extinct.

ALKALIS

Caustic soda demand is good and manufacturers' schedules strictly adhered to. Price has advanced to \$4.25 per 100 lb. carload flat 76 deg. solid f.o.b. point of production. Further increases are not unexpected. *Soda ash* demand is fair with prices remaining the same—that is, \$2.66@ \$2.75 per 100 lb. in less than carload lots. *Bicarbonate of soda* demand is poor, with the price \$2 per 100 lb. for barrels or \$1.75 per 100 lb. for bags, carlots f.o.b. producers works.

CHEMICALS, DRUGS AND PHARMACEUTICALS

Acetanilid is very dull. We are now at the threshold of the preserving and canning season and a good volume of business should be transacted on *benzoate of soda* and *acid benzoic*, and furthermore this should be the opportune time to procure requirements, as the prices on these commodities have undoubtedly reached bottom, and with an increased demand will have a tendency to advance. There is nothing more than routine business on *ammonia water*, 26 deg., with prices firm. *Bismuth salts*, particularly subnitrate, is moving very lively. *Bromides* are weak. *Caffeine* has shown a very substantial increase the past thirty days. The heavy demand for *carbon bisulphide* which was evident the past several weeks still continues. However, it is not expected that this condition will prevail much longer, as the demand from agricultural sources will cease the next few weeks. *Chloroform* and *ether* are two commodities which should be classified as stable articles, as they have a regular source of outlet. Manufacturers have reduced their price of *codeine* and its salts. There is nothing startling to report on *cream of tartar* or *acid tartaric*. *Creosote* and *guaiacol* should shortly show an increase, as we are about to enter the season of the year when these articles will be in demand and liberal stocks should be carried. *Epsom salts* is being quoted in carlots at \$2.10 per 100 lb., f.o.b. factory, and less carlots at \$2.60 per 100 lb., f.o.b. St. Louis. *Glycerine* declined one-half cent and is now quoted at 14c. in drums, spot or contract. This is an exceptionally low price and the manufacturers are not pushing contracts at this figure. *Mercurials* are firm with steady flow of orders. *Morphine* and its salts have been reduced. *Saccharine* has taken a sudden spurt with many inquiries received and in most instances business resulting. *Salicylates* continue to move in a fair way, and an increased demand is expected very shortly, as the season for the salicylates is now approaching. Several weeks ago it was reported that there was a brisk demand for *silver nitrate* and this condition still prevails. *Sodium hyposulphite* continues in routine way. *Sulphur* is in good demand, with price at \$2.10 per 100 lb. for commercial in bags. The price of *zinc oxides* remains the same, with fairly good demand for the lead-free from the rubber trade. *Zinc sulphate* is ruling at 3½c. per lb. f.o.b. St. Louis.

ACIDS AND VEGETABLE OILS

Producers of commercial mineral acids are very much pleased with the present free movement of acids especially the *sulphuric* grade, which is moving in very large volume. Producers attribute the increase to the fact that many of the industrial plants which have been shut down for some months are beginning to operate. *Acid carboic* is very quiet. The demand for *citric acid* has been very disappointing and very little improvement can be expected at this time, as the soft drink season is about to close. The demand for *acid pyrogallie* shows no inclination to drop off and the inquiries and demand continue to increase. *Acid tannic* is moving in fair way.

The *castor oil* movement has really been very heavy the past month and price of 11½c. per lb. for returnable drums is very firm. *Linseed oil* has held firm at 78c. per gal.

basis raw in barrels ex-warehouse. The majority of the buyers are taking spot oil as they need it. *Turpentine* continues to advance and it holds strong at 65c. per gal. in barrels ex-warehouse.

PAINT MATERIALS

Lithopone and *barytes* are unchanged in price and the demand is still much under routine, the expected activity in the paint industry having as yet failed to materialize.

The Iron and Steel Market

PITTSBURGH, Sept. 2, 1921.

The volume of demand for steel products, taken as a whole, has continued to increase in the past fortnight, albeit the increases have been relatively small and not altogether steady. Sheets, bars and tubular goods show improvement most distinctly. Shapes, plates and rails stand at the foot of the list. Tin plate and wire products show demand that is governed by the season rather than by general business conditions. All steel mills show improvement in bookings, comparing July and August.

As improvement in demand has been most pronounced in the lighter steel products, naturally no large increase in steel production is shown. The rate of steel ingot production this week may be estimated as nearer 30 per cent than 25 per cent, and it is possible a full presentation would show a rate above 30 per cent. This compares with an average in July of about 21 per cent and a rate probably between 18 and 19 per cent at the middle of July, when the record low point was reached. Production of finished steel has increased slightly more than production of ingots, as here and there stocks of semi-finished steel or ingots are being drawn upon.

As for weeks past, the prominent fact in an analysis of the purchases of steel is that the buying is widespread in character, both geographically and by trades. All sections of the country are represented more or less in the improvement, but the Southern States show the best gain in proportion to the volume of business two or three months ago.

PRICES MUCH STEADIER

A survey of the course of prices since the first of the year shows how much steadier the steel market has become in the past thirty days. The end of last year brought an equalization in prices between the independents, which had largely advanced their prices, and the Steel Corporation, which held to the Industrial Board schedule of March 21, 1919. January saw a continuance of the equalized prices, while February witnessed an inception of price cutting by independents. A weighted average of the prominent finished steel products shows that from Feb. 1 to Aug. 1 there was a decline of fully \$15 per net ton, February and July each showing declines of more than \$5 a ton, while in August the weighted average dropped only 80c. a ton. It is barely possible that no further declines will be recorded, taking a broad view of the price situation.

PIG IRON AND COKE

Pig iron has been firming up in several districts in the past fortnight, and definite advances are recorded in the Buffalo, Chicago and valley markets. The trend in these cases is away from a market price that was below the cost of replacing the stock iron sold. On a general average, the freight assembly cost of ore, coke and limestone necessary to make a ton of pig iron is about \$10, against about \$5 before the war, and expectations are that the rates will be reduced by about 20 per cent. The freight rate reductions, however, have not occurred, and no one knows just when they will occur, while in some districts the stocks have been fairly well reduced, and here and there it is necessary for a furnace to resume operations. Naturally the furnace requires the buyer to pay its cost at least, when it has the recourse of not making iron. Liquidation of stocks was another matter.

The local market is quotable at \$20 for bessemer, \$19 for basic and \$20 for foundry iron f.o.b. valley furnaces, these quotations representing no change in bessemer and advances of \$1 on basic and 50c. on foundry. The common asking price on basic, however, is now \$20.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots		Less Carlots	
Acetic anhydride.....lb.			\$0.40 - \$0.45	
Acetone.....lb.	\$0.12½ -	\$0.12½	.13 -	.13½
Acid, acetic, 28 per cent.....100 lbs.	2.50 -	2.75	3.00 -	3.25
Acetic, 56 per cent.....100 lbs.	5.00 -	5.25	5.50 -	6.00
Acetic, glacial, 99½ per cent, carboys, 100 lbs.	10.00 -	10.25	10.50 -	10.75
Boric, crystals.....lb.	.12½ -	.13	.13½ -	.14
Boric, powder.....lb.	.13 -	.13½	.14 -	.14½
Citric.....lb.			.45 -	.47
Hydrochloric.....100 lb.	1.25 -	1.50	1.60 -	1.75
Hydrofluoric, 52 per cent.....lb.	.11½ -	.11½	.12 -	.12½
Lactic, 44 per cent tech.....lb.	.10 -	.11	.11½ -	.12
Lactic, 22 per cent tech.....lb.	.04½ -	.05½	.06 -	.07
Molybdic, C. P.....lb.	4.00 -	4.50	4.50 -	5.00
Muriatic, 20 deg. (see hydrochloric).....lb.			.07 -	.07½
Nitric, 40 deg.....lb.	.07 -	.07½	.07½ -	.07¾
Nitric, 42 deg.....lb.	.07 -	.07½	.07½ -	.07¾
Oxalic, crystals.....lb.	.16 -	.16½	.17 -	.18
Phosphoric, 50 per cent solution.....lb.	.13 -	.13½	.14 -	.18
Pieric.....lb.	.20 -	.25	.27 -	.35
Pyrogallic, resublimed.....lb.			1.75 -	1.90
Sulphuric, 60 deg., tank cars.....ton			11.00 -	13.00
Sulphuric, 60 deg., drums.....ton			13.00 -	15.00
Sulphuric, 66 deg., tank cars.....ton	18.00 -	20.00		
Sulphuric, 66 deg., drums.....ton	21.00 -	22.00	22.50 -	23.00
Sulphuric, 66 deg., carboys.....ton				
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	21.00 -	22.00		
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	23.00 -	23.50	24.00 -	24.50
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	31.00 -	32.00	33.00 -	34.00
Tannic, U. S. P.....lb.			.75 -	.85
Tannic (tech.).....lb.	.45 -	.48	.50 -	.55
Tartaric, crystals.....lb.			.27 -	.28
Tungstic, per lb. of WO.....lb.			1.30 -	1.40
Alcohol, Ethyl.....gal.			4.80 -	4.90
Alcohol, Methyl (see methanol).....gal.				
Alcohol, denatured, 188 proof.....gal.			.35 -	.36
Alcohol, denatured, 190 proof.....gal.			.37 -	.38
Alum, ammonia lump.....lb.	.03½ -	.03½	.04 -	.04½
Alum, potash lump.....lb.	.03½ -	.04	.04 -	.04½
Alum, chrome lump.....lb.	.10 -	.11	.11 -	.12½
Aluminium sulphate, commercial.....lb.	.02 -	.02½	.02 -	.02½
Aluminium sulphate, iron free.....lb.	.03 -	.03½	.03½ -	.04
Aqua ammonia, 26 deg., drums (750 lb.).....lb.	.07½ -	.07½	.08 -	.08½
Ammonia, anhydrous, cyl. (100-150 lb.).....lb.	.30 -	.32	.33 -	.35
Ammonium carbonate, powder.....lb.	.07 -	.07½	.08 -	.09
Ammonium chloride, granular (white salamoniac).....lb.	.06 -	.06½	.06½ -	.07½
Ammonium chloride, granular (gray salamoniac).....lb.	.07 -	.07½	.07½ -	.08
Ammonium nitrate.....lb.	.07 -	.07½	.07½ -	.08½
Ammonium sulphate.....100 lb.	2.20 -	2.25	2.30 -	2.40
Amylacetate.....gal.			3.25 -	3.50
Amylacetate tech.....gal.			2.50 -	3.00
Arsenic oxide, (white arsenic) powdered lb.	.06½ -	.06½	.07 -	.07½
Arsenic, sulphide, powdered (red arsenic) lb.	.11 -	.11½	.12 -	.13
Barium chloride.....ton	48.00 -	50.00	51.00 -	53.00
Barium dioxide (peroxide).....lb.	.20 -	.21	.22 -	.23
Barium nitrate.....lb.	.08 -	.08½	.08½ -	.09½
Barium sulphate (precip.) (blanc fixe).....lb.	.04 -	.04½	.04½ -	.05½
Bleaching powder (see calc. hypochlorite).....lb.				
Blue vitriol (see copper sulphate).....lb.				
Borax (see sodium borate).....lb.				
Brimstone (see sulphur, roll).....lb.	.27 -	.28	.28½ -	.30
Bromine.....lb.	2.00 -	2.05		
Calcium acetate.....100 lbs.	.04½ -	.04½	.05 -	.05½
Calcium carbide.....lb.	23.50 -	24.00	24.50 -	25.50
Calcium chloride, fused, lump.....ton	.01½ -	.02	.02½ -	.02½
Calcium chloride, granulated.....lb.	2.85 -	2.90	3.00 -	3.50
Calcium hypochlorite (bleach'g powder) 100 lb.			1.40 -	1.50
Calcium peroxide.....lb.			.15 -	.16
Calcium phosphate, tribasic.....lb.			.73 -	.75
Camphor.....lb.	.06 -	.06½	.06½ -	.07½
Carbon bisulphide.....lb.	.10½ -	.10½	.11 -	.12
Carbon tetrachloride, drums.....lb.			.60 -	.75
Carbonyl chloride (phosgene).....lb.				
Caustic potash (see potassium hydroxide).....lb.				
Caustic soda (see sodium hydroxide).....lb.				
Chlorine, gas, liquid-cylinders (100 lb.).....lb.	.08 -	.09	.09½ -	.10
Chloroform.....lb.			.38 -	.43
Cobalt oxide.....lb.			2.00 -	2.10
Copperas (see iron sulphate).....lb.				
Copper carbonate, green precipitate.....lb.	.19 -	.19½	.20 -	.21
Copper cyanide.....lb.			.50 -	.62
Copper sulphate, crystals.....lb.	.05½ -	.05½	.05½ -	.06½
Cream of tartar (see potassium bitartrate).....lb.				
Epsom salt (see magnesium sulphate).....lb.				
Ethyl Acetate Com. 85%.....gal.			1.00 -	1.10
Ethyl Acetate pure (acetic ether 98% to 100%).....lb.			.40 -	.42
Formaldehyde, 40 per cent.....lb.	.12½ -	.12½	.13 -	.13½
Fusel oil, ref.....gal.			3.25 -	3.75
Fusel oil, crude.....gal.			1.50 -	1.75
Glauber's salt (see sodium sulphate).....lb.				
Glycerine, C. P. drums extra.....lb.			.14 -	.14½
Iodine, resublimed.....lb.			3.50 -	3.60
Iron oxide, red.....lb.			.10 -	.20
Iron sulphate (copperas).....ton	18.00 -	19.00	20.00 -	21.00
Lead acetate.....lb.			.10½ -	.12½
Lead arsenate, paste.....lb.	.09 -	.09½	.10 -	.11
Lead nitrate.....lb.			.15 -	.20
Litharge.....lb.	.08½ -	.09	.09½ -	.09½
Lithium carbonate.....lb.			1.30 -	1.40
Magnesium carbonate, technical.....lb.	.09 -	.09½	.10 -	.11
Magnesium sulphate, U. S. P.....100 lb.	2.40 -	2.75		
Magnesium sulphate, technical.....100 lb.			1.05 -	1.60
Methanol, 95%.....gal.			.66 -	.68
Methanol, 97%.....gal.			.70 -	.72
Nickel salt, double.....lb.			.12 -	.12½
Nickel salt, single.....lb.			.14 -	.14½
Phosgene (see carbonyl chloride).....lb.				
Phosphorus, red.....lb.	.40 -	.41	.42 -	.45
Phosphorus, yellow.....lb.			.30 -	.35
Potassium bichromate.....lb.	.11½ -	.11½	.12 -	.12½

		Carlots	Less Carlots
Potassium bitartrate (cream of tartar).....	lb.	\$ 28 1/2 - \$ 29 1/2	\$ 16 - \$ 25
Potassium bromide, granular.....	lb.	35 - 40	45 - 50
Potassium carbonate, U. S. P.....	lb.	.05 - .05 1/2	.06 - .06 1/2
Potassium chlorate, crystals.....	lb.	.07 - .07 1/2	.08 - .10
Potassium cyanide.....	lb.	.04 1/2 - .05	.26 - .28
Potassium hydroxide (caustic potash).....	lb.	.04 1/2 - .05	.05 1/2 - .06
Potassium muriate, 80% K.C.I.....	ton	42 50 - 45 00	
Potassium iodide.....	lb.		2 75 - 3 00
Potassium nitrate.....	lb.	.09 1/2 - .09 1/2	.10 - .12 1/2
Potassium permanganate.....	lb.	.25 - .26	.26 1/2 - .27
Potassium prussiate, red.....	lb.	.28 - .29	.29 1/2 - .30
Potassium prussiate, yellow.....	lb.	.20 1/2 - .21	.22 - .22 1/2
Potassium sulphate (powdered).....	per unit		1 20 - 1 25
Rochelle salts (see sodium potas tartrate)			
Salammoniac (see ammonium chloride)			
Salt soda (see sodium carbonate)			
Salt cake.....	ton		22 00 - 25 00
Silver cyanide.....	oz.		1 35 - 1 38
Silver nitrate.....	oz.		.41 1/2 - .42
Soda ash, light.....	100 lb.	2 10 - 2 15	2 20 - 2 70
Soda ash, dense.....	100 lb.	2 35 - 2 40	2 45 - 2 70
Sodium acetate.....	lb.	.04 1/2 - .04 1/2	.04 1/2 - .05 1/2
Sodium bicarbonate.....	100 lb.	2 25 - 2 40	2 50 - 2 75
Sodium bichromate.....	lb.	.07 1/2 - .08	.08 1/2 - .08 1/2
Sodium bisulphate (nitre cake).....	ton	5 00 - 5 25	5 50 - 6 50
Sodium bisulphate powdered, U.S.P.....	lb.	.04 - .05	.05 1/2 - .06
Sodium borate (borax).....	lb.	.05 - .06	.06 - .06 1/2
Sodium carbonate (sal soda).....	100 lb.	1 50 - 2 00	2 10 - 2 40
Sodium chloride.....	lb.	.07 1/2 - .07 1/2	.08 - .08 1/2
Sodium cyanide.....	lb.	.19 1/2 - .21	.22 - .30
Sodium fluoride.....	lb.	.11 - .11 1/2	.12 - .13
Sodium hydroxide (caustic soda).....	100 lb.	3 85 - 3 90	3 95 - 4 60
Sodium hyposulphite.....	lb.		.03 1/2 - .03 1/2
Sodium nitrate.....	100 lb.	2 10 -	2 30 -
Sodium nitrite.....	lb.	.07 - .07 1/2	.07 1/2 - .08
Sodium peroxide, powdered.....	lb.	.25 - .26	.27 - .30
Sodium phosphate, dibasic.....	lb.	.04 1/2 - .04 1/2	.05 - .05 1/2
Sodium potassium tartrate (Rochelle salts) lb.			.21 - .24
Sodium prussiate, yellow.....	lb.	.12 - .12 1/2	.12 1/2 - .13
Sodium silicate, solution (40 deg.).....	100 lb.	1 00 - 1 15	1 25 - 1 40
Sodium silicate, solution (60 deg.).....	lb.	.02 1/2 - .03	.03 1/2 - .03 1/2
Sodium sulphate, crystals (Glauber's salt) 100 lbs.		1 50 - 1 75	2 00 - 2 25
Sodium sulphide, fused, 60-62 per cent (conc.) lb.		.04 1/2 - .04 1/2	.05 - .05 1/2
Sodium sulphite, crystals.....	lb.	.03 1/2 - .04	.04 1/2 - .04 1/2
Strontium nitrate, powdered.....	lb.	.12 - .12 1/2	.13 - .14
Sulphur chloride, red.....	lb.	.05 1/2 - .06	.06 1/2 - .07
Sulphur, crude.....	ton	20 00 - 22 00	
Sulphur dioxide, liquid, cylinders extra.....	lb.	.08 - .08 1/2	.09 - .10
Sulphur (sublimed), flour.....	100 lb.		2 25 - 3 10
Sulphur, roll (brimstone).....	100 lb.		2 00 - 2 75
Tin bichloride, 50 per cent.....	lb.	.18 - .19	
Tin oxide.....	lb.		.38 - .40
Zinc carbonate, precipitate.....	lb.	.15 1/2 - .16	.16 - .17
Zinc chloride, gran.....	lb.	.11 - .11 1/2	.11 1/2 - .12
Zinc cyanide.....	lb.	.42 - .44	.45 - .47
Zinc dust.....	lb.	.11 1/2 - .11 1/2	.11 1/2 - .12 1/2
Zinc oxide, XX.....	lb.	.07 1/2 - .07 1/2	.08 - .09
Zinc sulphate.....	100 lb.	3 00 - 3 25	3 30 - 3 50

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude.....	lb.	\$1.10 - \$1.15
Alpha-naphthol, refined.....	lb.	1.25 - 1.30
Alpha-naphthylamine.....	lb.	.35 - .40
Aniline oil, drums extra.....	lb.	.18 - .21
Aniline salts.....	lb.	.25 - .28
Anthracene, 80% in drums (100 lb.).....	lb.	.75 - 1.00
Benzaldehyde U.S.P.....	lb.	1.00 - 1.25
Benzidine, base.....	lb.	1.00 - 1.10
Benzidine sulphate.....	lb.	.75 - .85
Benzoic acid, U.S.P.....	lb.	.60 - .65
Benzoate of soda, U.S.P.....	lb.	.55 - .60
Benzene, pure, water-white, in drums (100 gal.).....	gal.	.27 - .32
Benzene, 90%, in drums (100 gal.).....	gal.	.25 - .28
Benzyl chloride, 95-97%, refined.....	lb.	.25 - .27
Benzyl chloride, tech.....	lb.	.20 - .23
Beta-naphthol benzoate.....	lb.	3.50 - 4.00
Beta-naphthol, sublimed.....	lb.	.70 - .75
Beta-naphthol, tech.....	lb.	.32 - .35
Beta-naphthylamine, sublimed.....	lb.	1.75 - 1.80
Cresol, U. S. P., in drums (100 lb.).....	lb.	.16 - .18
Ortho-cresol, in drums (100 lb.).....	lb.	.25 - .27
Cresylic acid, 97-99%, straw color, in drums.....	gal.	.68 - .75
Cresylic acid, 95-97%, dark, in drums.....	gal.	.65 - .70
Cresylic acid, 50%, first quality, drums.....	gal.	.45 - .50
Dichlorobenzene.....	lb.	.06 - .09
Diethylaniline.....	lb.	1.20 - 1.25
Dimethylaniline.....	lb.	.45 - .55
Dinitrobenzene.....	lb.	.26 - .28
Dinitrochlorobenzene.....	lb.	.20 - .30
Dinitronaphthalene.....	lb.	.30 - .40
Dinitrophenol.....	lb.	.35 - .40
Dinitrotoluene.....	lb.	.27 - .30
Dip oil, 25%, car lots, in drums.....	gal.	.40 - .45
Diphenylamine.....	lb.	.65 - .70
H-acid.....	lb.	1.15 - 1.25
Meta-phenylenediamine.....	lb.	1.15 - 1.20
Monochlorobenzene.....	lb.	.12 - .14
Monoethylaniline.....	lb.	1.75 - 1.85
Naphthalene crushed, in bbls.....	lb.	.06 1/2 - .07 1/2
Naphthalene, flake.....	lb.	.06 1/2 - .08
Naphthalene, balls.....	lb.	.08 - .09 1/2
Naphthionic acid, crude.....	lb.	.70 - .75
Nitrobenzene.....	lb.	.12 - .15
Nitro-naphthalene.....	lb.	.30 - .35
Nitro-toluene.....	lb.	.16 - .18
Ortho-amidophenol.....	lb.	3.10 - 3.20
Ortho-dichlor-benzene.....	lb.	.15 - .20
Ortho-nitro-phenol.....	lb.	.80 - .85
Ortho-nitro-toluene.....	lb.	.15 - .20
Ortho-toluidine.....	lb.	.20 - .25
Para-amidophenol, base.....	lb.	1.40 - 1.45
Para-amidophenol, HCl.....	lb.	1.60 - 1.75

Para-dichlorobenzene.....	lb.	15 - 20
Paramitroaniline.....	lb.	75 - 80
Para-nitrotoluene.....	lb.	85 - 95
Para-phenylenediamine.....	lb.	1 70 - 1 75
Para-toluidine.....	lb.	1 25 - 1 40
Phthalic anhydride.....	lb.	50 - 60
Phenol, U. S. P., 1-lb.....	lb.	.09 - .11
Pyridine.....	gal.	2 00 - 3 50
Resorcinol, technical.....	lb.	1 60 - 1 55
Resorcinol, pure.....	lb.	2 25 - 2 30
Salicylic acid, tech., in bbls.....	lb.	.19 - .22
Salicylic acid, U. S. P.....	lb.	.20 - .25
Salol.....	lb.	.60 - .75
Solvent naphtha, water-white, in drums, 100 gal.....	gal.	25 - 28
Solvent naphtha, crude, heavy, in drums, 100 gal.....	gal.	14 - 16
Sulphanilic acid, crude.....	lb.	27 - 30
Tolidine.....	lb.	1 25 - 1 35
Toluidine, mixed.....	lb.	40 - 45
Toluene, in tank cars.....	gal.	25 - 28
Toluene, in drums.....	gal.	28 - 31
Xylidines, drums, 100 gal.....	lb.	40 - 45
Xylene, pure, in drums.....	gal.	40 - 45
Xylene, pure, in tank cars.....	gal.	45 -
Xylene, commercial, in drums, 100 gal.....	gal.	33 - 35
Xylene, commercial, in tank cars.....	gal.	30 -

Waxes

Prices based on original packages in large quantities:

Beeswax, refined, dark.....	lb.	\$0 24 - \$0 25
Beeswax, refined, light.....	lb.	.28 - .30
Beeswax, white pure.....	lb.	.36 - .42
Candelilla wax.....	lb.	.25 - .25
Carnauba, Florida.....	lb.	.48 - .50
Carnauba, No. 2, North Country.....	lb.	.25 - .26
Carnauba, No. 3, North Country.....	lb.	.15 - .16
Japan.....	lb.	.20 - .21 1/2
Montan, crude.....	lb.	.06 1/2 - .06 1/2
Paraffine waxes, crude match wax (white) 105-110 m.p.....	lb.	.03 1/2 - .03 1/2
Paraffine waxes, crude, scale 124-126 m.p.....	lb.	.02 - .02
Paraffine waxes, refined, 118-120 m.p.....	lb.	.03 - .03 1/2
Paraffine waxes, refined, 125 m.p.....	lb.	.03 1/2 - .03 1/2
Paraffine waxes, refined, 128-130 m.p.....	lb.	.03 1/2 - .04 1/2
Paraffine waxes, refined, 133-135 m.p.....	lb.	.04 - .05
Paraffine waxes, refined, 135-137 m.p.....	lb.	.05 1/2 - .06
Stearic acid, single pressed.....	lb.	.09 1/2 -
Stearic acid, double pressed.....	lb.	.10 -
Stearic acid, triple pressed.....	lb.	.11 - .11 1/2

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on earload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl.....	280 lb.	\$5 25 - 5 30
Rosin E-I.....	280 lb.	5 30 - 5 40
Rosin K-N.....	280 lb.	5 55 - 5 70
Rosin W, G.-W. W.....	280 lb.	6 60 - 7 35
Wood rosin, bbl.....	280 lb.	6 25 -
Spirit of turpentine.....	gal.	.65 -
Wood turpentine steam dist.....	gal.	.63 -
Wood turpentine, dest. dist.....	gal.	.61 -
Pine tar pitch, bbl.....	200 lb.	- 7 00
Tar, kila burned, bbl. (500 lb.).....	bbl.	- 11 50
Retort tar, bbl.....	500 lb.	- 11 50
Rosin oil, first run.....	gal.	.35 -
Rosin oil, second run.....	gal.	.37 -
Rosin oil, third run.....	gal.	.41 -
Pine oil, steam dist., sp.gr. 0.930-0.940.....	gal.	\$1 90
Pine oil, pure, dest. dist.....	gal.	1 50
Pine tar oil, ref., sp.gr. 1.025-1.035.....	gal.	.46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.....	gal.	.35
Pine tar oil, double ref., sp.gr. 0.965-0.990.....	gal.	.75
Pine tar, ref., thin, sp.gr. 1.080-1.960.....	gal.	.35
Turpentine, crude, sp. gr., 0.900-0.970.....	gal.	1.25
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990.....	gal.	.35
Pinewood creosote, ref.....	gal.	.52

Solvents

73-76 deg., steel bbls. (85 lb.).....	gal.	\$0.31
70-72 deg., steel bbls. (85 lb.).....	gal.	.35
68-70 deg., steel bbls. (85 lb.).....	gal.	.34
V. M. and P. naphtha, steel bbls. (85 lb.).....	gal.	.23

Crude Rubber

Para—Upriver fine.....	lb.	\$0.16 - .17
Upriver coarse.....	lb.	.09 - .09 1/2
Upriver caucho ball.....	lb.	.11 1/2 - .12
Plantation—First latex crepe.....	lb.	.14 -
Ribbed smoked sheets.....	lb.	.12 - .12 1/2
Brown crepe, thin, clean.....	lb.	.15 -
Amber crepe No. 1.....	lb.	.17 -

Oils

VEGETABLE

The following prices are f.o.b. New York for earload lots.

Castor oil, No. 3, in bbls.....	lb.	\$0.09 1/2 - \$0.09 1/2
Castor oil, AA, in bbls.....	lb.	.10 - .11
China wood oil, in bbls. (f.o.b. Pac. coast).....	lb.	.12 - .12 1/2
Cocoonut oil, Ceylon grade, in bbls.....	lb.	.10 - .10 1/2
Cocoonut oil, Cochin grade, in bbls.....	lb.	.10 1/2 - .11 1/2
Corn oil, crude, in bbls.....	lb.	.08 1/2 - .08 1/2
Cottonseed oil, crude (f. o. b. mill).....	lb.	.06 1/2 - .06 1/2
Cottonseed oil, summer yellow.....	lb.	.08 1/2 - .09
Cottonseed oil, winter yellow.....	lb.	.09 1/2 -
Linseed oil, raw, ear lots (domestic).....	gal.	.73 - .74
Linseed oil, raw, tank cars (domestic).....	gal.	.67 - .68
Linseed oil, in 5-bbl lots (domestic).....	gal.	.75 - .76

Olive oil, Denatured.....	gal.	\$1.10	—	\$1.20
Palm, Lagos.....	lb.	.07	—	.07½
Palm, Niger.....	lb.	.05	—	.06
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.07	—	.07½
Peanut oil, refined, in bbls.....	lb.	.10	—	.10½
Rapeseed oil, refined in bbls.....	gal.	.86	—	.88
Rapeseed oil, blown, in bbls.....	gal.	.92	—	.94
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.08½	—	.....
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.06½	—	.....

FISH

Light pressed menhaden.....	gal.	\$0.40	—	.....
Yellow bleached menhaden.....	gal.	.42	—	.....
White bleached menhaden.....	gal.	.44	—	.....
Blown menhaden.....	gal.	.48	—	.....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$24.00	—	30.00
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	22.00	—	26.00
Barytes, crude, 88% @ 94% ba., Kings Creek.....	net ton	10.00	—	12.00
Barytes, floated, f.o.b. St. Louis.....	net ton	26.50	—	28.00
Barytes, crude, first grade, Missouri.....	net ton	7.00	—	.....
Blanc fixe, dry.....	lb.	.04	—	.04½
Blanc fixe, pulp.....	net ton	45.00	—	55.00
Casein.....	lb.	.06½	—	.07½
Chalk, Precipitated, domestic, extra light.....	lb.	.04½	—	.05
Chalk, Precipitated, domestic, light.....	lb.	.04	—	.04½
Chalk, Precipitated, domestic, heavy.....	lb.	.03½	—	.04
Chalk, Precipitated, English, extra light.....	lb.	.04½	—	.05
Chalk, Precipitated, English, light.....	lb.	.04½	—	.05
Chalk, Precipitated, English, dense.....	lb.	.04	—	.04½
China clay (kaolin) crude, f.o.b. mines, Georgia.....	net ton	6.50	—	8.50
China clay (kaolin) washed, f.o.b. Georgia.....	net ton	9.00	—	10.00
China clay (kaolin) powdered, f.o.b. Georgia.....	net ton	13.00	—	20.00
China clay (kaolin) crude f.o.b. Virginia points.....	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points.....	net ton	13.00	—	20.00
China clay (kaolin), imported, lump.....	net ton	12.00	—	20.00
China clay (kaolin), imported, powdered.....	net ton	25.00	—	30.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	net ton	5.00	—	7.50
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27.00	—	30.00
Fullers earth, f.o.b. Mines.....	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Pa.....	net ton	15.00	—	18.00
Fullers earth, powdered, f.o.b. Fla.....	net ton	18.00	—	.....
Fullers earth, imported, powdered.....	net ton	24.00	—	27.00
Graphite, Ceylon lump, first quality.....	lb.	.06	—	.07
Graphite, Ceylon chip.....	lb.	.04½	—	.05
Graphite, high grade amorphous crude.....	lb.	.00	—	.02½
Magnesite, calcined.....	net ton	66.00	—	70.00
Pumice stone, imported, lump.....	lb.	.03	—	.40
Pumice stone, domestic lump.....	lb.	.05	—	.05½
Pumice stone, ground.....	lb.	.06	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore.....	net ton	.....	—	10.00
Quartz (acid tower) 1½ @ 2 in., f.o.b. Baltimore.....	net ton	.....	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	.....	—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange fine.....	lb.	.52	—	.53
Shellac, orange superfine.....	lb.	.55	—	.56
Shellac, A. C. garnet.....	lb.	.44	—	.45
Shellac, T. N.....	lb.	.45	—	.46
Soapstone.....	ton	12.00	—	15.00
Sodium chloride.....	long ton	12.50	—	13.00
Talc, paper-making grades, f.o.b. Vermont.....	ton	11.00	—	18.00
Talc, roofing grades, f.o.b. Vermont.....	ton	8.50	—	13.00
Talc, rubber grades, f.o.b. Vermont.....	ton	11.00	—	18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	10.00	—	14.00
Talc, imported.....	ton	30.00	—	40.00
Talc, California talcum powder grade.....	ton	18.00	—	40.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	per ton	\$37.50—40.00		
Carborundum refractory brick, 9-in.	1,000	1,250.00		
Chrome brick, f.o.b. Eastern shipping points.....	net ton	60		
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in car lots, f.o.b. Eastern shipping points.....	net ton	30—32		
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	36—40		
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	30—35		
Magnesite brick, 9-in. straight.....	net ton	70		
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	77		
Magnesite brick, soaps and splits.....	net ton	98		
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	42—45		
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	46—50		
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	35—38		

Ferro-Alloys

All f.a.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00 — \$225.00		
Ferrochrome per lb. of Cr. contained, 6.8% carbon, carlots.....	lb.	.12 —		
Ferrochrome per lb. of Cr. contained, 4-6% carbon, carlots.....	lb.	.13 —		
Ferromanganese, 76-80% Mn, domestic.....	net ton	65.00 —	67.00	
Ferromanganese, 76-80% Mn, English.....	net ton	65.00 —	67.00	
Spiegelisen, 18-22% Mn.....	net ton	25.00 —	27.00	
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.50 —		
Ferrosilicon, 10-15%.....	net ton	40.00 —	42.00	
Ferrosilicon, 50%.....	net ton	65.00 —	68.00	
Ferrosilicon, 75%.....	net ton	135.00 —	138.00	
Ferrotungsten, 70-80%, per lb. of contained W.....	lb.	.40 —	.45	
Ferrouanium, 35-50% of U, per lb. of U content.....	lb.	6.00 —		
Ferrovandium, 30-40% per lb. of contained V.....	lb.	4.25 —	4.50	

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content.....	net ton	\$8.00 — \$10.00		
Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃	unit	.30 —	.33	
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard.....	unit	30 —	.33	
Coke, foundry, f.o.b. ovens.....	net ton	4.25 —	4.50	
Coke, furnace, f.o.b. ovens.....	net ton	3.00 —	3.25	
Coke, petroleum, refinery, Atlantic seaboard.....	net ton	14.00 —	15.00	
Fluorspar, lump, f.o.b. mines, New Mexico.....	net ton	12.50 —	.....	
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	20.00 —	22.00	
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01½ —	.01½	
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	.22 —	.....	
Manganese ore, chemical (MnO ₂).....	net ton	50.00 —	55.00	
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.55 —	.60	
Monazite, per unit of ThO ₂ , c.i.f. Atlantic seaport.....	unit	30.00 —	.....	
Pyrites, Spanish, fines, c.i.f. Atlantic seaport.....	unit	.12 —	.12	
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.12 —	.12	
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.11 —	.12	
Rutile, 95% TiO ₂ per lb. ore.....	lb.	.15 —	.....	
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	2.75 —	3.00	
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	3.00 —	3.25	
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	1.50 —	2.50	
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.25 —	2.50	
Vanadium pentoxide, 99%.....	lb.	12.00 —	14.00	
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1.00 —	.....	
Zircon, washed, iron free.....	lb.	.03 —	.....	

Non-Ferrous Metals

New York Markets

Cents per Lb.

Copper, electrolytic.....	12 00@12.25		
Aluminum, 98 to 99 per cent.....	24.5@25		
Antimony, wholesale lots, Chinese and Japanese.....	4½@4½		
Nickel, ordinary (ingot).....	41.00		
Nickel, electrolytic.....	44.00		
Monel metal, spot and bl. ebs.....	35.00		
Monel metal ingots.....	38.00		
Monel metal, sheet bars.....	40.00		
Tin, 5-ton lots, S.rai.....	27.00		
Lead, New York, spot.....	4.40		
Lead, E. St. Louis, spot.....	4.20@4.25		
Zinc, spot, New York.....	4.50@4.55		
Zinc, spot, E. St. Louis.....	4.15@4.20		

OTHER METALS

Silver (commercial).....	oz.	\$0.62½		
Cadmium.....	lb.	1.00—1.25		
Bismuth (500 lb. lots).....	lb.	1.50@1.55		
Cobalt.....	lb.	3.00@3.25		
Magnesium (f.o.b. Philadelphia).....	lb.	1.25		
Platinum.....	oz.	75.00@78.00		
Iridium.....	oz.	160.00@170.00		
Palladium.....	oz.	55.00—60.00		
Mercury.....	.75 lb.	43.50—45.00		

FINISHED METAL PRODUCTS

Warehouse Price

Cents per l.b.

Copper sheets, hot rolled.....	19 75@20.00		
Copper bottoms.....	27 25@27.50		
Copper rods.....	18.50@19.00		
High brass wire.....	16.75		
High brass rods.....	13.75		
Low brass wire.....	18.25		
Low brass rods.....	18.25		
Brazed brass tubing.....	27.00		
Brazed bronze tubing.....	31.75		
Seamless copper tubing.....	20.00		
Seamless high brass tubing.....	18.50		

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current	Cleveland	Chicago
Copper, heavy and crucible.....	9 00@ 9 25	9 25	9.50
Copper, heavy and wire.....	8 25@ 8 50	8 50	8.50
Copper, light and bottoms.....	7 00@ 7 25	7.50	7.25
Lead, heavy.....	3 00@ 3 25	3.25	3.25
Lead, tea.....	2 25@ 2 35	2.25	2.25
Brass, heavy.....	4 00@ 4 25	4.50	5.00
Brass, light.....	3 00@ 3 25	3.25	3.50
No. 1 yellow brass turnings.....	3 75@ 4 00	4.25	4.50
Zinc.....	2 00@ 2 25	2.00	2.25

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ½ in. and larger, and plates ½ in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes.....	\$2 18	\$3.00	\$3.00
8 ft steel bars.....	2 18	2.80	2.80
Soft steel bar shapes.....	2 18	2.90	2.90
Soft steel bands.....	2 50	3.20	3.20
Plates, ½ to 1 in. thick.....	2 18	3.00	3.00

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

BIRMINGHAM—The Birmingham Flour Mills, 803 American Trust Bldg., have awarded a contract to Earl Cline, 1205 North 17th St., for the construction of its proposed new flour mill, 50 x 150 ft., to be equipped for a daily output of about 1,000 bbl. J. O. Walker is president.

Connecticut

BRIDGEPORT, CONN.—Arrangements are being perfected for a merger between the Raybestos Co., with local plant, and the General Asbestos & Rubber Co., Charleston, S. C., under the last noted name. Both companies specialize in the manufacture of textile asbestos products, including brake linings, etc., and the assets of the consolidated company will total \$9615,000. In addition to its Bridgeport works, the Raybestos Co. also maintains plants at Stratford, Conn., and Peterboro, Ont. The new company will continue the operation of these different factories. C. Bissell Jenkins will be chairman of the board of directors of the new organization, and Sumner Simpson, president.

Delaware

MILTON—The Edgewater Flour Mills have been acquired by Wilson & Hazzard. The new owners will make a number of improvements in the plant and place the mill in operation at an early date.

Florida

JACKSONVILLE—The Tidewater Glass Co., recently organized with a capital of \$1,150,000, has acquired local property for the erection of a new plant for the manufacture of commercial glassware products, as milk bottles, jars, etc., utilizing local sand in connection with production. Two plant units will be constructed at the present time, estimated to cost about \$300,000, with daily output of about two carloads of material. The equipment installation will include glass furnaces, tanks, annealing ovens, air compressors and other power equipment, mold shops, and with department for box manufacture. The new company is headed by C. H. Dankworth, Bellaire, O., and F. W. Stewart, Pittsburgh, Pa. Local offices are care of B. R. Kessler, secretary Jacksonville Chamber of Commerce, who has been instrumental in securing a site for the new company.

MIAMI—The Hector Supply Co. has acquired a local building, formerly used by the Southern Utilities Co., and will remodel the structure for a new plant for the manufacture of fertilizer products.

JACKSONVILLE—William W. Sheppard and Harry Whittier, both of Jacksonville, are organizing a new company, capitalized at \$3,000,000, for the establishment of a new oil-refining and gasoline plant. The initial capacity will be about 2,000 bbl. of crude oil and 20,000 gal. of gasoline per day.

TAMPA—The Southern Bottle Mfg. Co., recently organized with a capital of \$1,500,000, has completed plans for the erection of its proposed new local plant, to be 60 x 150 ft. Construction will be commenced at an early date. I. F. Jones is president and R. L. Rundell secretary.

Georgia

MONTICELLO—The Farmers' Milling Co., recently organized, is planning for the construction of a new flour mill on local site, with initial daily output of about 60 bbl.

COLUMBUS—The Armour Fertilizer Co., 209 West Jackson Blvd., Chicago, Ill., is reported to be planning for the rebuilding of its fertilizer works at Columbus, destroyed by fire, Aug. 9, with loss estimated at close to \$300,000.

Louisiana

NEW ORLEANS—The Louisiana Colotex Co. has commenced production at its new

local mill, recently completed at a cost of \$500,000. The plant will be devoted to the manufacture of special board products made from bagasse, the refuse from sugar cane. The new plant is the first of a number of such mills the company proposes to construct in different parts of the state.

Maryland

BALTIMORE—The Cooknut Corp., Lexington and Paca Sts., Baltimore, has completed plans for its proposed new 4-story plant on Canton St., 88 x 100 ft., for the manufacture of hard substitutes and kindred products. It is estimated to cost \$125,000. Erection will be commenced at an early date. W. R. Spruill is head.

WESTPORT—The Spanish American Cork Products Co., recently organized with a capital of \$500,000, is planning for the establishment of a large plant at Westportman, for the manufacture of cork products. The company is headed by Walter V. Harrison and Philip S. Ball. Westport.

BALTIMORE—The Maryland Vegetable Oil Co., recently organized with a capital of \$1,000,000, will take over an existing local plant, recently completed at a cost said to be over \$500,000, for the manufacture of refined cottonseed oil and other oil products. Operations will be commenced at an early date. Enos Stockbridge and Roland H. Brady, Baltimore, head the company.

Massachusetts

CHELSEA—Fire, Aug. 23, destroyed a portion of the plant of the United Indigo & Chemical Co., with loss estimated at about \$125,000.

HAVERHILL—The Bay State Brick & Stone Co., recently organized with a capital of \$200,000, has construction under way on a new plant on the local river front for the manufacture of brick; it is proposed to make the plant one of the largest in this section. The company has acquired the plant and property of the Auburn Brick Co., West Auburn, Mass., and will remove the equipment to the new Haverhill works. George L. Baldwin, formerly manager of the Auburn plant, is president.

Michigan

GRAND RAPIDS—The Cross-Kramer Oil Co., recently organized with a capital of \$50,000, and now operating an oil-compounding plant at Chicago, Ill., is considering the establishment of a similar plant at Grand Rapids. Richard A. Cross is president, and Fred W. Kramer secretary.

Missouri

CAPE GIRARDEAU—The National Silica Mining Co. is planning for the development and operation of silica properties in this section. Plans for the proposed plant are being prepared by G. E. Doane, consulting engineer, Poplar Bluff, Mo.

New Jersey

NEWARK—Matthew Walsh, Brooklyn, N. Y., manufacturer of leather belting, has leased a 3-story building at the rear of 28 Orange St., Newark, totalling about 6,000 sq. ft., for the establishment of a new belting factory.

PERKINTOWN—Fire, Aug. 24, caused by an explosion, destroyed the powder plant of the Columbia Salvage Co., adjoining the Delaware Ordnance Reserve Depot of the War Department. An official estimate of the loss has not been made.

CAMDEN—The Lutz Co., Thirty-first St. and Grays Ferry Ave., Philadelphia, Pa., manufacturer of castings, machinery, etc., has commenced the erection of a 1-story addition to its foundry, 80 x 120 ft., on Hayes Ave. William Lutz is president.

New York

BROOKLYN—The H. D. Roosen Co., 78 Twentieth St., manufacturer of inks, has filed plans for the erection of a new 1-story plant, 38 x 95 ft., at 67-87 Twenty-first St., to cost about \$16,000.

MECHANICSVILLE—Fire, Aug. 22, caused by a boiler explosion destroyed a portion of the plant of the West Virginia Pulp & Paper Co., including boiler department, equipped with a battery of three high-pressure boilers. The amount of estimated loss has not been announced.

NEW YORK—The Sinclair & Valentine Co., 21 St. Clair Pl., manufacturer of lithographing inks has commenced excavations for its proposed new 3-story plant on Broadway, between 125th and 130th Sts. The Lustbader Co., 423 Madison Ave., has the building contract.

TONAWANDA—The J. Spaulding & Sons Co., Wheeler St., manufacturer of fiber products, has construction under way on its new plant addition, consisting of a number of buildings estimated to cost about \$125,000. The company plans for early occupancy and will increase its present working force from 175 to about 400 operatives as soon as the extensions are ready for service.

Ohio

GARRETTSVILLE—The McWade Rubber Co. has broken ground for the erection of a 2-story plant addition, 48 x 130 ft. The P. L. Frank Construction Co., Garrettsville, has the building contract.

DAYTON—The Refiners Oil Co., 315 South Main St., has awarded a contract to Frank Hill Smith, Inc., Winters National Bank, for the erection of a new 1-story works building on South Ludlow St., 106 x 144 ft. to cost about \$40,000.

COVENTRY—The Palmer Match Co., ninth floor, Second National Bank Bldg., Akron, O., recently organized, has preliminary plans under way for the erection of its proposed new match-manufacturing plant at Coventry, near Kenmore, estimated to cost close to \$1,000,000. Charles H. Palmer is president.

Oklahoma

TULSA—The Producers & Refiners Corp., is planning for the construction of a new oil refinery on local site, to utilize crude oil from the Salt Creek field.

Pennsylvania

PITTSBURGH—The Standard Sanitary Mfg. Co., Ontario St. and Preble Ave., manufacturer of burned clay sanitary wares, has filed plans for the construction of a 1-story works addition to cost about \$15,000.

PHILADELPHIA—The General Smelting Co., Stock Exchange Bldg., has taken bids for the erection of a new 1-story plant at Bath and Westmoreland Sts. Emile G. Parrot, 328 South Broad St., is architect.

PHILADELPHIA—The Atlantic Refining Co., Passyunk Ave., is reported to have plans under way for the rebuilding of the portion of its local refinery, destroyed by fire Aug. 14, with loss estimated at close to \$1,000,000. The loss included a number of large tanks, 3 pumping plants, works buildings, etc.

Rhode Island

EAST GREENWICH—The Warwick Chemical Co., recently organized with a capital of \$50,000, is planning for the establishment of a local plant for the manufacture of dyes and affiliated products. The company is headed by Samuel A. Olevson, Arctic, R. I., and John J. Clarke, West Warwick, R. I.

South Carolina

PROSPERITY—The Prosperity Oil Mill Co. is considering plans for the construction of a new flour mill on a local site. Estimates of cost and details of equipment installation are being arranged.

West Virginia

NITRO—The Viscose Co. of America, Marcus Hook, Pa., has acquired a portion of the former powder works of the Government at Nitro, comprising Area E, totalling about 52 acres of land, with a number of large buildings. Three of the structures will be used by the new owner for the manufacture of pulp from cotton linters, to be utilized at its artificial silk mills at Marcus Hook and Roanoke, Va. Work has been commenced on an addition to this latter plant to cost about \$1,000,000.

Texas

WAXAHACHIE—The Texas Oil Products Co. has construction under way on a new local oil-refining plant, estimated to cost about \$750,000.

MEXIA—The Golden State Refining Co. has acquired a local site and plans for the erection of a new oil refinery with initial output of about 6,000 bbl. a day.

New Companies

THE NOBLE COLOR WORKS, INC., Brooklyn, N. Y., has been incorporated with a capital of \$25,000, to manufacture colors, paints, inks, etc. The incorporators are P. Conforti and V. Malvani. The company is represented by Collin, Wells & Hughes, 120 Broadway.

THE WESTERN METAL PRODUCTS CORP., Joliet, Ill., has been incorporated with a capital of \$50,000, to manufacture metal goods. The incorporators are Alan A. Bakewell, Walter B. Stewart and Frederick A. Hill, 314 Barber Bldg.

THE HENRYETTE GLASS & MFG. CO., Henryette, Okla., has been incorporated with a capital of \$50,000, to manufacture glass products. The incorporators are J. Balison and H. L. Chambers, Henryette.

BEETLE-BARNES-BAKER, INC., Lynn, Mass., has been incorporated with a capital of \$30,000, to manufacture waxes, rubber cement and kindred products. Lorenz F. Muther is president and William R. Beetle, 362 Massachusetts Ave., treasurer.

THE ASBESTOS MATERIALS CORP., New York, N. Y., has been incorporated with a capital of \$400,000, to manufacture asbestos products. The incorporators are H. L. Delatour, H. Kaufman and J. Steinbrink. The company is represented by M. Steinbrink, 215 Montague St., Brooklyn.

THE WRIGHTSMAN OIL CO., Jersey City, N. J., has been incorporated with a capital of 5,000 shares of stock, no par value, to manufacture refined oil products. The incorporators are Charles J. Skinner and John R. Turner. The company is represented by the Corporation Trust Co., 15 Exchange Pl.

THE ELITE CHEMICAL CO., Nashville, Tenn., has been incorporated with a capital of \$10,000, to manufacture chemicals and chemical byproducts. The incorporators are E. B. Harper and Biscoe Griffith, Nashville.

THE CAMBRIDGE TANNING CO., Cambridge, Mass., has been incorporated with a capital of \$100,000, to manufacture leather products. Rishton T. Bailey, Massachusetts Ave. and Tannery St., is president and treasurer; Joseph J. Hurley is secretary.

THE VELVET SPECIALTY CO., 4708 Hastings St., Detroit, Mich., has been incorporated with a capital of \$25,000, to manufacture paints, oils, polishes, etc. The incorporators are Edward F. Callan, M. E. Jaynes and Thomas A. Jaynes, 5957 Stanton Ave.

THE SUPERIOR SMELTING & REFINING CO., Jersey City, N. J., has been organized under state laws to operate a metal smelting and refining plant. The company is headed by Godfrey A. Welter and Louis Friedman, 819 Jersey Ave.

THE FIBRE TIRE & RUBBER CO., New York, N. Y., has been incorporated with a capital of \$100,000, to manufacture fiber and rubber products of various kinds. The incorporators are M. N. Salamon, E. F. File and E. F. Stockle. The company is represented by C. Foley, 38 Park Row.

THE PRICE OIL CORP., Los Angeles, Cal., has been incorporated with a capital of \$1,000,000, to manufacture refined petroleum products. The incorporators are Harry Hirsh, M. Kantor and C. A. Kleinman. The company is represented by Joseph Crail, Union Oil Bldg.

THE UNION RUBBER CO., Calais, Me., has been incorporated with a capital of \$500,000, to manufacture rubber products. Charlotte L. Lello, Calais, is president and treasurer; Harold H. Murchie is secretary.

THE FRANK MILLER CO., New York, N. Y., has been incorporated with a capital of \$100,000, to manufacture leather dressings, dyes and affiliated products. The incorporators are Frank C. Miller, S. G. Martin and G. V. Hart. The company is represented by E. A. Kenney, 120 Broadway.

THE INDUSTRIAL PETROLEUM CORP., 14 East Jackson Blvd., Chicago, Ill., has been incorporated with a capital of \$25,000, to manufacture petroleum products. The incorporators are Samuel J. Lombard, Abner R. Allison and Thomas P. Collins.

FRASER & CO., Trenton, N. J., have been incorporated with a capital of \$50,000, to manufacture chemicals and chemical byproducts. The company is represented by Arthur W. Britton, 65 Cedar St., New York.

THE VERIBEST PRODUCTS, INC., New York, N. Y., has been incorporated with a capital of \$20,000, to manufacture chemicals, oils and kindred products. The incorporators are J. E. Morrell, L. F. Iverson and H. Grayer. The company is represented by J. C. Lewis, 247 Fifth Ave.

THE AVON MFG. CO., INC., Natick, Mass., has been incorporated with a capital of

\$25,000, to manufacture leather products. Lester F. Sargent is president and treasurer; Winfield Temple, High St., Westwood, Mass., is secretary.

THE PARAMOUNT DYESTUFF & CHEMICAL CO., Jersey City, N. J., has been incorporated with a capital of \$100,000, to manufacture chemicals, dyes and affiliated products. The incorporators are Maurice M. Reinhard, Francis J. Kremin and Maxwell Tischler. The company is represented by William M. Rysdyk, 76 Montgomery St.

THE NON TOX CHEMICAL CORP., Washington, D. C., has been incorporated under Delaware laws with a capital of \$300,000, to manufacture chemicals and chemical byproducts. The incorporators are Harry W. Bagby, Christie H. Fesler and Joseph J. Mawhinney, Washington. The company is represented by the Capitol Trust Co., Dover, Del.

THE B. ROBBINS CO., New York, N. Y., has been incorporated with a capital of \$12,000, to manufacture chemicals, chemical byproducts, etc. The incorporators are B. Robbins, H. D. Naum and J. Cohen. The company is represented by L. H. Robinson, 2 Rector St.

THE EXOLINE PRODUCTS & REFINING CO., 1924 Washington Blvd., Chicago, Ill., has been incorporated with a capital of \$200,000, to manufacture refined oils, gasoline, etc. The incorporators are D. M. Kelly, Henry F. Snyder and Frank Mooney.

THE SAND LIME PRODUCTS CO., Detroit, Mich., has been incorporated with a capital of \$50,000, to manufacture bricks and other sand lime products and byproducts. The incorporators are John Wyman, Harry W. Gould and Theron C. Taylor, 2436 West Grand Blvd.

THE COMMUNITY CUT GLASS CORP., Buffalo, N. Y., has been incorporated with a capital of \$100,000, to manufacture glass products. The incorporators are F. Schneider, J. H. Stoffel and F. J. O'Connor. Harding & Harding, attorneys, Buffalo, represent the company.

THE EMPIRE OIL CORP., Long Beach, Cal., has been incorporated with a capital of \$350,000, to manufacture petroleum products. The incorporators are J. D. Hawk, E. E. Bean and Charles R. Lewis, Long Beach. The company is represented by Louis N. Whealton, 206 Marine Bank Bldg.

THE KENYON BRICK & TILE CO., Oklahoma City, Okla., has been incorporated with a capital of \$125,000, to manufacture brick, tile and other burned clay products. The incorporators are W. A. Kenyon and David Oliver, Oklahoma City.

CARRIS & WATSON, INC., Newark, N. J., has been incorporated with a capital of \$50,000, to manufacture paper products. The incorporators are Milton Carris, Robert Watson and A. E. Jock. The company is represented by Michael Silver, 790 Broad St.

THE ALEXANIAN HOOPOE MFG. CO., South Bend, Ind., has been incorporated with a capital of \$10,000, to manufacture chemical products, cleaning compounds, etc. The incorporators are J. G. and M. G. Alexanian, South Bend.

THE DALFORD OIL REFINING CO., Wilmington, Del., has been incorporated with a capital of \$100,000,000, to manufacture refined oil products. The company is represented by the Corporation Trust Co., du Pont Bldg., Wilmington.

THE SIMPICI-T FOLDING BOX CO., Pawtucket, R. I., has been incorporated with a capital of \$25,000, to manufacture paper boxes and other containers. The incorporators are Daniel L. Baxter, Pawtucket; Howard R. Thayer, Cranston; and Hayward T. Parsons, Providence, R. I.

THE PERMA-COLOR-LITE PRODUCTS CORP., New York, N. Y., has been incorporated with a nominal capital of \$5,000, to manufacture enamels and kindred specialties. The incorporators are W. J. Snell, W. R. Respass and L. J. Smith. The company is represented by L. F. Stumpf, 233 Bway.

THE ANTHRACITE REFRACTORIES CO., Blakely, Pa., has been incorporated with a capital of \$150,000, to manufacture refractory products. D. J. Beardslee, Peckville, Pa., is treasurer.

THE EASY PRODUCTS MFG. CO., New York, N. Y., has been incorporated with a capital of \$50,000, to manufacture paints, varnishes, etc. The incorporators are W. J. Cook, J. H. and J. K. Barry. The company is represented by William M. Rysdyk, 76 Montgomery St., Jersey City, N. J.

THE NEW ENGLAND REFINING CO., Providence, R. I., has been incorporated with a capital of \$30,000, to manufacture refined oil products. The incorporators are William H. Butcher, E. C. Rohman and Lawrence J. Golden, 692 Summit Ave., Jersey City, N. J.

Capital Increases, Etc.

THE RADIUM LUMINOUS MATERIAL CORP., 58 Pine St., New York, N. Y., has filed notice of change of name to the United States Radium Corp.

THE CROWN OIL CO., Syracuse, N. Y., manufacturer of refined oils, has filed notice of increase in capital from \$150,000 to \$300,000.

THE CONTINENTAL CHEMICAL CORP., Watseka, Ill., has filed notice of increase in capital to \$25,000.

THE MIDDLETOWN RUBBER CO., Middletown, N. Y., has filed notice of increase in capital from \$1,000,000 to \$2,000,000.

THE AUDUBON CHEMICAL CO., a Delaware corporation, has filed notice of organization to operate in New York, with a capital of \$250,000. H. N. Bennett, 47 West Sixty-third St., New York, represents the company.

THE SCOBELL-MILLER CHEMICAL CO., Rochester, N. Y., has filed notice of change of name to the Scobell Chemical Co.

THE J. A. C. PRODUCTION CO., Danville, Ill., has filed notice of increase in capital from \$50,000 to \$400,000, at the same time changing its name to the Vermillion Oil Co.

THE UNIVERSAL TRANS-LEVER SPRING CO., Detroit, Mich., manufacturer of steel springs, etc., has filed notice of increase in capital from \$75,000 to \$250,000.

THE STANDARD DRUG & CHEMICAL CO., 817 North Ashland Ave., Chicago, Ill., has filed notice of increase in capital from \$10,000 to \$50,000.

Coming Meetings and Events

AMERICAN CERAMIC SOCIETY will hold its twenty-first annual meeting at St. Louis, Feb. 27 to March 2, 1922.

AMERICAN CHEMICAL SOCIETY, THE SOCIETY OF CHEMICAL INDUSTRY and the American Section of the latter society are holding a joint meeting in New York, Sept. 6 to 10.

AMERICAN GAS ASSOCIATION will hold its third annual convention in the Congress and Auditorium Hotels, Chicago, the week of Nov. 7.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in Lake Placid, N. Y., Sept. 29 and 30, and Oct. 1.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its annual winter meeting at Baltimore, Md., Dec. 6 to 9. Headquarters will be at the Southern Hotel and the sessions will be held in the Engineers' Club.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its fall meeting at Wilkes-Barre, Pa., Sept. 12 to 17.

AMERICAN MINING CONGRESS AND NATIONAL EXPOSITION OF MINES AND MINING EQUIPMENT will hold its twenty-fourth annual convention in the Coliseum, Chicago, Oct. 17 to 22.

AMERICAN PEAT SOCIETY will hold its fifteenth annual convention at the Hotel Commodore, New York City, Sept. 7, 8 and 9.

AMERICAN SOCIETY FOR STEEL TREATING will hold its third annual convention and exhibition Sept. 19 to 24 at Indianapolis.

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SEVENTH) will be held during the week of Sept. 12 in the Eighth Coast Artillery Armory, New York City.

NEW JERSEY CHEMICAL SOCIETY has discontinued meetings for the summer and will resume them in October.

SOCIETY OF INDUSTRIAL ENGINEERS will hold its fall meeting at Springfield, Mass., Oct. 5 to 7.

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY will hold its fall convention with the American Pulp and Paper Mill Superintendents' Association, at Washington, Philadelphia, Spring Grove, York, York Haven, Pa., and Wilmington, Del., Oct. 18 to 20.

The following meetings are scheduled to be held in Rumford Hall, the Chemists' Club, New York: Oct. 7—American Chemical Society, regular meeting; Oct. 14—Société de Chimie Industrielle, regular meeting; Oct. 21—Society of Chemical Industry, Grasselli Medal; Nov. 11—American Chemical Society (in charge), Society of Chemical Industry, American Electrochemical Society, Société de Chimie Industrielle, joint meeting; Nov. 18—American Electrochemical Society, regular meeting; Dec. 2—Society of Chemical Industry, regular meeting; Dec. 9—American Chemical Society, regular meeting.

CHEMICAL & METALLURGICAL ENGINEERING

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A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY and IRON & STEEL MAGAZINE

ALAN L. WIKOFF
S. M. BRIDE
CHARLES N. HILL, CRT
Associate Editor
CHESTER E. JONES
Associate Editor
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Associate Editor

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New York, September 14, 1921

Number 11

The Facts About American Dyes

THE other day we heard an estimable gentleman fulminating about dyes. He is a large wholesaler of cotton goods and he protested with vigor against this hullabaloo that is being made to keep German dyes out of the country while the very kind that is needed for his goods—to wit, vat dyes of the indanthrene type—are not made here.

We delivered a little reply about the anthracene base of most of them, told how pitch with the anthracene extracted does not seem available for roads and roofing, but that abroad, where pitch is largely used as a binder for coal briquets, the extraction of anthracene made no difference, but we felt that our reply was weak. Indeed it was weak, for we subsequently learned that there is plenty of anthracene available in this country but that manufacturers of dyes generally do not know how to use it. From what we can learn it appears that no American manufacturer has thus far succeeded in making, successfully and economically, a full line of the special type of vat dyes generally known by the German trade names of "indanthrene," "ciba" and "algol" colors. Their special use is for such cotton goods as shirtings. All the other colors with the exception of some of the related alizarines are made here in quantity and of standard quality. Vast amounts of indigo of supreme quality and a number of true alizarines of domestic manufacture are at hand as vat dyes. The only real hitch has been in those of the indanthrene type and we are assured that two American concerns are making a few indanthrene colors that are wholly up to standard and that they are producing them in quantity. The full line, however, has been "coming along" for five years, and experience teaches us to be conservative in waiting for them.

But why worry! *The very vat dyes which are needed are today being imported in large quantities under license!* There is no shortage of any kind of dye needed by American textile manufacturers, either in quantity or in quality. Not only the old dyes but even the new ones are available.

Then what is the trouble? We think it would have been better if the makers of dyes had been as frank in admitting their failures as they have been in telling their achievements, but this habit of frankness has not yet been incorporated into the *mores* of American industry. And it is not the cause of the present discontent. The discontent comes from improperly dyed goods. And why are improperly dyed goods offered for sale? The answer is the same as that given after mature thought by an old elder in the Bible class when the dominie asked him why GOD hardened PHARAOH'S heart. "He had," replied the elder, "various reasons."

Now among our various reasons is the cost of labor.

One dip costs less than several dips, and the high wages paid to dyers induce many textile manufacturers to take the shortest cuts to get results irrespective of quality. This, we believe, is a leading reason. Then, too, there used to be a nasty situation in dye houses in that dyers wanted bribes—and got them in profusion. They don't get them any more, and this may have a bearing. Again there used to be German competition, and the Germans are good dyers. There are just such good standards of quality on the market today, but the public does not know the trademarks. Sulphur black is plentiful and cheap, and no better sulphur blacks were ever made than are made by a number of American concerns. Plenty of dyers can and do apply it. But direct black, which does not hold so well in the wash, may be put on at less cost, and one pound of it will take the place of two or three of sulphur black. And here a new cause of trouble appears—drygoods pass through many hands before they reach the retail counter, and the converter who handles the goods may have little more than a cent a pound margin in the transaction. He therefore orders the material dyed at the lowest cost, and the cheapest goods win out with the buyers. So the fault is not alone with the dyer. A good part of the blame rests with the manufacturer, the converter, the jobber, the wholesaler and the retailer as well.

As for woolens and silks, there has been no shortage of any dye needed for years. Light, delicate shades never were fast to light, they are not now and there is no promise of their becoming so. But 1914 was seven years ago and people forget a great deal in seven years. One of the things they have forgotten is that such garments used to fade.

So we come back to the statement which we reaffirm—that every dye, the use of which has not been given up because of its defects, is available to the American dyer today. In addition to this there are a few new and better dyes to be had which were not procurable before the German war. Still more, American dyers are proficient in their art; not all of them, perhaps, but the proficient ones are here and they know how to get the best results obtainable. Improperly dyed goods are on the market and they are offered because there is more profit in them for somebody than there would be if the best that can be had were offered. If the statement is made that "We cannot guarantee these goods as to color because German dyes are not available," it is false. It is made either in ignorance or in cupidity. It may explain the price or the ignorance of the buyer, but it does not state a fact.

The American public buys on finish rather than on intrinsic quality. Whenever it demands quality and insists on it, it can have it. Duty-free dyes would not give us cheaper or better clothing. Duty-free textiles would, but do we want duty-free textiles?

Fundamental Conceptions

Underlying Metallurgical Advance

TECHNICAL literature and scientific transactions—at least as far as metallurgical science is concerned—seem now to be almost exclusively occupied with quality rather than quantity of output, with inquiry into hidden causes rather than exposition of their effects. One ton of metal of excellent properties, great reliability and endurance is apparently more interesting than 600 tons of ordinary stuff. Investigators are more interested in the one condenser tube which fails than the thousands which prove satisfactory in every way. Research men are borrowing the utmost resources of physics and chemistry to discover the mechanism of so common an occurrence as a breaking axle.

But are these investigations, these accounts of failures, these lists of physical properties, descriptions of laboratory manipulations, and speculations about things too small to be seen in the microscope, are these things of any real value to work-a-day life? Are they more than mere star gazing, not worth the paper they are printed upon?

Undoubtedly they are of value, if for no other reason (and there are many others) than that from them will emerge, some time, somehow, the idea whose development and wide application will be the mainspring of the next epochal movement in metallurgy. It would not be surprising if that idea has already been born!

It seems to be a fact that civilization moves forward in sharp rushes—advancing a certain detail very rapidly from a position which it had maintained for years, even centuries, to another position of advantage and apparent rest, only to be followed by a further striking advance on some other sector. Ancient Egypt furnishes an early example. Savants affirm that the Egyptians found something, no one now knows what it was, but they thought out some great idea, which in not more than a short century led that people forth from the place where they were barely able to range a few stones around their dwellings as rough boundaries or defences, to the pinnacle of skill in cutting, fitting, transporting and building huge blocks of granite into pyramids and sphinxes.

Last century it dawned upon some men in the iron trade that mechanical handling could be applied to metallurgical processes, and in twenty years JOHN FRITZ, HOLLEY, BROWN and WELLMAN (to mention but a few) led that remarkable "Duquesne Revolution" which increased the capacity of blast furnaces and steel mills one hundred-fold. We could build them bigger, but what's the use? They would lose flexibility, or rather adaptability, and be more than ever subject to intermittent operation, with consequent interest and overhead charges mounting to ruinous proportions.

So, it may be repeated, metallurgists have been for some years groping, somewhat haltingly, for the new idea which will carry them forward on the next advance. But has not the new conception already been dimly seen?—the realization that physical properties and reactions must be interpreted in terms of forces acting between atoms, even within the very structure of an atom.

How else can the field of alloying, stupendously great, almost uncharted, without apparent form, a tangle, be mapped out and comprehended? What else is common to such widely divergent things as hardest tool steel and softest lead, toughest copper and most brittle tungsten,

infusible calcium and liquid mercury, the corrosion of metal and the smelting of ore? Fundamental hypotheses and theories four-square with our ever widening knowledge of the atom itself are the only ones which will allow the tremendous mass of experimental information to be classified and truly understood, but, more important still, will enable one to predict with fair accuracy the expected result of a hopeful investigation—to steer a course which will lead to those new discoveries and valuable improvements which will form the milestones of civilization's advance.

Suggesting a New

Branch of Chemistry

WE HAVE so many kinds of chemistry—inorganic, organic, physical, colloid, photo and such a lot more—that it will scarcely do harm if we add still another division, and for this we propose the term Credulochemistry. It is published almost exclusively in daily newspapers, and is, in effect, chemistry that isn't so. A few years ago it flourished more actively than it does now, but we still have remarkable manifestations offered for study. A curious feature is that contributors to this amazing field of research are almost invariably wholly ignorant of science. They do not have to reason or think; they just make "expurments."

The latest step in credulochemistry we gather from the New York *Herald*, but it was also published as a news item in several other leading journals. This "special despatch" was dated Laporte, Ind., and it set forth the news that WALTER BUNTON, twenty-eight years old, a war veteran with a wound stripe, employed by the New York Blower Co., had discovered the "lost art" of hardening copper. This is a favorite stunt, and has been discovered so many times that it seems a pity that, after all the inventions, copper isn't really any harder than it is.

Mr. BUNTON of the Blower company seems, according to the report, to have had better luck. First he found an ash-can in which were some leaves of an encyclopædia which told of "an ancient metallurgist, incidentally a murderer, with whose death the secret of hardening copper was lost." Then he proceeded to experiment, and, presto! there was his metal which, according to the *Herald*, "is said to be the hardest metal known, except for one called 'Steelite,' (*sic*). It means cutting tools for lathes that will not strike sparks . . . electric motors and generators that will not burn out"—it means, in other words, an awful lot. Then he went to Gary, Ind., and saw Judge GARY, showing him his discovery, and he, as soon as BUNTON finished talking, said: "Name your terms."

(Now isn't that just like Judge GARY?)

BUNTON replied: "One million dollars . . . and two cents a pound royalty."

"We will let you know. Good day," answered the chairman of the board of the U. S. Steel Corporation, and on Friday, the paper says, "a letter came accepting the terms." The account closes with, "BUNTON is to be married in October." That gives it what they call on the stage "the heart interest."

Now the people at the Steel Corporation do not know anything about this great find and strategic purchase, and neither does anybody else as far as we can find out. It is merely an eruption of credulochemistry. A study of its origins would be interesting. But we wish they would stop hardening copper.

Russian Chemists And Organic Chemistry

IN A monograph on "The Chemistry of the Non-Benzene Hydrocarbons," by Dr. BENJAMIN T. BROOKS, which will soon be published, over half the citations refer to work by Russian chemists. We need to be reminded of the splendid work, the masterful research in chemistry, more particularly in the organic field, which was in progress in Russia when the German war began. Where are those men now? What are they doing? Have the Soviets put them to work sweeping streets because it required capital to prosecute chemistry and therefore the science itself is a phase of wicked capitalism? Where are IPATIER, KISHNER, MARKOWNIKOV, KANOWALOV, ELINSKY, BREDT, OSTROMUISTESENSKI, LEBEDEV and CHARITSEKOV? Where is P. WALDEN, who was here in 1912? The rubber industry is in a bad way, and research is the best cure for bad times. Wouldn't it be a good plan to send out a search party to find OSTROMUISTESENSKI? His contributions to the chemistry of rubber have been of high rank, and his splendid talent and understanding would be a godsend to the industry. If these men are not at work at their chosen calling it would be an investment of supreme value to find them and to provide opportunity for them. It is no reflection on American chemists to say that these Russians are needed. Talent is always needed in science, and men with a real vision of chemistry have to be born as well as made. We cannot induce the quality by fluttering a flag over their mothers' childbeds. The Germans thought they could and that chemistry was Kaiserlich-Königlich-Deutsch, but they found out their mistake. As soon as we begin to think that American chemists are the only pebbles on the beach, it will be sunset time with us.

Relations In Wage Rates

THE decision rendered last week by Judge LANDIS in the Chicago building trades dispute is interesting from several viewpoints. When first solicited to act in the matter Judge LANDIS refused to undertake to set wage rates as long as certain working conditions were allowed to continue. Various changes were then made in the rules, in the direction of efficiency, and Judge LANDIS consented to act in the matter of rates. It is well that the conditions making for waste in building operations in Chicago were thus emphasized and that some correction has been applied. There cannot be too much publicity given to the extravagant waste of time and wages that has characterized building operations in many centers.

In CHEMICAL & METALLURGICAL ENGINEERING of July 27, 1921, reference was made to statistics gathered by Dr. RALPH G. HURLIN, statistician of the Russell Sage Foundation, covering commodity prices and wage rates for a century or so. It was shown that from 1820 to 1910, while wages in general almost trebled, the wages of five selected classes of artisans ran quite uniformly at 80 per cent above the rate for common labor. In the past few months we have seen common labor receiving 25 to 30 cents an hour in many descriptions of work in various parts of the country, while artisans were demanding a dollar or more an hour. This brought up the question whether conditions had changed from those that ruled for perhaps a century or longer, so that skilled labor should now be worth more than for-

merly in terms of dollars in relation to common labor. Considerations that are obvious would suggest a contrary conclusion.

In this connection the award of Judge LANDIS is of particular interest. Eight of the skilled crafts involved will receive less than 85 cents an hour, while a few will receive a trifle more than a dollar. "Common labor" is evidently defined peculiarly in the Chicago building trades, for the reports show that Judge LANDIS has set at least four rates for different classes of common labor, 47½ cents, 50 cents, 70 cents and 72½ cents. A common labor rate of 50 cents and an average of 90 cents for skilled labor would show the 80 per cent relation of skilled over common labor that Dr. HURLIN's statistics indicate is worthy of much respect. A curious point is that the previous standards in Chicago were \$1 for common labor and \$1.25 for skilled labor, showing a 25 per cent premium for skill instead of 80 per cent. One experiences no difficulty in concluding that the wages were due to membership in unions and the restrictions that had been thrown about building operations. One could work this out by some very simple algebra, but it is not necessary to set down the equations. Take 31 cents for common labor and 56 cents for skilled labor, which makes the latter approximately 80 per cent above the former. Then add to each rate 69 cents an hour as the part played by the unions and one has \$1 for common labor and \$1.25 for skilled labor.

Salvage for The Wise Ones

There is a certain frame of mind to which a cemetery is, if not an antidote, at least an alleviation. If you are in a fit of the blues, go nowhere else.—Stevenson.

PATIENT men will amusedly tolerate the talk of the fellow in these days who propounds a philosophy of optimism unsupported by facts. The most imperturbable man, however, loses all control in the presence of the individual carrying the morbid mien in bad industrial weather and mounting fleecy clouds to air castles during periods of booming business.

Last year this latter chap vowed the sunny season would never end because it was upon us. It has taken a period of hard depression to convince him to the contrary until now he is just as certain that business will be bad for the next decade. The pitiful thing about the whole situation is that his type is in the majority and is found even in our so-called big business circles. Were the advice of STEVENSON taken seriously, the burying grounds of this country would have no standing room available.

Keen thinkers are not talking so much about the good times coming, but realizing that the worst has happened in many industries, are quietly preparing to reap a profit from the weak-hearted ones. Opportunely purchasing failing business enterprises, stocking up on materials and equipment at bargain prices and slowly building up organizations for the future harvest are all a part of their plans. Accumulating economic goods on a lowered tide, they will witness the same old spectacle of their ships coming in with the full flood of industrial prosperity and the graveyard artist, now become a horn-tooter, standing by anxious to purchase the cargoes at the highest figures.

The repetition of the sun-moon ocean tide is no more certain than the return of prosperity in the greatest creditor nation.



MEMBERS AND VISITORS, CANADIAN MEETING, SOCIETY OF CHEMICAL INDUSTRY

1—Dr. J. P. Longstaff, secretary of the society. 2—Dr. R. F. Ruttan, president of the society. 3—Sir William Pope, K.B.E., F.R.S., retiring president. 4—E. F. Smith, president of the American Chemical Society. 5—William H. Nichols, past president of

the American Chemical Society. 6—T. H. Wardleworth, vice-president of the Society of Chemical Industry. 7—C. S. Garland, A.R.C.Sc., chairman of Lighting Trades, Ltd., and vice-president of the Society of Chemical Industry.

Canadian Meeting, Society of Chemical Industry

Large Number of Delegates From Great Britain and Visitors From the United States Gather in Montreal and Later Experience the Hospitality of Various Sections of Canada—Dr. R. F. Ruttan Elected President—Summary of Papers Presented

THE extended tour of the delegates to the annual meeting of the Society of Chemical Industry was concluded on Sept. 7, and we give below a short summary of the principal events, of the papers and discussions and of other features in the itinerary. Photographs and particulars of the principal delegates have already appeared in these columns. Some were prevented at the last moment from attending, these including the Hon. Treasurer of the society, E. V. Evans, and Dr. MacWilliam, the well-known metallurgist of Sheffield. Additional members of the party are Peter Kerr, chemist to the Shell Mex interests, W. Gordon Adam, of the Gas Light & Coke Co., and Keith Benham, managing director of the Universal Grinding Wheel Co. of Stafford.

The passage on the "Melita" was uneventful and good weather enabled the ship to establish a record crossing of some hours under seven days to Quebec.

The delegates' reception at Quebec was of the most cordial and hospitable description, and it is really extraordinary how much the party was able to see of Canada in a very short space of time, thanks to the admirable arrangements which were made. Visits to Ste. Anne de Beaupré, the Golf Club, Kent House, Montmorency Falls and the battlefields constituted, with Sir George Garneau's dinner at the Garrison Club, the first day's program, while on Saturday the Lieutenant-Governor's luncheon at Spencerwood was a really notable occasion in the happiest of surroundings. In the afternoon the party left for the Manoir Richelieu, Point-a-Pic, Murray Bay, and the beautiful surroundings and invigorating atmosphere of this delightful resort did much to cement the intimate and cordial relationship which had already sprung up between the delegates and their Canadian hosts.

Incidentally, progress was made in arranging the following week's program and certain departures from a somewhat hidebound precedent were necessary in conducting a meeting of this kind in another continent.

The Annual Meeting

The annual meeting was held at McGill University on Aug. 29, and it was announced that more than 225 members of the society had registered at the Chemistry Building. In addition to the British visitors several notable American chemists were also present, including Dr. Edgar F. Smith, president of the American Chemical Society; Dr. C. H. Herty, and Dr. W. H. Nichols, president of the Allied Dye & Chemical Corporation. Theodore Wardleworth, the chairman, called on the Rt. Hon. Sir Charles Fitzpatrick, K.C.M.C., Lieutenant-Governor of the Province of Quebec, who extended a hearty welcome and a personal message of good will from the Prime Minister of the Dominion. Sir Charles eulogized the work that the members of the society had done during the war and expressed the hope that the same high ideals would animate them in their reconstruction tasks.

At the request of the Canadian Section, and of its three branches, the Section has been dissolved and separate sections have been established at Montreal, Ottawa and Toronto. A new section has also been formed at Shawinigan Falls, so that the society has now five Canadian sections—namely, at Vancouver and at the four centers above mentioned. There has been formed an executive committee for Canada, consisting of the chairmen and secretaries of the five sections, to arrange for the annual convention of chemists and to take charge of matters affecting the Canadian chemical industry.

A conference on the standardization of chemical plant was held at the Institution of Civil Engineers in July, 1920. It was attended by representatives of government departments and of scientific bodies interested, including the Society of Chemical Industry. It was unanimously recommended that a Chemical Engineering Committee of the British Engineering Standards Association should be set up, and this was subsequently approved. The representatives of the society on this committee are Prof. Hinchley, Capt. Goodwin, Mr. Reavell, Mr. Garland and Dr. Ormandy.



1—Group of some of the party on S. S. Melita.
2—Chief Justice William H. Taft at Murray Bay.
3—Dr. R. F. Ruttan, Chief Justice Taft, Sir William Pope.

4—Dr. R. F. Ruttan, president Society of Chemical Industry
5—Sir William Pope, retiring president of the society.
6—Dr. J. P. Longstaff, secretary of the society.

President's Address

Sir William Pope, the retiring president, brought out forcibly the good effects resulting from the co-operation of all the peoples of the British Empire and dwelt especially on the part played by the great Dominion of Canada. He then outlined the wide field covered by the society, and after mentioning that the society's financial status is now quite satisfactory and that great strides are made by the Council and publication committee to broaden the scope of the *Journal of the Society of Chemical Industry*, he spoke with enthusiasm about the great problems now confronting the British chemical industry. He said in part:

"Seven years ago the situation and the outlook in all branches of scientific industry were very different from those which now confront us. In 1914, certain of the chemical industries of Great Britain were expanding slowly but steadily, while others were slowly but just as surely shrinking before foreign competition; in some of the chemical industries Great Britain was supreme, but in others we were losing ground. The interval has seen the commencement and the conclusion of a great conflict, a war which has reduced to mediocrity several of the dominant European powers, and has left nearly every nation struggling under an accumulation of debt.

"The problem now is an entirely novel one in that it is accompanied by certain factors which were previously absent or which were at any rate of subsidiary importance. Thus it cannot be doubted that the bonds uniting all parts of the British Empire have become far stronger in consequence of the events of recent years; further we realize to a greater extent than ever before that for purposes of production our empire must be, if not absolutely self-contained, at least in possession of modes which could be rapidly mobilized so as to render us self-contained.

"In the past we have, I venture to think, endeavored to build up our chemical industries far too much on the lines which proved so fruitful in Germany. I am

speaking now not of the heavy chemical industry, in which we have always been to the fore, but of those industries which involve the production of the use of a great variety of more or less complex organic compounds. The organic chemist has long had before him, as one great object of his work, the artificial production of the myriads of organic compounds which we find among animal and vegetable products; he may be justly proud of his achievements in this direction and the success attained justifies our belief that we shall within quite a short time be able to prepare in the laboratory any compound substance formed by the animal or plant. Immediately some important natural product of commercial value is produced in the laboratory, the German technologist has sought to convert the laboratory method into a works process capable of competing with that of the plant or animal.

"My point in suggesting that we have erred in adopting German views concerning the methods and aims of chemical technology, without reflecting that economic conditions in Central Europe are entirely different from those which prevail in the British Empire regarded as a whole, perhaps calls for some explanation. The object of all technology consists in converting raw materials of inorganic origin into products of greater value by expending upon them a certain amount of labor, and a certain amount of energy. To a Central European nation labor means high wages to its population and energy means mainly coal or waterpower; only one type of technological process is thus in the main to be considered, and this is one in which certain raw materials enter the works to be handled by costly labor and to be treated by the burning of fuel, which is another form of costly labor.

"We have other methods for obtaining similar results, methods which are available in many cases but have been worked out in only a few cases."

He cited the specific example of the synthetic india rubber made in Germany as compared with the natural

product from the plantations in the British territory and added:

"It would not be fair to depreciate the installation of synthetic methods for manufacturing complex natural products. Nature in general furnishes us with but one very complex member of any particular class of organic compounds. Thus the numerous plants which produce indigo yield but minute proportions of other compounds of a similar type and, in this instance, the chemical technologist has succeeded in manufacturing a whole range of valuable dyestuffs of the indigo family which do not occur among vegetable products; his efforts have to this extent been amply justified, but it is difficult to believe that synthetic indigo itself would ever have been able to compete in the market if a similar amount of scientific skill and intelligence had been devoted to the improvement of the cultivation and utilization of the indigo plant. The work which is now being done by Armstrong, Davis and others on natural indigo may well result in the re-establishment of the Indian indigo plantations.

APPLICATION OF LOW POTENTIAL ENERGY

"The last century has witnessed two great phases in the development of practical chemical work. Roughly speaking, it may be said that the progress of chemistry up to about forty years ago, great though that progress was, resulted from the application of rather fierce methods; a time came, however, when it was recognized that much was to be learnt, especially in organic chemistry, by the study of delicately balanced reactions in which the practical methods applied were devoid of violence and in which conditions, such as concentrations, temperatures and the like, were carefully controlled. The organic chemistry of to-day does not distill fragile organic compounds through red-hot tubes; it proceeds by more subtle methods which, nevertheless, have greatly developed the broad knowledge of the science bequeathed to us by our predecessors. In its adoption of milder modes of operating and its consequent application of energy at a low potential, organic chemistry is approximating in its laboratory methods to those which occur in plants and animals; but the chemical changes which occur during the course of animal or vegetable life are still far more complex than those brought about in the laboratory. This complexity doubtless arises from the utilization of low potential energy in the living organism; temperature changes of more than 1 deg. C. are not permissible in the healthy animal organism. The great majority of the chemical reactions which take place in living matter occur catalytically in colloidal media.

"While the first great epoch in the history of organic chemistry was marked by the application of violent experimental methods, the second developed milder modes of procedure; the third epoch, which is in course of inauguration, will bring us into direct competition with the experimental chemical methods practiced by living matter. It is impossible to doubt that a vast expansion of organic chemistry will be witnessed by many of us, an expansion which will result from an imitation of the gently effected chemical operations carried out in the animal and vegetable creation.

"While this prophecy is not a mere surmise as to the nature of the next step forward to be taken by the science of organic chemistry, but is rather of the nature of a logical deduction from past events, it is perhaps surprising that more use has not been made

of the chemical methods of living matter for technological purposes."

He then directed attention to the fact that up to the present far too little progress has been made in the direction of combating the different types of parasitic vegetable and animal life, and finally spoke on the pressing need of a better use of the petroleum resources.

In moving a vote of thanks to the president, Dr. R. F. Ruttan, in a happy speech, referred to the progress made in the application of biochemistry to industry in recent times, instancing the Weizmann and Fernbach processes of starch fermentation for the production of acetone and the successful way in which these and the synthetic production from acetylene had been carried through at Shawinigan Falls.

OFFICERS ELECTED, LUNCHEONS AND BANQUET

The remainder of the business was of a purely formal character and a luncheon followed at the Ritz-Carlton Hotel under the chairmanship of Dr. Milton Hersey, at which a civic welcome was extended by Dr. Dubeau on behalf of the Mayor of Montreal.

On the following day H. W. Matheson of the Shawinigan Company presided over a luncheon at the Windsor Hotel at which Sir F. Williams-Taylor was the guest of honor. Sir William Pope took the opportunity of addressing the members of Rotary Club of Montreal at the same time and gave them a digest of his writings on the future of gas warfare and its relative merits and efficiency as against other forms of destruction. The banquet took place at the Engineers' Club.

The officers elected are: President, Dr. R. F. Ruttan; vice-presidents, Dr. J. L. Barker, C. S. Garland and Sir William Pope; members of the Council, H. Allan, F. Armstrong, J. W. Hinchley and J. D. Wilcock.

Technical Sessions

At the technical sessions papers were presented by speakers prominent in their various lines.

NEED FOR REFORM IN THE EDUCATION OF CHEMISTS

Prof. Lash Miller, speaking on the need for reform in the education of chemists, pointed out that far more students were taking up chemistry than were dreamed of a few years ago. The training given them is the same today as it was when chemistry was a purely experimental science. There is need for reform of chemical language, to make terms and formulas mean something to the students learning them.

THE LAURENTIDE HIGH-SPEED NEWS MACHINE

A paper on the Laurentide high-speed news machine, by George D. Kilberry, was read by J. L. Stephenson.

The new 166-in. news machines installed in the Laurentine Company's mill at Grand Mere, Que., probably represent the very best effort heretofore applied to the design and construction of news machines, and the recent results obtained amply justify the Laurentide Company in believing that it has reached the goal selected—namely, marketable paper at 1,000 ft. per minute or better as a continuous operation.

These machines embody no new principle in paper making, but have some features of design not common to most machines, chiefly the method of putting on new wires, the application of suction couch and suction press rolls, the novel arrangement of compressed air jets for passing the tail or ribbon of paper from couch to press and between the presses as well as at the

calenders and reel and a very generous use of ball bearings at the wet end of the machine.

The fourdrinier part of the machines is constructed without the usual shaking arrangement, as it has been demonstrated that there is no more need for shake on a news machine than five wheels on an automobile.

THE ACTION OF THIOCYANATES ON CELLULOSE

R. H. Clayton read a very important paper on "The Action of Thiocyanates on Cellulose" by R. H. Clayton and H. E. Williams. The contention of their paper is that solvents for cellulose must have the following specific properties:

1. High solubility in water.
2. High boiling point in concentrated solution.
3. Suitable viscosity and of a positive, but not too great, heat of dilution.
4. Mixed salts not to react chemically.

Diagrams showing the correct conditions were shown and explained.

Of all the cellulose solvents examined, calcium thiocyanate is the most suitable; it has the further advantage of being derived from a cheap base, and hence has been most considered from the industrial standpoint.

Following the discussion on this paper a moving picture of the manufacture of paper showing the complete operation from the tree in the forest to the roll of finished paper leaving the mill was presented by A. L. Dawe, secretary of the Pulp and Paper Association. This film depicted the operation at Price Bros.' plant, Kenogami, Que., and is considered one of the finest industrial films that has ever been taken.

PROPERTIES OF PURE HYDROGEN PEROXIDE

Dr. O. Maass' address dealt with the preparation and properties of 100 per cent peroxide, a research carried out at McGill University.

Hydrogen peroxide is the name commonly applied to an article which may be procured in any drug store, but this really consists of a 3 per cent aqueous solution which generally contains as well inorganic salts, a little acid and other impurities. The water and other impurities are removed in three stages. The first consists of a vacuum concentration and distillation to a 35 per cent pure aqueous solution, this is then concentrated to a 90 per cent solution and the latter subjected to fractional crystallization on the end product of which is the 100 per cent. Special apparatus was designed for this work, including a sulphuric acid pump, which alone made it possible to obtain large yields. Strong solutions of hydrogen peroxide were prepared in the past and were reputed as being highly explosive and several serious accidents are recorded. This instability is due to the presence of impurities. Pure acid-free hydrogen peroxide is not explosive.

OBSERVATIONS ON THE CHEMISTRY OF RUBBER

In "Some Observations on the Chemistry of Rubber" Prof. G. S. Whitby touched on a variety of points of interest in the researches which he and his co-workers have recently conducted at McGill University into the chemistry of raw rubber and the vulcanization of rubber. He described an investigation of the resin of rubber, which represents the first successful attempt to elucidate in some degree the problem of the chemical nature of a constituent of raw rubber which, although present in only a small proportion, has an important influence on the behavior of the rubber when the latter

is vulcanized and in other ways. Dr. Whitby's investigations show that a considerable number of crystalline substances can be isolated in small amounts from raw rubber. One of these substances is an interesting sugar-like body, which was known to occur in rubber latex but the presence of which in prepared rubber was unexpected, on account of its great solubility in water.

Experiments were described on the artificial conversion of rubber into a resin as a result of the absorption of oxygen from the air under the influence of catalysts. One mode of carrying out this conversion which Dr. Whitby has worked out may lead to the production of lacs or varnishes from rubber. The study of this conversion is also of importance because of its relation to the "perishing" of rubber goods.

MANUFACTURE, PROPERTIES AND EMPLOYMENT OF HEAT-INTERCEPTING GLASSES

Prof. Celert Alleman in introducing the subject of heat-intercepting glasses described how silver nitrate when exposed to the action of light passing through ordinary glass is discolored, while if placed in a container of special glass no change is noticed. Similarly smoked bulb thermometers exposed under the same conditions will record different temperatures, that in which the ordinary glass is used showing a higher temperature than that protected by the special glass.

Sir William Crookes was the first to investigate glass with the object of securing a spectacle glass which would protect the eyes from heat and ultra-violet rays and reduce glare. He concluded that cerium salts were most effective in this way and black mica added to the melt produced a glass which almost completely obstructed the invisible heat rays.

About five years ago Mr. Sherman, then chief chemist of the Pennsylvania Wire Glass Co., conducted 227 experiments using various mixtures and confirmed Crookes' work and produced a more brilliant glass by a slight manipulation of the furnace temperature. This material is now a commercial product known as actinic or heat-intercepting glass, manufactured into plate polish, plate wire, plate proof wire, aqueduct wire, ribbed wire and corrugated wire glass.

These different types were described, emphasis being laid upon the importance of annealing. An instance was given of the resistance of the corrugated wire glass to shock. A 2½-in. steel smokestack 24 in. in diameter and 25 ft. in length fell in a severe windstorm on the corrugated wire glass roof of a large boiler house. While two plates were destroyed and the remainder of the glass cracked or bent, it was not shattered and did not leak, although the steel beams on which the glass rested were bent out of line about 3 in.

Tables were shown covering tests made on houses erected of the various types of heat-intercepting glass showing the marked difference between the temperatures inside and outside the house and also showing the high percentage of light transmitted, the lowest being 72 per cent.

PREPARATION OF SYNTHETIC ORGANIC CHEMICALS

In dealing with "The Preparation of Synthetic Organic Chemicals at Rochester," Dr. C. E. K. Mees first took up the status of chemistry of the present day as compared to that of ten years ago, emphasizing the need of research and its co-operation with industry.

Before 1914 the supply of synthetic organic chemicals was entirely in the hands of one or two firms in Ger-

many. With the outbreak of hostilities, this supply was cut off and the effect was soon felt. Many researches had to be abandoned. Prof. C. G. Derick of University of Illinois met the situation by inviting the most promising students to work during vacation on those organic compounds most needed. This was a unique step, the reactions being conducted on a scale unusual in research work. As it was very evident that the supply of organic chemicals was inadequate, the Eastman Kodak Co. in 1918 decided to enter the field, having no prospect of immediate profit. The work undertaken was: 1. Synthesis of compounds which are not prepared technically but are required for laboratory purposes. 2. Purification of technical materials got from chemical manufacturers. 3. Distribution of such technical chemicals in form in which purchased.

Raw materials were obtained largely from dye, dye intermediate, perfumery, explosives and pharmaceutical chemical manufacturers, also from individuals in university and other laboratories. The chemicals produced are classified under: 1. The Eastman chemicals (highest possible purity). 2. The practical chemicals (purity sufficient for synthesis). 3. Technical products (as from large scale manufacturers).

BRIQUETTING OF LIGNITES

Leslie R. Thomson described the work that has been done on lignite briquetting by the Lignite Utilization Board of Canada since its inception in October, 1918, and illustrated his paper with a number of diagrams, drawings and tables of results.

The Provinces of Manitoba and Saskatchewan are largely dependent upon American anthracite coal for domestic heating purposes and during the years preceding the war about 500,000 tons was annually imported. The price of this imported coal naturally increased as one went westward owing to the higher freight charges. It continued to find a market until the price went so high that the consumers were willing to put up with the disadvantages of the much cheaper Alberta coals. This "peak" line runs in a general north and south direction through the eastern part of Saskatchewan. Directly beneath this area, however, there are very large deposits of rather low-grade lignites, which, after carbonizing and briquetting, are capable of being converted into a fuel of high calorific value.

The Lignite Utilization Board was therefore established by the Canadian Honorary Advisory Council for Scientific Research to attack this problem and if possible to demonstrate the feasibility of producing a satisfactory domestic fuel from these lignites by the method of carbonizing and briquetting. After preliminary experiments at the Fuel Testing Laboratory of the Department of Mines, Ottawa, into various phases of the methods to be adopted, a plant was designed and erected at Bienfait, Sask., to have a capacity of 100 tons of briquets per day and has just been put into operation.

At this plant the lignite is first carbonized by heating to a low temperature in order to drive off the more volatile portion and the residue is mixed with a coal-tar pitch binder under suitable control, and after grinding together the mixture is pressed into briquets in a roll press. The briquets weigh about 2 oz. each and are egg shaped. The summarized results are:

1. It has been possible to make a first-quality commercial fuel briquet from carbonized lignite using any one of such binders as coal-tar pitch, petroleum pitch,

hardwood tar pitch, sulphite liquor pitch, or by using combinations of them.

2. The quantity of binder required is much in excess of that necessary to make a correspondingly good briquet from anthracite fines.

3. A waterproof briquet of carbonized lignite cannot be made using sulphite pitch as a single binder unless the briquets are heat-treated subsequently.

4. The choice of binder does not rest so much with the technical difficulties involved in its use, but with the economic supply of that particular binder. In other words, the Lignite Board has succeeded in making good briquets from many binders.

THE RECOVERY OF PEAT BY AIR-DRYING

Dr. Ernest V. Moore in his paper on "The Recovery of Peat by Air-Drying" described a practical method of turning raw peat into a product of economic value. Peat is a combustible substance produced by slow decomposition of vegetable matter and occurs saturated with water in peat bogs typical of the Northern Hemisphere. To transform raw peat into combustible material it is necessary to reduce its water content of 90 or 95 per cent to about 30 per cent. Drying is effected best by evaporation in the open air.

Great difficulties of collecting peat are overcome by gathering it with a combined excavator and macerator which is supported on caterpillar-tread carrying elements—a device more useful than rails on a soft peat bog. The raw peat is carried by a belt conveyor from the macerator to adjoining higher land, where it is spread from 3 to 6 in. thick on the ground, cut into blocks and allowed to dry in the sun. The blocks are turned to insure uniform drying, and in from 30 to 40 days the moisture content drops to 30 per cent and the peat is ready for domestic use or even for some industrial uses—especially drying operations where a very clean fuel is necessary. Though air-dried peat has twice the volume of an equal weight of coal, Dr. Moore declared that the average householder would gain by replacing 20 per cent of his anthracite pound for pound with air-dried peat.

THE ACTIVATION OF CARBON

Prof. E. G. R. Ardagh in presenting his paper on "Activated Carbon" pointed out that of all the so-called common elements carbon appears to possess greater possibilities both to the investigator in pure science and the researcher in the industrial field.

The paper dealt with amorphous carbon, more especially with its power of absorbing colors from liquids and gases, a phenomenon generally known as adsorption. The progress that has been made in this field is shown to be very considerable particularly during the last ten years. Carbons are today being manufactured that are replacing to some extent fullers earth as a decolorizing and dechlorizing substance in certain industries, and it is not too much to hope that in the not distant future a carbon sufficiently active as a color remover may be produced at a price to supplant bone black in the manufacture of sugar and syrups.

The work of Dr. N. K. Chaney of the U. S. Chemical Warfare Service has thrown an entirely new light on the causes of activity in carbon. Basing its work on Chaney's hypothesis the Chemical Warfare Service of the U. S. was able to produce absorbents for gas mask canisters that were greatly superior to any the enemy were able to make.

Other Entertainment

One of the most interesting functions was that held on the third day of the meeting in Montreal, when an inspiring address was delivered after luncheon by Jacques Bureau, M.P. for Three Rivers, in which district the Shawinigan industries are situated. In pleading for the elimination of waste Mr. Bureau paid tribute to the work of scientists in connection with the pulp and paper industries, which in the St. Maurice Valley alone represented an investment of about \$150,000,000.

"ANCIENT ORDER OF TRISMEGISTIANS" ORGANIZED

On the evening of Aug. 31 the overseas delegates entertained their hosts to a dinner of the "Ancient Order of Trismegistians," which had been formed for the occasion and the rites in connection with which were of a novel and amusing description. The ritual included the presentation to Dr. R. F. Ruttan of a "piece of plate" and of an "illuminated address." The former consisted of a fragment of a dinner plate in a handsome case and the latter was a card mounted in a silver frame illuminated for the occasion by an electric torch and bearing the inscription "Dr. R. F. Ruttan, Society of Comical Industry, Sensible House, Fairand Square, London." As is customary in the Ancient Order, Dr. Ruttan had to give a song when returning the thanks, and these and other entertaining items contributed to a happy and thoroughly enjoyable evening, punctuated by Sir William Pope's usual dry humor.

Visits to Other Sections and Works

Prior to the annual meeting proper the overseas delegates spent some days in Montreal visiting works, such as the St. Lawrence Sugar Refinery, the Gillette Razor Co., the Laval University of Montreal, and similar institutions. They were also the guests of the Harbor Commissioners, who took them for a trip around the harbor in a steam yacht. Frederick W. Cowie, the chief engineer, and Mr. Ross were the hosts at the luncheon given on board, which proved so enjoyable that when it was over the visitors found that they had returned to the spot from which the boat had started, so that the latter was really the one that did the sight-seeing. Several of the visitors were subsequently solaced by a personally conducted tour on land over the grain elevators, warehouses, cold storage buildings and other developments now in process of construction at Montreal Harbor.

On leaving Montreal a whole day was spent at the Laurentide Company's Paper Mills at Grand Mère and in going over the extensive electrochemical industries at Shawinigan Falls, where a section of the Society of Chemical Industry has just been established. Following this, entertainments on a lavish scale were successively provided by the Ottawa and Toronto sections, the visitors being continuously cared for during this period on special sleeping cars. A rough crossing over Lake Ontario preceded their arrival at Niagara Falls, where on Sept. 5 they were officially received by an American delegation including General Kincaid, representing the Governor of New York State; Dr. W. H. Nichols, A. H. Hooker, and the presidents of the American Chemical Society, the American Institute of Chemical Engineers and the American Electrochemical Society. Dinner was served at the Buffalo University Club and in the happiest of surroundings the visitors greatly appreciated their first introduction to American banquet procedure.

The visit to Syracuse, where the plant of the Solvay Process Co. was visited, proved of great interest and the visitors were informed that an inspection by members of learned societies and by industrial chemists was without precedent at these works. In view of the subsequent announcement made by Dr. Nichols that the problem of manufacturing synthetic ammonia had now been completely solved at these works, it is unfortunate that it was not possible to inspect the nitrogen products section. But instead a few of the visitors were able to spend some time in the works of the Franklin Motor Car Co. and to take with them some idea of modern American methods in this important industry.

The general impression among the visitors is that the convention will do an immense amount of good to the status and influence of the Society of Chemical Industry. It has not only been a liberal education to its officials, but all members of the party have learned that it is only by a personal visit to the American Continent that the essential differences in outlook between English and American chemists can be harmonized, such divergences being in the relative size of organization. Thus it is doubtful whether any member of the party had previously realized that Canada's fundamental difficulty and source of her partial dependence upon the United States is the location of her coal fields at the eastern and western extremities, while the intervening districts must largely be supplied with fuel from Pennsylvania, etc., until such time as peat or other fuel developments can partly relieve the situation.

DR. RUTTAN WISE SELECTION AS PRESIDENT

On the personal side there is no doubt that Dr. Ruttan was an eminently wise and suitable selection for the office of president as well as an intensely popular one. He can be relied upon not only to represent the academic but also the industrial and chemical engineering interests of the many different countries over which the society wields its influence. Mention should also be made of the new vice-president, C. S. Garland, managing director of Lighting Trades, Ltd., a constituent of Nobel Industries. Like so many really busy men, Mr. Garland finds time for the development, organization and welfare not only of the chemical industry but of the younger generation of chemists, while for the society his business capacity has been a great asset. Mr. Clayton, Mr. Heap and Dr. Attack represent the manufacturing interests, from which a far larger number of representatives should undoubtedly have attended. Mr. Alliot represents the chemical plant interest and Dr. Jordan is chemical engineer to the British Xylonite Co. Consulting chemical engineers are represented by Capt. C. J. Goodwin of London, whose work in this country and abroad is well known and who is also the official delegate of the Chemical Engineering Group and of the Chemical Industry Club.

NEW SPIRIT OF CO-OPERATION AND PROGRESS

In the past the Society of Chemical Industry has often been held to be an ultraconservative institution, yielding slowly to public opinion, progress and publicity. There are many indications that a new spirit is abroad, and although the number of visitors is small, every one of them will return as a missionary preaching not only the broad principles of progress suitably modified to suit local conditions, but also that spirit of co-operation and personal friendship which the present memorable trip has done so much to foster.

Further Observations on p_H in Natural Waters

Factors Affecting the Hydrogen-Ion Concentration of Natural Waters—Influence of Hydrogen-Ion Concentration on the Removal of Bacteria and Suspended Matter by Filtration, and on the Processes of Disinfection With Chlorine or Its Derivatives

BY ABEL WOLMAN* AND FRANK HANNAN†

IN AN earlier publication¹ by the present authors the theoretical aspects of the influence of p_H on the precipitation of aluminum salts in water were discussed at some length. Since that time it has been possible to accumulate a considerable number of p_H readings on a natural water, the consideration of which should be of interest. The field of knowledge of H-ion concentration is being so diligently explored in all directions, particularly in this country, that it would be a gigantic if not an impossible task to enumerate pertinent references in current literature. It would therefore certainly be invidious to make any selection. However, to any who follow even in a general manner the trend of progress in this field such names as Loeb, Clark and Lubs, Michaelis and Bechhold will offer ample opportunity for intensive study.

In the present discussion it is the intention of the authors to sketch briefly the preliminary conclusions resulting from p_H observations during the past eleven months in a natural water. At the same time the opportunity will be taken to suggest the particular and general significance of such p_H readings as now appear probable.

FACTORS CONTROLLING p_H IN WATER

At this point it may be proper to recall the primary factors which govern the H-ion concentration of waters. These have been set forth in considerable detail and with admirable clearness by Johnston² and Stieglitz³ in the papers noted in the bibliography below. Their conclusions are summarized in strikingly clear form by Bjerrum and Gjaldbaek⁴ in the expression $[H^+] = K\sqrt{P \times [Ca^{++}]}$. This formula holds for all waters which are at one and the same time in equilibrium both with calcite and with the partial pressure P of CO_2 in the atmosphere. Collins⁵ has shown that this is the case approximately with the majority of our natural waters. In those waters which are not yet in equilibrium the general trend is in that direction. In the remarks to follow we shall confine ourselves to the consideration of those waters which approximate equilibrium with calcite and atmosphere.

The value of K varies only with the temperature. At any given temperature, therefore, the equilibrium value of $[H^+]$ varies directly as the square root of the concentration of the calcium-ion and as the square root of the partial pressure of CO_2 in the atmosphere. Under particular conditions, it appears that, to all intents and purposes, K is a constant. The reactions, however, which bring about and constitute equilibrium are numerous and are subject to minor local disturbances and some of them may require many hours for completion. The natural result of such a condition is that

in practice the p_H value of a water as a rule is found to be oscillating gently in the neighborhood of the equilibrium point, much as a tree is swayed by the wind or as a boat moored in a tideway. When subjected to violent alteration—as for example by filtration—it returns slowly toward the equilibrium. In a similar manner biological concentration above a certain critical limit is able to effect a semi-permanent change in $[H^+]$ which may last even for months. Eventually, however, if isolated, the biological concentration falls and the p_H value returns to the equilibrium.

In the foregoing statements no mention has been made of the effect of temperature, which is, under natural conditions, considerable. The constant K is built up from five other constants. It has a marked temperature coefficient; becoming greater as the temperature falls. Bjerrum and Gjaldbaek⁴ give the value of -5.2 for $\log K$ at 18 deg. C. It would be decidedly helpful if determinations of the value of K were available through the range from 0 deg. to 100 deg. C., since the considerable changes which the value of K undergoes by reason of temperature variation would shed much light on many natural processes which are now relatively inexplicable.

ACTUAL OBSERVATIONS OF p_H VALUES

p_H and Temperature. Beginning in August, 1920, daily determinations of the reaction of Lake Ontario water have been carried out for a period of eleven months. During this time approximately 4,400 tests were made at various stations and at different intervals of time. In the absence of electrometric apparatus, the following procedure was adopted: To 100 c.c. of a sample of water there was added 0.5 c.c. of a 0.5 per cent solution of phenolphthalein. The reactions are reported according to the following arbitrary scale of numbers, the p_H equivalents of which it is hoped to determine later.

Reaction No.	Description	p_H Equivalent (Provisional Estimate)
0	Indistinguishable from water.....	7.8
5	Indistinguishable without comparison tube.....	8.0
10	Faintly alkaline.....	8.2
15	Alkaline.....	8.4
20	Strongly alkaline.....	8.6
25	Very strongly alkaline.....	8.8
30	Intensely alkaline.....	9.0

The first determinations in each instance were made upon a fresh sample of water, and subsequent readings were taken upon standing in the laboratory for 24, 48, 72 and, at times, 96 hours. The importance of these series of readings will be discussed at greater length later.

In view of the manner in which the above determinations have been obtained (the only method available under the local conditions), the authors expressly disclaim any pretension to "absolute-value" accuracy. It is certainly justifiable, however, to make strong claim

*Maryland State Department of Health.

†Toronto Water Filtration Plant.

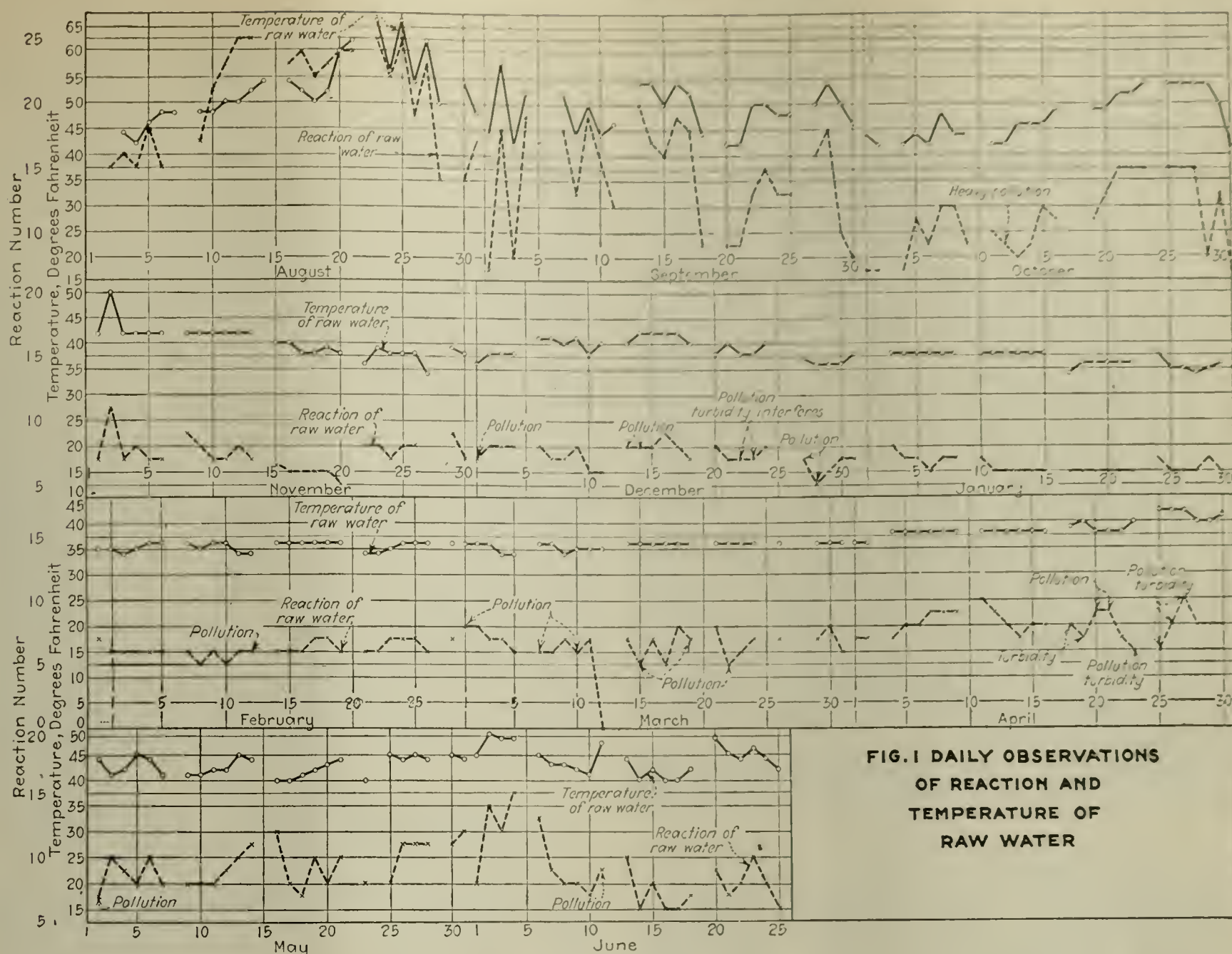


FIG. 1 DAILY OBSERVATIONS
OF REACTION AND
TEMPERATURE OF
RAW WATER

to "relative-value" accuracy so far as the conditions of the experiments go and because of the care taken in carrying out the tests. In each instance the test tube used was rinsed, brushed and soaked for some time with fairly strong HCl, to prevent after-effects due to solution of glass with resultant increase in alkalinity of the liquid tested. After soaking, the tube is again well-rinsed, brushed twice with complete rinsing following each brush, and then rinsed three times with distilled water. This procedure is followed by three washes with the water to be tested, after which the tube is filled to the mark.

In Fig. 1 there have been plotted the daily readings, for eleven months, of the temperature and the p_H of the waters at a certain intake on Lake Ontario, which supplies a mechanical filtration plant. A similar series of readings at a neighboring intake, furnishing a slow-sand plant, are not plotted, since they differ only slightly from those used. It is at once apparent from the data in Fig. 1 that the reaction of the raw water is continually fluctuating in accordance with the water temperature. The striking fact appears that the p_H values show marked seasonal as well as daily changes, which in turn are influenced in a secondary manner by biological contamination. It is important to call attention to the fact that in most instances these delicate fluctuations in reaction are not reflected in the usual titration measurements for alkalinity.

p_H and Filtration. In order to study the changes which such processes as alum addition and rapid filtration effect in reaction of water, daily determinations

were carried out upon the effluents of a mechanical filtration plant from August, 1920, to June 26, 1921. Only two months' observations are shown on Fig. 2, since these are characteristic of the summer and winter conditions as indicated by all the tests. It is apparent that the combination of alum treatment and filtration causes striking changes in p_H conditions. The fact that filtration alone is responsible for major effects is further illustrated by data shown in Fig. 3, where a comparison is presented between reactions of slow-sand as against those of rapid-sand filter effluents. It is well to bear in mind that such upheavals as filtration alone may occasion as profound changes in the equilibria of waters as do the more familiar chemical processes, as alum treatment.

It is true, of course, that such changes in reaction as have been indicated above are only semi-permanent in character, but they are of sufficiently long duration to make their effect of prime importance. Although adjustments are continually in process, the periods of time necessary to reach complete equilibrium, after such cataclysmic disturbances as filtration, may stretch into three or four days. These phenomena of internal adjustment in reaction are well brought out in another series of selected readings in Fig. 4, which represent only a few of hundreds of similar tests during summer and winter conditions.

The significance of the data shown on Fig. 2 will be even more striking when it is noted that the most effective filtration, from the standpoint of removal of bacteria and suspended matter, is accomplished usually

at those times when the reaction of the filtered water is in the neighborhood of 0 to 2 on the particular scale used in these tests. It is certainly of great importance to emphasize this observation, since therein lies probably one of the least known and most crucial regulating factors of filtration—namely, the reaction of the liquid filtered. We call attention especially to this particular phenomenon, in view of the fact that hitherto little attention has been paid in the interpretation of filtration experiment to the reaction of the water under study. The standardization of rates of filtration, of depths of sand beds and of sizes of sand grains have been determined in most instances without reference to the reactions and electrical signs of either the water or the materials suspended therein. In this connection it need only be recalled that many substances when suspended in water become negatively charged, with the intensity of the charge increasing when the concentration of the hydroxyl-ion becomes greater. In particular, clay particles and bacteria are usually negative, while it is believed that alumina used for mechanical filtration is negative when the p_H of the solution is greater than 7.5 (Sørensen's scale). Naturally the negative charges of such substances are influenced greatly when the H-ion concentration is increased or lowered. Because of these influences, it is possible to see why reaction should control, to a degree, both rate and efficiency of filtration.

The importance of the reaction of the medium being filtered has been amply demonstrated in another field

In fact, Holderer concludes from his series of observations on filtration of finely divided particles, comparable in size with bacteria usually found in water, that the reaction of the liquid filtered is of prime importance. His process of reasoning, based on his experimental results carried out with care, may be briefly summarized as follows: The volume of granules is very variable and is especially a function of the reaction of the medium. One ought, therefore, to take account of this reaction, all the more because upon it depend the sign and the size of the electrical charge. Perrin has shown in effect that every membrane in contact

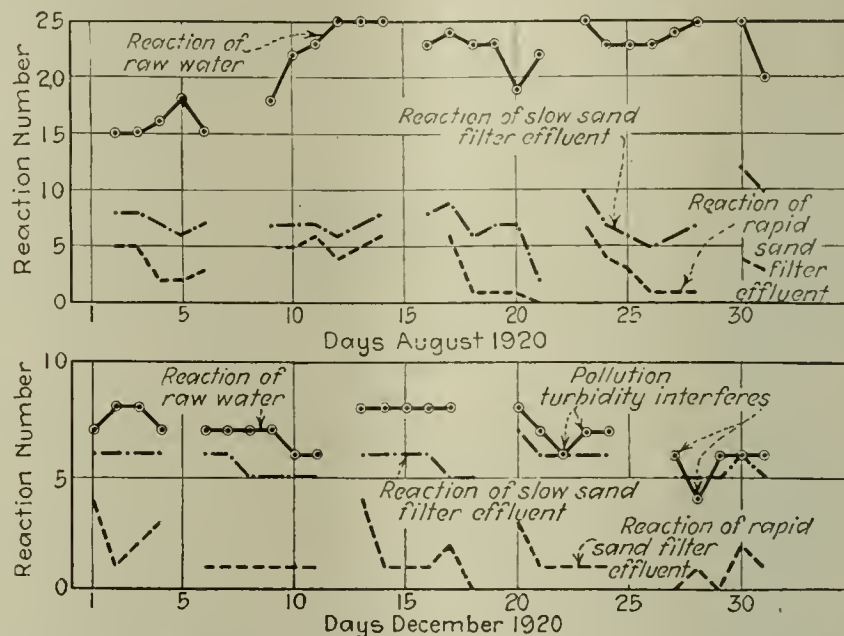


FIG. 3. COMPARATIVE EFFECTS OF RAPID AND SLOW SAND FILTRATION ON REACTION OF RAW WATER

with an alkaline solution is charged with negative electricity. If the solution is acid, the membrane is positive. Quincke further demonstrates that if we cause alkaline water to pass through a capillary tube, or a filter of sand or of gelatine, we obtain the positive charge of the water toward the outlet, while at the entrance the negative electricity has accumulated. These two charges, positive and negative at outlet and inlet, constitute an electromotive force of filtration opposing the movement of liquid.

Since we have already seen that the size of the particles is primarily a function of the reaction of the medium, there is nothing astonishing therefore that, from the point of view of speed of filtration, it is again the reaction of the liquid which is most important. This conception is further supported by evidence accumulated to show that the adsorption effects in filtration are also dependent upon the reaction of the medium and of the polyvalent coagulating ions.

THE NATURE OF FILTRATION

One cannot refrain, on account of the excellence of the reasoning, from quoting further from the thesis by Holderer, on the question of the nature of filtration:

"By what mechanism is the retention of enzymes brought about? Is it a sort of entrapping or a phenomenon of attraction? The study of the influence of coagulating and dispersing agents, such as albumin, has made it possible for me to conclude that it is particularly a phenomenon of adsorption—that is to say, by attraction primarily. Yet for enzymes poorly dissolved or which are in a state of partial coagulation, it is evident that we have a phenomenon of entrapping.

"One cannot attribute the retention of sucrase on the filter to an impoverishment of salts, for the addi-

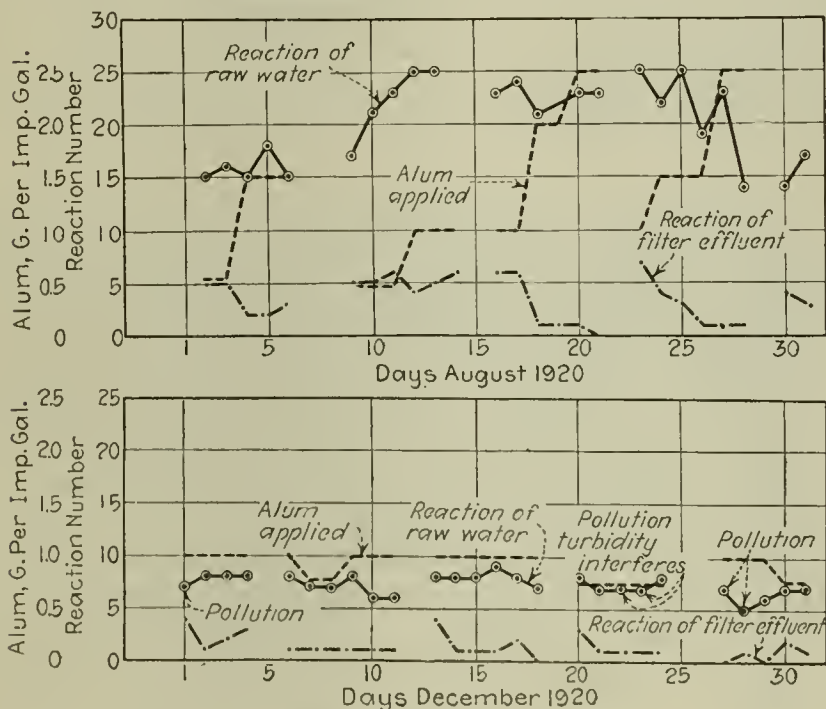


FIG. 2. EFFECT OF RAPID SAND FILTRATION AND ALUM TREATMENT ON REACTION OF RAW WATER

of scientific investigation by Holderer⁶ in a masterly thesis, which should be more familiar to waterworks men. Holderer, in his experiments on the filtration of enzymes, obtains the following characteristic results:

Reaction of Liquid	Per Cent Removal of Enzymes by Filtration
a. Neutral to phenolphthalein	0
b. Neutral to methyl orange	96
c. Intermediate reaction	75

It is clear from the data shown above, which are typical of those found in the filtration of numerous other finely suspended or colloidal materials, that the reaction of the medium being filtered is fundamentally the controlling mechanism of the success or failure of filtration.

tion to the filtrate of all the salts of the original solution produces no activation.

"Sucrase is retained therefore by adsorption and not by entrapping. It is the most frequent case. Enzymes act like bacteria. Duclaux in fact has already noted the force of adhesion which retains bacteria. 'From the standpoint of the average dimension of spores,' he said, 'the pores of the most porous substance are as tunnels toward wagons.'" Holderer further points out that "the spores of *Aspergillus niger* are retained by simple filtration through paper in a reaction neutral to methyl-orange, while at neutrality to phenolphthalein they pass through the filter paper. This remark suggests the thought of a work similar to this upon the question of the filterability of bacteria at various reactions."

Unfortunately the authors have been unable to find any further research along the lines suggested above, but it certainly appears from the data which Holderer has set forth, from the recent work on the filter-pressing of sewage sludge by Wilson, Copeland and Heisig⁷ and from the observations reported in this paper by the present authors, that important results would probably appear if new studies were carried out upon the entire problem of the mechanism of water filtration from the standpoint referred to above. It is not too optimistic to suggest that in such studies it may even be found that a considerable revision of our present concepts of the importance of definite gra-

dation of size of sand and of definite rates of filtration may be necessary.

In a similar manner, as has already been pointed out by the writer,¹ much fruitful research is possible in the field of precipitation and sedimentation of suspended particles, where the forces of electrical repulsion and of molecular attraction come into play. The solution of the problems arising in this field do not differ in method from those which appear in filtration. For the sand filter itself has the character of a charged membrane, the variations in whose charge may tend materially to promote or to retard the rate and efficiency of filtration.

p_H and Chlorination. Some reference should be made, if only briefly, to the possible significance of reaction of water in processes of disinfection with chlorine or its derivatives. Insufficient material is available upon which to draw any conclusions at this time. It is known, however, that the efficiency of such processes varies from season to season and even from hour to hour, but only the elementary causes of such variations are understood. For this reason, the recent studies reported upon by Rideal and Evans⁸ are of special importance. They recognize that hypochlorites, for instance, are usually applied to waters "irrespective of whether the fluid be acid, neutral or alkaline." Their preliminary conclusions are peculiarly interesting in connection with the figures reported upon in this paper. Several excerpts from the work of Rideal and Evans⁸ are, therefore, noted here for emphasis:

RIDEAL AND EVANS' CONCLUSIONS

"We find that two waters, one an 'acid' water containing free carbon dioxide and the other an 'alkaline' water, such as occurs in the London basin, dosed with hypochlorite so that they contain the same amount of 'available chlorine' (as measured by the ordinary iodometric method with titration in presence of acetic acid), give quite different results when allowed to flow through the electrical instrument. The acid water gives a large deflection, indicating high oxidizing activity; the alkaline water gives a much smaller deflection, indicating that the oxidation potential has been depressed.

"Since the germicidal properties . . . are in part due to its oxidizing power, it seems likely that these also will be affected by the hydrogen-ion concentration of the water. It would be worth while, therefore, to consider whether, if alkaline waters have to be treated with this class of sterilizer, they should not at the same time be rendered just acid to litmus, or at least neutral, by the addition of niter cake, aluminum sulphate or even by treatment with carbon dioxide gas."

TEMPERATURE, REACTION AND FILTRATION

If the data presented above are valid, what effect may we be led to expect in such processes as sand filtration from season to season? Theory would certainly indicate that it should be more difficult to get good results from our filters in the warmer months, when the *p_H* is higher. In actual practice, this is frequently the case, but it is sometimes ascribed to "colloidal difficulties." Its obvious remedy should be an increased dose of alum, which will result in a reduction of *p_H* to the point of improved operation. In calculating such dosages of chemical, we should not lose sight of the fact that the initial CO₂ content of the water, as well as that lost to the atmosphere in such processes as mixing, are controlling factors no less than the alumi-

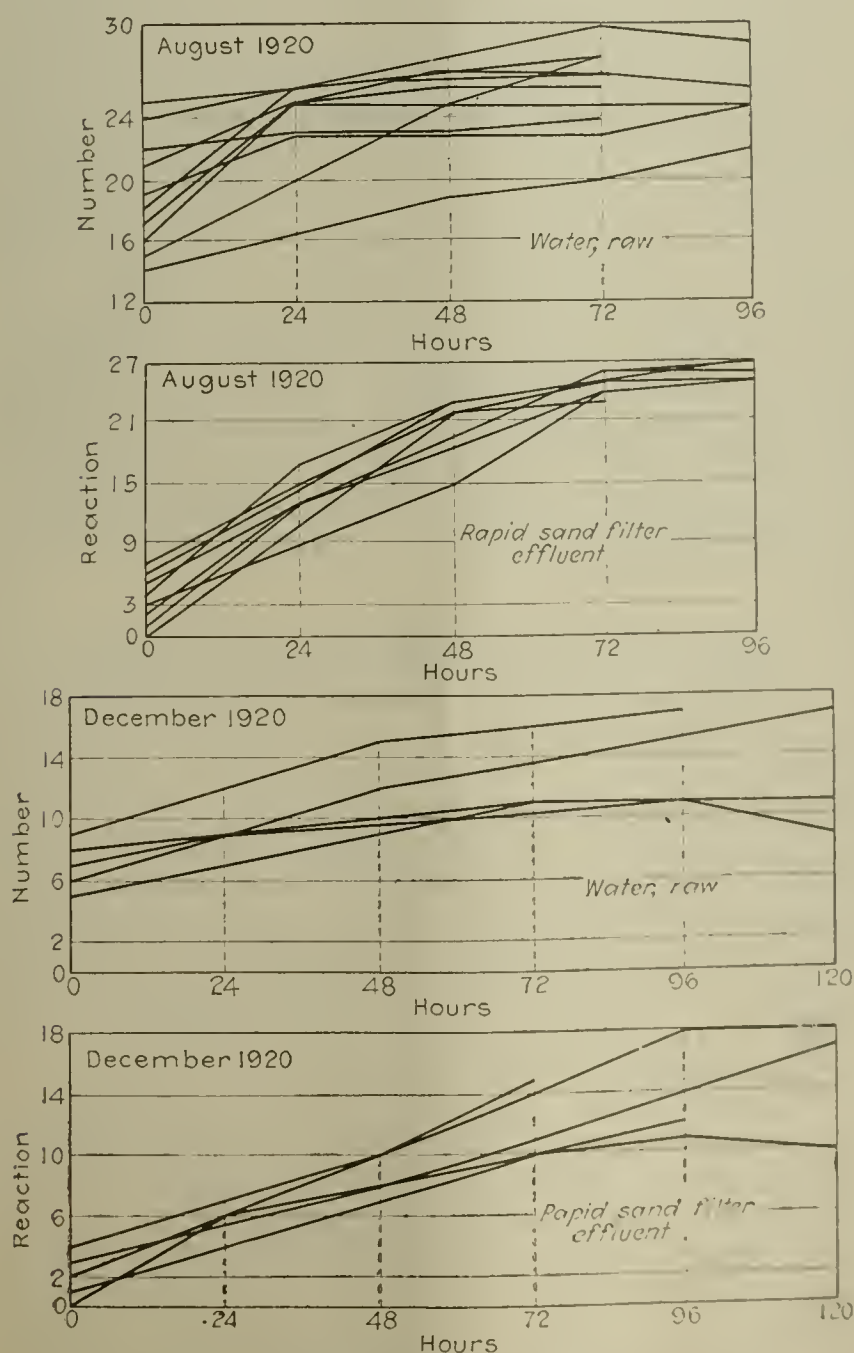


FIG. 4. TREND OF REACTION OF WATERS TOWARD EQUILIBRIUM

num sulphate used. In other words, the floc-forming power of alum has frequently overshadowed its CO_2 productivity. The latter may be the more important regulating mechanism of precipitation and filtration.

Evidence confirmatory of the hypothesis that efficiency of filtration and coagulation processes vary inversely with p_H is given by the data presented in an excellent paper by Jordan.⁹ The latter clearly points out that filtration, taken as a whole, falls off in effectiveness as the temperature rises, a phenomenon which Jordan associates with increased biological activity. But biological activity is actuated by such mechanisms as osmotic pressure across the membranes, which pressures Loeb¹⁰ has shown vary with potential difference and with p_H . Since temperature, p_H and biological activity are correlated phenomena, p_H again is the significant explanatory index to seasonal variation in filter efficiency.

CORRELATED PHENOMENA

The opportunity should be taken at this point to indicate the fact that the temperature-reaction phenomena discussed above may have important applications to problems not specifically mentioned in this paper. The principles outlined herein should have far-reaching effects in clarifying some of the concepts in the fields of botany, zoology and physiology. It is not, of course, within the scope of this paper to go into the details of the problems in these fields, but a sufficient number of pertinent facts have appeared in our researches to indicate the importance of the data herein presented to the other branches of science. The workers with soils, plants and animals will no doubt be able to adapt some of the findings to their own problems.

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Decline of the Sicilian Sulphur Industry

Until recent years Sicily was the most important factor in the world's supply of sulphur, but it has now been displaced by the American sulphur industry, which has developed a very large production owing to the easy extraction of this mineral from the Louisiana and Texas mines, declares Consul Louis G. Dreyfus, Jr., of Palermo, Italy, in *Commerce Reports*.

The production of sulphur in Sicily rose from 120,000 tons in 1860 to 538,534 tons in 1905. In 1919 production decreased to 181,374 tons, but rose to 219,844 tons in 1920. On the other hand, the production of American sulphur increased from 893 long tons in 1883 to 25,000 tons in 1903 and 491,080 tons in 1913, and reached 1,255,249 long tons (preliminary figures of the United States Geological Survey) in 1920. Besides these two countries, Japan, with an output of about 50,000 tons, is the only other important source of sulphur. Small quantities are produced in Spain and Austria.

During the war sulphur, which was required for the production of ammunition, was in great demand, but owing to the lack of tonnage the shipment of American sulphur to Europe was interrupted. The Italian Government commandeered the sulphur trade, authorizing exportation only with special permits. Now that freights are again normal, American sulphur exporters are everywhere underbidding the Sicilian product. In fact, the American quotation c.i.f. Hamburg, delivery weight, was at the beginning of June, 1921, 1,320 marks, while Sicily was quoted about 3,000 marks. The Sicilian product has been completely displaced in the important Scandinavian markets and is facing keen competition in Belgium, England, the Netherlands, France, Germany and Africa.

It is said that American sulphur is superior to the Sicilian for the chemical industries. However, the latter is preferred locally for the vineyards, where it is used to protect the foliage against parasites, because it is said the flour-milled product from the United States does not adhere to the leaf to the same extent as does the Sicilian. Partly for this reason and partly because of their geographic location France, Spain, Portugal, Algeria and Greece still look to Sicily for sulphur to be used in their vineyards.

Statistics of the Canadian Soap Industry

Canada spends in the neighborhood of \$14,000,000 a year on soap, according to a recent report of the Dominion Bureau of Statistics relating to the manufacture of soap in Canada during 1918.

Thirteen of the twenty-eight plants engaged in this industry are located in Ontario. During the year reported over 100,000,000 lb. of soap was manufactured in Canada and the quantity sold by the producers was worth over \$13,000,000. In addition to this there was imported into Canada something over \$1,000,000 worth of soap produced in other countries.

The report states that exports of soaps amounted to only slightly over \$100,000. There is thus an apparent opportunity for the expansion of the soap industry in the country to take care of the million dollar importation which now exists. It is stated that the bulk of the imported soap is of the common or laundry variety, there being 5,000,000 lb. of this soap imported during the year under review. Over 800,000 lb. of soap powders was also brought in. The quantity of toilet soap imported is not stated, but the value was \$592,000.

Melting Fine and Sterling Silver by Electricity

A Description of the Operating Conditions for Melting Fine and Sterling Silver in an Electric Furnace—Arrangement of a Silver Melting Outfit—Comparison of the Qualities of Electric and Crucible Silver

BY H. A. DE FRIES
Consulting Engineer

THE writer lately had the opportunity to conduct the melting of fine and sterling silver on a large scale in an electric furnace. In the following will be enumerated the principal points which have to be taken into consideration for such melting:

It is generally surmised that a pouring temperature of 1,900 to 2,000 deg. F. (about 1,040 to 1,095 deg. C.) is sufficient. This degree of heat will suffice if the silver is cast into bars for remelting. If one, however, endeavors to pour silver at this temperature into rolling stock or castings, the resulting metal would be so brittle as to be entirely worthless for subsequent working. The proper temperature at which such silver should be cast is 2,360 to 2,380 deg. F. (about 1,295 to 1,305 deg. C.) if cast into horizontal or nearly horizontal molds, or 2,200 deg. F. (about 1,205 deg. C.) when vertical molds are used. Utmost care has to be exercised in handling the molten metal between furnace and molds, and any chilling should be prevented as much as possible, as a difference of only 200 deg. F. will produce crystallization with attending brittleness. During melting the silver should remain quiet and the bath should not be disturbed by stirring or rocking.

AFFINITY OF SILVER FOR GASES

It seems that during melting a protective cover is formed, which protects the silver from gases. It is well known that silver has a great affinity for gases, especially oxygen, and if this cover is disturbed by stirring, etc., unprotected silver is brought into contact with the furnace gases and entering air, which will be absorbed at once.

Notwithstanding that fine silver is supposed to liberate most occluded gases by spitting on cooling, enough will remain, even though in very small quantities, to have a decided influence on the structure and ductility of the resulting metal.

How susceptible silver is to gases is best illustrated by melting it in an oil-fired crucible. In such operation a marked difference in quality of the metal will be apparent when using oils of varying analyses; even a change in the barometric pressure of the air used for combustion will be immediately noticeable.

As the atmosphere in an electric furnace is independent of outside conditions and can be changed at will, an absolute oxygen control is made possible, and this is of the greatest advantage. In practice it was found that an almost neutral atmosphere, tending toward being slightly reducing, is most suitable. This atmosphere can be easily obtained in an arc furnace and the carbon supplied by the electrodes is in most cases sufficient.

If a more reducing atmosphere is required, some charcoal may be added after the silver is molten. Pow-

dered coal in quantities not exceeding 1 lb. per 5,000 oz. of silver will be found most effective. It is evident that the furnace itself should be airtight and if an arc furnace is used stuffing boxes should be provided at the electrode ports. Pouring the charge through the furnace door will not do, if the door has to be open during pouring. It is much better to pour the silver through a separate taphole, which can be lined and kept closed by a plug made from an electrode stump.

The travel of the metal from spout to mold should be as short as possible. With proper arrangements the writer has experienced no trouble from skin forming during pouring. If an intermediate receptacle is used between spout and mold, it should be thoroughly preheated. Any metal left in this receptacle should be poured out and no new metal should be poured on top of it. The molds should be smoked and heated to about 400 deg. F. (about 205 deg. C.).

In making rolling silver, the time-honored method of having a piece of wrought iron or mild steel in the bottom of the hearth should be adhered to, as it will be a great help in keeping a low oxygen equilibrium in the metal, and at the same time this piece of iron will act as a stabilizer for the heat of the silver.

In starting up a new furnace the operator may not be able to judge the right pouring temperature from the appearance of the metal, and until he becomes familiar with it he should resort to the well-known pouring and annealing tests.

ELIMINATION OF IMPURITIES

The impurities in silver, especially if old metal and scrap are remelted, will be mostly in such small quantities as to be but a fraction of a per cent; in most cases the impurities are due to small quantities of german silver. Two methods can be used of partly eliminating the impurities in the furnace—i.e., by either slagging them off or by removal through cupellation. The second method is the one most commonly employed in arc furnaces. When using this method the electrodes are to be brought almost in contact with the bare bath and the furnace run slightly oxidizing for a short period.

FURNACES USED

After having thus discussed the principal necessities for the electric melting of silver, it is apparent that only two types of furnaces can come into consideration—i.e., the indirect arc furnace of the stationary type and a certain type of induction furnace, such as the Ajax-Northrup. The indirect arc furnace seems to possess greater adaptability to this work than the Ajax-Northrup, and this is especially true in regard to capacity.

The furnace the writer used during his silver runs was of the Rennerfelt type, especially constructed for the purpose and of 10,000-oz. capacity. The average charge was 4,000 oz. and the power consumption averaged 330 kw.-hr. per ton of silver. I understand that silver was melted in the Ajax-Northrup furnace with about 320 kw.-hr., so that it checks closely with results obtained in the Rennerfelt. Preheating is included in the figure of 330 kw.-hr.

The lining of the indirect arc furnace should be either of silica brick or firebrick, with a hearth of gannister or carborundum. This hearth material should be wetted down with silicate of soda, tightly rammed in and thoroughly sintered with the arc. The life of such a lining will be almost indefinite.

The determination of the metal loss was not quite conclusive, but on the average it amounted to about 2 oz. per 1,000 oz. melted. Some silver will always be absorbed in any newly lined furnace, and after the furnace has been in use a little longer I feel confident that silver can be melted in electric furnaces with a total loss not exceeding 5 oz. per 10,000 oz. melted. The electrode consumption will average about 5 lb. per ton.

The furnace will produce about 60,000 oz. of silver per eight hours and the cost of melting and casting 1,000 oz. into rolling ingots will be as follows:

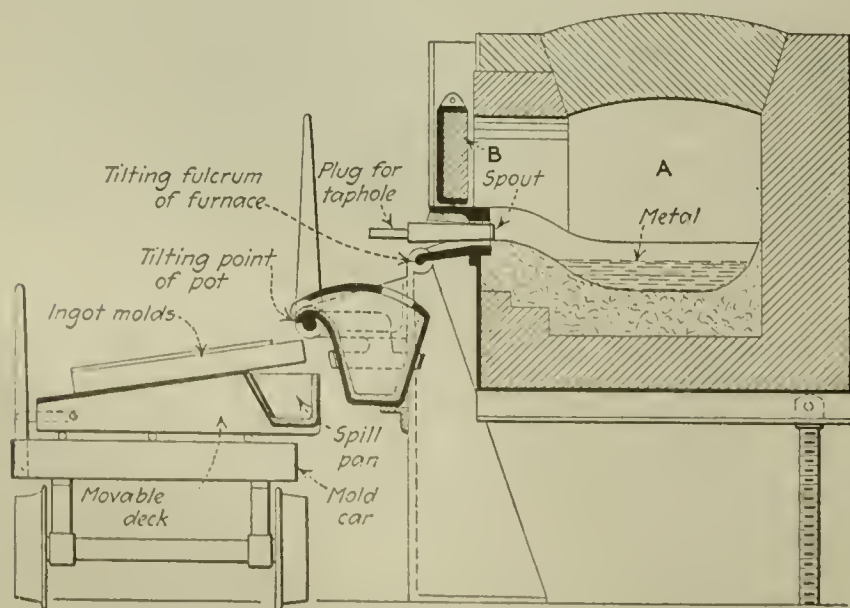
Loss, 0.5 oz. per 1,000 oz.....	\$0.25
Power, 12 kw.-hr. at 2c.....	.24
Labor, melting and pouring.....	.20
Charcoal, at 2c. per lb.....	.0025
Electrodes.....	.05
Refractories.....	.01
Heating ladle and molds.....	.02
Total.....	\$0.7725

ARRANGEMENT OF A SILVER-MELTING OUTFIT

As previously intimated, the handling of the metal after it comes from the furnace is of just as much importance as the melting itself, and the writer herewith will give a design¹ as to how an efficient silver-melting outfit should be constructed:

A is a lip-tilting electric furnace which is charged through door B. A special lined taphole and spout are placed directly beneath the charging door. During pouring the door remains closed and the metal flows through the taphole into a lined pot or crucible hung in front of the furnace. The crucible or pot is provided with a cover and sets into a ring so that the

¹Patent applied for.



CONSTRUCTION OF SILVER-MELTING OUTFIT

entire pot is removable. Before using it should be thoroughly preheated and it should be of sufficient capacity to hold enough metal to fill one or more molds. The pot is also lip-tilting and is worked with a lever. In front of this pot runs the mold car, provided with a deck which can be moved back and forth by a lever. Under the lip of the mold car is placed a spillpan, into which also is poured any surplus metal from the pot.

As mentioned before, it will not do to leave any metal in the pot and pour new metal on top of it. If insufficient metal is left in the pot to complete a mold, it should be poured into the spillpan and remelted afterward.

The operation of this equipment is very simple and the operator will get used to it very quickly.

COMPARISON OF ELECTRIC AND CRUCIBLE SILVER

Comparing now the quality of the electric silver produced by this method with standard-grade crucible silver, we get some very interesting figures. The electric silver and the crucible silver were submitted to various tests with the following results:

I. *Fracture*. Electric silver of much finer grain than crucible silver.

II. *Rolling*. Electric silver easier to roll.

III. *Stamping*. Electric silver stamped perfectly.

IV. *Deep Forging*. Extreme test; 100 per cent sound forgings from electric silver against 15 per cent from crucible silver.

V. *Spinning*. On the same extreme long draw, crucible silver failed completely, whereas electric silver came out 100 per cent perfect.

Magnesium Carbonate in the Glue Industry

Light carbonate of magnesia is a material which should be of interest to manufacturers of glues and mucilages, since it is of value as an opaquing agent. For such a use there is required a finely-divided, white, inert pigment, and magnesium carbonate has been shown, by a preliminary investigation at the Mellon Institute of Industrial Research, to meet these requirements. The material has a decided cost advantage over zinc oxide used for the same purpose, owing to the fact that it has a specific gravity of only 2.2, as compared to 5.78 for zinc oxide. Since the opaquing or pigmenting effect is determined on a volume basis, both the zinc oxide and magnesium carbonate being insoluble in the material in which they are suspended, the magnesium carbonate would be about one-third as expensive to use as zinc oxide, where the price of these two materials is the same per pound. The low specific gravity and bulky crystalline form of magnesium carbonate cause it to settle very slowly when suspended in a viscous material while zinc oxide, having much higher specific gravity and being more compact in the form of its particles, will not remain suspended so long.

Glues from different materials vary so in composition that it will be necessary to study the effect of each glue on this pigment, owing to the fact that in certain cases impurities may cause agglomeration and rapid settling of the pigment. Magnesium carbonate is basic in character and will, of course, be dissolved by large percentages of acid in glue, but the same is true of zinc oxide. Further information with regard to this material may be obtained by addressing the Director of the Mellon Institute of Industrial Research, University of Pittsburgh, Pittsburgh, Pa.

A Discussion of the Slip Interference Theory of Hardening

Professor Sauveur Is Prepared to Accept the Idea That Martensite Contains Alpha Iron, but Wishes More Evidence on the Contention That Its Hardness Is Due to Sub-Microscopic Grain Size, and That Cementite in Solid Solution Is Dissociated

By ALBERT SAUVEUR
Professor of Metallurgy, Harvard University

IRON containing a sufficient proportion of carbon, cooled with sufficient rapidity from a sufficiently high temperature, increases intensely in hardness. No such increase in hardness resulting from like treatment has ever been observed in any other metal or alloy. Strenuous efforts, experimental and mental, have been exerted by several generations of metallurgists to explain so important and unique a phenomenon. The metallurgical world was for a long period of time satisfied with the vague statement that quenched steel was hard because of the presence of "hardening" carbon, although at an early date the possible influence of severe internal strains was recognized. For a full score of years—namely, from about 1895 to about 1915—various theories were proposed to explain the hardening of steel, their discussion at times being conducted with considerable heat. By some the problem was taken from the domain of the laboratory to the quiet of the study, and several "desk" theories were added to those already under consideration. Activity in this field of research dates back to Osmond's epochal discovery of the allotropic transformations of iron and was further kindled by metallographic progress and by the application of the phase rule of Gibbs to metallic alloys. The theories that have been discussed include the "beta iron theory" of Osmond, the "alpha iron-solid solution theory" of Henry Le Chatelier, the "amorphous iron theory" of Humfrey, the "sub-carbide theory" of Arnold, the "stress theory" of André Le Chatelier, the "interstrain theory" of McCance and the "twinning and amorphous iron theory" of Carpenter and Edwards.

APPARENT STALEMATE

In 1915, summing up a short discussion of these theories, I ventured the following remarks: "It would seem as if the methods used to date for the elucidation of this complex problem have yielded all they are capable of yielding and that further straining of these methods will only serve to confuse the issue, a point having been reached when this juggling, no matter how skillfully done, with allotropy, solid solutions and strains is causing weariness without advancing the solution of the problem. The tendency of late has been to abandon the safer road of experimental facts and to enter the maze of excessive speculation, in which there is great danger of some becoming hopelessly lost. The conclusion seems warranted that new avenues of approach must be found if we are ever to obtain the correct answer to this apparent enigma."

The following remarks of Portevin and Garvin¹ are also to the point: "It is needful to guard against hypotheses which depend on the effect of an immeasurable quantity, as there is always a temptation to attribute to it values favoring *a priori* conception, and

to give to a *petitio principii* the appearance of a demonstration. It is from such methods of reasoning that the interminable disputes relating to theories of quenching have arisen, which have no likelihood of ending so long as they rest on such foundations."

The relative calm which for the last five or six years has prevailed in a previously turbulent sea has been brought to an end by the presentation of a new theory of hardening by Dr. Zay Jeffries and R. S. Archer, called by them the "slip interference theory."

The temptation is very great, and the danger also, to accept the authors' new theory, to declare the problem solved and to turn one's attention to others still unsolved and less elusive. O that this could be done! Any pretence, however, at scientific thinking carries with it its obligations, and one is compelled before accepting the newcomer to examine him critically to ascertain whether he is in reality a more sturdy and promising youth than his older brothers.

I desire at the outset to express my admiration for the mastery and skill with which the authors present their theory. Theirs is a brilliant thesis which discloses their erudition and scientific acumen.

OUTLINE OF THE NEW THEORY

The authors define hardness as "resistance to permanent deformation," which in turn results from the attractive forces between their atoms or interatomic "bonds." To deform the metal permanently we must break up some of the interatomic bonds. This definition of hardness can be accepted as accurate, although it would serve as well as a definition of elastic limit and although of two metals the one having the higher elastic limit has not necessarily the greater hardness.

The authors state that increased hardness implies increased resistance to slip, or "increased slip interference." Since it is generally accepted as proved that when a metal or alloy made up of crystalline constituents is permanently deformed, the deformation results from slips having taken place along some planes of weakness of the crystal which may be cleavage planes, it necessarily follows that increased hardness (since it means increased resistance to permanent deformation) results from greater resistance to slip—i.e., to greater "slip interference"—and that any factor tending to produce greater "slip interference" increases the hardness of the metal. The proposition is not of course applicable only to the authors' theory; on the contrary, it fits in with any theory of hardening, since it is based on the definition of hardness and on the manner in which crystalline metals yield on being permanently deformed.

The following factors, according to the authors, may be considered as increasing slip interference and therefore increasing hardness: (1) Boundaries of crystalline

¹Iron and Steel Institute, May, 1919.

grains—from which it would follow that the smaller the grain the harder the metal, since a smaller grain implies a greater number of boundaries; (2) possible presence of amorphous metal at the boundaries, intensifying their slip interference action; (3) the slip bands themselves, from which it follows that a metal increases in hardness on being permanently deformed; (4) the possible presence of amorphous metal at the slip planes, intensifying their slip interference action; (5) twin crystals—by opposing slip propagation in the crystal in which they occur; (6) the presence of foreign particles acting as “keys” in obstructing slip, an action which is the more marked the smaller the particles and the greater their number, this rule, according to the authors, reaching its limit as the particles approach atomic dimensions, and the hardening effect being maximum for what they term “critical dispersion.”

NATURE OF MARTENSITE MUST BE ADEQUATELY SET FORTH

The authors attribute the hardness of quenched steel to the hardness of martensite. This statement can be accepted without discussion. Any theory of hardening necessarily makes the same claim. It is only in regard to the nature of martensite that they differ. Martensite is claimed by the authors to be a solid solution. The same claim has been made before by others. Many have believed with Osmond that martensite is a solid solution of carbon or of the carbide Fe_3C in beta iron, while others prefer with Le Chatelier to consider it as a solid solution of carbon or the carbide in alpha iron. Again, those who, like McCance, Carpenter and Edwards, are inclined to attribute the hardness of quenched steel to “interstrain,” to twinning or to the presence of amorphous metal also consider martensite as a solid solution. The belief, therefore, that martensite is a solid solution is quite general and has been held for a long time.

Of necessity martensite must be (1) a definite chemical compound, (2) an aggregate, or (3) a solid solution. That it is a definite chemical compound, Fe_3C , containing iron in solution in hypo-eutectoid steel and Fe_3C in hyper-eutectoid steel, has been maintained by Arnold. The improbability of this hypothesis is so great that it may be dismissed without reviewing the arguments that have been so often offered in opposition. To decide whether martensite is a solid solution or an aggregate we naturally turn to the microscope, because we know what should be the appearance of a solid solution. We have been told and have frequently observed that solid solutions are made up of polyhedral crystalline grains corresponding to so-called “network” structures in polished plane surfaces. We fail, however, to observe under the microscope any such structure. Instead we discover that martensite has an “acicular” structure and we are unable to detect any suggestion of the existence of polyhedral grains. Our first impulse, therefore, would be to conclude that martensite is not a solution. The improbability of its being an aggregate, however, is so great that in spite of its structure we are reluctant to abandon the view that it is a solid solution and we try to find a satisfactory explanation for its acicular aspect. Carpenter and Edwards, for instance, contend that the “needles” of martensite correspond to austenite twins caused by the internal straining of the metal during quenching.

The authors of the theory under discussion express their belief that grains of martensite exist but that

they are sub-microscopic—that is, too small to be observed under the microscope. Indeed they consider this extremely small size of the grains of martensite to be the chief cause of its hardness. I do not understand that they offer any explanation of its acicular appearance.

While not denying that the weight of evidence supports the contention that martensite is a solid solution, it should be borne in mind that the conclusion rests on a process of elimination—that is, on our justified unwillingness to consider it an aggregate or a definite chemical compound—rather than on direct proofs, and furthermore, that it is not supported by the appearance of martensite under the microscope.

MUST A COMPOUND DISSOCIATE ON ENTERING SOLID SOLUTION?

The authors argue that a metal holding another metal or metalloid in solid solution is harder than the pure metal. They write: “It is a general rule that metals are hardened and strengthened by the addition of elements which dissolve in them to form solid solutions.” This they explain on the ground that intermetallic compounds are not dissolved as such in solid solution, but first must be dissociated to be held subsequently in solution in “atomic dispersion.” To clarify: The definite intermetallic chemical compound $\text{M}_x\text{M}'_y$ of two metals M and M' cannot form a solid solution with either of the metals; it is the metal M' in its elementary state that is dissolved in M, or *vice versa*. “The increased hardness and strength,” they write, “are therefore traceable directly to increased interatomic forces, the attraction between unlike atoms being in general greater than between like atoms.”

In order to follow the authors' demonstration of their theory, therefore, it is necessary to accept their views, (1) that an intermetallic compound cannot be held in solid solution in a metal and (2) that interatomic bonds between unlike atoms are stronger than between like atoms. In support of their first contention we are told that intermetallic compounds could not, because of their size, diffuse through the solvent metal. Applying this view to the solid solution of carbon in iron, they write: “Diffusion must consist in a migration of carbon atoms and not of groups or ‘molecules’ containing several iron atoms. Such groups could not, on account of their size, diffuse through solid iron.”

While not in a position to deny such claims, I believe that others will agree with me that before accepting as a demonstrated fact that intermetallic compounds cannot exist in a state of solid solution in a metal, more conclusive evidence should be forthcoming. The question is too important to be considered settled by the single argument of the authors. Their claim leads to many deductions requiring explanations. To mention but one: It is fairly conclusively established that silicon is present in iron as the silicide FeSi and it was generally believed that this compound was held in solid solution by the iron. According to the authors' view, however, this could not be; the compound must first be dissociated and silicon must be present in atomic dispersion. The silicide is, however, found in the steel at room temperature. When then did it form and where the evolution of heat that should accompany its formation? Such examples could be multiplied.

In regard to the statement that interatomic bonds between unlike atoms is greater than the bonds between like atoms, from which it follows that solid solutions

must be harder than the solvent metal, supporting evidences should be offered. If physical chemists have demonstrated this to their satisfaction, their proof should be given or at least the reader should be given the necessary references.

THE IRON OF MARTENSITE IS ADMITTED TO BE IN THE ALPHA MODIFICATION

The authors' theory, therefore, postulates as demonstrated facts, (1) that martensite is a solid solution, (2) that in martensite carbon in its elementary form and not the carbide Fe_3C is dissolved in iron, and (3) that solid solutions are harder than the solvent metal because of the greater interatomic bonds existing between unlike atoms, from which it follows that martensite must be harder than iron. We are justified, I believe, in accepting these conclusions with some reservation, especially in regard to claim 2.

We are further told by the authors that iron in martensite is present in its alpha form. This has long been the contention of Le Chatelier and of some other metallurgists. The additional evidence offered by the authors in support of this view is stated by them as follows:

"The X-ray spectrometer proves that alpha iron is the chief constituent of martensite. Steels which are non-magnetic show face-centered cubic lattices with the X-ray spectrometer, whereas martensite, which is magnetic, shows a body-centered cubic lattice. A 1.5 per cent carbon steel quenched from above the critical in iced brine showed both martensite and austenite under the microscope, and the X-ray spectrometer pattern showed both face- and body-centered lattices. A 0.35 per cent C steel quenched from above A_c , showed only martensite under the microscope and only a body-centered lattice with the X-ray spectrometer."

This proof of the presence of alpha iron in martensite and of the absence of gamma iron is considered definite and final by the authors. The conclusiveness of the evidence depends altogether upon the faith we have in the results yielded by the X-ray spectrometer.

I am not in a position to take issue on this point with the authors, nor do I desire it—on the contrary, I am quite prepared to accept the correctness of their view.

JEFFRIES AND ARCHER'S VIEW OF MARTENSITE

Admitting then that martensite is a solid solution of elementary carbon in alpha iron and that because it is a solid solution it must be harder than pure iron, we are told that this is only a contributory and relatively unimportant cause of its hardness—that its extreme hardness is due primarily to the *size* of its grains, which are described as "sub-microscopic." We naturally infer that if pure iron could be obtained in sub-microscopic grains it would be quite as hard as quenched steel.

To account for the formation of these sub-microscopic grains the authors argue that when austenite is transformed into pearlite at its normal critical temperature, two distinct transformations take place: (1) the allotropic transformation of gamma into alpha iron, followed by (2) the combination of carbon with alpha iron to form Fe_3C . They write: "The latter would not form unless the iron changed its crystal structure. Therefore the allotropic transformation of the iron is the cause and the formation of cementite is the result. . . . When austenite is slowly cooled through A_1 , the two changes occur so close one after another as to be called simultaneous. . . . When the cooling rate of the austenite

is sufficiently rapid to form martensite, the transformation of the gamma iron to alpha is substantially complete, whereas the formation of cementite is not complete. Martensite should therefore consist principally of sub-microscopic ferrite grains containing carbon in solution. . . . Although the ferrite of the martensite is held to contain carbon in solution, it is considered that the fineness of grain is chiefly responsible for the hardness." And again: "The hardness of martensite may therefore be attributed chiefly to a combination of two factors—namely (1) the super-refinement of the ferrite grains, and (2) the strengthening of ferrite by carbon."

The authors' theory therefore rests on the formation of sub-microscopic grains on quenching steel, and the following reasons are given by them in support of their contention:

"1. The conditions obtaining at the time of the formation of martensite are conducive to the production of small grains.

"2. In low-carbon martensite formed from coarse-grained austenite, ferrite can often be seen under the microscope in the form of very small plates.

"3. In higher carbon steels which are conducive to the formation of finer grains on quenching, no ferrite can be resolved under the microscope.

"4. In order to obtain a good Hull pattern with the X-ray spectrometer it is necessary that the specimen be fine-grained. In a 0.35 per cent C martensite, formed by quenching from 1,300 deg. C., the alpha iron pattern was typical of that obtained from fine-grained metals, even though the austenite grains from which the martensite was formed were large enough to be seen with the unaided eye."

MORE EVIDENCE NEEDED

Without any desire of being hypercritical I do not think that these reasons can be accepted as at all conclusive of the existence of sub-microscopic grains in martensite, and since they are essential to the theory proposed by the authors, it is in order that we should demand more convincing evidence.

The part played by carbon in the hardening of steel is thus described: "The presence of the carbon assists in the hardening indirectly by helping to produce a very fine ferrite grain size and directly by strengthening the ferrite grains." The authors face here the same difficulty as was encountered by their predecessors. The action of carbon is indirect, we are told—it helps in producing microscopic grains. The argument recalls the claim of the allotropists that carbon *helps* in retaining beta iron, a claim which has always been considered one of the most vulnerable points of the theory. Arnold, of course, took the bull by the horns in assuming the existence of a very hard carbide of iron (Fe_3C), but then his theory is untenable. Assuming, as we must, that carbon helps in the production of fine grains, the mechanism of the assistance rendered is not satisfactorily explained, if explained at all.

While appreciative of the talent and skill with which the authors present their theory of the hardening of steel, some of us, I believe, will hesitate to accept it as a fully satisfactory and final solution of the problem, because we are asked to accept as a demonstrated fact, without being given sufficient evidence in support of the contentions, that an intermetallic compound cannot exist in a metal in a state of solid solution, and that the carbide Fe_3C , therefore, cannot be present in solid

solution in gamma or alpha iron; because we are asked to accept as a demonstrated fact that in martensite grains of alpha ferrite exist in sub-microscopic dimensions without being given convincing evidences of that important, and to the theory essential, phenomenon; because, referring to the rôle played by carbon in the hardening of steel, we are asked to be satisfied with the rather vague statement that carbon helps in producing sub-microscopic grains without any explanation of the mechanism of this action; and because the theory does not satisfactorily explain why sub-microscopic grains and therefore hardness cannot be obtained in other metals and alloys by quenching.

We further hesitate to accept the theory as final because the authors reopen wide the doors of speculation. It might be claimed, for instance, that martensite is hard simply because it is a solid solution of alpha iron and carbon in atomic dispersion, the carbon atoms acting as "keys" (to use the author's expression), from which it would follow that the more carbon—that is, the more keys—the harder the martensite. Could not such a theory be defended vigorously and cogently? It would at least have the advantage of offering a more acceptable explanation of the need of carbon to harden steel and of the absence of hardness in the absence of carbon. This, of course, would be a return pure and simple to Le Chatelier's theory.

Legal Notes

BY WELLINGTON GUSTIN

Utzman Patents for Gypsum Plaster Board Held Valid

Two patents, 1,029,328, covering a process for making plaster board, and 1,034,746, covering the product, the plaster board, were the subject of an infringement suit decided recently by the United States Circuit Court of Appeals, Seventh Circuit, United States Gypsum Co. vs. Bestwall Mfg. Co., 270 Fed., 542. The court affirmed the District Court's decision that the patents were infringed.

The patentee says he aimed to construct a board "the edges of which will be entirely inclosed by a sheet of covering material and in which there will be no free or exposed edges of covering material which will be liable to be torn, loosened or pulled back in the handling of the board."

It appears, therefore, that the virtue of the patent is found in the protection which the covering over the edges affords. And there was evidence to support the claim that such covering protected the exposed edge of the gypsum body, prevented waste, strengthened the finished board, increased the output, improved the appearance of the finished product and reduced the cost of production. A very large increase in the production of plaster board followed the appearance of this patented article.

Plaster boards of the two-ply and of the composite type were old and well known at the time of this discovery, says the court. The advance over the prior art consists chiefly in the protection afforded the edges of the gypsum.

The process is described by counsel as follows: "The patented method consisted, broadly, in pouring a mass

of semi-liquid flowing material upon a rapidly moving continuous sheet of paper, folding the edges of such strip upward and inward over the edges of the layer of plastic material, superimposing a narrower continuous sheet of paper upon the bottom sheet and the layer of plastic material thereon, and passing the whole between a pair of pressure rollers, whereby the layer of plastic material is compressed to a uniform thickness throughout the width of the paper where its edges are confined and bound by the inturned edges of the bottom sheet, whereby the superimposed upper sheet is secured to the layer of plastic material and to the inturned edges of the bottom sheet by the adhesiveness of said material itself."

The evidence showing the extensive use that immediately followed the appearance of the new board the court thought was sufficient to show its utility. One issue alone was presented the court: Does the contribution of the patent spell invention?

QUESTION OF INVENTION RAISED

Utility, increased output, improved product, reduction in cost, are all factors that have been thrown into the scale and are somewhat determinative of this issue, as the court saw it. But the Court of Appeals did not agree with counsel for patentee that this patent was a "broad novelty," nor with its expert witness that it was a "daring conception." And it says invention is not determined by the extent of the advance in any art which the inventor makes.

In this suit the court found that the use of a covering as a retaining member with its resulting advantages heretofore enumerated was novel. Moreover, to utilize the plastic material thus inclosed as an adhesive material, in securing the edges of the retaining member, and to attach the top cover member to it as described in the process were novel and somewhat ingenious. Such double use of the plastic material together with the retaining member permitted the manufacturer to increase its output, to lessen the cost of production, to make a more sightly board which "chipped" less readily than the board previously used, all of which under the circumstances the court held to be novelty amounting to invention.

The process patent used the term "alternate layers of plastic material," and the Bestwall company's claim of non-infringement was based in part on the assertion that its product does not contain "alternating layers of plastic material" nor are they used in its process, but the board is made in a single plastic layer.

In reply to this the Gypsum company contended that the building up of the body of the board in alternate layers of plaster and paper was not of the essence of the invention, but that the really new things discovered by Utzman were the upturning of the edges of the bottom layer of paper and then sealing or impressing the top layer of paper, a little shorter than the completed board, over the upturned ends of the bottom layer and into the layer of plaster. There is a rule of law laid down in another case (120 Fed., 260) to the effect that an element of a claim not essential to the result which the inventor desired to accomplish is not absolutely requisite in an infringing device. Therefore it was contended that since the construction in alternate layers not being essential to the result which the inventor Utzman wishes to reach, the fact that the defendant does not use alternate layers in its board is immaterial.

The Use of Inert Gas for the Prevention of Explosions

Complete Combustion of Coke in a Specially Designed Generator Gives a Mixture of Carbon Dioxide and Nitrogen Which May Be Employed Effectively for the Prevention of Explosions—Tests With Sulphur-Dust-Laden Atmospheres

BY EDWARD F. WHITE

EXPLOSIONS in industries are not always the result of failure to recognize the flammability of the materials used or the means available for the prevention of fire.

Many manufacturing operations, involving the separation and synthetic compounding of different elements, require the handling of flammable, gaseous and pulverized materials, in processes wherein it has been impossible to guard successfully against accidental fire and explosions. For this and many other reasons it cannot be asserted that a possible means for providing against explosions is available for every case. There are, however, many instances of recurrent disastrous explosions which might never have occurred if available and well-understood means for prevention had been employed.

The purpose of this discussion is to call particular attention to one such means—namely, the use of inert gas as CO_2 plus N_2 manufactured on the premises for the purpose by burning coal or coke in a suitably arranged apparatus, so that the products of combustion containing no free oxygen are collected in a holder to be drawn from as called for. This, in the writer's opinion, may in many cases be even more effectively employed for the *prevention* of fire than it has been as forming the basis of operation in the modern fire extinguishers now for many years. It is now a known fact that in many dust-making operations, including such as involve the use of dust collectors, dust flues, inclosed elevators and conveyors, pulverizing and disintegrating machines, the circulating, dust-laden atmosphere can be made inert, that is to say, deprived of free oxygen to an extent sufficient to make the existence of fire an impossibility. Reference is made to this

particular line because it is one of the most prolific fields of disastrous fires and explosions and offers the most ready and convenient opportunity for the application of the inert gas preventive. The handling and milling of grains, manufacture of food products, the grinding of sugar, starch, castor oil meal, spices, chemicals, coal, wood and other carbonaceous materials, develop dust products which ignite and propagate flame readily.

Some interesting information is here given concerning the use of inert gas in the manner above described, to prevent the explosion of sulphur dust in a milling process involving the use of all the types of machinery above referred to with result of preventing absolutely explosion of the sulphur in any parts of the operations or machinery, so long as the gas was maintained and used in the manner planned for and specified to be used.

INERT GAS GENERATOR

The gas-making plant (Figs. 1 and 2) consists of four principal parts—namely, the primary generator *A*, a secondary generator *B*, a combination gas scrubber and cooler *C* and a gas holder *D*. In operation fire with coal, or preferably coke, produces the initial gas (products of combustion) in the primary generator *A*, which is a closed furnace with controlled air supply under pressure of about 4 oz. per sq.in., furnished by an ordinary pressure fan blower. The products of combustion pass from the top of the primary generator into the secondary generator, in which they mix with a further supply of air, regulated for complete combustion, the heat of combustion of which maintains the checker work filling of the secondary generator at a dull red heat, so that the gases leaving the secondary generator consist only of completely oxidized combustion products and nitrogen. The gases now pass into the scrubber and cooler through a cold water spray and layer of broken coke, being freed thereby of any dust mechanically carried over in the gas, cooled and delivered into the holder ready for use.

A plant of the above description for the production of 3,000 to 5,000 cu.ft. per hr. of inert gas is operated with labor only for fueling say three or four times in 24 hr., the cleaning of the fire and removal of ashes, perhaps twice daily, and a sufficient general oversight while running to maintain the correct air supply and testing of the gas (which latter may be automatic and continuous) to secure uniform production.

From various records of operations in the writer's experience, the following practical observations are noted:

An ordinary disintegrating mill of capacity 1 to 3 tons per hr. will have sufficient supply of inert gas

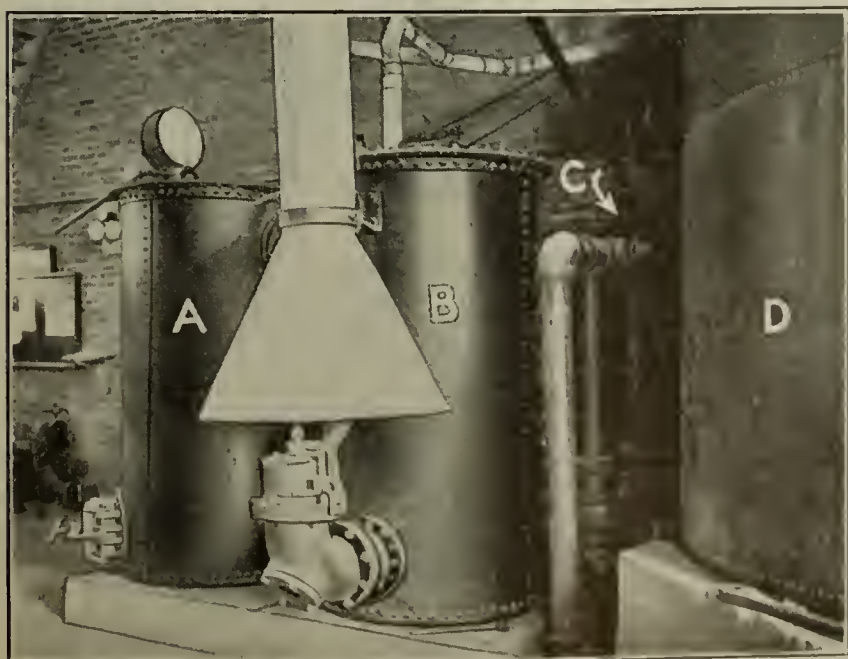


FIG. 1. FRONT VIEW OF GAS GENERATOR

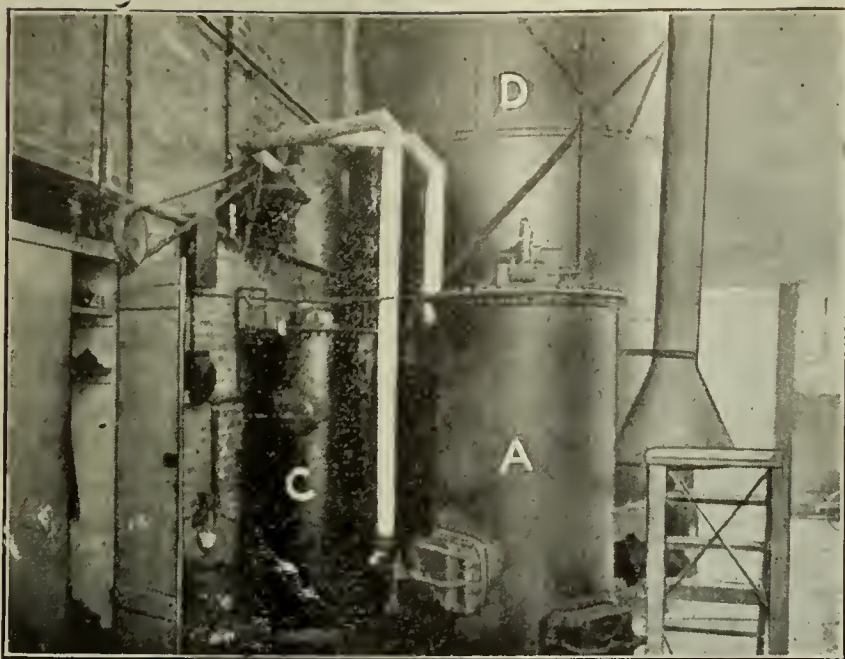


FIG. 2. SIDE VIEW OF GAS GENERATOR

through a $\frac{1}{4}$ - to $\frac{3}{4}$ -in. globe valve if the gas pressure at the valve is about 3 oz. per sq.in.

A large tight housed bucket elevator, with single leg say 50 ft. head to boot shaft, will have a sufficient supply of inert gas through a $\frac{1}{2}$ - to $\frac{3}{4}$ -in. globe valve if the pressure at the valve is about 3 oz. per sq.in.

A 500-cu.ft. floating bell gas holder will supply gas through a $\frac{3}{8}$ -in. globe valve for about 1 hr.

A standard Gas Engineering Co. 36-in. gas-generator set will fill a 500-cu.ft. bell holder in from 5 to 10 min., under normal conditions, according to openings given to combustion air valves.

Fuel consumption, if coke, with 36-in. set above referred to, operated at normal rate, will be about 50 lb. per hr.

Estimated cost of 1,000 cu.ft. gas, if coke costs \$20 per ton, about 8c.

As a matter of interest in connection with the study of explosions and means of preventing same, some helpful information is given below as obtained by the writer's investigations experimentally to determine the nature of and how to remedy explosions in the process of handling sulphur. The tests were with a special outfit set up for the purpose, as shown in Fig. 3, and described hereafter.

The questions to which answers were sought by the experiments may be stated as follows:

In a sulphur-dust-laden atmosphere, what proportion of sulphur dust in the air makes an explosive mixture?

What conditions seem especially noticeable in the propagation of fire in such atmosphere, particularly as to the extinguishing effect of the products of combustion resulting from the first burning and in the immediate vicinity of the place of ignition, the question being whether the explosion, or more specifically, the effect of a rapidly propagated fire—which an explosion is—may not be prevented by a partial elimination of the free oxygen as affecting the whole circuit by selecting effective places for injecting the gas.

What per cent in mixture of CO_2 and air will positively prevent fire regardless of fineness and per cent of sulphur present, as might be caused in any confined space from a spark caused by the striking of fire; e.g., in the disk chamber of a mill or by static or dynamic electricity.

What temperature and pressure conditions result from explosions with various mixtures of air and sulphur dust more or less confined as to circulation, as compared with theoretical calculations therefor for the known quantities of combining elements present, all as indicating the probable amount of sulphur oxidized and extent or distance reached by the fire.

The explosion chamber was a piece of 10-in. wrought-iron pipe about 4 ft. long, threaded and fitted at each

RESULTS OF EXPLOSION TESTS WITH SULPHUR-DUST-LADEN ATMOSPHERES

Test Series No.	Purpose of Test	Apparatus Conditions	Ignition	Atmosphere in Chamber	Temperature of Explosion	Pressure of Explosion	Observations	Conclusions
1	To explode measured equivalents of sulphur and oxygen.	Chamber closed, dusting by means of fan agitation.	Could not ignite.	Air	.....	.....	Saw good spark before closing chamber.	As repeated and sustained spark acting before and after and during running of fan failed to fire, evidently the intimacy between sulphur and oxygen was not close enough for combination, due to not enough dust of proper fineness and too slight circulation in immediate vicinity of the spark.
2	To explode mixtures of sulphur in excess of air.	Same as above except cover loosely laid on, held down by 2 bricks.	Only when S was double or more than the calculated equivalent	Air.	Varied from slightly warm to quite warm.	Never enough to show on gage but lifted cover and 2 bricks.	Inside of chamber showed fire was where sulphur was thickest and near spark plug.	Low pressure resulted probably from only partial combustion, due to the smothering effect of products of combustion of initial fire in connection with slight circulation, which prevented bringing up of fresh oxygen into the field of ignition.
3	To observe effect of excess of air and circulation.	As above except used top and bottom air valves.	Every time with positive explosion.	Air.	Decidedly warm.	Caused hissing through valves.	Noticed marks of burning S all parts of chamber especially around spark plug.	During this series of experiments it was noticed that by leaving the vent (air) valves opened, and running the fan continuously, explosions occurred at fairly uniform intervals, longer or shorter, according to the amount of air passing and the time required for purging after each explosion, showing conclusively the effect of the products of combustion to prevent firing. Very positive marks of firing were noticed in all parts of the chamber, and the explosions were decided detonations. From this the propagating effect of the oxygen-bearing air to carry the fire to all parts reached is obvious.
4	To determine what proportion of CO_2 prevents explosion.	Same as in test No. 2	With less force as gas increased.	Air and CO_2	As before under like conditions.	As before under like conditions.	Checked gas per cent in chamber by laboratory test of sample.	20 to 25 per cent of CO_2 in air, at normal atmospheric temperature and humidity, will undoubtedly prevent explosion of sulphur dust by spark ignition from any cause or source. By CO_2 is understood ordinary commercial carbonic acid made by the elimination of free oxygen from air through a process of burning coal or coke. Such gas, of course, contains a large percentage of nitrogen.

NOTE.—The sulphur used in these experiments was crude brimstone, ground, dust-chamber separated, and bolted through silk about 120 mesh. A sample of the crude before grinding showed less than 0.8 per cent moisture. A good per cent was impalpably fine. The experiments were made out of doors, on the afternoons of two different days in September, 1920. The weather was clear, temperature about 70 deg. F. Humidity about 85 per cent of saturation.

end with a standard 10-in. pipe cap. An 8-in. disk fan was placed axially with, and near the bottom of, the chamber, on a shaft journaled through the bottom cap and fitted on the outside end with a pulley for driving by an electric motor. This fan acted as an agitator for the sulphur and served also to excite a circulation of the atmosphere inside the chamber. The top cap was removable by unscrewing and during the trials was replaced by an asbestos-paper-lined light wooden cover laid on and held down with two common red bricks. Both top and bottom covers were fitted with 1-in. globe valves for the passing of the atmosphere into or out of the chamber. The ignition was by means of an ordinary series group of dry batteries (about 8) and an ordinary spark plug, the latter being placed in the side of the chamber about midway between top and bottom; also in the side of the chamber

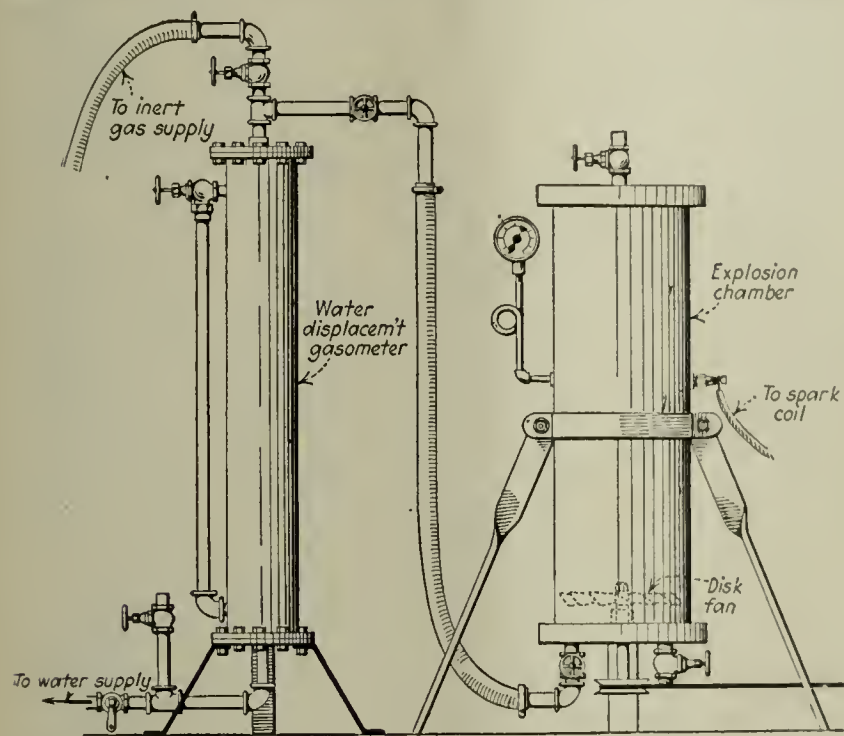


FIG. 3. APPARATUS FOR EXPLOSION TESTS WITH SULPHUR DUST

opposite the spark plug was a pressure gage, near which was an opening fitted with a valve for admitting inert gas. The inert gas used was CO_2 , taken from a gas cylinder through a water displacement gasometer. The sulphur for dusting was dropped into the chamber by removing the top cover while the fan was not running.

Some variations of conditions were made during the trials, most important of which were as follows:

Sparkling was done both with fan running and not running; that is to say, immediately following the stop and start of the fan;

The chamber was placed alternately in vertical and horizontal positions;

Several trials were made with each change and also charge of sulphur, preceded in every case by removal of cover and purging of chamber, by doing which it was possible with marked accuracy to obtain repeatedly very similar effects, depending upon the conditions set;

The activity of circulation within the chamber was varied under control by means of the air globe valves at top and bottom of the chamber.

As only approximations to actual conditions were possible to observe, the conclusions are correspondingly of indicating or empirical value, but it is the writer's belief that significant inferences may be drawn by study of the accompanying tabulation of the results of the tests.

A Plan to Reduce the Time and Cost of Air-Seasoning Wood

In co-operation with the sawmills and wood-utilization plants throughout the country, the Forest Products Laboratory, Madison, Wis., is organizing an extensive field study on the air-seasoning of wood. This study, it is believed, will be of extreme interest to the lumber manufacturer and to the wood-using industries. The purpose is to determine the piling practice which will result in the fastest drying rates consistent with the least depreciation of stock, the least amount of required yard space and the lowest handling costs. The study will be carried on concurrently on both hard woods and soft woods.

The air-seasoning of wood is an old practice. No systematic attempt has ever been made, however, to work out the exact conditions under which drying time and drying costs can be reduced to a minimum. It is not actually known which of the numberless methods of piling will give the quickest and the cheapest results under given climatic conditions. The new project will furnish a comparison of the effects of such piling variables as sticker heights, the spacings of boards in layers, the heights of pile foundations and the directions of piling with relation to prevailing winds and yard alleyways.

The study is expected to decide whether from a business standpoint lumber should be dried partly at the mill and partly at the plant of utilization, or whether it should be completely dried at the mill. The data collected will also go a long way toward showing whether air-seasoning or kiln-drying is the more profitable.

A tentative working plan of the air-seasoning study has been prepared by the Forest Products Laboratory, and copies are being sent to the secretaries of the various lumber and wood-using associations, state foresters, forest school heads and others.

Co-operation in the air-seasoning study is being offered on every side. As yet the plants at which the work will actually be done have not been definitely chosen, but the extreme interest already manifested indicates that there will be no difficulty in securing co-operation with plants ideal for the study. Actual field work will soon be well under way.

Estimated Production of Iron and Steel in Japan

The recent report of the financial and economic committee appointed by the Japanese government to study the future development of the mineral production of the country, as published in the *Far Eastern Review*, gives the following forecast of the production of iron and steel for the five years mentioned and of the coal and iron ore required under peace conditions:

Years	Production		Requirements	
	Pig Iron Tons	Steel Tons	Coal Tons	Iron Ore Tons
1920	377,616	1,031,350	6,040,000	3,709,000
1921	468,000	1,099,000	6,473,000	3,978,000
1922	437,000	1,164,000	6,926,000	4,275,000
1923	466,000	1,227,000	7,339,000	4,517,000
1924	492,000	1,287,000	7,733,000	4,786,000

The committee considers that the best policy to follow is the grouping of the various works and the levying of protective tariffs ranging from 10 per cent *ad valorem* on iron ore to 15 per cent for steel, material for ship construction remaining free as at present. The builders using native steel would receive a subsidy equivalent to the import duty.

Casting Aluminum:Zinc Alloys

BY F. A. LIVERMORE

ALUMINUM, as a material for casting, presents many advantages as regards lightness, good machining properties, a fair amount of strength and freedom from brittleness, the widespread adoption of aluminum alloy castings of recent years sufficiently demonstrating their reliability to withstand severe service.

It is a well-known fact that pure aluminum is entirely too soft to produce satisfactory castings which will be subject to any strain, owing to its comparative softness and lack of strength. To overcome this it is the universal practice to stiffen the metal with some hardening element, the amount and nature of the hardening element or elements depending on the physical and mechanical properties required.

Practically all the standard aluminum alloys used in the foundry can be successfully cast, but there are two main classes of aluminum casting alloys:

(a) Those whose principal hardening medium is zinc (with or without small percentages of other elements).

(b) Those containing copper as the hardening constituent.

We find class *a* extensively used in British aluminum foundries, while the copper alloy is favored by the French and American foundries.

Aluminum:zinc alloys have the reputation of being particularly subject to fatigue failures; this is due to the weakening effect of certain impurities of commercial spelter. Lead in particular is very deleterious to any aluminum alloy, and when castings of the zinc base alloy are required to pass severe physical tests, only high-grade zinc should be used. Other dangerous impurities are carbon, silicon and iron, hence the greatest precaution should be taken to prevent the introduction of this foreign matter either in the metal used or through the medium of crucibles and tools.

PRECAUTIONS TO BE TAKEN IN MELTING ALUMINUM ALLOYS

In melting aluminum alloys, plumbago or salamander crucibles (preferably with clay liners) should be used.

Melting is best carried out in a gas-fired furnace using a mixture of air and gas which can be adjusted to prevent overheating and subsequent burning of the metal. Electric furnaces are claimed by their proponents to be when properly made much more reliable and cheaper than the gas furnace or any other type of furnace. No charcoal or carbonaceous covering is used on the metal, as carbon combines with the alloy, forming a very brittle compound. Gates and sprues from castings must be freed from sand as nearly all the sand introduced into the pot is reduced to silicon, which weakens the alloy. In cases where there is a great danger of introducing sand, it is found beneficial to add powdered flux (75 per cent of potassium chloride and 25 per cent fluorspar). This tends to dissolve the silica and so keep it from combining with the aluminum.

It is found that a tough film of oxide often surrounds borings, turnings, chips and other scrap aluminum, making it extremely difficult for melting. This oxide can be dissolved off by heating with the alkali earths. The following process is recommended by the British Aluminum Co., Ltd.: The chips or other fine scraps are intimately mixed with varying amounts of flux (85 per cent of common salt and 15 per cent powdered fluor-

spar) depending upon the degree of cleanliness, and the whole is melted at a fairly high temperature.

Special precaution should be exercised when melting to prevent overheating, as this appreciably effects and is injurious to the working properties of the casting. The pouring temperature has a very noticeable effect upon the resultant castings. In general, the temperature should be as near the melting point as possible. After a considerable amount of research I have found by adhering to this rule an increase of 8,000 lb. per sq.in. in tensile strength is obtained together with a marked improvement of the surface appearance of the casting. The temperature I recommend is 650 deg. C. $\pm$ 10 deg. C.

In quite a number of British foundries the archaic method of guessing the temperature by the eye is still in vogue, and I am confident that a large percentage of the unsound work produced is due to this, what I think we can call discrepancy or oversight. All aluminum castings should be under strict pyrometric control to obtain satisfactory results, and I may add that the outlay for the installation is quickly compensated by a corresponding increase in sound production.

Just before pouring, a little flux is added to the molten mass and the metal is thoroughly stirred with a clay-covered skimmer. Flux tends to reduce the oxides and dross in the metal and put it in ideal condition for pouring; otherwise the heavy oxide which is occluded throughout the metal would cause blow-holes. The dross which forms on the surface must be removed with special care; the skimming should be done with a degree of thoroughness, as a little dross is likely to remain under the surface and pass into the casting.

An aluminum casting has a characteristic cleanliness when removed from the mold and very little dressing is required. In grinding off any rough spots, workmen often find that the emery wheel has a tendency to gather particles which interfere with the grinding; I find that a little lard-oil or grease on the surface of the emery wheel will prevent this clogging and thus insure smooth cutting with maximum efficiency.

The difficulty of welding aluminum has been overcome by treating the surface to be welded with a mixture of alkaline chlorides and fluorides, which completely dissolves the film of oxides formed. In one method, a mixture of four parts of potassium chloride, three parts sodium chloride and one part of sodium fluoride with a melting point of about 660 deg. C. gives very satisfactory results.

Cracks, shrink-holes, pinholes or other defects can be filled by means of an oxy-acetylene blowpipe.

In connection with the work I have carried out on alloys of aluminum, I have found the laboratory an indispensable asset; the co-operation on the part of the chemist has elucidated difficulties which may otherwise have been left unsolved.

Notes on Oil Shale Industry

The Bureau of Mines has recently issued some notes on the oil shale industry which are preliminary to the publication of a general bulletin on this subject. The history of the industry and its status in Scotland and the United States are discussed, and the method of assaying oil shales used in the Bureau is compared with the procedure used by the largest of the Scottish producers. A selected bibliography of approximately a hundred references is appended.

Briquetting Mineral Phosphates

Reducing Conditions Being Essential in the Production of Phosphoric Acid by the Volatilization Process, the Authors Have Investigated the Briquetting of Mixtures of Florida and Tennessee Phosphates With a Reducing Agent (Coke, Coal, Peat)

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THE briquetting of metals or minerals for industrial use is practiced as a rule for one of two reasons: first, either to utilize natural deposits of finely divided minerals which must be in nodular or lump form in order to handle them with commercial success, or second, to eliminate the loss or waste resulting from other mining or manufacturing processes where large tonnages of ore fragments and metallic filings and trimmings are produced. In countries therefore where natural deposits of high-grade coal and metallic ores have become less plentiful the science of briquetting and the perfection of briquetting machinery have made their greatest advances. As an example of this the general type of machine so successfully employed in making fuel briquets was long known as the Belgian roll press, because it originated in Belgium.

While briquetting has been practiced in certain European countries for many years, it is a comparatively new development in the United States, largely because our natural resources have been so great that we have felt little need to economize or to utilize fully our industrial wastes. Up to the present most of our effort has been spent upon the briquetting of the dust and culm incidentally obtained in the mining and preparation of anthracite coal, and so successful has the briquetting of coal proved that, according to the figures of the U. S. Geological Survey,¹ our output in 1918 amounted to 477,235 net tons. With the gradual exhaustion of the cream of our better grades of ore, however, and an ever-growing tendency toward greater efficiency in industry, briquetting processes promise to occupy a much wider field.

According to Stillman² investigations have been made and considerable success has been attained in the briquetting of a great variety of materials, such as carbonized lignite, hard steel, copper and tin ores, hardwood, metal leaf, and paper, sawdust and copper, steel and brass trimmings.

Recent advances on a new process of producing phosphoric acid from mineral phosphates has made the briquetting of phosphate rock a matter of considerable interest, and it was with a view to determining how widely applicable this method might prove to our more important phosphate deposits that the work described herein was undertaken.

THE DEVELOPED PHOSPHATES OF THE UNITED STATES

While the United States possesses larger known deposits of phosphate rock than any other nation in the world, our supplies at present are drawn from two main phosphate fields—namely, those of Florida and Ten-

nessee. The deposits in our Western States (Utah, Idaho, Wyoming and Montana), though vastly greater than those in the East, are so far removed from the fertilizer market that they are being exploited at present to only a limited extent. In both Florida and Tennessee a considerable quantity of the higher grade rock has already been mined, and though these fields are by no means exhausted, very elaborate and costly mining methods must now be employed in order to obtain the grade of phosphate rock which the fertilizer operator demands for the manufacture of acid phosphate. Modern methods of preparing phosphate for the market involve washing and screening the rock, which entail a considerable loss of finely divided phosphate due to its discharge upon the dumps along with the impurities carried in the deposits.³ The impurities thus removed are mainly silica and the oxides and phosphates of iron and aluminum, the first-mentioned being objectionable because of its diluting effect and the two latter chiefly because of the undesirable chemical and physical properties which they impart to the product.

THE VOLATILIZATION PROCESS OF OBTAINING PHOSPHORIC ACID

The process which has been receiving considerable attention within recent years is that based upon the volatilization of phosphoric acid from mixtures of phosphate rock, sand and coke by heating such mixtures to smelting temperature. Since the presence of silica or silicates is essential to bring about the chemical reactions involved, it is not necessary to employ high-grade phosphate rock for this process—in fact, if the furnace plant is located at the phosphate mines, it would be a foolish practice to eliminate the silica present in the deposit by a costly washing and screening process only to put this material back in order to obtain the proper lime and silica ratio required in the furnace charge. Moreover, the presence of a relatively high percentage of aluminum oxide or phosphate or both is apparently an actual help to the successful working of the process, since these compounds tend to lower the melting point of the slag obtained and thus facilitate the escape of the phosphoric acid.⁴ While the oxides or phosphates of iron are usually reduced to an iron-phosphorus alloy (ferrophosphorus), there is a ready market for this latter product and therefore the presence of iron in the phosphate deposit does not entail the loss of the amount of phosphorus equivalent to this metal.

Until the past year it was generally believed that the production of phosphoric acid by the volatilization process could be successfully and completely accom-

¹Tyron, F. G., "Mineral Resources of the U. S.," pp. 33-36 (1920).

²CHEM. & MET. ENG., vol. 22, No. 22, June 2 (1920).

³Waggaman and Wagner, *J. Ind. Eng. Chem.*, vol. 10 (1918), p. 353.

⁴Waggaman and Turley, *J. Ind. Eng. Chem.*, vol. 12 (1920), p. 646.

plished only in the electric furnace. Since phosphoric acid for fertilizer purposes must always be a relatively cheap product, it appeared doubtful if this process would have a very wide application in this country, because of the scarcity of cheap electric power. For this reason the Bureau of Soils in its laboratories for technical research undertook an investigation to determine if it were not possible to employ fuel for smelting mixtures of phosphate rock, sand and coke in lieu of the electric arc. This work has reached a status where it holds forth considerable promise of economic success,⁵ but the data so far obtained indicate that the successful briquetting of mine-run phosphates is a factor of very great importance to the commercial practicability of the process in Florida and Tennessee.

Experiments have shown that in order to obtain complete volatilization of the phosphoric acid from such mixtures it is highly important if not essential that reducing conditions be maintained within the mass of reacting materials until the charge is brought to a state of incipient fusion. These conditions are not difficult to maintain in the electric furnace, where the heat required in the smelting operation is not dependent upon oxidation, but where fuel is used as a heating source, air or oxygen must be introduced into the furnace in order to obtain the heat units necessary to attain a smelting temperature. If reducing conditions are maintained in such a furnace by the incomplete combustion of the fuel, not only is it difficult to obtain the temperature desired but in furnaces of the ordinary type a great loss or waste of combustible material results.

REALIZATION OF REDUCING CONDITIONS BY BRIQUETTING A MIXTURE OF PHOSPHATES AND COAL

After a considerable amount of experimentation it was decided that the most feasible method of bringing about the desired reactions in such mixtures as outlined above was to employ fuel from an outside source for the heating of the charge but to mix coke or some other carbonaceous material intimately with the phosphate rock and sand to act as the reducing agent. Even under these conditions, however, considerable difficulty was experienced in preventing this reducing agent from burning out of the charge and thus bringing the reaction to a standstill.

The most efficient form of furnace yet employed in trying out this method has been of a type combining the features of both the open hearth and blast furnaces in which the gases of combustion ascend through the green charge preheating it to the necessary temperature before it is fed upon the hearth. Since the mine-run phosphates of Florida and Tennessee could not be treated in their natural state in such a furnace because of the difficulty of forcing the phosphoric acid evolved and gases of combustion through a column of finely divided material, it soon became apparent that such material must be either nodulized or briquetted to allow a free passage for the gases between the interstices of the green charge. It was also found that by intimately mixing finely ground coke or other carbonaceous material with the sand and mineral phosphates and pressing or molding the mass into lumps the bulk of the reducing agent could be protected against oxidation and thus held available to bring about the necessary chemical reactions in the furnace. Because of the nature of the Florida

phosphates and certain advantages which fuel offered as a heating agent over the electric arc, briquetting appeared to be more feasible than nodulizing. According to investigations were undertaken to determine the most economic methods of making briquets from mixtures of phosphate rock, sand and coke for subsequent furnace treatment.

BINDING MATERIAL A PRIME FACTOR IN THE BRIQUETTING OF MINERALS

Investigations so far conducted on the briquetting of coal and lignite⁶ seem to show that the nature, quantity and value of the binder employed are the factors of prime consideration. The requirements which such a binder must fulfill are as follows: First, it must produce a briquet capable of withstanding the shocks incident to heavy handling and shipping; second, it should be practically waterproof, so the briquets will not disintegrate on exposure to wet weather; third, it must maintain its binding qualities on heating so that the briquet will not fall to pieces in the fire; fourth, it should add to rather than detract from the fuel value of the briquet; fifth, it must be sufficiently cheap to warrant the marketing of the briquets in competition with other fuels.

The problem of briquetting mineral phosphates is by no means analogous to that of briquetting coal, because even after the phosphate is briquetted it is still in the nature of a raw material which must be treated at its source of supply before it can be converted into a marketable product. If the furnace process of producing phosphoric acid is to be employed in treating the run-of-mine phosphates of Florida and Tennessee, it is logical that the plant be located at or near the phosphate deposits. The handling of the briquetted charge, therefore, would be reduced to a minimum and there is little reason for making the briquets waterproof, since they would not have to be shipped or stored in the open. Moreover, inorganic binders which are considered so objectionable in making fuel briquets because of the extra ash which they add are permissible in the case of briquetting mineral phosphates provided they do not interfere with the chemical reactions involved in the furnace process. Finally, the fact that the use of briquets made from mine-run phosphates offers a promising means of eliminating what at present constitutes an enormous loss or waste of a valuable fertilizer asset and therefore the actual cost of briquetting might well exceed that of preparing high-grade phosphate rock for the market and still prove economical makes the problem distinctly different from that of briquetting coal, lignite or other fuel.

EXPERIMENTAL WORK ON BRIQUETTING FLORIDA PHOSPHATES

The first experimental work was conducted with Florida phosphates from both the hard rock and land pebble fields, using a small hand press capable of making only a single briquet at a time under a pressure of a ton to the square inch. Various organic and inorganic binders were tried on mixtures of sand, coke and high-grade (washed) phosphate rock from these sources, but none of them proved very satisfactory either on account of their weak binding action or because of their prohibitive cost. It was found, however, that the clay-like material which occurs in many of the deposits inti-

⁵Waggaman and Turley, *CHEM. & MET. ENG.*, vol. 23, p. 1057 (1920).

⁶Wright, C. L., *Bull.* 58, Bureau of Mines.

mately mixed with the phosphate rock acted as a very efficient binder when from 8 to 12 per cent of water was present in the final mix. Briquets were thus produced from run-of-mine phosphates (containing only natural binder) which proved so satisfactory in resisting severe shatter tests and in retaining their form unaltered during the preliminary heating in the furnace that large batches of material were made up and briquetted in roll presses of commercial size through the courtesy of the Lehigh Coal & Navigation Co., of Lanford, Pa., and the General Briquetting Co., of New York City. Briquets have thus been turned out in lots of several tons which were subsequently successfully treated in an oil-burning furnace at Arlington Farm, Va.⁷

DESCRIPTION OF THE PRESS USED

A number of mechanical and chemical problems arose, however, in connection with briquetting mineral phosphates and their subsequent use which it was deemed desirable to work upon, but in order to prepare the briquets for experimental purpose it was necessary to build a small briquetting machine which could also be depended upon to make up charges sufficiently large for treatment in a furnace of semi-commercial size. Ac-

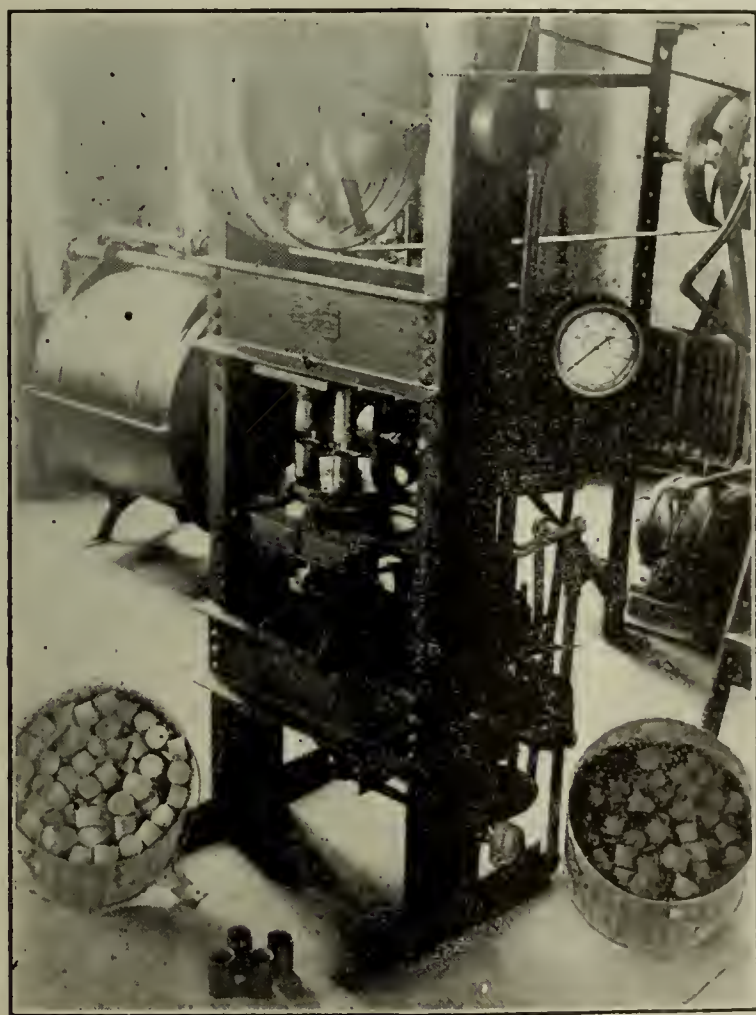


FIG. 1. BRIQUETTING MACHINE USED IN MAKING UP PHOSPHATIC CHARGES FOR FURNACE TREATMENT

Briquets of Florida phosphates on left and of Tennessee phosphates on right.

cordingly the machine shown in Fig. 1 was built from an old cider press and may be briefly described as follows:

Four vertical steel plungers $2\frac{3}{4}$ in. in diameter are rigidly bolted to the upper part of the steel framework of the machine. These plungers are directly above two horizontal steel plates fitted one above the other and

having four perforations in each corresponding in size to the plungers. The upper plate is held rigid and into its perforations are fitted four brass cylinders 3 in. in length which hold the mixture to be briquetted. By means of a lever the lower plate may be revolved so that the perforations therein will correspond to those in the upper plate and thus furnish a free passage for the plungers through each cylinder, or it may be so turned so as to close the bottom of the cylinders, forming a base upon which the briquets are pressed.

Both plates are mounted 3 in. above the bed plate of the press, which rests in turn upon the head of a 4-in. steel piston operating in a rigid sleeve. The necessary pressure is furnished by a small hydraulic pump operated by a 2-hp. motor.

To operate the press the piston is lowered by opening the valve controlling the water supply and permitting the water to flow back into its reservoir. The lower one of the two horizontal plates is then turned so as to form a base for the brass cylinders fitted into the perforations of the upper plate, and into these cylinders is loosely packed the mixture to be briquetted. The hydraulic pump is now started and raises the piston head carrying the brass cylinders filled with phosphate charge, pilot rods guiding these cups so that the four plungers are forced into them, pressing the mixture into briquets. When the pressure reaches 2,500 lb. to the square inch the valve controlling the pump is momentarily released, the lower plate revolved so as to open the bottom of the cylinders, the pressure again applied and the briquets forced out. In actual operation eight brass cylinders are provided, so that while four briquets are being made the supplementary cylinders are being filled.

MECHANICAL AND CHEMICAL PROBLEMS INVOLVED IN BRIQUETTING MINERAL PHOSPHATES

The mechanical and chemical problems involved in the briquetting and use of mineral phosphates may be conveniently grouped as follows: (1) The mechanical composition of the material which best adapts it for briquetting purposes. (2) The chemical composition and its control. (3) The degree of fineness to which the mixture must be reduced to produce satisfactory briquets. (4) Methods of incorporating into the mixture the water necessary for imparting to the natural binder its cementing qualities. (5) The best proportion of water to use for this purpose. (6) The effect of reducing agents upon the briquets.

A number of experiments conducted with samples of mine-run phosphates from the Florida fields showed that satisfactory briquets could be made from mixtures of phosphate rock, sand and coke if the percentage of material classed as clay (according to the system of mechanical analysis employed in the Bureau of Soils⁸) was equal to or exceeded 20 per cent of the entire mass.

EXPERIMENTAL WORK IN BRIQUETTING TENNESSEE PHOSPHATES

It seemed desirable to ascertain if the briquetting process which proved successful with Florida phosphates could also be applied to the Tennessee phosphates, particularly to those deposits which require elaborate plants to prepare a product suitable for the fertilizer industry. Moreover, many of the deposits in the brown rock phosphate fields of Tennessee from

⁷Waggaman and Turley, CHEM. & MET. ENG., vol. 23, p. 1057 (1920).

⁸Bull. 84, Bureau of Soils (1912).

TABLE I. LOCATION, DESCRIPTION AND MECHANICAL ANALYSES* OF PHOSPHATES USED IN BRIQUETTING EXPERIMENTS									
Sample No.	Location	Thickness of Stratum	Description	Mechanical Analysis, per Cent					
				Fine Gravel, 2-1 Mm.	Coarse Sand, 1-0.5 Mm.	Medium Sand, 0.5-0.25 Mm.	Fine Sand, 0.25-0.10 Mm.	Very Fine Sand, 0.10-0.05 Mm.	Silt, 0.05-0.005 Mm.
1-T	Consolidated Phos. Co., Hickman Co., Tenn.	6 ft. 0 in.	Brown phos. containing lump rock	6.1	9.7	5.1	39.0	13.4	14.6
3-T	Deposit near Gallatin, Summer Co., Tenn.	4 ft. 0 in.	Brown disintegrated phosphate	5.4	6.3	2.4	20.5	19.4	18.3
4-T	Deposit near Gallatin, Summer Co., Tenn.	4 ft. 0 in.	Similar to No. 3-T	6.5	5.3	2.1	17.4	24.1	17.6
5-T	Deposit near Gallatin, Summer Co., Tenn.	2 ft. +	Muck overlying Nos. 3-T and 4-T	5.1	5.9	2.3	19.4	18.9	19.1
6-T	Ruhm Phos. Co., Mt. Pleasant, Maury Co., Tenn.	5 ft. 0 in.	Brown phos. containing lump rock	3.9	8.5	8.4	35.5	9.6	16.1
7-T	Ruhm Phos. Co., Mt. Pleasant, Maury Co., Tenn.	7 ft. 0 in.	Brown phos. containing lump rock	3.3	9.3	5.0	31.3	10.0	16.8
8-T	Ruhm Phos. Co., Mt. Pleasant, Maury Co., Tenn.	14 ft. 0 in.	Sample from upper end of waste pond	0.1	0.5	0.7	22.2	18.8	39.0
9-T	Ruhm Phos. Co., Mt. Pleasant, Maury Co., Tenn.	15 ft. 0 in.	Sample taken 63 ft. from 8-T	0.0	0.0	0.2	7.7	16.3	50.2
10-T	Ruhm Phos. Co., Mt. Pleasant, Maury Co., Tenn.	10 ft. 3 in.	Sample taken 63 ft. from 9-T	0.0	0.2	0.2	11.8	18.2	45.8
11-T	Ruhm Phos. Co., Mt. Pleasant, Maury Co., Tenn.	5 ft. 11 in.	Sample taken 63 ft. from 10-T	0.0	0.1	0.0	1.7	9.8	56.7
12-T	Ruhm Phos. Co., Mt. Pleasant, Maury Co., Tenn.	5 ft. 0 in.	Sample taken 63 ft. from 11-T	0.0	0.0	0.1	13.4	11.0	41.1
13-T	Ruhm Phos. Co., Mt. Pleasant, Maury Co., Tenn.	4 ft. 6 in.	Sample taken 63 ft. from 12-T	0.0	0.0	0.1	2.3	4.8	44.0
14-T	Charleston, S. C., Mining Co., Wales, Giles Co., Tenn.	10 to 20 ft.	Brown disintegrated phosphate	3.6	9.5	5.6	23.7	7.8	20.4
15-T	Int. Agric. Corp., Wales, Giles Co., Tenn.	10 to 20 ft.	High-grade disintegrated phosphate	2.6	7.5	5.1	26.8	9.3	18.4
16-T	Int. Agric. Corp., Wales, Giles Co., Tenn.	10 to 20 ft.	Low-grade disintegrated phosphate	0.8	2.4	1.4	41.1	7.9	13.8
17-T	Federal Chemical Co., Ridley Mines, Maury Co., Tenn.	15 ft. +	Sample phos. sand from waste pond	0.0	1.6	2.3	37.9	28.3	17.8
18-T	Federal Chemical Co., Ridley Mines, Maury Co., Tenn.	6 to 10 ft.	Mine-run brown phosphate	3.4	7.8	4.5	22.2	8.6	19.7
19-T	Federal Chemical Co., Ridley Mines, Maury Co., Tenn.	6 to 10 ft.	Mine-run brown phosphate	5.5	11.2	6.5	29.7	9.4	16.6
20-T	Federal Chemical Co., Ridley Mines, Maury Co., Tenn.	6 to 10 ft.	Mine-run brown phosphate	3.4	8.8	5.3	25.6	9.4	22.4
1-F	Downing Phos. Co., Bartow, Polk Co., Florida		Mine-run phosphate	4.8	12.1	6.9	26.5	5.8	7.6

* Mechanical analyses made according to the conventional method employed in classifying soil types in the Bureau of Soils.

which the high-grade lump rock has been removed are now being reworked and much valuable material recovered. There are also immense beds of disintegrated phosphate rock in the southern part of this state which are frequently so high in silica that it is uneconomical to mine them. The senior author made a trip to these fields early in the year to examine the nature of many of these deposits and to determine if it were possible to briquet the mine-run phosphates and utilize them in the furnace process. Average samples of from 200 to 250 lb. each were taken from the various deposits and both mechanical and chemical analyses were made. Most of the experiments described below were conducted with samples from the Tennessee fields.

In Table I is given the mechanical analysis of the phosphates on which briquetting experiments were conducted.

Inspection of Table I will show that as far as their mechanical composition is concerned all of the samples of phosphate, with the exception of Nos. 1-T, 6-T, 8-T and 17-T, contained sufficient material classified as clay to bind them into satisfactory briquets. But the ultimate mechanical composition of the mix depends also upon the amount of sand or rock which must be added

TABLE II. CHEMICAL ANALYSIS AND SILICA-LIME RELATIONS OF NATURAL PHOSPHATES

Sample No.	Chemical Analysis						Ratio SiO ₂ :CaO	Material Necessary to Give Ratio SiO ₂ :CaO = 59.0:41.0 = 1.439
	SiO ₂	CaO	P ₂ O ₅	Fe ₂ O ₃	Al ₂ O ₃	Total		
1-T	10.00	42.66	31.86	3.26	3.90	91.68	0.232	51.35
3-T	30.23	28.17	22.03	4.06	6.94	91.43	1.073	10.27
4-T	38.74	23.00	17.88	4.45	5.00	89.07	1.686	8.20
5-T	24.39	31.15	24.10	4.10	6.50	90.24	0.783	20.41
6-T	15.53	38.32	27.68	3.56	4.33	89.42	0.405	39.65
7-T	18.69	33.09	25.20	4.84	5.54	87.36	0.565	28.91
8-T	49.60	18.24	14.21	3.76	4.73	90.54	2.717	33.9
9-T	58.94	12.20	10.23	4.30	5.06	90.73	4.830	60.1
10-T	56.32	15.16	12.05	3.98	4.41	91.92	3.716	50.0
11-T	66.81	8.05	6.92	4.46	6.82	93.06	8.300	80.0
12-T	55.68	12.58	10.51	4.78	7.85	91.40	4.430	54.5
13-T	61.18	6.60	6.32	5.68	9.57	89.34	9.275	74.8
14-T	23.42	30.78	22.70	5.22	7.40	89.52	0.762	20.85
15-T	22.26	31.41	23.85	4.78	7.79	90.09	0.708	22.94
16-T	57.34	12.00	11.23	4.90	7.23	92.70	4.775	58.0
17-T	21.85	35.61	26.01	2.93	4.75	91.15	0.613	29.43
18-T	23.86	30.26	22.76	4.55	8.40	89.83	0.788	19.64
19-T	16.50	37.41	25.84	3.02	5.50	88.27	0.441	37.33
20-T	28.90	28.64	20.79	3.82	6.63	88.78	1.070	12.31
1-F	26.96	29.05	23.61	2.09	8.40	90.11	0.928	14.85

* The rock used in reinforcing the lower grades of phosphate was an average grade of pebble phosphate from the Florida fields.

to obtain the proper silica lime ratio in the furnace charge, therefore the fitness of these mine-run phosphates for briquetting purposes and subsequent furnace treatment must be determined by their chemical composition.

In Table II are given the chemical analyses of the same samples, together with the ratio of lime to silica therein. The quantities of sand or high-grade rock which must be added to 100 parts of the sample in order to obtain the proper relation between lime and silica to

TABLE III. BRIQUETS FORMED BY MIXTURES OF NATURAL PHOSPHATE ROCK, SAND AND COKE

Sample No.	Briquet Mixture			Calculated Composition of Briquet Mixture (Air Dried)					
	Rock Sample, G.	Sand, G.	Coke, G.	SiO ₂	CaO	P ₂ O ₅	Fe ₂ O ₃	Al ₂ O ₃	Coke*
3-T	100	10.27	15.05	32.31	22.47	17.60	3.24	5.54	12.00
5-T	100	20.41	16.40	32.80	22.80	17.62	3.00	4.75	12.00
7-T	100	28.91	17.55	32.70	22.59	17.20	3.31	3.78	12.00
14-T	100	20.85	16.47	32.25	22.40	16.54	3.80	5.39	12.00
15-T	100	22.94	16.75	32.35	22.50	17.09	3.42	5.58	12.00
18-T	100	19.64	16.30	32.00	22.23	16.75	3.35	6.18	12.00
1-F	100	14.85	15.65	32.10	22.25	18.10	1.60	6.44	12.00

* The fixed carbon plus ash considered as coke. The coke used in these experiments contains 14.9% of ash. An analysis of this ash showed that the coke in the briquetted mixture adds 0.98% SiO₂, 0.02% CaO, and 0.63% Al₂O₃, Fe₂O₃, to the mix.

bring about the reaction involved in the volatilization process are also shown in this table.

The phosphoric acid content of Nos. 8-T, 9-T, 10-T, 12-T, 13-T and 16-T are so low as to eliminate these samples as commercial possibilities unless they are reinforced with a considerably higher grade phosphate rock. Most of the samples low in phosphoric acid, however, were taken from the waste ponds of old phosphate plants and represent the detritus washed out from run-of-mine material in preparing a high-grade rock for the market. It will also be noticed that in almost every instance these lower grade phosphates contain a high proportion of both the clay-like binding material and silica and hence offer a promising source of material to mix with higher grade phosphates low in these two ingredients.

In Table III are given the quantities of sand, coke and better grades of mine-run phosphate used in making up the briquetted charge. The composition of the briquetted mixture (air dried), is also given in the same table.

In the cases of Nos. 14-T and 18-T the percentage of

phosphoric acid in the briquetted charge was somewhat lower than in the other mixtures. This is no doubt due to the fact that in addition to the lime combined with phosphoric acid a part of this base present in the original phosphate samples was in the form of carbonate and therefore the sand added to take care of the lime in this latter compound reduced the percentage of phosphoric acid in the briquets.

In Table IV the same data are given for mixtures of two or more samples of phosphate and the figures show how deposits of low-grade phosphate may be utilized by

TABLE IV. BRIQUETS FORMED BY MIXTURES OF HIGH-GRADE AND LOW-GRADE PHOSPHATE ROCK WITH COKE

Sample No.	Briquet Mixture — SiO ₂ : CaO :: 59.00 : 41.00			Calculated Composition of Briquet Mixture (Air Dried)						
	Rock Sample, G.	Sand, G.	Coke, G.	SiO ₂	CaO	P ₂ O ₅	Fe ₂ O ₃	Al ₂ O ₃	Coke*	
3-T	35.48		13.63	31.42	20.92	17.00	3.80	5.00	12.00	
4-T	64.52									
7-T	44.7									
8-T	55.3									
15-T	63.6		13.63	30.80	21.45	16.95	4.25	6.68	12.00	
16-T	36.4									
18-T	33.33									
19-T	33.33									
20-T	33.33	23.10	16.79	33.00	22.95	16.55	4.89	6.37	12.00	

* The fixed carbon plus ash considered as coke. The coke used in these experiments contains 14.9 per cent of ash. An analysis of this ash showed that the coke in the briquetted mixture adds 0.98 per cent SiO₂, 0.02 per cent CaO and 0.63 per cent Al₂O₃, Fe₂O₃ to the mix.

mixing the material with that from adjacent or nearby deposits of higher grade.

In preparing the materials for briquetting purposes they were first dried down to a point where they contained approximately from 2 to 4 per cent of moisture. They were then ground in a small grist mill and passed through a sieve having fifteen meshes to the linear inch. Although some preliminary experiments indicated that finer grinding imparted somewhat greater resisting power to the briquets, the difference between the durability of the briquets produced from the materials of these different degrees of fineness was not sufficiently great to warrant the additional expense involved.

One of the problems encountered in preparing the ground material for briquetting purposes is to find a satisfactory method of introducing the necessary water to give the mass its binding qualities. At least 10 per cent of water must be contained in the mixture before satisfactory briquets can be produced, and if this water is merely poured or sprinkled upon the material the clay contained therein has a tendency to ball up and prevent

the uniform distribution of the moisture. Introducing the water, however, by means of sprays or atomizers while constantly turning the mass gave a very uniform distribution and prevented the formation of clay balls. It was also found that if a basin-like depression were made in the pile of the charge to be briquetted and the necessary water poured into this basin and covered with dry material, at the end of eighteen or twenty hours the mass was in a fairly friable condition which admitted of thorough mixing.

The most satisfactory method of introducing the necessary moisture, however, particularly where the phosphate requires the addition of both sand and coke, is to mix the water with this sand and coke and then add these two ingredients to the phosphate mineral. This procedure seems to eliminate the difficulty encountered in the balling up of the clay contained in the mass.

In Table V the results obtained on briquetted charges of relatively high-grade phosphate, sand and coke are given. These briquets were made up with varying percentages of moisture and the shatter and compression tests were applied not only to the fresh briquets but to the air-dried and oven-dried samples as well.

With the exception of Nos. 3-T, 7-T and 1-F all of the briquets in the air-dried condition withstood a drop on a cement floor of from 6 to 8 ft. and a drop of 20 ft. or more upon a mass of other briquets. The drying of the briquets in an oven increased considerably the effec-

TABLE VI. SHATTER TESTS ON BRIQUETS MADE FROM MIXTURES OF LOW- AND HIGH-GRADE PHOSPHATE ROCK WITH COKE

Sample No.	Fresh Briquets —		Air-Dried Briquets —			Oven-Dried Briquets —		
	Weight, G.	H ₂ O, Per Cent	Shattered on Dropping to Cement Floor, Ft.	Shattered on Dropping to Cement Floor, Ft.	Withstood Drop on Mass of Similar Briquets, Ft.	Compression Test, Lb./Sq. In.	Shattered on Dropping to Cement Floor, Ft.	Withstood Drop on Mass of Similar Briquets, Ft.
3-T	118.5	12.00	12	12	18	728.0	14	20
4-T								
7-T	113.5	11.90	8	8	20	738.0	8	20
8-T								
7-T	103.0	14.30	10	10	20	960.0	10	20
8-T								
15-T	111.6	14.35	20+	10	20	1,004.0	18	20
16-T								
18-T								
19-T	121.6	11.02	9	8	15	811.0	11	20
20-T								

TABLE V. SHATTER TESTS ON BRIQUETS MADE FROM NATURAL PHOSPHATE ROCK, SAND AND COKE

Sample No.	Fresh Briquets —		Air-Dried Briquets* —			Oven-Dried Briquets —		
	Weight, G.	H ₂ O Per Cent	Shattered on Dropping to Cement Floor, Ft.	Shattered on Dropping to Cement Floor, Ft.	Withstood Drop on Mass of Similar Briquets, Ft.	Compression Test, Lb./sq. in.	Shattered on Dropping to Cement Floor, Ft.	Withstood Drop on Mass of Similar Briquets, Ft.
3-T	133.5	8.69	4	5	18	472.0	9	20
3-T	124.7	11.15	8	6	20	800.0	10	20
3-T	115.2	13.63	14	7	20	838.0	12	20
5-T	113.7	11.08	8	7	20	483.0	11	20
5-T	126.4	13.13	12	8	20	654.0	12	20
7-T	122.1	10.49	..	5	..	..	7	20
7-T	105.2	9.50	8	6	15	815.0	9	20
7-T	116.4	13.14	10	7	16	950.0	12	15
14-T	131.3	9.96	9	6	18	724.0	9	20
14-T	120.9	10.47	12	6	18	793.0	10	20
15-T	121.7	9.53	6	8	20	407.0	11	20
15-T	119.2	12.35	20	7	20	894.0	13	20
15-T	115.7	12.62	12	11	20	538.0	10	20
18-T	120.6	13.27	20+	8	20	887.0	13	20
1-F	107.0	11.21	5	4	..	..	6	14
1-F	105.5	13.53	10	5	..	..	9	16
1-F	108.7	13.45	20+	..	..	..	8	20

* Average weight = 109.0 g. Average H₂O content = 2.95%

tiveness of the binder, but in actual commercial practices it would scarcely be economically feasible to dry the briquets in this way. In furnace practice, however, the briquets would never be subjected to a drop of over 15 ft. upon a mass of similar briquets, and therefore for practical purposes they would meet all requirements.

In Table VI the same tests are given on briquets made up of two or more samples of phosphate rock, and it will be noted that these briquets were even more satisfactory than those given in Table V. The figures given in these tables seem to show that the moisture content required for the successful briquetting of the mixtures employed range from 8½ to 14 per cent, but on the whole briquets of a very satisfactory nature can be obtained where the average moisture content is between 10 and 12 per cent.

In order to determine the effect of high heat upon the briquetted samples a number of freshly made briquets with their full percentage of moisture were placed in a muffle furnace heated to bright redness (1,000 deg. C.). These briquets showed no signs of splitting or disinte-

grating when submitted to this severe test, but shatter tests subsequently conducted with them indicated that the internal stress set up by the rapid elimination of moisture weakened them to a slight extent. In no instance, however, was this weakness sufficiently pronounced to render them unfit for furnace use.

BITUMINOUS COAL AND PEAT AS REDUCING AGENTS

Because of the difficulty of grinding coke, its abrasive action on milling machinery and the difficulty of obtaining an adequate supply at a low price in those phosphate fields far removed from the coke ovens or municipal gas plants, a number of experiments were made to determine if bituminous coal or peat might be employed as the reducing agent in the briquetted charge.⁹ It was feared that the high percentage of volatile matter in these materials would cause the briquets to split open at the temperatures attained in the furnace, particularly if sufficient amounts were added to give the same quantity of fixed carbon supplied by the coke. Moreover, it seemed likely that in order to burn completely the extra amount of combustible gas evolved from such briquets in actual furnace practice so much air must be drawn into the system that the efficiency of the towers for collecting or absorbing the phosphoric acid would be considerably reduced.

The briquets made up with these two reducing agents stood up very well under the shatter test employed, though those containing peat were rather light and somewhat weaker than the coal and coke briquets.

By referring to Table VII it will be noted that where bituminous coal was employed as a reducing agent the amount used in making up the briquets supplied only

TABLE VII. APPROXIMATE ANALYSIS OF COKE, BITUMINOUS COAL AND PEAT, QUANTITIES USED IN BRIQUETTED CHARGE AND AMOUNT OF FIXED CARBON CONTAINED IN BRIQUETS BEFORE AND AFTER HEATING

Material	Approximate Analyses, Per Cent				Amount Added to Briquetted Charge, Per Cent	Amount of Fixed Carbon in Briquets	
	Moisture	Volatile Matter	Fixed Carbon	Ash		Dried Briquet, Per Cent	Heated to 1,000 Deg. C., Per Cent
Coke.....	0.38	0.84	84.59	14.19	12.00	10.40	9.61
Bituminous Coal	4.15	35.72	48.15	11.99	18.50	9.16	11.73
Peat.....	10.97	52.93	30.30	5.80	19.37	6.10	4.83

88.0 per cent as much fixed carbon as was furnished by the coke and where peat was used it was added in quantities supplying only 58.7 per cent as much fixed carbon as was furnished by the coke.

The coal and peat briquets made up in this manner when ignited in a muffle furnace at 1,000 deg. C. soon burst into flame, but did not split open or disintegrate as expected, although the latter briquets subsequently showed considerable porosity. The same thing held true when the briquets were placed in a forge fire, except in the latter case a glaze or slag formed over their surfaces, protecting more efficiently the carbon in the interior from oxidation.

Upon breaking open the briquets subjected to this treatment, the carbon content of those made up with bituminous coal was found so uniformly distributed throughout the mass and apparently in so much larger quantities than in the coke briquets submitted to the same treatment that it seemed probable that some of



FIG. 2. SAMPLES OF BRIQUETS (AFTER HEATING IN MUFFLE AND FORGE FIRE) MADE FROM TENNESSEE MINE-RUN PHOSPHATES MIXED WITH VARIOUS REDUCING AGENTS

Note the distribution of carbon in those made up with coal and peat (two piles to right) as compared with those in which coke was used (pile to left of center).

the volatile hydrocarbons had decomposed within the briquets and deposited their carbon content. The difference in the appearance of the briquets made up with coke, coal and peat is shown in Fig. 2.

Analyses of the ignited briquets bore out this assumption, since the actual fixed carbon found in those made up with coal was higher after ignition than before and surpassed the fixed carbon content of the briquets made up with coke. The approximate analyses of the reducing agents used, the quantities added and the fixed carbon content of the briquets before and after ignition are given in Table VII.

The fixed carbon content of the ignited coal briquets shows that over 35 per cent of the volatile matter was retained within the mass as precipitated carbon, but those briquets in which peat was used actually showed a loss of fixed carbon due probably to the fibrous nature of the peat and the consequent porosity of the briquets in which this reducing agent was used.

The deposition of carbon through the mass of finely divided minerals in the coal briquets should insure quicker and more complete reactions between the ingredients in the furnace charge and make it possible to reduce the percentage of coal used at least 18 per cent below that which was first deemed necessary.

While the results obtained with peat as a reducing agent were not as promising as those obtained when coal was employed, the indications are that the former may be used to replace at least part of the coke or coal required. It is realized that the final proof of the effectiveness of these materials in lieu of coke and the practicability of using them in the volatilization process of producing phosphoric acid must rest in the actual furnace tests which are now being planned; nevertheless the results obtained with coal are very encouraging and give promise of further reducing the cost of preparing the phosphatic charge for subsequent furnace treatment.

Chinese Vegetable-Tallow Industry

Exports of vegetable tallow from China total annually about 200,000 piculs (1 picul = 133½ lb.), most of which, before the war, was sent to the Netherlands, France and Germany. Now, however, the United States, Italy and Great Britain have become the chief buyers. The following figures quoted from the Chinese Maritime Customs show the exports of the commodity in China's trade from 1914 to 1920, in piculs: 1914, 190,094; 1915, 181,482; 1916, 256,960; 1917, 151,385; 1918, 162,881; 1919, 164,544; 1920, 69,118.

⁹Peat is available in large quantities close to the Florida phosphate fields, and bituminous coal from Kentucky is the chief fuel used by the Tennessee phosphate operators.

Eliminating Blow-Holes in Thermit Welds

A NEW grade of molding material for Thermit welding has recently been developed by the Metal & Thermit Corporation, New York, which, as proved, will definitely prevent blow-holes and assure sound welds.

The design of the new molding material, designated as "Thermit Molding Material," is based on the theory that good silica sand will stand the heat of the Thermit reaction very well and that the weakness in all molding material is the clay binder. Therefore there should be as little clay as possible in the mixture, in order to make the mold more refractory and to increase its porosity. Plastic clay has been selected instead of a fireclay. The sand and plastic clay are ground together in a foundry pan or moller, with the intention of coating each grain of sand with a minimum thickness of clay. This gives a good, clean molding material, which should be rammed hard in the mold, which will stand up well under the pre-heating flame and which is extremely porous to the gases generated in the mold, resulting in a sound weld with a very clean exterior.

THE MIXTURE USED

The mixture now being used is composed of the following: Three parts clean, sharp silica sand (100 per cent of which should pass through a screen having a 0.03-in. square opening, and 40 per cent of which should be retained on a screen having a 0.012-in. square opening), mixed with 1 part Welsh Mountain plastic clay. These parts are first thoroughly mixed in the moller together with one-fortieth part glutrin by volume and sufficient water (one-twelfth part) to bring to the proper consistency. If mixed by hand, the sand and clay must be dried before mixing (being careful not to subject the clay to a temperature higher than 400 deg. F.) and thoroughly mixed before adding the glutrin and water. The glutrin should be mixed with the water before adding to the sand and clay.

In case a plastic clay fatter than the Welsh Mountain be used, the mixing, of course, will have to be more thorough and less clay used. Welsh Mountain clay is being used in the present mixture because in carefully run tests it has proved to be the most refractory. The use of the new molding material necessitates harder packing next to the weld; in fact, the regular Thermit rammer may be supplemented by the use, for instance, of a tool having an end $\frac{3}{8} \times 1\frac{1}{2}$ in., so that the operator may be able topeen the sand next to the wax collar and the various patterns.

PRECAUTIONS THAT ARE ESSENTIAL

It is absolutely essential, in the production of sound welds, to be sure that no loose sand exists in the mold when the Thermit steel is poured. This is why very hard ramming is advocated, also why it is most important to blow out all loose material from the interior of the mold by putting the pre-heating burner in the riser before the heating gate is plugged and being sure that no sand is detached by the operation of inserting this heating gate. The burner should be removed from the riser before plugging the heating gate, because otherwise it may detach some sand, which could not be blown out after the plug is in place. The heating gate plug should be thoroughly dry, and if it has been car-

ried in stock for some time, it should be warmed before using.

By perforating the sides and bottom of the mold box, the escape of the gases which pass through the molding material is greatly facilitated; $\frac{3}{4}$ -in. diameter holes, spread 3 or 4 in. apart, are sufficient. To facilitate the escape of gas from the bottom of the mold box, the mold should rest on blocks, not directly upon the foundry floor.

As unnecessary molding material simply increases the resistance to the passage of gas, the mold box should be made as small as possible commensurate with safety. For example, in welding a 4 x 4-in. section, only about 4 in. of sand is necessary at all points, except perhaps on the pouring gate side. It is most important thoroughly to vent the mold box by forcing a rod or wire down at a number of points to within $\frac{1}{2}$ in. or so of the collar. Care should be taken that these do not touch the collar, because such vent holes will fill with steel and will therefore not facilitate the escape of gas.

Recent Chemical & Metallurgical Patents

British Patents

For complete specifications of any British patent apply to the Superintendent, British Patent Office, Southampton Buildings, Chancery Lane, London, England.

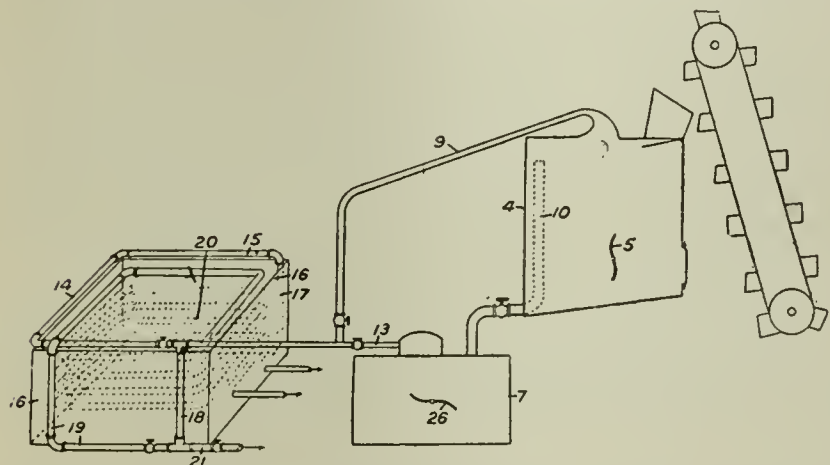
Alkaline Earth Chlorides.—Calcium, magnesium and other alkaline earth metal chlorides in anhydrous condition suitable for electrolysis are obtained by adding ammonium chloride and the oxide, hydrate, carbonate or oxychloride of the alkaline earth metal to a melt of one or more haloid salts of a metal electropositive to the alkaline earth metals, such as a mixture of sodium and potassium chlorides, and collecting the ammonia or ammonium carbonate evolved. The ammonium chloride may be 10 to 20 per cent in excess of the theoretical quantity. The ammonia or ammonium carbonate is converted into ammonium chloride for re-use by combining it with hydrochloric acid obtained by passing a mixture of chlorine and steam over carbon heated to 300 deg. C. (Br. Pat. 163,304; not yet accepted. Minami Manshu Tetsudo Kabushiki Kaisha, assignees of I. Namari, Osaka Fu, Japan; July 6, 1921.

Extracting and Separating Metals.—(The production of one salt from a mixture of oxides such as that obtained by roasting a sulphide ore is effected by submitting the mixture to the action of a gaseous acid radical under such temperature and with such pressure of the acid radical as will effect the preferential reaction desired. The invention is described in connection with the treatment of a mixture of copper and iron oxides obtained by roasting copper pyrites. This mixture is heated with sulphur trioxide under the necessary conditions at a temperature of about 620-700 deg. C., when copper sulphate alone forms. The invention is applicable to the formation of other salts such as chlorides, and to the treatment of various mixtures of oxides. The separation of copper and nickel and the extraction of aluminum salts from bauxite or other materials are mentioned. In a similar manner a mixture of salts of the same acid radical may be treated in order to effect the decomposition of one but not of the other. (Br. Pat. 163,348. W. J. Niiranen, Helsingfors, Finland, and A. Hibbert, Bexhill, Sussex; July 6, 1921.)

Casein Cements.—Powdered glue or gelatine is incorporated with the normal constituents of a casein cement in powder form. A material such as an alkali salicylate,

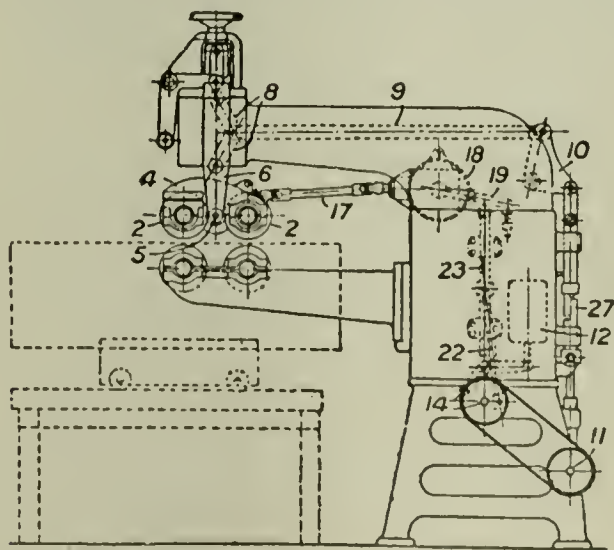
benzene or naphthalene sulphonate, may be added to facilitate the solution of the glue in cold water. An example is given of a powdered cement containing casein, lime, gelatine or glue, sodium fluoride and sodium naphthalene sulphonate. (Br. Pat. 163,349. P. H. W. Serle, London; July 6, 1921.)

Distilling Waste Grease.—Waste roll or axle grease or pitch obtained from steel-works, tin-plate rolling mills, etc., is distilled to obtain oils and greases, and, in some cases, a residue of coke. The waste grease is melted in a primary



still 4, from which the vapors are led by a pipe 9 to a condenser. The melted grease is drawn off by a perforated pipe 10 to a main still 7. The vapors pass to a condenser in which, by means of cocks, alternative passages may be opened. The light vapors are passed through pipes 18, 19 and a coil 20 immersed in a cooling tank 16. The middle vapors are passed through pipes 14, 15 and a pipe 17 in the cooling tank and the heavy vapors through pipe 18 and an exit pipe 21. A tank containing a freezing mixture may be used to condense very light vapors. Air may be injected into pipe 13 to assist in condensing the heavy vapors. Stirrers 5, 26 are provided in the stills 4, 7. The liquid residue from the still 7 may be distilled in a separate still to form coke. (Br. Pat. 163,056. L. Lane and D. H. Williams, both in Glamorgan; July 6, 1921.)

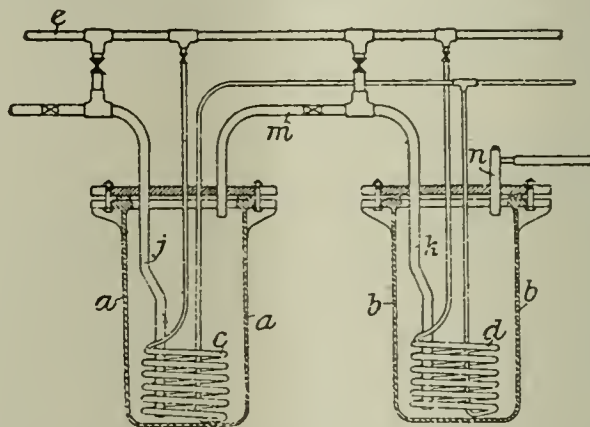
Electric Welding.—Thick metal plates or sheets, etc., are electrically welded by two pairs of intermittently rotated roll or wheel electrodes, current being on only when they are stationary. The work may be fed between the electrodes, or the electrodes traversed over the work. The pairs of electrodes may be arranged in tandem so that the parts left unwelded by one pair are welded by the second pair or they may be arranged so that the axes of the upper electrodes and also those of the lower electrodes are coincident, the two



lower electrodes in this case being practically in one. In the former case the shafts may be spaced well apart or may be close together so that the welds partly overlap. The upper electrodes are connected to the terminals of the transformer secondary, and the lower electrodes are electrically connected together. In the tandem arrangement shown, the upper electrodes 2 are mounted in a carrier 4 pivoted at 5 to the slide 6 so that they always bear evenly on the work. The slide is operated by a toggle 8, rod 9, bell-crank 10 and rods 27 from the shaft 11. The electrodes are rotated inter-

mittently by spur and worm gear through a shaft 17, which is rotated by gearing through a ratchet wheel 18 operated by a pawl lever 19 from a crank-shaft 14 through rods 22, 23. The current is put on when the electrodes are stationary by a switch 12, operated by a cam on the shaft 14, which is driven by a belt from the shaft 11. The electrodes are further pressed down when the welds are made to put the welds under pressure. (Br. Pat. 163,083. British Insulated & Helsby, Charles Ltd., and L. B. Wilson, Prescot, Lancashire; July 6, 1921.)

Converting Oils and Fats Into Triglycerides.—Fatty acids, or oils or fats containing free fatty acids, are converted into triglycerides by heating with glycerine to a temperature of 200-250 deg. C., whereby the glycerine reacts in the vapor state. According to one method of procedure, the glycerine contained in a still *a* is carried over by superheated steam into a vessel *b* containing the fatty acid or oil or fat containing free fatty acid, the superheated steam being admitted to the vessels *a*, *b* by pipes *j*, *k* connected with the main pipe *e*. Both vessels are provided with heating coils *c*, *d* and are subjected through pipes *m*, *n* to the action of a vacuum pump. In an alternative method, the glycerine is introduced in the liquid form into the bottom of a still containing the fatty acid material heated to the requisite temperature; in this case, an addition of 2 per cent of water



to the glycerine favors its vaporization. Any known catalyst may be employed, together with means for agitating the material. Mono- and di-glycerides can be produced by combination with the requisite amount of glycerine vapor. (Br. Pat. 163,352. E. R. Bolton and E. J. Lush, both of London; July 6, 1921.)

Ammonium Salts.—Residual liquor from the ammonia-soda process containing principally ammonium chloride and carbonate and sodium chloride is heated to near its boiling point until all the ammonium carbonate and free carbon dioxide are evolved. The ammonium carbonate or mixture of carbonate and bicarbonate is collected in the solid condition; preferably carbon dioxide is introduced if necessary so that all the ammonium is in the form of bicarbonate. The liquor is concentrated to one-third to two-thirds its volume and cooled to below 25 deg. C., when technically pure ammonium chloride crystals are obtained. After filtration, the mother liquor is again concentrated at its boiling point to one-third to two-thirds its volume, in order to separate sodium chloride. The latter is removed as nearly as possible at 110 deg. C., the boiling point of the solution. The liquor now contains ammonium chloride and sodium chloride in approximately the same proportion as the original solution and may be treated as above described, but preferably fresh residual liquor is first added. The ammonium chloride contains only small quantities of sodium chloride and is suitable as a manure, but it may, however, be purified by recrystallization or sublimation. (Br. Pat. 164,001; not yet accepted. Elektrizitätswerk Lonza, Basel, Switzerland; July 20, 1921.)

Soluble Silicates.—Soluble silicates of high silica content are prepared by dissolving silicic acid in alkali silicate solutions obtained by fusing silica and alkali, or silica, alkali and borax, and treating the cooled and broken melt with water. The silicic acid is prepared, for example, by adding sulphuric acid to cold water-glass solution and after dialysis is dissolved in the silicate solution, by continued grinding or agitation. (Br. Pat. 163,877. F. J. Phillips, London; July 20, 1921.)

Current Events

in the Chemical and Metallurgical Industries

Special Duties Continued on Coal-Tar Products and Dyes

Title V of the Act of Sept. 8, 1916, entitled "An act to increase revenue and for other purposes," imposing duties on dyes and other chemical coal-tar products, contains the following provision in section 501:

During the period of five years beginning five years after the passage of this act such special duties shall be annually reduced by 20 per centum of the rate imposed by this section, so that at the end of such period such special duties shall no longer be assessed, levied or collected; but if, at the expiration of five years from the date of the passage of this act, the President finds that there is not being manufactured or produced within the United States as much as 60 per centum in value of the domestic consumption of the articles mentioned in Groups II and III of section 500, he shall by proclamation so declare, whereupon the special duties imposed by this section on such articles shall no longer be assessed, levied or collected.

As a result of the coal-tar censuses taken by the Tariff Commission, the commission was able to report to the President that the domestic production of the articles enumerated in Groups II and III is much in excess of 60 per cent of the domestic consumption. The facts, therefore, do not call for the issuance of a proclamation removing the specific duties under section 501 of the act cited above.

Government to Study Helium Production

An engineering study of the whole subject of helium recovery at the Petrolia plant is to be made by a board of engineers which has been named by Director Bain of the U. S. Bureau of Mines with the approval of the Army and Navy Helium Board. M. H. Roberts, formerly chief engineer of the Air Reduction Co., is chairman of the board of engineers. The other members are R. C. Tolman, head of the Fixed Nitrogen Laboratory of the Department of Agriculture, and Prof. W. L. DeBaufre of the University of Nebraska, formerly an instructor at the U. S. Naval Academy.

The large-scale operations at Petrolia, Tex., have been discontinued due to the reduction made by Congress in the appropriation for this work. It is the intention to continue the study on a small scale along the lines which will be designated by the new board of engineers.

In the fiscal year ended June 30, 1921, the Army transferred \$545,200 to the Bureau of Mines for helium work. During the same period, the Navy transferred \$207,500 to the Bureau of Mines for the same purpose. The allocation of the fund was as follows: operation and maintenance of helium plant No. 3, at Petrolia, Tex., \$425,000; equipment of cryogenic laboratory, at Washington, D. C., \$15,000; operation and maintenance of cryogenic laboratory, \$61,000; helium laboratory, Fort Worth, Tex., \$18,000; helium storage, Pittsburgh, Pa., \$1,000; railroad repurification unit, Washington, D. C., \$25,000; helium repurification plant, Langley Field, Va., \$42,700; helium gas leasing fund, \$150,000; co-operative work at Massachusetts Institute of Technology, \$3,000; co-operative work at Harvard University, \$2,000, and for other helium work, \$10,000.

Phosphates in Morocco

Five hundred tons of phosphates from Onedzem are now being shipped weekly to France. It is estimated that the yearly output at Onedzem will reach 500,000 tons in 1926, 1,750,000 tons in 1930 and 3,000,000 tons in 1940.

Germany Advances Prices of Dyes

Manufacturers in Germany have advanced the prices of dyes for silk piece goods 300 per cent.

Appointment of Chemistry Chief to Be Delayed

In all probability no nomination will be made until after the first of the year to fill the vacancy made by the resignation of Dr. Carl L. Alsberg as chief of the Bureau of Chemistry of the Department of Agriculture. Despite earnest efforts on the part of Dr. E. D. Ball, Assistant Secretary of Agriculture, who is handling the matter, no properly qualified chemist has been found who is willing to take the place at the present salary of \$5,000. As a result of that situation, it is understood that an appropriation of \$7,500 will be asked. No action on such an appropriation is likely before March. Last year the appropriations committees declined to increase the salaries of any one position until a report could be had from the reclassification committee. When that report is in hand it is expected that there will be a uniform increase in the salaries of all heads of bureaus, as well as in many subordinate positions.

Protest Spanish Tax on Pyrites

Spain's proposal to place an export tax of eight pesetas per metric ton on iron pyrites is receiving active attention at both the State and Commerce Departments. Informal protests already have been filed with the Spanish Government and the matter has been discussed extensively by the Spanish Ambassador to Washington and representatives of the sulphuric acid industry. A decision by the Spanish Government is expected before the end of September. If it should be decided to impose an export tax on pyrites of even as much as \$1 per ton, it would act as a very decided stimulus to the domestic sulphur industry and probably would encourage considerable activity in the mining of pyrites in the United States.

Ask Embargo on Chemical Stoneware

The manufacturers of chemical stoneware have joined in submitting a brief to the Finance Committee of the Senate asking that their products be protected by a duty of 200 per cent, which they admit to be practically an embargo. The tariff bill as passed by the House provides a duty of 35 per cent ad valorem on chemical stoneware, chemical porcelain and other vitrified wares. The manufacturers of stoneware contend that their industry is relatively of as great importance as is the dye industry, since carefully and laboriously made stoneware is absolutely essential in the handling of acids, alkalis and other chemicals. It was pointed out that no machinery is used in this industry except in the grinding of the clay. Labor, which must have a special expertness, represents more than 80 per cent of the total cost of the finished product. It was contended that chemical stoneware should be taken out of the paragraph containing porcelain and other vitrified ware and placed in a paragraph by itself.

American Wood Preservers' Association Establishes Service Bureau

To promote the use of wood properly treated to resist decay, marine borers and insect attack, thereby aiding in the conservation of the forest resources of the nation, the American Wood Preservers' Association has established a Service Bureau.

The value of wood for construction purposes is fairly well understood, but for permanent structures treatment with a standard preservative, such as creosote or zinc chloride, is absolutely necessary. The policy of the Service Bureau is to give the public reliable information on the treatment of timber according to the standards of the American Wood Preservers' Association, and on the use of treated wood. The bureau is located at 1146 Otis Building, Chicago. P. R. Hicks is secretary-manager.

T.A.P.P.I. Meeting

A joint meeting of the Technical Association of the Pulp and Paper Industry and the American Pulp and Paper Mill Superintendents' Association will be held at Washington, Oct. 18 to 21, with headquarters at the New Willard. The preliminary program follows:

TUESDAY, OCT. 18

9 a.m.—Assemble at Industrial Building of the Bureau of Standards for reading and discussion of papers in general and group meetings arranged by T.A.P.P.I. Service Committee, and committee of A. P. & P. M. S. A.

12:30 p.m.—Luncheon, Bureau of Standards.

2 p.m.—Inspection of sections of the Bureau of Standards; visit to paper and dye laboratories of the Bureau of Chemistry; optional visits to Government Printing Office, Bureau of Engraving and Printing, and mill of District of Columbia Paper Manufacturing Company.

7 p.m.—Supper at New Willard Hotel, followed by smoker, and continuation of papers, group meetings and discussions.

12 m.—Take Pullman cars for York, for visits to York, York Haven and Spring Grove, Pa.

WEDNESDAY, OCT. 19

Mill and plant visitations in York, York Haven and Spring Grove, Pa. Leave Washington for York, Pa., by midnight train. Breakfast on arrival at York. Visits to plants in York and York Haven, followed by trip to Spring Grove in afternoon. Leave York for Philadelphia in evening.

THURSDAY, OCT. 20

Breakfast in Philadelphia at Bellevue-Stratford, association headquarters, where members and guests will register for visits to the various mills and plants to be inspected during the day.

7 p.m.—Banquet at Bellevue-Stratford.

FRIDAY, OCT. 21

Excursion to Wilmington, Del. Leave Philadelphia for Wilmington by early train. Breakfast at cafeteria of Pusey-Jones Co. on arrival, followed by visits to plants as follows: Pusey-Jones Co., du Pont Co.'s plant at Carney's Point, inspection of laboratory and dye works of the du Pont Co.

Naval Stores and Fertilizer Movement for the Past Fiscal Year

The data on the movement of naval stores—rosins and turpentine—show a marked decrease in the demand for domestic rosins, with almost as great an increase in the call for our turpentine, as compiled by the Bureau of Foreign and Domestic Commerce for the fiscal year ended June 30.

During the past three years American rosin was purchased abroad to the following extent: 881,777 bbl., valued at \$11,323,381, in 1919; 1,322,034 bbl., valued at \$24,847,691, in 1920; and 877,160 bbl., valued at \$10,364,804, in 1921. The decrease in quantity during the past year was 34 per cent; the average price per barrel, however, dropped from \$18.80 to \$11.82. During the month of June there was a noticeable increase in this product and exports advanced from 70,938 bbl., valued at \$1,306,279, for June, 1920, to 101,189 bbl., valued at \$516,791, in 1921. The price one year ago was \$18.79 per bbl. For June, 1921, it averaged \$11.82.

The sales for export on our spirits of turpentine amounted to 8,064,578 gal. (\$6,069,853) in 1919, 7,461,355 gal. (\$11,121,864) in 1920 and 9,741,711 gal. (\$11,279,353) in 1921. The increase during the past year was 30.7 per cent. The price per gal. averaged \$1.49 in 1920 and \$1.16 during the past fiscal year. A pronounced increase in shipments of turpentine was recorded in June. A year ago figures for the month were 360,213 gal., valued at \$664,655. In June, 1921, there was 1,477,416 gal., invoiced at \$867,302. The export price of \$1.84 per gal. in June, 1920, fell to 59c. in June, 1921. Great Britain takes 53 per cent of our shipments of turpentine; Canada is next with 9.6 per cent. Other leading markets in decreasing order of importance are Holland, Belgium and Argentina. Great Britain is also the leading market for American rosin, purchasing 33 per cent. Brazil takes 14 per cent, Argentina 12 per cent, Canada 9.6 per cent and Australia 4.6 per cent.

Tar, pitch and minor naval stores were exported to the extent of 48,008 bbl., valued at \$384,263, during the fiscal

year 1919; 61,790 bbl. (\$534,175) in 1920, and 41,864 bbl. (\$380,267) in 1921. In June, 1921, the exports in this class were 2,098 bbl., valued at \$15,857, as compared with 5,357 bbl. (\$49,730) during the previous year.

The total value of our exports of naval stores amounted to \$17,777,497 in 1919, \$36,503,720 in 1920 and \$22,024,424 in 1921. In the fiscal year 1913-1914 it was \$19,882,165.

In volume our shipments of rosin for the past year were 36 per cent of the exports of seven years ago. Turpentine shipments are now but one-half those recorded just before the war. Tar and pitch have dropped 88 per cent.

The fiscal year figures covering the fertilizer materials show a slight gain over the previous year. During the month of June, however, the imports became practically negligible, while the exports were about one-third the value and two-thirds the volume for the same month in 1920. In the latter month we exported 112,708 long tons of fertilizers valued at \$2,862,688. In June this year the shipments were 75,391 long tons, valued at \$971,757. The heaviest reductions were in ammonium sulphate and miscellaneous fertilizers and also in superphosphates, which fell from 1,038 to 70 tons. Raw phosphate rock decreased 23 per cent. Imports in this group amounted to 96,796 tons in June, 1920, valued at \$3,441,616. In June of this year the total was 4,642 tons, valued at \$183,983. This downward trend was most marked in the potassium salts group. The chloride dropped from 4,811 to 10 tons; manure salts from 24,642 to 105 tons.

During the fiscal year ended June 30, 1919, we imported fertilizers to the amount of 118,236 long tons, valued at \$5,883,376; 867,623 tons (\$38,578,063) in 1920; 608,287 tons (\$28,550,111) in 1921. During the past year, as compared with the previous one, there was a decrease of 30 per cent in volume and 26 per cent in value. The drop is less than that for chemical products in general, which is 30.5 per cent. Some increases in the volume of imports are recorded. Potassium sulphate and guano doubled; bone in various forms advanced from 7,340 to 27,413 long tons; on the other hand, calcium cyanamide dropped 50 per cent; manure salts 51 per cent; potassium chloride 55 per cent.

There was a drop of 24.8 per cent in the value of fertilizers exported during the fiscal year 1921. The outward movement in 1919 was 346,944 long tons (\$9,405,242); in 1920 it reached 1,129,369 tons (\$33,243,411); in 1921 it totaled 1,147,864 tons, of a value of \$24,969,271. Superphosphates lost 68 per cent, and ammonium sulphate dropped 58 per cent in quantity and 40 per cent in value. Ammonium sulphate itself has become a leading factor in our fertilizer exports. During the past year it constituted 30 per cent of the total value. Noteworthy is the movement of ammonium sulphate. During 1913-14 we imported 74,440 tons. In the fiscal year just ended our imports were 2,537 tons, while we shipped abroad 65,915 tons—almost as much as we purchased from Europe seven years ago.

New Navy Wage Scale Fixed

The Navy Wage Board has recommended and the Secretary of the Navy has approved a new schedule of wages for all the employees of the navy establishments. The schedule for chemists ranges from \$10.56 per day to \$7.20 per day. Chief chemists are to receive \$11.36 per day. Assistant chemists are to receive from \$6.88 to \$4.88. Chief metallurgists are to receive \$3,000 per annum. Assistant chief metallurgists are to receive \$8.32 per day. Chemical laborers are to receive \$5.36 and \$4.56 per day.

Ford Invited to Washington

The Secretary of War has invited Henry Ford to come to Washington to discuss Mr. Ford's proposal to take over the Muscle Shoals water power project and nitrate plant. At the time of this writing, Secretary Weeks had not heard whether or not Mr. Ford will accept the invitation.

India Imposes Export Tax on Lac

The government of India has approved the imposition of a small export tax on lac, in order to finance research work in connection with the lac industry.

A bill authorizing the tax will be introduced in the ensuing session of the Indian Legislature.

The Ceramic Station of the Bureau of Mines Investigates Industrial Burning Problems

The Ceramic Experiment Station of the U. S. Bureau of Mines has entered into a co-operative agreement jointly with the Common Brick, Face Brick, Paving Brick and Hollow Building Tile Associations, in order to investigate problems in connection with burning clay products. The ultimate objects of the work are to conserve fuel, shorten the time of burning and improve the qualities of the products.

The four clay associations have contributed a joint fund of \$10,000 for the investigation. Of that sum \$7,500 has been allotted to the Ceramic Experiment Station of the Bureau of Mines for making field investigations on industrial kilns. In addition to this sum the Bureau of Mines purposes to spend \$15,000 or more.

The kiln investigations will consist in obtaining data on fourteen or more kilns to determine the amount of fuel used, the amount of ware placed in the kiln, temperatures at three different levels during the process of burning, temperature of the flue gases, analysis of the flue gases, the end point of water smoking, the end point of oxidation, length of time for burning, analysis of the fuel and ash, drawings of the kilns showing dimensions, their age and condition as to repairs. From the study of the data obtained changes in the construction of the kilns, the shortening of the time of burning and change in method of setting and firing are to be made. From isolated cases where similar kiln studies have been made as much as 0.5 ton of coal per 1,000 brick has been saved and a shortening in the time of burning of as much as 25 per cent. On a plant of 20,000,000 annual brick capacity it is possible to make a saving of from 5,000 to 10,000 tons of coal annually. This is especially true in plants where firing conditions are exceptionally bad.

The work will be under the supervision of R. T. Stull, chief ceramist of the bureau, who has placed three ceramic engineers on the field work. In connection with the field studies the services of the fuel section of the bureau will be available and the services of a fuel engineer will be placed on the work for at least six months. Laboratory studies are also to be made at the ceramic station on oxidation and vitrification problems.

Transportation of Dangerous Materials

Effective Sept. 1, the Interstate Commerce Commission has placed amended regulations in force governing the transportation of arsenic, paris green, arsenate of lead, calcium arsenate and other such materials. Such articles must not be offered or accepted for shipment in bulk, but must be packed in strong and tight containers, of type to prevent sifting or escaping of contents in transit. Permission is allowed, however, for the shipment of sintered arsenical flue dust in steel gondola cars, with suitable covers, between plants.

Radium Plants Merge

The United States Radium Co., New York, recently organized, will take over a number of the larger radium companies in this country, including the Radium Luminous Material Corp., 58 Pine St., New York, with works at Orange, N. J.; the subsidiaries of the latter company will also be included in the merger, and the Undark Radium Mines, in the Paradox Valley section of Colorado. The radium works and extraction plant at Orange will be continued in operation by the consolidated company, and also the radium research laboratory of the Undark organization. Arthur Roeder is chairman of the board of directors of the new company.

Glass Workers Accept Wage Reduction

Skilled operatives and other workers at the "hand plants" devoted to the manufacture of sheet glass have accepted a wage reduction of 28 per cent, effective Sept. 6, as a result of a series of conferences between representatives of the Window Glass Manufacturers' Association of America and the American Window Glass Workers. About 18,000 persons are affected by the reduction.

Non-Metallic Investigations of Bureau of Mines

Experimental work on cement and heavy clay products for which Congress recently appropriated \$35,000 now is under satisfactory headway at the Bureau of Mines ceramic station at Columbus, Ohio.

The Department of the Interior, which is a large buyer of cement, felt the lack of certain technical and economic data regarding the cost of raw materials, of burning and of the factors entering into quality and deterioration. At the same time the building industry was stagnant, in part because of the high cost of materials in which fuel and labor were the main items. The manufacture of the non-metallic building materials, except perhaps in the case of cement, is conducted in small scattered plants few of which have adequate technical knowledge or direction, the situation being similar in many particulars to that of the small farming industry. It is the purpose of this appropriation, at once to develop improved technology where that may be possible, and to disseminate widely among the smaller producers knowledge of the best current practice to the end that costs and wastes be reduced.

Much of this appropriation is being expended through the bureau's ceramic station at Ohio State University. A study has been started there of the technology of the cement industry, particularly as to choice of raw materials, economic use of fuel and related economic problems of transportation. To this has been allotted \$10,600 and the co-operation of the Department of Commerce has been arranged.

Other non-metallics, including the mining and utilization of feldspar, phosphate rock, slate and potash, are being studied and efforts made to reduce cost of production and utilization of byproducts hitherto considered waste. To this work \$5,700 has been allotted.

Several basic ceramic chemical problems connected with the burning of clay products will be worked out at the University of Illinois under the direction of a consulting ceramic chemist. For the carrying on of this study \$1,000 is allotted.

Society of Industrial Engineers to Meet in Springfield

One of the most important industrial meetings of the year will be the fifth annual convention of the Society of Industrial Engineers, to be held in Springfield, Mass., Oct. 5, 6 and 7. In the membership of this national organization are business executives and industrial engineers from almost every line of industry, which naturally tends to add interest to the national meetings.

Industrial stability will be the main theme for discussion, the topics on the program covering four of the major functions of industry—production, finance and accounting, sales, and industrial relations. All the speakers will be men of broad practical experience and national reputation.

Afternoon and evening sessions will be held on each of the three days, the mornings being devoted to visiting some of the most progressive plants in the Springfield district. All the sessions will be open to the public.

Uncertain as to Potash Discoveries

Every effort is being made by the United States Potash Producers' Association to ascertain the real facts in regard to the discovery of potash in two oil wells drilled in western Texas. While there is no disputing that material which carries as much potash as does the German product has been found, no information reaching the Potash Producers' Association carries with it any proof that the potash deposit is of sufficient thickness to justify the expensive mining operations which would be required to recover it. It is believed that it will require diamond drilling to get definite data as to the occurrence of potash-bearing material in commercial quantities.

British Chemical Dispute Settled

A settlement of the dispute in the chemical industry has been effected.

Metric System Hearings

A sub-committee of the Senate Committee on Manufactures has been designated to conduct hearings on a bill by Senator Ladd, of North Dakota, providing for the compulsory adoption, after ten years, of the metric system of weights and measures. Senator McNary, of Oregon, will act as chairman of the sub-committee. The other members are Senator Weller, of Maryland, and Senator Jones, of New Mexico.

It is the intention to have limited hearings shortly after the congressional recess, so that the proponents and opponents of the legislation may state their views as to the desirability of such a law. It then is the intention to circulate as widely as possible a stenographic record of the hearing, with the idea of acquainting the public with the problems involved. Later, during the regular session of Congress which begins in December, it is planned to have further hearings, after which an attempt will be made to get favorable action by the committee, thereby obtaining a place for the bill on the Senate calendar where its consideration would be taken up in due course.

Experimental Paper Mill Being Sent to Siam

As a result of tests made on the experimental paper machine at the Bureau of Standards using rice straw, banana tree stems and lalang grass from Siam, Siamese officials saw the possibilities of the paper industry in their country and their government asked the American Government, through the State Department and the Department of Commerce, to supervise the design and purchase of a similar experimental machine.

Although not intended primarily for commercial purposes, the machine which is now en route will furnish the writing and printing paper for the Siamese army. It will be erected at Bangkok, Siam, under the supervision of the Royal Survey Department of the army.

The paper mill consists essentially of a 44-in. Fourdrier paper machine, two 300-lb. beaters, a small Jordan engine, a 600-lb. rotary boiler, a cylinder duster, screen, sheet cutter, suitable pumps, shafting, pulleys and motors, bleach plant, necessary electrical fittings, and plumbing, belting and spare parts. It is capable of producing 1,200 lb. of paper per day.

Iron Industry at Buffalo Resuming Activity

A number of the iron and steel plants at Buffalo, N. Y., are resuming production on an increased scale, following a long period of inactivity. The Lackawanna Steel Co. is now operating nine of its rolling mills and adding many former employees to the working force. This company has entered the pig iron field, and is reported to have sold about 30,000 tons in recent weeks. The Wickwire Steel Co. has placed a number of additional mills in service, with increased working force, while the plant of the Seneca Iron & Steel Co., at Blasdell, near Buffalo, is again in operation after a period of idleness. Production is still curtailed at the local works of the Rogers, Brown Co.

Hungarian Banks Organize Company to Manufacture Artificial Manures

Some of the largest Hungarian banks have organized a company for the purpose of transforming Magyarovar Munitions Works into a plant for the manufacture of artificial manures.

Duties for Non-Metals Asked

One of the features of the hearings before the Finance Committee of the Senate has been the particularly strong pleas that have been made for protection sufficiently high to allow the domestic mining of the non-metals to flourish.

Few Purchases of Heavy Chemicals in Brazil

Due to the uncertainty as to exchange, few purchases of heavy chemicals are being made in Brazil, say cable advices to the Department of Commerce.

Glass Plant Operations in West Virginia

Despite the decreased demand for flint glassware during recent months, the different plants of this character in the Wheeling, W. Va., district have been making a number of improvements and expanding their works. The slack period of the past eight weeks particularly has been used to good advantage in this direction. The majority of the plants are now in condition to meet all expected demands, and the general situation in the industry is showing noticeable improvement.

The cut glass and gift glassware plants in this section report an increased volume of business and large number of inquiries for material for fall and holiday trade. Blown and etched tableware glass plants also are receiving larger orders, and current business is better than for a number of months past.

Bottle and jar manufacturers in the district have been engaging on an improvement program during recent months, with a number of plant extensions and betterments, as well as repairs to machinery and equipment. This branch of the glassware industry reports an increased demand for material. Plants devoted to the manufacture of lamp chimneys and kindred glassware have been operating on a much curtailed schedule for the past three or four months, with present indications that production can be resumed on a near-normal basis at an early date.

Glassware for lighting service is showing an improved demand, and plants engaged in this line are commencing to increase production in anticipation of a good holiday business.

Artificial Leather From Cordite

Following experiments and investigations for a year past, the chemical department at the plant of the Ford Motor Co., Detroit, Mich., has perfected a process for the manufacture of artificial leather from cordite gunpowder, a high explosive. The new development will be utilized at the leather works of the company at once. It is said that a purchase of 857 carloads, or about 35,000,000 lb. of the material has been made from the British Government, at a price less than one-fifth of the war-time value of cordite. It will be transferred to the Highland Park works in such quantities as needed for artificial leather production. The new process is stated to reduce the cost of manufacture about one-half. The local plant of the company has an average output of about 25,000 sq.yd. of artificial leather per day, the entire production being used on Ford automobiles.

Internal Revenue Collections

An analysis of internal revenue collections during the fiscal year ended June 30 shows that the tax on perfumes, cosmetics and medicinal articles produced \$5,800,768.41. This shows a slight decrease from the revenue derived from these sources during the preceding fiscal year, when it was \$6,427,881.08. The levy on toilet soap and toilet soap powders produced \$2,223,773.99. This is an increase over the collection during the fiscal year ended June 30, 1920, when collections under that head totaled \$1,919,398.44. The tax on importers, manufacturers, compounders and dealers in opium, coca leaves and their salt derivatives, including the tax on the product, amounted to \$1,161,174.12. In the preceding fiscal year the collection from the same sources was \$1,153,919.50.

British Columbia Paper Plant Reopens

The Whalen Pulp & Paper Co. reopened its plant at Wood Fibre, B. C., on Aug. 15. This plant of the Whalen company produces only pulp suitable for the manufacture of book paper; the demand for this class of pulp fell off early in the season, and the plant was closed. T. W. McGarry, president of the company, states that conditions now have improved, and it is expected that the Wood Fibre plant will be worked at capacity and will give employment to about 300 men. The Whalen company's Port Alice plant, which produces pulp for newsprint paper, has been working at capacity and turning out 1,800 tons of pulp weekly. The Reliance Mill & Trading Co. has retired from the management of the Whalen company's plants.

Personal

HAROLD W. ABBOTT, former technical supervisor at the Massena plant of the Aluminum Co. of America, has accepted a position along the same lines in the research and development division of the Stackpole Carbon Co., St. Mary's, Pa.

Dr. RAYMOND F. BACON has resigned as director of Mellon Institute to take effect Jan. 1, 1922. Dr. E. R. Weidlein has been appointed acting director.

OSCAR H. BETTS has been elected president of the Bethlehem Paper Co., Bethlehem, Pa.

H. S. BOUTELL has been elected treasurer of the Detroit Graphite Co., Detroit, Mich., succeeding W. F. Monroe, resigned.

C. S. BRYAN has become connected with the Provident Chemical Works, St. Louis, Mo., as chemical engineer. He was for several years with the Virginia-Carolina Chemical Co. as superintendent and research chemist, and more recently has been acting as manager of the Charleston Chemical Co., Charleston, S. C.

Dr. F. G. COTTRELL, head of the chemical activities of the National Research Council, will sail from France on Oct. 11 on his return to the United States. Dr. Cottrell has spent the summer in Europe studying various phases of the chemical industry. Among other things he paid particular attention to the liquefaction of gases.

O. D. CUNNINGHAM has become connected with the physical chemistry department of the plant of the Republic Creosoting Co., Indianapolis, Ind., to engage in research work. He was engaged formerly in a similar capacity at the plant of the National Aniline & Chemical Co., Buffalo, N. Y.

Dr. F. A. GILGILLIAN has become connected with the research department of the Calco Chemical Co., Bound Brook, N. J.

RALPH C. HOLDER recently resigned as junior chemist in the food research laboratory, Bureau of Chemistry, to accept a position as chemist in charge of the chemical laboratory for the Collis Products Co. at St. Paul, Minn.

B. B. GOTTSBERGER was recently elected secretary of the Mining and Metallurgical Society of America, and assumed the duties of that position on Aug. 1.

H. B. MYERS has resumed his position as head of the finishing department at the plant of the Hartford City Paper Co., Hartford City, Ind., after an absence of about ten months, during which time he has been connected with a paper mill at Bryn Mawr, Pa.

JOHN F. SLEEPER, author and chemist, is retiring to his fruit ranch at Santa Barbara, Cal., and leaves his home in Tenaflly, N. J., the middle of September.

Dr. REUBEN S. TOUR, Government chemical expert, has been appointed professor of chemical engineering at the University of Cincinnati, Cincinnati, Ohio, succeeding Dr. O. R. Sweeney, who resigned because of ill health. Dr. Tour will continue as a consulting expert for the Government. His new duties began Sept. 1, 1921.

Obituary

CHARLES H. FOOTE, well known in the steel trade as an officer of the Illinois Steel Co. for a number of years, died on Aug. 28 at Burlington, Vt., aged seventy-nine. Mr. Foote leaves two daughters, and a son, Thomas W. Foote, of Cleveland.

WILLIAM VOGEL, of Proffit, Va., secretary-treasurer of the Ohio Sulphur Mining Co., died at the University Hospital, Charlottesville, Va., Aug. 17, from peritonitis.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, Sept. 12, 1921.

Chemical trading continues to show a gradual improvement, especially in the fertilizer trade, where firmer prices have been reflected. Miscellaneous inquiries have been freer and more business is passing through export channels, particularly to South America, Japan and some European centers. This clearly indicates that large surplus stocks held by these countries have finally been absorbed and that a steady expansion in trade may be expected to develop in the near future. Increased production at some of our largest caustic soda and soda ash plants is an extremely optimistic sign and bids fair to dispel some of the gloom surrounding these items. Ammonium sulphate is in strong demand in view of the limited supplies available. The activity of fertilizers has resulted in greater activity in sulphuric acid and this has reflected itself in other directions in the heavy chemical market. While general trading is not very broad, the market is beginning to feel the stimulating influence of inquiries from the paper, textile, glass, tanning and other consuming industries. Sales all around are larger than a month ago and more transactions are noted. Those close to the pulse of trading expect a good volume of business during the last quarter. Outside developments have been quite favorable. Our export trade is showing a spark of real snappy improvement. Sound and effective measures have been provided for the farming industry. The only thing that is keenly awaited is a wise tariff policy.

CHEMICALS

Prices on *caustic potash* have recently been advanced and some of the largest sellers are refusing to shade 4½c. per lb. for either spot or forward shipments of the imported 88-92 per cent. It is stated that a few odd lots might still be purchased at 4½c., but the tone of the market is decidedly firmer. There were rumors that some producers abroad have stopped making this product on account of the relatively low price. Spot *bichromate of soda* was quoted at a higher price in several directions and the general range was 8@8½c. per lb., although a few small lots might be purchased at a slight concession. The movement at present is confined chiefly to small quantities, as consumers appear satisfied to operate very cautiously.

Buying orders on *ammonium sulphate* have been in the market during the past week from Japan and Spain and large lots of sulphate have been moved out on them. The consequence has been a rise in the export price to \$2.40 per 100 lb. in double bags, f.a.s. New York. Makers are unable to quote for prompt delivery, but name a nominal price of \$1.90 per 100 lb. for bulk sulphate at the works. Prices on *barium chloride* are weakening on competition among importers. The price of \$45 per ton for spot goods can probably be shaded considerably for firm business in quantity. The resale *bleaching powder* market is stiffening as stocks keep moving. The quoted price of \$2.05 per 100 lb., f.o.b. works, is becoming increasingly hard to do. Makers quote 2½c. per lb. for prime bleach at the plant. Spot prices are around \$2.60 per 100 lb.

Dealers of solid *caustic soda* quote \$3.85 per 100 lb. at the works, while spot material of standard make is held at \$3.90@\$4 per 100 lb., with sales reported at \$3.95. Additional export business of moderate dimensions went through at 4c. per lb., f.a.s. New York, for South America. Producers are holding the market steady at 3½c. per lb., basis 60 per cent, f.o.b. works, in carload lots. The tone of the general market may be described as steady. A slow demand for *copper sulphate* has forced importers' prices down to 5c. per lb. on spot. In the absence of any noticeable business, makers have not reduced their prices below 5½c. per lb. Large lots of *hyposulphite of soda* are quoted at \$3.40 per 100 lb., while small lots on spot have commanded up

to 3½c. per lb. The market remained steady. Demand for spot *prussiate of soda* is active enough to hold the market firm at the late advance. While 12½c. per lb. might be done in some quarters, in others 12¼c. was quoted. Spot supplies are not heavy and it is said to be doubtful if prompt shipment can be purchased at prices much below those prevailing in the spot market. Dealers are holding light *soda ash* in single bags at prices ranging from \$2.05@\$2.15 per 100 lb. on spot. Sales of barrels have been reported by second hands at \$2.45@\$2.50 per 100 lb. The tone of the market is firm, with a better inquiry reported by both makers and dealers. At the works \$1.60 per 100 lb. is named for single bags in carload lots, basis 48 per cent. Fused 60-62 per cent *sodium sulphide* is moving at 4½c. per lb. for the imported grade. In one quarter the sale of 100 tons at this figure was noted. Small lots are quoted up to 5c. per lb. The broken variety is quoted at the same price as fused. Domestic producers quote fused at 5¼c. per lb. in carlots and broken at 6c.

Commercial *white arsenic* is quoted on the spot at 6¼@6½c. per lb. The movement of late has been rather quiet and the tone has been a shade easier on account of the absence of support. *Red arsenic* is also moving quietly at prices ranging from 11@12c. per lb. Producers of *formaldehyde* report sales at 12@12½c. per lb. in barrels, f.o.b. works. The spot market is quoted at 12½@13c. per lb. in most directions. A moderate inquiry is reported, with some first hand sales at the inside figure. Sales of technical *magnesia carbonate* in bags are reported on the basis of 8½c. per lb. Sales of barrels are reported at 9½c. Kegs are quoted up to 10½c. Irregular activity is noted in the market, with consumers buying only actual wants. Spot *oxalic acid* is quoted from 16@17½c. per lb., depending upon the quantity, brand and seller. The best open price given by producers is 16c. per lb., at the works, although it is understood that actual sales have gone through a shade under this figure. Small lots are attracting the attention of consumers and in the aggregate a fair volume of business is passing.

PRICE VARIATIONS OF INDUSTRIAL CHEMICALS
DURING AUGUST, 1921

Article	Open	High	Low	Close
Acetate of soda..... lb.	\$0.04½	\$0.04½	\$0.04	\$0.04
Arsenic, white..... lb.	.06½	.06½	.06½	.06½
Bicarbonate soda..... lb.	.02½	.02½	.02	.02½
Bichromate soda..... lb.	.08	.08	.07½	.07½
Bleaching powder..... lb.	.02½	.02½	.02	.02½
Carbonate potash, 80-85 per cent..... lb.	.05	.05½	.05	.05
Caustic potash, 88-92 per cent..... lb.	.04½	.04½	.04	.04½
Caustic soda..... lb.	.03½	.04	.0360	.0390
Citric acid..... lb.	.44	.45	.44	.45
Formaldehyde..... lb.	.12½	.13	.12½	.12½
Muriate potash..... ton	45.00	45.00	42.50	42.50
Oxalic acid..... lb.	.17	.17½	.16	.16
Permanganate potash..... lb.	.26	.26	.26	.26
Soda ash..... lb.	.02	.02½	.0190	.02½
Sulphide soda..... lb.	.04½	.05	.04½	.04½

COAL-TAR PRODUCTS

Considerable improvement was noted in the general list of coal-tar products during the past week. Consumers are taking on supplies to cover their requirements at least until the expiration of the emergency tariff and in this way quite a volume of business has been done. The intervention of the holiday had some effect in limiting the number of buying orders, but in spite of this, prospects for the immediate future are much brighter than a few months ago. The financial weakness of some makers of intermediates has forced sales at reductions, but as a rule prices are holding well. Resale *benzene* is very difficult to find and prices are well above refiners'. The 90 per cent has sold at 38c. per gal., with 40c. quoted for c.p. Refiners are offering only for future delivery at 27@33c. per gal. for c.p. and 25@31c. for 90 per cent. The English market for *cresylic acid* is holding firm. Spot supplies are sufficient to take care of the present demand, but any sustained inquiry would deplete stocks considerably and probably lead to higher prices, as replacement costs are above present selling levels. Insecticide makers are displaying interest and most of the present buying is being done by them. The 97@99 per cent is quoted at 70@75c. per gal., with the 95 per cent at 60@65c. per gal. The demand for *toluene* is moderately active and the scarcity of benzene tends to strengthen the market. Resale goods are selling at 36@40c. per gal. in

drums with refiners quoting 27@34c. per gal. Prices on *phenol* are quoted lower on light demand. Resale offers of limited quantities are heard down to 8¼c. per lb. Resale stocks of *aniline oil* are large and competition among sellers is keen. Business is still passing at 18@18½c. per lb., although producers' lowest figures are 20c. A fair amount of small-lot buying is being done, but round lot sales are infrequent. Sellers of *aniline salt* quote from 25@28c. per lb. The demand is confined to small quantities, with practically no export business recorded. A slight improvement is noted in the demand for *dimethylaniline*. Resale goods are held at 43@45c. per lb. with first hands asking up to 50c. The lowest quotation heard on *diphenylamine* is 62c. per lb., with 75c. asked in some directions. The demand is slightly better, but it is mostly small-lot orders that are being booked.

WAXES

There was a firm market for both crude and refined *beeswax*. African crude on spot closed at 16@16½c. per lb., while on forward business the ideas of sellers ranged from 14½@15c. per lb., depending upon the quantity. Brazilian crude held at 22@24c. per lb. Pure white refined was quotably unchanged at 36@42c. per lb. Offerings of *Carnauba wax* were not pressing, and with reports from primary centers holding steady, quotations were well maintained on a basis of 25@26c. per lb. for the No. 2 North Country, with No. 3 North Country slightly lower, at 14½@15c. per lb. The spot situation in *Japan wax* was strong and for small quantities prices as high as 25c. per lb. were paid. For goods to arrive the market ranged from 21@22c. per lb. Futures were firmly maintained, leading factors quoting from 18@19c. per lb., according to brand and quantity. The general spot quotation ranged from 24@25c. per lb. The export inquiry for *paraffine wax* has shown slight improvement, but with stocks on hand liberal, selling pressure continues and prices present a rather unsettled appearance. Crude *scale wax* of 122 to 124 degree melting point was available at 1½c. per lb., carload lots, prompt shipment from works. *Match wax* held around 3¼@3½c. per lb., barrels included.

The Iron and Steel Market

PITTSBURGH, Sept. 9, 1921.

Scrutiny of details as to the buying and selling of steel mill products, with an open mind, leads to a clear conception of the underlying conditions and the prospects for the nearby future, while attempts to appraise the present steel market in the light of market "movements" before the war bring only confusion. Such confusion is disclosed in much of the comment that is made in relatively uninformed quarters, where what may be called criticism of the present steel market is indulged in.

Thus it is impatiently remarked sometimes that there is "no forward buying" of steel products, as if nothing could be good or encouraging in steel without the performance indicated. The steel mills had an average operation of less than 20 per cent of capacity at the middle of July, and their owners put many things ahead of a desire to have a full operation Christmas week. In the market movements before the war much of the forward buying was predicated not so much upon requirements the buyer was assured he would have as upon a belief that prices were going to advance. First, prices were allowed to go too far down. Then buyers were permitted to buy at those prices for prompt delivery. Next they were permitted to contract a short time ahead at a slight advance. After a short time another advance would be made, and buyers would be permitted to "cover" for an additional period. This was the regular performance, and it was prolonged until it became top heavy. One must not expect that sort of thing now. The desire of steel producers is not to advance prices above the present level, but to reduce costs.

Then there is complaint that the Steel Corporation's "unfilled tonnage" does not increase when it is reported that more steel is being bought. The condition, of course, is that the corporation has contracts with nearly all its customers, these contracts being represented in the "unfilled tonnage" reported month by month. The orders the

corporation receives are chiefly specifications against these contracts. The more business the corporation receives the more tonnage it ships and the more its unfilled obligations decrease. If bond interest and dividends are to be paid, they will be paid by the steel that is shipped and paid for, not by the contracts that fail to be specified against. The July decrease in the "unfilled tonnage" was less than the June decrease, because the corporation shipped less steel.

PRODUCTION

There has been a slight upward trend in the production of pig iron in the past few weeks, but a more distinct increase is to be expected in the next few weeks. The rate now is about 25 per cent of the actual capacity. Steel ingot production is increasing, in general, but at a very slow rate, production being now in the neighborhood of 30 per cent of capacity, this being fully one-half greater than production at the low point, about the middle of July.

Tonnage output, however, is not an altogether fair criterion as to the improvement that has been occurring in fundamental conditions relating to steel demand, for the reason that the increase in demand has been almost wholly in the lighter finished steel products, particularly sheets, tubular goods, tin plate and merchant bars, where a given tonnage means more than a similar tonnage in plates, shapes and rails, which have shown scarcely any improvement.

The American Sheet & Tin Plate Co. (Steel Corporation) had last week both the largest volume of orders and specifications and the heaviest shipments of its products, tin plates and sheets, for any week since last April, and for this week it has scheduled a 50 per cent operation for both sheet mills and tin mills. There was a time recently when there was only about a 25 per cent operation in each class. Bookings of the pipe mills were 30 to 35 per cent greater in August than in July. Merchant steel bars showed a smaller improvement.

Demand for steel for construction purposes has had its ups and downs, with no important improvement plainly marked. Just at the moment it would appear that the trend is distinctly upward, but on account of the season of the year no great amount of reliance should be placed on this showing.

STEEL PRICES

Bars, shapes and plates can be bought at prices ranging, roughly speaking, from 1.65c. to 1.75c., depending on the size and desirability otherwise of the order offered. The range is narrower than a month or six weeks ago, and the average is but little lower. Sheets are very steady since the recent declines to 2.25c. for blue annealed, 2.75c. for black and 3.75c. for galvanized. Shading in standard steel pipe generally does not run more than \$2 a ton at the outside from the prices openly named July 9. Wire products are quite steady at prices developed two months ago, 2.50c. for plain wire and \$2.75 for nails. Altogether, while the steel market may not have struck bottom for the nearby future, it is amply near enough for safety to those who buy for nearby requirements, and no one has occasion to buy otherwise. Even for a construction job that would be expected to yield a return over a period of many years, the possible decline in prices of mill products would not be a serious drain upon annual earnings. If there is disinclination to buy steel for construction work, it is due to the cost of putting the steel into employment, or uncertainty as to earnings of the structure, rather than to the cost of the steel itself.

PIG IRON AND COKE

Pig iron continues to show, in general, a slight stiffening tendency, this being due, as previously indicated in these reports, to unexpected delay in reductions in freight rates, which would lower the cost of production, while there has been liquidation of furnace stocks. In the local market bessemer and basic are quotable unchanged at \$20 and \$19 respectively, f.o.b. valley furnaces, while foundry iron is up another 50c., to \$21 valley.

Connellsville coke has advanced 25c., to \$3.25 for furnace and \$4.25 as minimum for foundry, some brands commanding \$4.50 as hitherto.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots		Less Carlots	
	\$0 12 1/2	\$0 12 1/2	\$0 40	\$0 45
Acetic anhydride.....lb.	12 1/2	12 1/2	13	13 1/2
Acetone.....lb.	2 50	2 75	3 00	3 25
Acid, acetic, 28 per cent.....100 lb.	5 00	5 25	5 50	6 00
Acetic, 56 per cent.....100 lb.				
Acetic, glacial, 99 1/2 per cent, carboys.....100 lb.	10 00	10 25	10 50	10 75
Boric, crystals.....lb.	12 1/2	13	13 1/2	14
Boric, powder.....lb.	13	13 1/2	14	14 1/2
Citric.....lb.			45	47
Hydrochloric.....100 lb.	1 25	1 50	1 60	1 75
Hydrofluoric, 52 per cent.....lb.	11 1/2	11 1/2	12	12 1/2
Lactic, 44 per cent tech.....lb.	10	11	11 1/2	12
Lactic, 22 per cent tech.....lb.	0 4 1/2	0 5 1/2	0 6	0 7
Molybdic, C. P.....lb.	4 00	4 50	4 50	5 00
Muriatic, 20 deg. (see hydrochloric).....lb.				
Nitric, 40 deg.....lb.	0 6 1/2	0 6 1/2	0 7	0 7 1/2
Nitric, 42 deg.....lb.	0 7	0 7 1/2	0 7 1/2	0 7 1/2
Nitric, 42 deg.....lb.	16	16 1/2	17	18
Oxalic, crystals.....lb.	13	13 1/2	14	15
Phosphoric, 50 per cent solution.....lb.	20	25	27	35
Picric.....lb.			1 75	1 90
Pyrogallol, resublimed.....lb.			11 00	13 00
Sulphuric, 60 deg., tank cars.....ton			13 00	15 00
Sulphuric, 60 deg., drums.....ton	18 00	20 00		
Sulphuric, 66 deg., tank cars.....ton	21 00	22 00	22 50	23 00
Sulphuric, 66 deg., drums.....ton				
Sulphuric, 66 deg., carboys.....ton				
Sulphuric, fuming, 20 per cent (oleum).....ton	21 00	22 00		
Sulphuric, fuming, 20 per cent (oleum).....ton	23 00	23 50	24 00	24 50
Sulphuric, fuming, 20 per cent (oleum).....ton	31 00	32 50	33 00	34 00
Tannic, U. S. P.....lb.			75	85
Tannic (tech.).....lb.	45	48	50	55
Tartaric, crystals.....lb.			27	28
Tungstic, per lb. of WO.....lb.			1 30	1 40
Alcohol, Ethyl.....gal.			4 65	4 90
Alcohol, Methyl (see n ethanol).....gal.				
Alcohol, denatured, 188 proof.....gal.			35	36
Alcohol, denatured, 190 proof.....gal.			37	38
Alum, ammonia lump.....lb.	0 3 1/2	0 3 1/2	0 4	0 4 1/2
Alum, potash lump.....lb.	0 3 1/2	0 4	0 4	0 4 1/2
Alum, chrome lump.....lb.	10	11	11 1/2	12 1/2
Aluminum sulphate, commercial.....lb.	0 2	0 2 1/2	0 2 1/2	0 2 1/2
Aluminum sulphate, iron free.....lb.	0 3	0 3 1/2	0 3 1/2	0 4
Aquarium onia, 26 deg., drums (750 lb.).....lb.	0 7 1/2	0 7 1/2	0 8	0 8 1/2
Ammonia, anhydrous, cyl. (100-150 lb.).....lb.	30	32	33	35
Ammonium carbonate, powder.....lb.	0 7	0 7 1/2	0 8	0 9
Ammonium chloride, granular (white).....lb.	0 6 1/2	0 6 1/2	0 7	0 7 1/2
Ammonium chloride, granular (gray).....lb.	0 6 1/2	0 6 1/2	0 7	0 7 1/2
Ammonium nitrate.....lb.	0 7	0 7 1/2	0 7 1/2	0 8 1/2
Ammonium sulphate.....100 lb.	2 20	2 25	2 30	2 40
Amylacetate.....gal.			3 25	3 50
Amylacetate tech.....gal.			2 50	3 00
Arsenic oxide, (white arsenic) powdered.....lb.	0 6 1/2	0 6 1/2	0 7	0 7 1/2
Arsenic, sulphide, powdered (red arsenic).....lb.	11	11 1/2	12	13
Barium chloride.....ton	45 00	46 00	47 00	50 00
Barium dioxide (peroxide).....lb.	20	21	22	23
Barium nitrate.....lb.	0 8	0 8 1/2	0 8 1/2	0 9
Barium sulphate (precip.) (blanc fixe).....lb.	0 4	0 4 1/2	0 4 1/2	0 5 1/2
Bleaching powder (see calc. hypochlorite).....lb.				
Blue vitriol (see copper sulphate).....lb.				
Borax (see sodium borate).....lb.				
Brimstone (see sulphur, roll).....lb.	27	28	28 1/2	30
Bromine.....lb.				
Calcium acetate.....100 lb.	2 00	2 05		
Calcium carbide.....lb.	0 4 1/2	0 4 1/2	0 5	0 5 1/2
Calcium chloride, fused, lump.....ton	23 50	24 00	24 50	25 50
Calcium chloride, granulated.....lb.	0 1 1/2	0 2	0 2 1/2	0 2 1/2
Calcium hypochlorite (bleach powder).....100 lb.	2 60	2 70	2 80	3 25
Calcium peroxide.....lb.			1 40	1 50
Calcium phosphate, tribasic.....lb.			15	16
Camphor.....lb.			73	75
Carbon bisulphide.....lb.	0 6	0 6 1/2	0 6 1/2	0 7 1/2
Carbon tetrachloride, drums.....lb.	10 1/2	10 1/2	11	12
Carbonyl chloride (phosgene).....lb.			60	75
Caustic potash (see potassium hydroxide).....lb.				
Caustic soda (see sodium hydroxide).....lb.				
Chlorine, gas, liquid-cylinders (100 lb.).....lb.	0 8	0 9	0 9	1 0
Chloroform.....lb.			38	43
Cobalt oxide.....lb.			2 00	2 10
Copperas (see iron sulphate).....lb.				
Copper carbonate, green precipitate.....lb.	19	19 1/2	20	21
Copper cyanide.....lb.			50	62
Copper sulphate, crystals.....lb.	0 5 1/2	0 5 1/2	0 5 1/2	0 6
Cream of tartar (see potassium bitartrate).....lb.				
Epsom salt (see magnesium sulphate).....lb.				
Ethyl Acetate Com. 85%.....gal.			1 00	1 10
Ethyl Acetate pure (acetic ether 98% to 100%).....lb.			40	42
Formaldehyde, 40 per cent.....lb.	12 1/2	12 1/2	13	13 1/2
Fusel oil, ref.....gal.			3 25	3 75
Fusel oil, crude.....gal.			1 50	1 75
Glauber's salt (see sodium sulphate).....lb.			14	14 1/2
Glycerine, C. P. drums extra.....lb.			3 50	3 60
Iodine, resublimed.....lb.			10	20
Iron oxide, red.....lb.				
Iron sulphate (copperas).....ton	18 00	19 00	20 00	21 00
Lead acetate.....lb.			10 1/2	12 1/2
Lead arsenate, paste.....lb.	0 9	0 9 1/2	10	11
Lead nitrate.....lb.			15	20
Litharge.....lb.	0 7 1/2	0 8	0 8 1/2	0 9
Lithium carbonate.....lb.			1 30	1 40
Magnesium carbonate, technical.....lb.	0 8 1/2	0 9 1/2	10	10 1/2
Magnesium sulphate, U. S. P.....100 lb.	2 40	2 75		
Magnesium sulphate, technical.....100 lb.			1 05	1 60
Methanol, 95%.....gal.			66	68
Methanol, 97%.....gal.			70	72
Nickel salt, double.....lb.			12	12 1/2
Nickel salt, single.....lb.			14	14 1/2
Phosgene (see carbonyl chloride).....lb.				
Phosphorus, red.....lb.	40	41	42	45
Phosphorus, yellow.....lb.			30	35
Potassium bichromate.....lb.	11 1/2	11 1/2	12	12 1/2

	Carlots	Less Carlots
Potassium bitartrate (cream of tartar)..... lb.	\$. . . \$. . .	\$0.28 1/2 - \$0.29 1/2
Potassium bromide, granular..... lb.		.16 - .25
Potassium carbonate, U. S. P..... lb.	.35 - .40	.45 - .50
Potassium carbonate, 80-85%..... lb.	.05 - .05 1/2	.06 - .06 1/2
Potassium chlorate, crystals..... lb.	.06 1/2 - .07	.07 1/2 - .10
Potassium cyanide..... lb.		.26 - .28
Potassium hydroxide (caustic potash)..... lb.	.04 1/2 - .04 3/4	.05 - .06
Potassium muriate, 80% K.C.I..... ton	42.50 - 45.00	
Potassium iodide..... lb.		2.75 - 3.00
Potassium nitrate..... lb.	.09 1/2 - .09 3/4	.10 - .12 1/2
Potassium permanganate..... lb.	.23 - .24	.24 1/2 - .25
Potassium prussiate, red..... lb.	.28 - .29	.29 1/2 - .30
Potassium prussiate, yellow..... lb.	.20 1/2 - .21	.22 - .22 1/2
Potassium sulphate (powdered)..... per unit		1.20 - 1.25
Rochelle salts (see sodium potas tartrate).....	. . . . .	. . . . .
Sal ammoniac (see ammonium chloride).....	. . . . .	. . . . .
Salt soda (see sodium carbonate).....	. . . . .	. . . . .
Salt cake (bulk)..... ton		20.00 - 25.00
Silver cyanide..... oz.		1.35 - 1.38
Silver nitrate..... oz.		.41 1/2 - .42
Soda ash, light..... 100 lb.	2.10 - 2.15	2.20 - 2.70
Soda ash, dense..... 100 lb.	2.35 - 2.40	2.45 - 2.70
Sodium acetate..... lb.	.04 - .04 1/2	.04 1/2 - .05
Sodium bicarbonate..... 100 lb.	2.25 - 2.40	2.50 - 2.75
Sodium bichromate..... lb.	.08 - .08 1/2	.08 1/2 - .09
Sodium bisulphate (nitre cake)..... ton	5.00 - 5.25	5.50 - 6.50
Sodium bisulphate powdered, U.S.P..... lb.	.04 1/2 - .04 3/4	.05 - .06
Sodium borate (borax)..... lb.	.05 1/2 - .06	.06 1/2 - .07
Sodium carbonate (salt soda)..... 100 lb.	1.90 - 2.00	2.10 - 2.40
Sodium chloride..... lb.	.07 1/2 - .07 3/4	.08 - .08 1/2
Sodium cyanide..... lb.	.19 1/2 - .21	.22 - .30
Sodium fluoride..... lb.	.11 - .11 1/2	.12 - .13
Sodium hydroxide (caustic soda)..... 100 lb.	3.90 - 4.00	4.10 - 4.60
Sodium hyposulphite..... lb.		.03 1/2 - .03 3/4
Sodium nitrate..... 100 lb.	2.10 -	2.30 -
Sodium nitrite..... lb.	.07 - .07 1/2	.07 1/2 - .08
Sodium peroxide, powdered..... lb.	.25 - .26	.27 - .30
Sodium phosphate, dibasic..... lb.	.04 1/2 - .04 3/4	.05 - .05 1/2
Sodium potassium tartrate (Rochelle salts) lb.		.21 - .24
Sodium prussiate, yellow..... lb.	.12 1/2 - .12 3/4	.12 1/2 - .13
Sodium silicate, solution (40 deg.)..... 100 lb.	1.00 - 1.15	1.25 - 1.40
Sodium silicate, solution (60 deg.)..... lb.	.02 - .03	.03 1/2 - .03 3/4
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	1.50 - 1.75	2.00 - 2.25
Sodium sulphide, fused, 60-62 per cent (conc.) lb.	.04 1/2 - .04 3/4	.05 - .06
Sodium sulphite, crystals..... lb.	.03 - .04	.04 1/2 - .04 3/4
Strontium nitrate, powdered..... lb.	.12 - .12 1/2	.13 - .14
Sulphur chloride, red..... lb.	.05 - .05 1/2	.05 1/2 - .06 1/2
Sulphur, crude..... ton	20.00 - 22.00	
Sulphur dioxide, liquid, cylinders ex a..... lb.	.08 - .08 1/2	.09 - .10
Sulphur (sublimed), flour..... 100 lb.		2.25 - 3.10
Sulphur, roll (brimstone)..... 100 lb.		2.00 - 2.75
Tin bichloride, 50 per cent..... lb.	.18 - .19	
Tin oxide..... lb.		.38 - .40
Zinc carbonate, precipitate..... lb.	.16 - .16 1/2	.17 - .17 1/2
Zinc chloride, gran..... lb.	.09 1/2 - .09 3/4	.10 - .11
Zinc cyanide..... lb.	.42 - .44	.45 - .47
Zinc dust..... lb.	.11 1/2 - .11 3/4	.11 1/2 - .12 1/2
Zinc oxide, XX..... lb.	.07 1/2 - .07 3/4	.08 - .09
Zinc sulphate..... 100 lb.	3.00 - 3.25	3.30 - 3.50

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude..... lb.	\$1.10 - \$1.15
Alpha-naphthol, refined..... lb.	1.25 - 1.30
Alpha-naphthylamine..... lb.	.35 - .40
Aniline oil, drums extra..... lb.	.18 - .21
Aniline salts..... lb.	.25 - .28
Anthracene, 80% in drums (100 lb.)..... lb.	.75 - 1.00
Benzaldehyde U.S.P..... lb.	1.00 - 1.25
Benzidine, base..... lb.	1.00 - 1.10
Benzidine sulphate..... lb.	.75 - .85
Benzoic acid, U.S.P..... lb.	.60 - .65
Benzoate of soda, U.S.P..... lb.	.55 - .60
Benzene, pure, water-white, in drums (100 gal.) gal.	.27 - .32
Benzene, 90%, in drums (100 gal.)..... gal.	.25 - .28
Benzyl chloride, 95-97%, refined..... lb.	.25 - .27
Benzyl chloride, tech..... lb.	.20 - .23
Beta-naphthol benzoate..... lb.	3.50 - 4.00
Beta-naphthol, sublimed..... lb.	.70 - .75
Beta-naphthol, tech..... lb.	.32 - .35
Beta-naphthylamine, sublimed..... lb.	1.75 - 1.80
Cresol, U. S. P., in drums (100 lb.)..... lb.	.16 - .18
Ortho-cresol, in drums (100 lb.)..... lb.	.25 - .27
Cresylic acid, 97-99%, straw color, in drums..... gal.	.70 - .75
Cresylic acid, 95-97%, dark, in drums..... gal.	.60 - .65
Cresylic acid, 50%, first quality, drums..... gal.	.45 - .50
Dichlorobenzene..... lb.	.06 - .09
Diethylaniline..... lb.	1.20 - 1.25
Dimethylaniline..... lb.	.43 - .50
Dinitrobenzene..... lb.	.26 - .28
Dinitrochlorobenzene..... lb.	.20 - .30
Dinitronaphthalene..... lb.	.36 - .40
Dinitrophenol..... lb.	.35 - .40
Dinitrotoluene..... lb.	.27 - .30
Dip oil, 25%, ear lots, in drums..... gal.	.40 - .45
Diphenylamine..... lb.	.65 - .70
H-acid..... lb.	1.15 - 1.25
Meta-phenylenediamine..... lb.	1.15 - 1.20
Monochlorobenzene..... lb.	.12 - .14
Monoethylaniline..... lb.	1.75 - 1.85
Naphthalene crushed, in bbls..... lb.	.06 1/2 - .07 1/2
Naphthalene, flake..... lb.	.06 1/2 - .08
Naphthalene, balls..... lb.	.08 - .09 1/2
Naphthionic acid, crude..... lb.	.70 - .75
Nitrobenzene..... lb.	.12 - .15
Nitro-naphthalene..... lb.	.30 - .35
Nitro-toluene..... lb.	.16 - .18
Ortho-amidophenol..... lb.	3.10 - 3.20
Ortho-dichlor-benzene..... lb.	.15 - .20
Ortho-nitro-phenol..... lb.	.80 - .85
Ortho-nitro-toluene..... lb.	.15 - .20
Ortho-toluidine..... lb.	.20 - .25
Para-amidophenol, base..... lb.	1.40 - 1.45
Para-amidophenol, HCl..... lb.	1.60 - 1.75

Para-dichlorobenzene..... lb.	.15 - .20
Paranitroaniline..... lb.	.75 - .80
Para-nitrotoluene..... lb.	.85 - .95
Para-phenylenediamine..... lb.	1.70 - 1.75
Para-toluidine..... lb.	1.25 - 1.40
Phthalic anhydride..... lb.	.50 - .60
Phenol, U. S. P., drums..... lb.	.08 1/2 - .10
Pyridine..... gal.	2.00 - 3.50
Resorcinol, technical..... lb.	1.60 - 1.65
Resorcinol, pure..... lb.	2.25 - 2.30
Salicylic acid, tech., in bbls..... lb.	.19 - .22
Salicylic acid, U. S. P..... lb.	.20 - .25
Salol..... lb.	.60 - .75
Solvent naphtha, water-white, in drums, 100 gal..... gal.	.25 - .28
Solvent naphtha, crude, heavy, in drums, 100 gal..... gal.	.14 - .16
Sulohanic acid, crude..... lb.	.27 - .30
Tolidine..... lb.	1.25 - 1.35
Toluidine, mixed..... lb.	.40 - .45
Toluene, in tank cars..... gal.	.25 - .28
Toluene, in drums..... gal.	.28 - .31
Xylidines, drums, 100 gal..... lb.	.40 - .45
Xylene, pure, in drums..... gal.	.40 - .45
Xylene, pure, in tank cars..... gal.	.45 -
Xylene, commercial, in drums, 100 gal..... gal.	.33 - .35
Xylene, commercial, in tank cars..... gal.	.50 -

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark..... lb.	\$0.24 - \$0.25
Beeswax, refined, light..... lb.	.28 - .30
Beeswax, white pure..... lb.	.36 - .42
Candelilla wax..... lb.	.25 - .26
Carnauba, Flora..... lb.	.48 - .50
Carnauba, No. 2, North Country..... lb.	.25 - .26
Carnauba, No. 3, North Country..... lb.	.14 1/2 - .15
Japan..... lb.	.24 - .25
Montan, crude..... lb.	.06 1/2 - .06 3/4
Paraffine waxes, crude match wax (white) 105-110 m.p..... lb.	.03 1/2 - .03 3/4
Paraffine waxes, crude, scale 124-126 m.p..... lb.	.02 -
Paraffine waxes, refined, 118-120 m.p..... lb.	.03 - .03 1/2
Paraffine waxes, refined, 125 m.p..... lb.	.03 1/2 - .03 3/4
Paraffine waxes, refined, 128-130 m.p..... lb.	.03 1/2 - .04 1/2
Paraffine waxes, refined, 133-135 m.p..... lb.	.04 1/2 - .05
Paraffine waxes, refined, 135-137 m.p..... lb.	.05 1/2 - .06
Stearic acid, single pressed..... lb.	.09 1/2 -
Stearic acid, double pressed..... lb.	.10 1/2 -
Stearic acid, triple pressed..... lb.	.11 - .11 1/2

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl..... 280 lb.	\$5.25 - 5.30
Rosin E-I..... 280 lb.	5.30 - 5.40
Rosin K-N..... 280 lb.	5.55 - 5.70
Rosin W. G.-W. W..... 280 lb.	6.60 - 7.35
Wood rosin, bbl..... 280 lb.	6.25 -
Spirits of turpentine..... gal.	.68 -
Wood turpentine, steam dist..... gal.	.66 -
Wood turpentine, dest. dist..... gal.	.64 -
Pine tar pitch, bbl..... 200 lb.	 - 7.00
Tar, kila burned, bbl. (500 lb.)..... bbl.	 - 11.00
Retort tar, bbl..... 500 lb.	 - 11.00
Rosin oil, first run..... gal.	.35 -
Rosin oil, second run..... gal.	.37 -
Rosin oil, third run..... gal.	.44 -
Pine oil, steam dist., sp.gr. 0.930-0.940..... gal.	\$1.90 -
Pine oil, pure, dest. dist..... gal.	1.50 -
Pine tar oil, ref., sp.gr. 1.025-1.035..... gal.	.46 -
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla..... gal.	.35 -
Pine tar oil, double ref., sp.gr. 0.965-0.990..... gal.	.75 -
Pine tar, ref., thin, sp.gr. 1.080-1.960..... gal.	.35 -
Turpentine, crude, sp. gr., 0.900-0.970..... gal.	1.25 -
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990..... gal.	.35 -
Pinewood creosote, ref..... gal.	.52 -

Solvents

73-76 deg., steel bbls. (85 lb.)..... gal.	\$0.37 -
70-72 deg., steel bbls. (85 lb.)..... gal.	.35 -
68-70 deg., steel bbls. (85 lb.)..... gal.	.34 -
V. M. and P. naphtha, steel bbls. (85 lb.)..... gal.	.23 -

Crude Rubber

Para-Upriver fine..... lb.	\$0.16 - .17
Upriver coarse..... lb.	.09 - .09 1/2
Upriver caucho ball..... lb.	.11 1/2 - .12
Plantation—First latex crepe..... lb.	.14 -
Ribbed smoked sheets..... lb.	.12 - .12 1/2
Brown crepe, thin, clean..... lb.	.15 -
Amber crepe No. 1..... lb.	.17 -

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls..... lb.	\$0.09 1/2 - \$0.09 3/4
Castor oil, AA, in bbls..... lb.	.10 1/2 - .11
China wood oil, in bbls. (f.o.b. Pac. coast)..... lb.	.11 - .11 1/2
Cocanut oil, Ceylon grade, in bbls..... lb.	.10 - .10 1/2
Cocanut oil, Cochín grade, in bbls..... lb.	.10 1/2 - .11 1/2
Corn oil, crude, in bbls..... lb.	.08 1/2 - .08 3/4
Cottonseed oil, crude (f. o. b. mill)..... lb.	.08 - .08 1/2
Cottonseed oil, summer yellow..... lb.	.10 - .10 1/2
Cottonseed oil, winter yellow..... lb.	.10 1/2 - .11
Linseed oil, raw, ear lots (domestic)..... gal.	.73 - .74
Linseed oil, raw, tank cars (domestic)..... gal.	.67 - .68
Linseed oil, in 5-bbl lots (domestic)..... gal.	.75 - .76

Olive oil, Denatured.....	gal.	\$1.10	—	\$1.20
Palm, Lagos.....	lb.	.07	—	.08
Palm, Niger.....	lb.	.07	—	.07
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.07	—	.08
Peanut oil, refined, in bbls.....	lb.	.10	—	.10
Rapeseed oil, refined in bbls.....	gal.	.86	—	.88
Rapeseed oil, blown, in bbls.....	gal.	.92	—	.94
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.08	—	.08
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.06	—	....

FISH

Light pressed menhaden.....	gal.	\$0.40	—	....
Yellow bleached menhaden.....	gal.	.42	—	....
White bleached menhaden.....	gal.	.44	—	....
Blown menhaden.....	gal.	.48	—	....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$24.00	—	30.00
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	22.00	—	26.00
Barytes, crude, 88% @ 94% ba., Kings Creek.....	net ton	10.00	—	12.00
Barytes, floated, f.o.b. St. Louis.....	net ton	23.00	—	24.00
Barytes, crude, first grade, Missouri.....	net ton	7.00	—	....
Blanc fixe, dry.....	lb.	.04	—	.04
Blanc fixe, pulp.....	net ton	45.00	—	55.00
Casein.....	lb.	.06	—	.07
Chalk, Precipitated, domestic, extra light.....	lb.	.04	—	.05
Chalk, Precipitated, domestic, light.....	lb.	.04	—	.04
Chalk, Precipitated, domestic, heavy.....	lb.	.03	—	.04
Chalk, Precipitated, English, extra light.....	lb.	.04	—	.05
Chalk, Precipitated, English, light.....	lb.	.04	—	.05
Chalk, Precipitated, English, dense.....	lb.	.04	—	.04
China clay (kaolin) crude, f.o.b. mines, Georgia.....	net ton	6.50	—	8.50
China clay (kaolin) washed, f.o.b. Georgia.....	net ton	9.00	—	10.00
China clay (kaolin) powdered, f.o.b. Georgia.....	net ton	13.00	—	20.00
China clay (kaolin) crude f.o.b. Virginia points.....	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points.....	net ton	13.00	—	20.00
China clay (kaolin), imported, lump.....	net ton	12.00	—	20.00
China clay (kaolin), imported, powdered.....	net ton	25.00	—	30.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	net ton	5.00	—	7.50
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27.00	—	30.00
Fullers earth, f.o.b. Mines.....	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Pa.....	net ton	15.00	—	16.00
Fullers earth, powdered, f.o.b. Fla.....	net ton	18.00	—	....
Fullers earth, imported, powdered.....	net ton	24.00	—	27.00
Graphite, Ceylon lump, first quality.....	lb.	.06	—	.07
Graphite, Ceylon chip.....	lb.	.04	—	.05
Graphite, high grade amorphous crude.....	lb.	.00	—	.02
Kieselguhr, f.o.b. mines, Cal.....	per ton	40.00	—	....
Kieselguhr f.o.b. N.Y.....	per ton	61.00	—	....
Magnesite, calcined.....	per ton	66.00	—	70.00
Pumice stone, imported, lump.....	lb.	.03	—	.40
Pumice stone, domestic lump.....	lb.	.05	—	.05
Pumice stone, ground.....	lb.	.06	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore.....	net ton	....	—	10.00
Quartz (acid tower) 1 1/2 @ 2 in., f.o.b. Baltimore.....	net ton	....	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	....	—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange fine.....	lb.	.52	—	.53
Shellac, orange superfine.....	lb.	.55	—	.56
Shellac, A. C. garnet.....	lb.	.44	—	.45
Shellac, T. N.....	lb.	.45	—	.46
Soapstone.....	ton	12.00	—	15.00
Sodium chloride.....	long ton	12.50	—	13.00
Talc, paper-making grades, f.o.b. Vermont.....	ton	11.00	—	18.00
Talc, roofing grades, f.o.b. Vermont.....	ton	8.50	—	13.00
Talc, rubber grades, f.o.b. Vermont.....	ton	11.00	—	18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	10.00	—	14.00
Talc, imported.....	ton	30.00	—	40.00
Talc, California talcum powder grade.....	ton	18.00	—	40.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	per ton	\$37.50—40.00	
Carborundum refractory brick, 9-in.	1,000	1250.00	
Chrome brick, f.o.b. Eastern shipping points.....	net ton	60	
Chrome cement, 40-45% Cr ₂ O ₃	net ton	30—32	
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in car lots, f.o.b. Eastern shipping points.....	net ton	33—35	
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	36—40	
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	30—35	
Magnesite brick, 9-in. straight.....	net ton	70	
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	77	
Magnesite brick, soaps and splits.....	net ton	98	
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	42—45	
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	46—50	
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	35—38	

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00 — \$225.00	
Ferrochrome per lb. of Cr. contained, 6-8% carbon, carlots.....	lb.	.12 —	
Ferrochrome, per lb. of Cr. contained, 4-6% carbon, carlots.....	lb.	.13 —	
Ferromanganese, 76-80% Mn, domestic.....	net ton	65.00 — 67.00	
Ferromanganese, 76-80% Mn, English.....	net ton	65.00 — 67.00	
Spiegelisen, 18-22% Mn.....	net ton	25.00 — 27.00	
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.50 —	
Ferrosilicon, 10-15%.....	net ton	38.00 — 40.00	
Ferrosilicon, 50%.....	net ton	60.00 — 65.00	
Ferrosilicon, 75%.....	net ton	130.00 — 135.00	
Ferrotungsten, 70-80%, per lb. of contained W.....	lb.	.40 — .45	
Ferrouanium, 35-50% of U, per lb. of U content.....	lb.	6.00 —	
Ferrovanadium, 30-40% per lb. of contained V.....	lb.	4.25 — 4.50	

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Ilvaite, 52% Al content.....	net ton	\$8.00 — \$10.00	
Chrome ore, Calif concentrates, 50% min. Cr ₂ O ₃	unit	.27 — .30	
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard.....	unit	.27 — .30	
Coke, foundry, f.o.b. ovens.....	net ton	4.25 — 4.50	
Coke, furnace, f.o.b. ovens.....	net ton	3.00 — 3.25	
Coke, petroleum, refinery, Atlantic seaboard.....	net ton	14.00 — 15.00	
Fluorspar, lump, f.o.b. mines, New Mexico.....	net ton	12.50 —	
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	20.00 — 22.00	
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01 — .01	
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	.20 — .21	
Manganese ore, chemical (MnO ₂).....	net ton	50.00 — 55.00	
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.55 — .60	
Monazite, per unit of ThO ₂ , c.i.f. Atlantic seaport.....	unit	30.00 —	
Pyrites, Spanish, fines, c.i.f. Atlantic seaport.....	unit	.12 — .12	
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.12 — .12	
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.11 — .12	
Rutile, 95% TiO ₂ per lb. ore.....	lb.	.15 —	
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	2.75 — 3.00	
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	3.00 — 3.25	
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	1.50 — 2.50	
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.25 — 2.50	
Vanadium pentoxide, 99%.....	lb.	12.00 — 14.00	
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1.00 —	
Zircon, washed, iron free.....	lb.	.03 —	

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic.....	12.00 @ 12.25
Aluminum, 98 to 99 per cent.....	24.5 @ 25
Antimony, wholesale lots, Chinese and Japanese.....	4 1/2 @ 4 1/2
Nickel, ordinary (ingot).....	41.00
Nickel, electrolytic.....	44.00
Monel metal, shot and blocks.....	35.00
Monel metal ingots.....	38.00
Monel metal, sheet bars.....	40.00
Tin, 5-ton lots, Straits.....	27.00
Lead, New York, spot.....	4.40
Lead, E. St. Louis, spot.....	4.20 @ 4.25
Zinc, spot, New York.....	4.50 @ 4.55
Zinc, spot, E. St. Louis.....	4.15 @ 4.20

OTHER METALS

Silver (commercial).....	oz.	\$0.63 1/2
Cadmium.....	lb.	1.00—1.25
Bismuth (500 lb. lots).....	lb.	1.50 @ 1.55
Cobalt.....	lb.	3.00 @ 3.25
Magnesium (f.o.b. Philadelphia).....	lb.	1.25
Platinum.....	oz.	75.00 @ 78.00
Iridium.....	oz.	160.00 @ 170.00
Palladium.....	oz.	55.00—60.00
Mercury.....	75 lb.	43.50—45.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled.....	19.75 @ 20.00
Copper bottoms.....	27.25 @ 27.50
Copper rods.....	18.50 @ 19.00
High brass wire.....	16.75
High brass rods.....	13.75
Low brass wire.....	18.25
Low brass rods.....	18.25
Brazed brass tubing.....	27.00
Brazed bronze tubing.....	31.75
Seamless copper tubing.....	20.00
Seamless high brass tubing.....	18.50

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current	Cleveland	Chicago
Copper, heavy and crucible.....	9.00 @ 9.25	9.25	9.50
Copper, heavy and wire.....	8.25 @ 8.50	8.50	8.50
Copper, light and bottoms.....	7.00 @ 7.25	7.50	7.25
Lead, heavy.....	3.00 @ 3.25	3.25	3.25
Lead, tea.....	2.25 @ 2.35	2.25	2.25
Brass, heavy.....	4.00 @ 4.25	4.50	5.00
Brass, light.....	3.00 @ 3.25	3.25	3.50
No. 1 yellow brass turnings.....	3.75 @ 4.00	4.25	4.50
Zinc.....	2.00 @ 2.25	2.00	2.25

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by 1/2 in. and larger, and plates 1/2 in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes.....	\$2.88	\$2.88	\$2.88
Soft steel bars.....	2.78	2.78	2.78
Soft steel bar shapes.....	2.78	2.78	2.78
Soft steel bands.....	3.42	3.48	3.48
Plates, 1/2 to 1 in. thick.....	2.88	2.80	2.80

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

GOODWATER—The Flake Graphite Corp. is planning for the rebuilding of its local plant destroyed by fire, Aug. 23, with loss estimated at close to \$500,000, including refining and other machinery.

California

LOS ANGELES—The Western Chemicals Co., 503 Merchants' National Bank Bldg., has plans under way for the construction of a new plant at San Pedro Harbor, comprising a main building, 40 x 200 ft., with wing extensions 40 x 100 ft. Headquarters of the company are at Tonah, Nev.

LONG BEACH—The Fredonia Window Glass Co., Fredonia, Kan., is considering the erection of a new glass-manufacturing plant on site selected at Long Beach. Plans are under way and construction will be commenced at an early date. The local Chamber of Commerce, George A. Brown, secretary, is interested in the project. C. F. Lutz is president and general manager of the company.

LONG BEACH—The Shell Oil Co. has completed plans for the construction of a number of new mechanical buildings at its plant in the Signal Hill section, to be located on Obispo Ave. The structures are estimated to cost \$51,000 and will comprise a machine works, 52 x 75 ft.; forge shop 52 x 60 ft.; mechanical shop and warehouse 76 x 90 ft., and other miscellaneous buildings.

Connecticut

NEW HAVEN—The Star Paper Co. will rebuild the portion of its plant, destroyed by fire Aug. 13, with loss reported at about \$12,000.

MANCHESTER—The Oxford Soap Co., Hilliard St., has filed plans for the construction of a 1-story addition to its plant, about 14 x 100 ft.

HARTFORD—The United States Envelope Co., 248 Pearl St., will commence the immediate erection of a new 4-story plant addition, estimated to cost about \$50,000. Contract for construction has recently been let to the Casper Ranger Construction Co., 20 Bond St., Holyoke, Mass.

Florida

PUNTA GORDA—The Southern Tanning & Mfg. Co., recently organized, is planning for the establishment of a local tannery for the production of high-grade leather products.

OCALA—The Sure Shot Timber Killer Co., recently organized to manufacture chemical products for the destruction of timber growths, weeds, etc., has plans under way for the establishment of a new local plant for the manufacture of its products. A local building has been leased for the works. E. H. Hopkins, Reddick, Fla., is president.

Georgia

BRUNSWICK—The Industrial Chemical & Fertilizer Co., recently incorporated, is planning for the construction of a new 1-story plant, 100 x 100 ft., to be equipped for the manufacture of fertilizer products. B. S. Brown is general manager.

Illinois

CHICAGO—E. F. Houghton & Co., 3524 Shields Ave., manufacturer of refined oil products, with main plant at Philadelphia, Pa., has filed plans for the construction of a new 1-story building, 30 x 100 ft., at its local works. The Austin Co., 208 South La Salle St., has the erection contract.

Louisiana

NEW ORLEANS—The Jefferson Distilling & Denaturing Co. is planning for the reconstruction of its local plant building, destroyed by fire Aug. 24, with loss estimated in excess of \$50,000, including equipment and stock.

NEW ORLEANS—The Colonial Chemical Corp., Reading, Pa., manufacturer of chemical compounds, disinfectants, etc., has leased a building at New Orleans for the establishment of a new branch works. George Bowman, secretary, will represent the company in this section.

Maryland

BALTIMORE—The Canton Co. has filed plans for the construction of a new plant on O'Donald St. near Third St. for the manufacture of lard and kindred products, consisting of a main 4-story building, 72 x 114 ft., and two 1-story structures, 50 x 58 ft., and 33 x 50 ft., respectively. The new plant will cost about \$75,000.

BALTIMORE—The American Sugar Refining Co. has filed plans for a 1-story building, 72 x 138 ft., at its new refinery, now in course of erection. The structure will be used for general manufacturing purposes, and will be located at Clement and Woodall Sts.

ARBUTUS—The Adamantex Brick Co. has construction under way on a new 2-story plant, 162 x 268 ft., to be equipped for the manufacture of sand-lime brick under a special process. The company has a tract of about 50 acres of property for its plant site and as a source of raw materials. The works will be equipped for a daily output of about 100,000 bricks, composed of sand, portland cement and a special chemical binder. Louis F. Drucker is president; and George B. Clemmert, 416 North Howard St., Baltimore, secretary and treasurer.

Michigan

HOLLAND—The DePree Chemical Co. has completed plans and will soon commence the erection of a new 2-story and basement building at its plant, 60 x 140 ft., estimated to cost about \$15,000.

Mississippi

GULFPORT—Charles T. Madison and George S. Dodds, Gulfport, are organizing a new company to construct an oil refinery on local site with daily output of about 300 bbl. of material.

Missouri

ST. LOUIS—The Standard Stamping Co., 2000 North Broadway, manufacturer of stamped metal products, has awarded a contract to the A. H. Haessler Contracting Co., Wainwright Bldg., for the erection of a new 1-story plant at Broadway and Madison St., 107 x 135 ft., to be equipped as an enameling works. George Weigand is president.

WACO—The American Zinc, Lead & Smelting Co., Pierce Bldg., St. Louis, Mo., has acquired the property of the High Five Mining Co. at Waco, for a consideration said to be \$250,000. The new owner plans to develop the site with installation of mining and other equipment.

KANSAS CITY—The Kelly Mill Co., Rochester and Park Aves., is reported to be planning for the rebuilding of its flour mill at location noted, recently destroyed by fire with loss reported in excess of \$250,000. A. B. Kelly is president.

Nebraska

ANTIOCH—The plant and equipment of the Alliance Potash Co. has been purchased by Herman J. Krause, who has been interested in the company, at a sheriff's sale, for a consideration said to be \$32,600. The plant was constructed about four years ago at a cost of close to \$500,000, including machinery. The new owner will reorganize the company and operate the works.

New Jersey

GLOUCESTER CITY—The Argo Paper Mills Corp. has been incorporated under Delaware laws with a capital of \$3,000,000, to operate a local plant for the manufacture of newsprint and other paper products. The company will take over the former Argo Mills plant at this place, previously used for the manufacture of textile products, and Frank J. Hummel, the owner of the property, heads the new organization. The works will be remodeled to accommodate

the new industry and equipment installed at an early date.

NEWARK—The Celluloid Co., 290 Ferry St., will take bids at once for the construction of a new 1-story building, 72 x 210 ft., located at Niagara and Westcott Sts., estimated to cost about \$200,000. The J. G. White Co., 43 Exchange Pl., New York, is architect and engineer.

New York

OGDENSBURG—The Bob White Chemical Co., formerly known as the Morgan Chemical Co., is planning for the construction of a new laboratory and other buildings at its plant.

CADYVILLE—The International Paper Co., 30 Broad St., New York, N. Y., has commenced the construction of a new hydro-electric power plant on the Saranac River, near Cadyville, estimated to cost about \$250,000. It will be used for paper mill operations in this district.

TROY—The Hercules Powder Co. is planning for the rebuilding of the portion of its plant at Schaghticoke, near Troy, recently destroyed by fire.

Ohio

ROSEVILLE—The T. S. Lowry Pottery Co. has completed plans for the erection of a new 1-story plant addition, 60 x 135 ft., estimated to cost about \$35,000. Construction will be commenced at an early date. N. I. Tyner is president.

DAYTON—The Allsteel Ridewell Tire & Rubber Co., 513 Lindsay Bldg., has completed plans for the erection of its proposed new plant on South Dayton St., to be 3-story and basement, 125 x 300 ft., and estimated to cost about \$500,000 with machinery.

YOUNGSTOWN—The Wells Process Co., Youngstown, is taking bids for the erection of a new plant at Conneaut, O., to be 1-story, 60 x 108 ft., and estimated to cost about \$25,000. Ralph Wells of the Wells Mfg. Co., Youngstown, heads the company.

Oklahoma

OKLAHOMA CITY—The Choate Oil Corp. is planning for enlargements in its oil refinery to increase the daily output from 2,500 to 3,000 bbl.

Pennsylvania

ECONOMY—The Wyckoff Drawn Steel Co., Frick Bldg., Pittsburgh, Pa., has completed plans for the erection of a 1-story addition to its plant at Economy, Pa., to be 60 x 240 ft.

PITTSBURGH—The Air Reduction Co., 120 Broadway, New York, has commissioned Architects Francisco & Jacobus, 511 Fifth Ave., New York, to prepare plans for its proposed new oxygen-manufacturing plant on property recently acquired on Ridge Ave., Pittsburgh, to be 1- and 2-story, 80 x 140 ft., and estimated to cost close to \$250,000 with equipment.

PHILADELPHIA—The General Smelting Co., Stock Exchange Bldg., has awarded a contract to H. E. Baton, 1713 Sansom St., for the erection of its proposed new 1-story plant at Bath and Westmoreland Sts., 60 x 100 ft., to be used for chemical service.

Tennessee

KNOXVILLE—The Pure Paint & Varnish Co., recently organized with a capital of \$150,000, has plans under way for the erection of a new 3-story plant on local site for the manufacture of paint, varnish and kindred products. It is estimated to cost about \$40,000. J. C. Trewitt, Knoxville, is vice-president in charge. J. R. Lee, Sparta, Tenn., is president.

CHATTANOOGA—The plant of the New Citico Brick Co. has been acquired by H. G. Fleming, J. J. Wall and associates. The new owners are planning for the erection of an addition to double the present output, approximating 40,000 bricks a day.

Texas

WANAHAHACHIE—The new oil refinery to be constructed by the Texas Oil Products Co., initial work for which is under way, will comprise the second unit of the company's local plant. The first unit is now in operation under a 24-hour period, with output rated at 500 bbl. per day. The new extension will have a like capacity.

WILLS POINT—The Van Zandt Cotton Oil Co., recently incorporated with a capital of \$600,000, is planning for the erection of a local plant for the manufacture of cottonseed oil and byproducts. W. P. Allen heads the company.

New Companies

THE ANSONIA CHEMICAL Co., New York, N. Y., has been incorporated with a capital of \$25,000, to manufacture chemicals and chemical byproducts. The incorporators are W. S. Perry, F. S. Mordaunt and L. Sterns. The company is represented by DeWitt & Mulqueen, 111 Broadway.

THE CARBOLOID PRODUCTS CORP., Jersey City, N. J., has been incorporated with a capital of \$20,000, to manufacture composition specialties. The incorporators are William E. Barddusch, Emil W. A. Schumann and William H. Carey, 1 Montgomery St.

THE BECKER PAPER Co., Springfield, Mass., has been incorporated with a capital of \$50,000, to manufacture paper goods. Earl Becker, Springfield, is president and Edward M. Miller, treasurer.

THE MYSTIC GLASS Co., Los Angeles, Cal., has been incorporated with a capital of \$300,000, to manufacture glass products. The incorporators are John V. Hoffman, LeVerne Fox and George D. Hussey. The company is represented by David P. Hatch, Room 1121 I. N. Van Nuys Bldg.

THE FIBROUS MFG. Co., 130 Market St., Newark, N. J., has filed notice of organization to manufacture fiber products. The company is represented by Elwood B. Hendricks, 645 Springdale Ave., East Orange, N. J.

THE CALUMET CHEMICAL Co., 4100 Fillmore St., Chicago, Ill., has been incorporated with a capital of \$50,000, to manufacture chemicals and chemical byproducts. The incorporators are F. O. Mason, P. Lee and Raymond S. Pruitt.

THE MCRAE STEEL Co., Detroit, Mich., has been incorporated with a capital of \$30,000, to manufacture steel products. The incorporators are Herbert C. Shotwell, D. Shepard Shine, Jr., and Kenneth C. McRae, 2714 Pingree Ave.

THE DEFIANCE PAINT PRODUCTS Co., INC., South River, N. J., has been incorporated with a capital of \$500,000, to manufacture paints, varnishes and kindred products. The incorporators are Benjamin W. Moreland, John H. Sloan and Matthew H. Loughridge, South River.

THE RIDDLE MFG. Co., Jacksonville, Fla., has been incorporated with a capital of \$25,000, to manufacture chemicals, and chemical byproducts. J. R. Crosby is president; W. H. McGee, vice-president; and G. B. McDaniel, secretary-treasurer, all of Jacksonville.

THE FRENCH QUALITY TOILET SOAP MFG. Co., Brooklyn, N. Y., has been incorporated with a capital of \$40,000, to manufacture soaps and affiliated products. The incorporators are G. R. Hall, M. L. Gilman and C. Steiner. The company is represented by C. S. Sachs, 119 Nassau St., New York.

THE DUSTBANE PRODUCTS Co., 3629 South Ashland Ave., Chicago, Ill., has been incorporated with a nominal capital of \$5,000, to manufacture sweeping compounds and other chemical products. The incorporators are M. B. Woodrich, Daniel Burkhartsmeier and G. A. Gillmurry.

THE GOLDEN STATE COLOR & CHEMICAL WORKS, Obispo Ave., Long Beach, Cal., has filed notice of organization to manufacture chemicals and affiliated products. James V. Nevin, 2817 East Second St., Long Beach, heads the company.

THE METAL GOODS MFG. Co., Boston, Mass., has been incorporated with a capital of \$100,000, to manufacture metal products. Ralph C. Heath, 267 Washington St., Melrose, Mass., is president and treasurer.

THE GORTON PAPER CORP., Bridgeport, Conn., has been incorporated with a capital of \$50,000, to manufacture paper goods. The incorporators are C. W. Gorton, N. P. Bump and C. T. Appleton, 45 Curtis Ave.

THE PENN SHOPE BRICK Co., Reading, Pa., has been incorporated with a capital of \$50,000, to manufacture brick and other burned clay products. A. F. Kostenbader, Reading, is treasurer.

THE STELLAR CHEMICAL Co., New York, N. Y., has been incorporated with a capital of \$20,000, to manufacture chemicals and chemical byproducts. The incorporators are H. S. Leman, A. M. Lee and H. M. Schechter. The company is represented by H. N. Wessel, 45 Cedar St.

THE SANDY CREEK OIL Co., Port Arthur, Tex., has been incorporated with a capital of \$100,000, to manufacture petroleum products. The incorporators are A. V. McFadden and F. C. Pfeiffer, Port Arthur.

THE JORDON SPECIALTY Co., Tampa, Fla., has been incorporated with a capital of \$10,000, to manufacture chemicals and chemical byproducts. Leo B. Jordon is

president; A. T. Jordon, vice-president; and P. T. Jordon, secretary and treasurer, all of Tampa.

THE RELIABLE JAPANING Co., INC., Newark, N. J., has been incorporated with a capital of \$25,000, to manufacture japanned metal goods, electroplated wares, etc. The incorporators are Frank Principe, Peter and Walter F. Lynch, 14 Ferdon St.

THE ROTARY OIL Co., Los Angeles, Cal., has been incorporated with a capital of \$200,000, to manufacture petroleum products. The incorporators are James M. Ross, William H. Yerian and W. G. Purser. The company is represented by Peyton H. Moore, 915 Black Bldg.

THE CLARK PAPER TUBE Co., Huntington, W. Va., has been incorporated with a capital of \$50,000, to manufacture paper products. The incorporators are George G. Clark and G. F. Templeman, Huntington.

THE MIDDLESEX OIL CORP., Perth Amboy, N. J., has been incorporated with a capital of \$125,000, to manufacture refined oil products. The incorporators are Samuel Sedersky and Oliver H. Brown. The company is represented by Joseph E. Stricker, 117 Smith St.

THE CONSOLIDATED OIL PRODUCERS, INC., Los Angeles, Cal., has been incorporated with a capital of \$1,500,000, to manufacture petroleum products. The incorporators are T. S. Trebell, Harvey A. Young and Irving V. Auger. The company is represented by James E. Kelby, 929 W. P. Story Bldg.

THE STANDARD STEEL Co., Detroit, Mich., has been incorporated with a capital of \$10,000, to manufacture steel products. The incorporators are Julius G. and Samuel B. Solomon, 220 Elmhurst Ave., Highland Park, Detroit.

THE J. & M. BRICK Co., 903 Boundry Ave., Los Angeles, Cal., has filed notice of organization to manufacture brick and other burned clay products. The company is headed by D. B. Jeffries, 1818 West 49th St.

THE RUBBER SERVICE Co., South River, N. J., has been incorporated with a capital of \$50,000, to manufacture rubber goods. The incorporators are Anders K. White, Chester R. Holman and Herman W. Ritter, South River.

THE GIBSON OIL Co., Vincennes, Ind., has been incorporated with a capital of \$250,000, to manufacture petroleum products. The incorporators are A. W. Keith, J. M. England and W. F. Farrell, Vincennes.

THE NEW YORK PAINT REMOVER & MOTOR CLEANING Co., INC., New York, N. Y., has been incorporated with a capital of \$100,000, to manufacture chemical specialties, cleaning compounds, etc. The principal incorporator is W. A. Craddock, 10 West 61st St.

THE MARSHALL-PRESTON OIL PRODUCING & MFG. Co., Cameron, W. Va., has been incorporated with a capital of \$50,000, to manufacture petroleum products. The incorporators are C. E. Plummer and G. T. Logsdon, Newburg, W. Va.

JAMES A. ROSS, INC., Boston, Mass., has been incorporated with a capital of \$100,000, to manufacture chemicals and affiliated products. James A. Ross, 1 Canal St., Lawrence, Mass., is president and treasurer.

THE WHITE STAR OIL Co., Monroe, La., has been incorporated with a capital of \$100,000, to manufacture refined oil products. Henry Burnstein is president; Allan Sholars, vice-president; and John J. Potts, secretary and treasurer, all of Monroe.

THE OKLAHOMA LUBRICATING OIL Co., Oklahoma City, Okla., has been incorporated under Delaware laws, with capital of \$400,000, to manufacture lubricating and other refined oils. The company is represented by the Corporation Trust Co., of America, Du Pont Bldg., Wilmington, Del.

THE PENLAND FELDSPAR & KAOLIN Co., Penland, N. C., has been incorporated with a capital of \$25,000, to operate feldspar and clay properties. The incorporators are Charles R. Harry and L. P. Bailey, all of Penland, N. C.

HENCHY & FITZSIMMONS, INC., New York, N. Y., has been incorporated with a capital of \$15,000, to manufacture chemical specialties. The incorporators are R. F. Henry, J. J. Flood and G. F. Maguire, 149 Broadway.

THE TRIANGLE CHEMICAL Co. has been organized in Vancouver, B. C., to manufacture hydrochloric acid, sulphuric acid, superphosphates, and fertilizers generally. The company has arranged with the city of New Westminster for a lease of land on the waterfront of the Northwest arm, where a plant is to be erected.

THE SHRIVER OIL Co., Westminster, Md., has been incorporated with a capital of

\$50,000, to manufacture refined oil products. The incorporators are Robert T. R. S. and William H. Shriver, Westminster.

THE CARONI PRODUCTS Co., New York, N. Y., has been incorporated with a capital of \$100,000, to manufacture flavoring extracts, alcohol byproducts, etc. The incorporators are H. J. Terwilliger, E. R. Whittingham and W. C. Blach. The company is represented by Stockton & Stockton, 2 Rector St., New York.

THE PACIFIC MINERALS & CHEMICAL Co., INC., New York, N. Y., has been incorporated under Delaware laws, with a capital of \$10,000,000, to manufacture chemicals, chemical byproducts and kindred specialties. The company is represented by Arthur W. Briton, 65 Cedar St.

THE OHIO-KENTUCKY FLUORSPAR & LEAD CORP., Smithland, Ky., has been incorporated with a capital of \$1,000,000, to operate fluorspar and lead properties, lead refining plants, etc. The incorporators are F. B. Moddle, Smithland; and Thomas J. Clay, White Castle, La.

Capital Increases, Etc.

THE OWEGO MFG. Co., Owego, N. Y., has been merged with the Wilbur White Chemical Co., Owego, under the latter name.

THE APONA CHEMICAL Co., South Bend, Ind., has filed notice of dissolution under state laws.

THE KLEYENSTEUBER-WHITE FOUNDRY Co., Birmingham, Ala., manufacturer of metal castings, has increased its capital to \$20,000. M. G. Kleyensteuber is president.

THE NEW JERSEY CAR SPRING & RUBBER Co., 91 Brunswick St., Jersey City, N. J., has filed a petition in bankruptcy. The assets and liabilities have not been stated.

THE WOLVERINE PETROLEUM Co., Saginaw, Mich., has filed notice of increase in capital from \$50,000 to \$250,000.

THE GLIDDEN Co., Cleveland, O., manufacturer of paints, varnishes, etc., has arranged for a bond issue of \$3,350,000. Adrian D. Joyce is president.

THE CORSICANA PETROLEUM Co., Houston, Tex., has filed notice of increase in capital from \$20,000 to \$80,000. J. H. Farber is president.

THE LAWTON REFINING Co., Lawton, Okla., manufacturer of refined petroleum products, has filed notice of increase in capital from \$100,000 to \$150,000.

THE LIMETON LIME Co., Front Royal, Va., manufacturer of lime products, has filed notice of increase in capital from \$20,000 to \$50,000. R. E. Herr is president.

THE SALT SPRINGS SOLAR COARSE SALT Co., Syracuse, N. Y., has filed notice of reduction in capital from \$120,000 to \$24,000.

Manufacturers' Catalogs

THE CONVEYORS CORPORATION OF AMERICA, Chicago, Ill., has issued a booklet, "The Proof of the Pudding," which consists of 70 testimonial letters received from users of its conveyors. Copies will be sent on application.

THE YALE & TOWNE MFG. Co., Stamford, Conn., has issued two leaflets. The first is on "Electric Industrial Trucks, Model A-17 Crane Truck" and the second on "Electric Industrial Trucks, Model C-6-36 Trailer." Illustrations and specifications are given.

THE YORK MFG. Co., York, Pa., calls attention to Bulletin 10a, which supersedes Bull. 10, on ice-making and refrigerating machinery.

THE ATLAS VALVE Co., Newark, N. J., calls attention to Bulletin 5, entitled "Victor Damper Regulator No. 3, High Pressure." This regulator is designed for boiler pressures up to 250 lb.

THE NASH ENGINEERING Co., South Norwalk, Conn., has published a catalog covering Jennings hytor return line vacuum and low pressure boiler feed pumps. This is known as Bulletin 15.

THE INGERSOLL-RAND Co., New York, has issued a very attractive catalog on its products. This catalog gives a general idea of the numerous products manufactured by the company. For easy reference the products have been subdivided into various classifications. Particular attention is called to the Engineering Data Section, which is of value in solving everyday pneumatic problems, and in determining exact requirements for new equipment.

Industrial Notes

THE ENGINEERING ADVERTISERS' ASSOCIATION, Chicago, has proposed, and the Technical Publicity Association of New York has seconded, the proposal to hold an industrial advertising conference with the Associated Advertising Clubs of the World, meeting in Milwaukee in 1922. Both the Chicago and New York advertising associations have a large membership representing industrial and technical advertisers. The rapid growth of this kind of advertising and the necessity for specialist treatment in its development make it necessary to consider the subject apart from the usual question pertaining to advertising, and accordingly a special program for industrial advertising is proposed for the Milwaukee convention. The conference will serve an important purpose in suggesting new subjects for thought and investigation by advertising agencies.

THE GASOLINE RECOVERY CORP., New York, announces that a commercial natural gas gasoline plant operating according to the Burrell-Oberfell charcoal process is in operation at Bradford, Pa. The plant has a capacity of 900 gal. per day. It is also announced that the charcoal gasoline plant of the Monroe-Louisiana Carbon Co., located at Monroe, La., is nearing completion.

THE SCHAFFER ENGINEERING & EQUIPMENT CO., Pittsburgh, Pa., announces the combining of the administrative, sales and manufacturing departments in its new general offices at 2828 Smallman St., Pittsburgh, Pa.

THE COCHRANE STEAM SPECIALTY CO. OF MASSACHUSETTS has been organized to represent in New England a number of well-known manufacturers of power-plant equipment, including the H. S. B. W.-Cochrane Corp., manufacturer of feed water heaters, steam and oil separators, V-notch meters and metering heaters, hot and cold process softeners, flow meters, precision meters, weighing meters, multiport valves and multiport drainers, also the Steam Motors Co., Inc., manufacturer of steam turbines for driving generators, pumps, fans, etc., and the D. Connelly Boiler Co., builder of water tube steam boilers. The office at 1045 Oliver Bldg., Boston, Mass., is in charge of Elliott Greene.

THE LINK-BELT CO., Chicago, has acquired all of the capital stock of the H. W. Caldwell & Son Co., and Frank C. Caldwell has been elected a director of the Link-Belt Co. The H. W. Caldwell & Son Co.'s plant will continue to operate under separate corporate existence under its present name.

THE SULLIVAN MACHINERY CO., Chicago, Ill., has moved its Cleveland office from 810 Park Bldg., to Room 824, Kirby Bldg. Ralph T. Stone is manager. It is also announced that a supply depot and service station for coal-mining machinery supplies and repair parts has been opened at Seventh Avenue and Thirteenth Street, Terre Haute, Ind. H. T. Wiley is in charge.

CHARLES CORY & SON, INC., 183-187 Varick St., New York City, has obtained the manufacturing and selling rights for the Royer line of portable and stationary flow indicators. These indicators are designed for indicating the flow of all kinds of corrosive and non-corrosive gases, vapors and liquids and were formerly manufactured and sold by the A. H. Sloan Co. of Detroit, Mich. It is intended, through the increased manufacturing facilities provided by the Cory company, to increase the production of these meters and make further extensions to the Royer line.

THE MALCOLMSON ENGINEERING CO. has just finished the peat harvesting machinery for the Dominion Government Peat Committee at Alfred, Ont. This involves equipment for excavating the peat from the ground and distributing it in piles for air-drying, when it is later picked up ready for the market.

THE MALCOLMSON ENGINEERING & MACHINE CORP., Old Colony Bldg., Chicago, Ill., has just completed the plant of the Tennessee-Illinois Phosphate Co., at Centerville, Tenn.

CASE SERVICE, INC., District National Bank Bldg., Washington, D. C., is an organization conducted for the purpose of serving non-residents of Washington, who have relations with various branches of the Government. It is designed to expedite business through personal attention.

C. W. LEAVITT & Co., New York, have been appointed selling agents in the United States for Mines de Manganese, Marquesa-Baja, Chile, producer of high-grade manganese ore. New equipment now being installed at the mines will place that company in a position to ship up to 300,000 tons manganese ore per annum.

New Publications

BOOKS

TECHNOLOGY OF CELLULOSE ESTERS, VOL. I, in five parts. By *Edward Chauncey Worden, First*. Pp. 3,709; 296 illustrations. New York: D. Van Nostrand Co., 1921. Price, \$40.

Those interested in the subject of nitrocellulose and other cellulose esters are familiar with the author's earlier two-volume "Nitrocellulose Industry" and with Vol. VIII of this series on cellulose esters, which deals with cellulose acetate. The volume just issued represents the combined efforts of a number of workers over a period of years. Some idea of the labor involved may be gained from the fact that there are 19,611 footnotes covering 39,458 patent and 80,504 literature references to the work of 33,740 investigators. Part 1 treats the raw materials cellulose, starch, cotton and the preparation of cotton for esterification; part 2, nitric acid, sulphuric acid and mixed acids; part 3, nitrocellulose theory, nitration of cellulose, analytical determinations of the cellulose nitrates; part 4, historical development of the cellulose esters. Part 5 is the patent, name and subject index to the first four parts.

TRANSACTIONS OF THE AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, Vol. XIII, Part I, 1920. Pp. 463, illustrated. New York: D. Van Nostrand Co., 1921. Price, \$6.

This volume contains the papers presented at the Montreal meeting, June, 1920.

A DICTIONARY OF APPLIED CHEMISTRY, Vol. II, revised and enlarged edition. By *Sir Edward Thorpe*, assisted by eminent contributors. Pp. 717, illustrated. London and New York: Longmans, Green & Co., 1921. Price, \$20.

This volume of the revised and enlarged edition covers topics from calculus to explosion, gaseous. Some of the more important articles are as follows: Camphor, Candles, Carbohydrates, Carbon, Cellulose, Cement, Chemical Affinity, Chlorine, Chromium, Cinchona Alkaloids, Citric Acids, Clay, Cobalt, Coke Manufacture and the Recovery of Byproducts, Colloids, Colorimeters, Color and Chemical Constitution, Copper, Corrosion of Metals, Corrosion (Protection of Metals From), Corrosion and Fouling of Steel and Iron Ships and Its Prevention, Creosote, Cyanides, Decolorising Carbons, Desiccation and Drying, Diazo-Compounds, Disinfectants, Distillation, Dyeing, Dyestuffs (Identification on Fabrics), Electrodeposition and Electroplating, Esterification, Ethyl, Evaporation, Explosion (Gaseous).

AMERICAN SULPHURIC ACID PRACTICE. By *Philip DeWolf* and *E. L. Larison*. Pp. 270; 85 illustrations. New York: McGraw-Hill Book Co., Inc., 1921. Price, \$3.50.

This is the first book to deal with modern American sulphuric acid practice from the point of view of actual plant operation. It is designed to meet the needs of, say, a new chamber operator or of men in allied lines who wish to acquaint themselves quickly with the subject. After introductory chapters on the history of the industry, elementary chemistry of H_2SO_4 , characteristics and uses, the raw materials and the production of SO_2 are discussed. The chamber process is treated in the following chapters: A brief description of the process, dust-settling apparatus, the Glover tower, the chambers, Gay-Lussac towers, acid circulation, introduction of niter, draft, testing, operation, concentration. An outline of the contact process is followed by chapters on purification of gases, converting, absorption, and converter mass. A special chapter on accounting was prepared by W. M. Le Clear. Acid tables, data for calculating the volume of acid in tank cars, etc., are given in the appendix.

THE ELECTRIC FURNACE. By *J. N. Pring, D.Sc.* Pp. 485; 241 illustrations. London and New York: Longmans, Green & Co., 1921. Price, \$10.50.

Practically all electrochemical and electrometallurgical process in which the electric current functions as a source of heat energy are included in this book, which is one of the monographs on industrial chemistry edited by Sir Edward Thorpe. Electrolysis in aqueous solutions is outside the scope of the text, although the electrodeposition of zinc and copper is referred to briefly. The electrochemical industries include calcium carbide, nitrogen fixation and ammonia oxidation, carborundum, aluminum, graphite, phosphorus, carbon bisulphide, electrolytic processes with fused electrolytes (aluminum, sodium and calcium). The electrometallurgical industries are the electric smelting of iron ores, electric steel, ferro-alloys, melting and prepara-

tion of non-ferrous metals and alloys, electric smelting of zinc, copper and tin ores. There are also general chapters on the principles of electric furnaces, laboratory and experimental types, current supply, transformers, pyrometry, refractories, heat losses through walls and electrodes, design of terminals, power expenditure, water-power developments, steam-power stations and electrochemical centers. In short, electric furnaces and their industrial applications are very thoroughly covered.

CERAMICS. By *A. Malinovsky*. Pp. 274, illustrated. New York: D. Van Nostrand Co., 1921. Price, \$3.

A condensed review of ceramic processes, including the methods of qualitative and quantitative analysis of silicates, and chemical and ceramic calculations used in everyday practice. Many tables which will be helpful to the ceramic engineer are also included.

METALLURGY OF THE COMMON METALS. Fifth edition. By *Leonard S. Austin*, formerly professor of metallurgy and ore dressing, Michigan College of Mines. Pp. 615; 330 illustrations. New York: John Wiley & Sons, Inc., 1921. Price, \$7.

Since 1913, the date of the last edition, such radical changes and improvements have been made in the metallurgy of the common metals that this edition has been largely rewritten. Great pains have been taken to set forth underlying principles clearly and at the same time to give the details of methods and metallurgical equipment, and their cost. A chapter has been devoted to questions of the economic situation of the business of metallurgy. Little attempt has been made to describe methods not now in use.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its seventy-fourth meeting at Toronto, Canada, Dec. 27 to 31, 1921.

AMERICAN CERAMIC SOCIETY will hold its twenty-first annual meeting at St. Louis, Feb. 27 to March 2, 1922.

AMERICAN GAS ASSOCIATION will hold its third annual convention in the Congress and Auditorium Hotels, Chicago, the week of Nov. 7. More than 100 manufacturers will exhibit their latest gas-burning appliances.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in Lake Placid, N. Y., Sept. 29 and 30, and Oct. 1.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its annual winter meeting at Baltimore, Md., Dec. 6 to 9. Headquarters will be at the Southern Hotel and the sessions will be held in the Engineers' Club.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS is holding its fall meeting at Wilkes-Barre, Pa., Sept. 12 to 17.

AMERICAN MINING CONGRESS AND NATIONAL EXPOSITION OF MINES AND MINING EQUIPMENT will hold its twenty-fourth annual convention in the Coliseum, Chicago, Oct. 17 to 22.

AMERICAN SOCIETY FOR STEEL TREATING will hold its third annual convention and exhibition Sept. 19 to 24 at Indianapolis.

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SEVENTH) is being held this week in the Eighth Coast Artillery Armory, New York City.

NEW JERSEY CHEMICAL SOCIETY has discontinued meetings for the summer and will resume them in October.

SOCIETY OF INDUSTRIAL ENGINEERS will hold its fall meeting at Springfield, Mass., Oct. 5 to 7.

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY will hold its fall convention with the American Pulp and Paper Mill Superintendents' Association, at Washington, Philadelphia, Spring Grove, York, York Haven, Pa., and Wilmington, Del., Oct. 18 to 20.

The following meetings are scheduled to be held in Rumford Hall, the Chemists' Club, New York: Oct. 7—American Chemical Society, regular meeting; Oct. 14—Société de Chimie Industrielle, regular meeting; Oct. 21—Society of Chemical Industry, Grasselli Medal; Nov. 11—American Chemical Society (in charge), Society of Chemical Industry, American Electrochemical Society, Société de Chimie Industrielle, joint meeting; Nov. 18—American Electrochemical Society, regular meeting; Dec. 2—Society of Chemical Industry, regular meeting; Dec. 9—American Chemical Society, regular meeting.

CHEMICAL & METALLURGICAL ENGINEERING

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A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY and IRON & STEEL MAGAZINE

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R. S. McBRIDE
CHARLES N. HULEBURT
Assistant Editors
CHESTER H. JONES
Industrial Editor
J. S. NEGRU
Managing Editor

Volume 25

New York, September 21, 1921

Number 12

Sixty-second Meeting of The American Chemical Society

THE sixty-second meeting of the American Chemical Society is over, and it may be described as a good one. Under the distinguished presidency of Dr. EDGAR FAHS SMITH it was bound to have quality. The man at the head is certain to give tone to what he directs, and the Provost Emeritus is of the Blood Royal of Good Fellowship. It could not be a commonplace meeting, although it bore none of the hallelujah appellations so dear to the hearts of the scare-head writers. It did not suffer from being a "Get Together" or a "Press Onward" meeting. It was just the sixty-second meeting, and excellent of its kind.

There were 334 papers presented before the various divisions, and that was, of course, too many. One can get "fed up" on almost any subject, and we are of the opinion that fewer papers and livelier discussions would do more to speed the gospel of chemistry and the enlightenment that goes with it than more papers and less talk. Perhaps if, after every fifty minutes, a recess of ten minutes were taken it would give those present a chance to stretch their legs and get a breath of fresh air. After several hours of miscellaneous listening one gets tired and classroom-worn. He misses points, and if he is tired enough he will agree tentatively by saying nothing when his chemical conscience should have prompted him to protest, or to oppose that with which he does not agree.

The international meeting in the Great Hall of the City College was an occasion of leading importance, and the papers were full of meat. But this also was too long. To listen to papers, even of such rare merit as these, from 2:30 until after 5 o'clock is too much. It was like a Gothic festival: so bounteous as to paralyze.

On the whole the meeting was an important scientific achievement. Our only criticism is a call for reorganization of the method of presenting papers. We think a little closer association of division chairmen might bring about a correction of this weariness factor. As the meetings are now conducted the incidence of weariness is too early; it comes long before the sessions are over.

Is It Dyes, Dyers, Ignorance or Cupidity?

ON THE afternoon of September 13 there was called an informal meeting in the clubrooms of the United Waist League of America, to discuss problems and troubles relating to dyes and dyed goods. Curiously enough—for such is the mutability of space!—this association of manufacturers of ladies' ready-made waists occupies the former habitation of the learned Grolier Club, and in the very apartment where the discussion took place there were erstwhile disputes as to first editions of Junius, exhibitions of renaissance bindings,

second folios of Shakespeare, and, if we remember aright, it was there that we saw for the first time a Breeches Bible. Who dares deny that time is a dimension of space?

On September 13, however, the discussion was far more direct and to the point than is the habit of bibliophiles in their arguments. Manufacturers of garments are having trouble with dyed goods today, and some complained that the quality was worse than ever before. One of the principal complaints was of black silks and navy blues. Another frequent trouble was with "bisque," a light shade of tan. Others reported difficulty in getting desired results in woolen goods. If producers of cotton goods were present, they were less audible than the others. Mr. MOESSOHN, the chairman, explained the difficulty: they buy the materials, make them up into garments, and then complaints come in. Thereupon they endeavor to trace the source of trouble, and there follows a manifestation of "passing the buck" that leaves the garment manufacturer bewildered and no wiser than he was before. He doesn't get anywhere when he tries to find out.

The desire was generally expressed, except by a few silent representatives of importers of German dyes, that the American dye industry be maintained, and the statement was made that the fault does not lie in American-made products. It was soon made clear that black silks, for instance, should be dyed with logwood, and that there is no shortage of that material nor any novelty in applying it. The delicate, light shades, it was declared, never had been fast, and against this was reported a claim by one establishment that it had developed a new process that makes "bisque," for instance, reasonably fast to light and wash—if the water is not too hot.

A complaint about blue bathing suits brought out the fact that the goods had been dyed with a perfectly good color—for other purposes—but that the medium used was not and never had been fast to light, salt water and perspiration.

This brought out the fact that very often the dyer does not know what the goods are to be used for. Fastness is a relative term. No dye ever was or ever will be absolutely fast. Yarn for bathing suits requires different dyes and treatment from yarn for dress goods. Black stockings—at least in the good old days when we were young—did not have to be made fast to light.

A gentleman of large experience said that in the past eight or nine years a large number of so-called dyers had sprung up in this country who are not dyers at all; they are painters.

Mr. BLUM of the United Piece Dye Works, who speaks with unquestioned authority, said that 90 per cent of the dyes we had before the war are made here, and the remaining 10 per cent can be obtained under license. The fault, he said, does not lie with the American-made products. Every trouble in dyeing has its specific

cause, and the number of them is legion. We are likely to forget that 1914 was nearly eight years ago, and that many classes of goods were as unreliable then as they are now. Mr. LEE, of the National Vigilance Committee, said that, what with high prices and buyers' strikes, the public had a grouch, and was disposed to blame the profiteer if anything was wrong. Dr. MATTHEWS, of the *Color Trade Journal*, struck the keynote when he said that goods should be dyed for quality rather than for price.

The meeting concluded with the appointment of a strong committee of textile chemists, dyers and manufacturers of garments to take up each complaint, trace each piece of goods through its history and find out what is wrong. That will bring out the fault and indicate just where it lies. It will show up incompetent dyers and put the blame on the man who skimmed his work, no matter who he be, and whether the cause were due to the strain of economy, ignorance of conditions that should have been understood, lack of right dye or use of wrong one, or downright incapacity.

We have nothing to take back of what we said lately about the trouble with dyed goods.

Further Defense of The Selective Embargo

ONE of the arguments sometimes urged against the selective embargo feature of the dye bill is that it is a legislative experiment and entirely revolutionary in nature. In answer to these objections most of us have been content to emphasize the fact that the unusual character of the present emergency and the vital importance of the dye industry call for a new and unusual sort of legislative treatment. We have felt, however, that this answer was not always convincing and we are very grateful, therefore, to the good friend who has called to mind a rather striking parallel of the dye bill. Think back for a moment to the recent immigration law. Is it not of exactly the same nature as the selective embargo? American labor found itself out of employment and the few existing jobs were threatened by an influx of cheap labor from abroad. Foreign countries were preparing to dump their surplus population on this country. Did we permit them to do it? No; the zealous safeguards of labor were on the job and quickly devised a careful plan for the restrictive control of immigration. At first we were frankly skeptical of the measure and not altogether sure that it was right in principle, but we are ready to admit that as far as our observation goes the embargo on immigration has contributed much to the common good.

Certainly the case of the dye industry has been so carefully and completely presented that it is scarcely necessary for us to vouch for the validity of its claims. The heads of our military establishments have told us that a dye industry is not only a helpful adjunct in the prosecution of modern warfare but is absolutely essential to the national defense. Economists have shown it to be a key industry upon whose products the employment of millions is dependent. The medical fraternity relies upon it for the medicinals vital to our health and happiness, and finally our universities and colleges—in fact the science of chemistry itself—cannot progress if this industry is stifled. When so much is at stake, why should we hesitate? The welfare of the nation will be served by the selective embargo on dyes, and certainly it is no more revolutionary than much of our present law.

A number of similar precedents can be found even in the existing tariff schedules. The Department of Agriculture, for example, can place an absolute embargo on foods which fail to meet the standards of the pure food and drugs act. Potatoes, grain, farm animals, pets, foreign drugs, vaccines and serums and many other articles can be imported only under strictest quarantine which in many cases amounts to a practical embargo. Are these commodities more inimical to the good of the country than are the products purposely intended to destroy our dye industry? We think not.

Mr. Ford's Offer For Muscle Shoals

LOOKING backward into the history of the notorious Muscle Shoals project, the fact stands out that there has been a deliberate confusing of the public mind in connecting the manufacture of nitrates with water-power development on the Tennessee River. Private interests desiring to enrich themselves at the expense of the Federal Government and politicians seeking forced economic development in one small section have been largely responsible for this.

Supported by President WILSON, Senator UNDERWOOD succeeded in locating the nitrate plants in Alabama, not because it was the best place to get them finished quickly for the nation's defense in time of war but rather for the reason that the South would be benefited. So one need not be surprised to find in Mr. FORD'S recent offer to lease the water power and purchase the nitrate plants the same attempt to handle the two things in lump bargaining. They should be considered separately, because the factors affecting each are entirely different.

As a matter of fact not one kilowatt of power from the Tennessee River was ever used, nor need it ever be required to operate these establishments at full capacity. Both U. S. Nitrate Plant No. 1 and No. 2 have fully equipped steam power houses on the properties and are connected in a common system with the Alabama Power Co. network and the Government power plant at Gorgas, on the Warrior River.

Water-power development at Muscle Shoals, promoted in Congress on the plea of war-time emergency by the local interests and put through by President WILSON for political reasons, has always been a questionable business venture in the minds of engineers and economists. However, the first dam stands partly constructed with about \$17,000,000 expended in a territory where power cannot now be sold. It is estimated that approximately \$31,000,000 more must be spent to complete the entire project. Mr. FORD would have the Government expend this latter sum and he would in turn attempt to establish industrial enterprises to use the power. He would have it further grant him special rights, contrary to existing policies built up after fifteen years struggle for conservation of water power.

The Roosevelt policy, now a law, provides that water-power leases shall be limited to fifty years with possibility of recapture by the Government at the end of that time; provides for regulation of price to power consumer, and that public water power taken for profit shall make a return to the public. Mr. FORD wants a lease for 100 years with indefinite renewals at the end of that time, or, in other words, continued private possession. His offer provides for no check on what the power consumer must pay. Further, he would receive several hundred thousand horsepower for nothing.

Consistent action on the Government's part would be to make a deal with Mr. FORD or other interested parties, whereby the existing works on the Wilson dam be purchased and a standard contract be entered upon for continued development and use of power on the same basis as at any other water-power site. The partly completed dam can much more economically be liquidated at a discount on \$17,000,000 than for the Government to spend \$31,000,000 more in times when money is sorely needed in other departments. Liquidation of the minor sum rather than added appropriations of the larger sum for construction is certainly a business-like procedure at this time.

Mr. FORD then asks that the two nitrate plants, Waco quarry, Gorgas power plant and an 80-mile transmission line be thrown in as a sort of horse trade for only \$5,000,000. Now, these are first-class properties which cost close to \$100,000,000 and are not to be compared with temporary war plants like Nitro, W. Va. Writing off the excessive cost due to war times, it would cost about \$50,000,000 to replace them today.

It would be necessary for the purchaser to convert Plant No. 1, costing \$13,000,000, to other uses, for the process was unsuccessful at this location. However, the cost of the apparatus which would necessarily be scrapped is a small proportion of the value of the plant.

Plant No. 2 is a valuable chemical property, probably the largest in the world. It can be operated to produce several basic chemicals and fertilizers and at the same time be held intact for military emergency. There is nothing particularly mysterious or out of the ordinary about the apparatus. One 60,000-kw. power house, one process steam plant, twelve 8,500-kva. carbide furnaces, seven rotary limekilns, coal-pulverizing plant, two 600-ton mills, thirty-six nitric acid towers, 1,532 electric ovens, twenty-three 600-lb. air compressors, fifty-six autoclaves, filtering and causticizing plant, 696 catalyzers are some of the items, all usable equipment to chemical engineers. Numerous large permanent plant buildings and several hundred permanent homes are located on a tract of about 1,700 acres of land.

It is not necessary to accept Mr. FORD's offer because it is the only one made at this time. Other companies in the chemical manufacturing business would doubtless pay considerably more for the property listed above were it not for the present financial depression. They simply cannot in sound business policy entertain expansion when their own plants are running at low capacity. In the meantime the Government can afford to wait, for cash maintenance in standby condition costs only the time of a few officers, a score of men and a negligible amount of material.

Mr. FORD shows he is a good business man, because he has conserved his cash resources to purchase when things are cheap. Maybe he could manufacture fertilizer at No. 2 so cheaply that a flivver would be found in each 2,000-lb. package. We also recall that he was going to "call the boys out of the trenches by Christmas," or, in other words, a pacifist is proposing to take over a property that may be needed in war. This situation might involve delay at a moment embarrassing to the nation. His business ability is a thing of passive interest to the private citizens, but all are actively concerned that those in command of these affairs should likewise display sufficient acumen to realize that this is not the time to throw valuable property on the market to the highest bidder. The Government can afford to wait for a better market.

Railroad Service

And Railroad Buying

SOME ideas die hard, and one of these is the idea that the railroads of the United States can contribute largely to the prosperity of the country by making purchases. With many of those who are talking of prospective railroad buying, self-interest is prominent. What they want is orders. The history of American railroading can be divided into three periods. The first was a period in which railroading was exploited by speculators. The second was one in which railroads were thought to exist chiefly for the purpose of placing orders. The third period was one in which a large number of persons thought the chief function of the railroads was that of having payrolls. In the hope of making that period permanent the "Plumb plan" was devised. The railroad payrolls are now undergoing a slow process of deflation, by reducing the number of names and the quantity of emolument per name. Let us hope that a fourth period will be inaugurated in which the universal view will be that of the railroads existing chiefly for the purpose of rendering service to the public.

The idea still prevails in some quarters that normal or at least accumulated requirements of the railroads can furnish employment to a large proportion of the steel-producing industry. That is not the case now. It was the case occasionally years ago, when there were great bursts in railroad building and the iron and steel industry was very much smaller than it is now. To illustrate, more miles of railroad have been abandoned in the past few years than have been built, while in 1887 nearly 13,000 miles of road was built, the country's pig-iron-producing capacity in that year having been about one-seventh the present capacity.

Making rough but sufficiently close estimates, there is more than 300,000,000 gross tons of steel in service in the United States, while the amount in service on the railroads is less than 100,000,000 gross tons. The productive capacity, in finished rolled steel, not ingots, is about 40,000,000 gross tons a year. As the railroads are already built and need to increase in efficiency rather than in size, while uses of steel outside of railroad employment present great possibilities, it is easy to see that the future of steel demand lies outside the railroads rather than inside. If two years of full steel production could be rolled and fabricated into the particular forms required by railroads, the railroad facilities would be doubled. That would be utterly absurd.

In the first six months of this year the railroads earned at the rate of 1.8 per cent a year on their tentative valuation, when the rates prescribed by the revision of last August contemplated their earning $5\frac{1}{2}$ per cent as a return on their value and $\frac{1}{2}$ per cent additional, looking to betterments, or a total of 6 per cent. In six months the railroads did not do one-third as well as was desired. Some claim that rates are too high, others claim that the railroads ought to spend a great deal of money.

The better view of the railroads is that they can help the industries of the United States by furnishing convenient and cheap service, by efficient operation of an investment kept down to the lowest possible notch, rather than by spending money. The less spending the railroads can get along with the better it will be for business in general, and the less we expect "business" to be made "good" by railroad expenditures in the next six months the less likely we are to be disappointed.



Meeting of the American Chemical Society

Report of the Sixty-Second Meeting of the American Chemical Society Held in New York, Sept. 6 to 10, 1921—Synopsis of the Papers Presented at the International, General and Divisional Meetings

THE sixty-second meeting of the American Chemical Society was held in New York, Sept. 6 to 10, 1921, with headquarters at the Waldorf-Astoria. In addition to the largest number of members ever present at a fall meeting of the society, leading chemists of Great Britain, Canada and other countries took part in the international meeting at the College of the City of New York and the other meetings held in the gymnasium and lecture rooms of Columbia University.

Council Meeting

The Council of the American Chemical Society met at 3 p.m., Sept. 6, in Rumford Hall of the Chemists' Club, with President Edgar Fahs Smith in the chair.

After the reading of the minutes the report of the committee on patents was taken up, which elicited rather lengthy discussion. In regard to the measure now before the U. S. Senate the committee reported against it on the ground that it might open the way to still greater abuses in blocking the development of American industries as practiced by German organizations previous to 1917. The conclusion was that while the Council was disposed to accept the report, it was of the opinion that more constructive measures should be included in any expression of the official opinion of the society.

The Sugar Section made an appeal that its status be changed to the Division of Sugar Chemistry and Technology of the American Chemical Society and its proposed constitution and bylaws were presented and found to be in order. By resolution the appeal was granted. The same action was taken in regard to the Leather Section, which now becomes the Division of Leather Chemistry.

Sir William J. Pope and Dr. Paul Kestner were nominated and elected by the Council to be honorary members of the society. The action was confirmed at the general meeting of the society on the following morning.

The invitation of the Pittsburgh Section to hold the September meeting in 1922 at that city was accepted with thanks. The April meeting in 1922 had already been determined to be held at Birmingham, Ala.

The editors of the several journals of the society and of the scientific and technological monographs were re-elected.

President Smith reminded the Council that the society was founded at the home of Priestley at Northumberland, Pa., and suggested that the Council bear in mind that 1926 will mark the fiftieth anniversary of the society and that a pilgrimage to the spot would be timely in connection with a spring or fall meeting which might be held in the neighborhood.

The secretary reported that on Aug. 1, 1921, the society had 15,157 members. This is about the same number as last year.

The advisory committee recommended that the officers of all divisions and sections be instructed to file with the society's news service all matters on which they desire publicity at general meetings.

Dr. John E. Teeple, on behalf of the Chemists' Club, suggested that inasmuch as the employment bureau which the club had conducted for many years had outgrown the club's facilities for housing and maintaining it, and in view of the wider scope which the bureau might enjoy if taken over by the society, the question of taking it over be considered by a special committee to be appointed for the purpose. It was resolved that such a committee, to consist of three members, be appointed, to report at the spring meeting.

The General Meeting

Three thousand chemists were present in the large gymnasium of Columbia University when the general meeting of the society was called to order by President Smith. Dr. John E. Teeple, the chairman of the New York Section and president of the Chemists' Club, was presented and in a brief greeting welcomed the sixty-second meeting of the American Chemical Society in the name of the members of the New York Section. The representatives of the sister society of the British Empire, the Society of Chemical Industry, who had come to join with American chemists in the discussion of scientific problems of mutual interest, also received a hearty greeting from their New York hosts. Dr. Smith responded for the society and expressed the gratitude of all present for the hospitality offered.

Francis P. Garvan, formerly Alien Property Custodian and now president of the Chemical Foundation, was introduced by Dr. Smith as "a gentleman to whom every chemist is deeply indebted for the services which he has rendered to the chemical profession." Mr. Garvan responded with an eloquent address on "Chemistry and the State," in which he made a dramatic appeal for chemists to accept the responsibility of teaching the people of this country the truth of Pasteur's statement that "Science is the soul of the prosperity of nations and the living source of all progress."

What the German chemist accomplished was not alone in his laboratory but in the forum of public opinion.

As an instance of the foresight of German chemical interests, Mr. Garvan told how a former American Commissioner of Patents, with the permission of an acting Secretary of State, had been induced to go to Berlin and to negotiate the patent treaty of 1909 by which Germany was released from working her chemical patents in this country. This Mr. Garvan characterized as the "crushing of the last hope of development of the organic chemical industry of this country."

Declaring that "German agents in America are once more plotting against us, he said: "If we allow Germany to stifle an American industry that would within a very few years make the United States absolutely safe, then, I say, it will have been through your neglect and temerity and failure to realize that it is your responsibility not only to search the truth but to preach it."

TELEGRAM FROM PRESIDENT HARDING AND RESOLUTIONS TO CONGRESS

Several items of interest came before the general meeting in its brief business sessions. A telegram from President Harding was read by Dr. Parsons. The President said:

Probably none of the materialistic sciences holds promise of so great contributions to human welfare in the coming generation as that which your organization represents. The developments of applied chemistry involve both a possibility of vastly increased horrors in human conflict and ultimately inestimable benefits to a peaceful civilization. Let us hope that a science so fraught with either good or vicious possibilities may be turned, through the wisdom of the nations, to the benefit and advancement of mankind.

Following the appointment of a committee, consisting of Drs. Chandler, Reese and Parsons, to frame a proper reply to the message from the President of the United States, resolutions to Congress were passed which requested that the coming disarmament conference should give due consideration to the subject of limiting chemical armament. The necessity of including in the permanent tariff law a temporary selective embargo against importations of synthetic organic chemicals was also urged.

MUSTARD GAS

Sir William J. Pope called attention to the peculiar philosophy of war. War is essentially the super-sport and anything which increases the sporting element is welcomed. Thus chemical warfare was condemned as inhumane, while preventive medicine was hailed as a blessing, in spite of the fact that preventive medicine made it possible to increase the army unit from 100,000 to 1,000,000 men and thus keep 20,000,000 men in the field. From this point of view, nine-tenths of the 15,000,000 combatants killed during the war died as a direct result of the use of preventive medicine. Con-



Photo, Underwood & Underwood

SIR WILLIAM J. POPE; GENERAL AMOS A. FRIES, U. S. A.
DR. CHARLES L. REESE, CHEMICAL DIRECTOR OF
THE DU PONT INDUSTRIES

trasted with this, chemical warfare constitutes a most humane weapon of war, and mustard gas is probably the most effective casualty agent known at present.

ORGANIZATION OF INDUSTRIAL RESEARCH IN CANADA

Prof. R. F. Ruttan described the workings of the plan for the development of industrial research in Canada. In 1916 the government of Canada by order in council established an Honorary Advisory Council for Scientific and Industrial Research, corresponding very closely in organization to the National Research Council for the United States and modeled largely on the Advisory Council for Scientific and Industrial Research in Great Britain, which has now become the Department of Scientific Research of the British Government.

Recognizing after investigation that liaison between research and industry could not be effected except by organized effort, a Central Research Institute was established near Ottawa. It is to be housed in a four-story building, 200 x 60 ft., with power plant and laboratories, the first \$100,000 being specially granted by the Cabinet to get the work under way during 1921.

The functions of the institute may be briefly described as follows:

- (1) It will be the Bureau of Standards for Canada.
- (2) It will carry on fundamental research in chemistry, physics, biology and related fields, investigations similar to those engaging the attention of university professors in scientific laboratories.
- (3) Investigations in biochemistry and bacteriology, both general and as applied to such industries as the fisheries and packing industries.
- (4) Investigations undertaken on recommendation of the Research Council from time to time to promote the utilization of the natural resources and valuable waste materials of the country.

The type of research work described under these four heads will be carried on by the permanent staff of the institute, associated with specialists engaged from time to time. This group of highly qualified investigators will form an advisory body for the industrial specialists who will be engaged by the Research Council or paid by the industries "to conduct inves-

tigation and standardization at the request of any group of industries in Canada concerning the materials used by them or of the products of such industries."

The difficult question of remuneration for valuable and patentable discoveries has been left largely to the discretion of the Research Council. The intention of the Council is to give a liberal share in the commercial rights of all such discoveries. Its function is to develop research, not to exploit it.

Smoker

The big ballroom of the Waldorf-Astoria was not large enough to care for the crowd that attended the smoker which began promptly at 8 o'clock on Wednesday evening.

After a number of songs and some instrumental music the stage was set for a sketch written by Ellwood Hendrick with the aid of Miss Marguerite Merington, author of "Captain Letterblir," "Snow White" and other plays, who acted as producer. In the performance *Uncle Sam* and his secretary *Civil Service* received *John Bull* and *Miss Canada*, who arrived by airplane to attend the chemical meeting. They discussed their varied difficulties in chemical industry and *Uncle Sam* declared that his worst trouble was the fly-by-night speculator who bought control of chemical works, dismantled research laboratories, made the research reserves appear as available for dividends, then got out from under. *John Bull* said he lost some of his leading industries through just such persons. *Uncle Sam* thought it might be well if the chemist should assert himself more than he does—at which point an *American chemist* broke his way past a garrulous *Italian waiter* and wanted to see *Uncle Sam*. He was taken for a lunatic and made to sit down when an *English chemist* came in from the audience and wanted to see *John Bull*. As soon as the authorities recognized that they were chemists they gave them a hearing. They wanted to go to the meeting and their employers would not let them. This amazed the authorities, but it was a fact; their employers were afraid they might give something away. The powers concluded to get to the bottom of the question and concluded that the responsible party to reach was old *Quickturn Capital*, a man of vast wealth and arrogance who was hard to find and hard to deal with when found. At this point old *Q. Capital* burst into the apartment. He had seen a couple of chemists come in there and he wanted to fire them. He was resolved to cut out all the deadwood. Even when he learned who his hosts were he persevered in his autocratic ways, declaring that he had got what he wanted out of his chemists and now he was through with them; they were neither raw material nor finished product nor sales force nor administration. "If you ask them what they are doing," he exclaimed, "they give you a lot of hot air. They stall . . . and they eat up dividends." He soon showed himself to be unconscious of any obligations or responsibilities other than to make a good showing and then sell out. He was therefore turned over to the chemists, who squirted information into him. A telegram arrived telling him the works were shut down and they did not know what to do because the research laboratory had been closed. Then followed a transformation scene in which he begged the chemists to see him through, and all concluded to go to the meeting together.

Aside from the parts taken by *John Bull* (J. D. H.

Randall), the English chemist (W. L. Cofren of the U. S. Industrial Alcohol Co.), and one of the alchemists, J. Lainson Wills, the characters were all represented by members of the staffs of CHEMICAL & METALLURGICAL ENGINEERING and other McGraw-Hill publications. *Uncle Sam* was Mr. Gordon, now business manager of *Ingenieria Internacional* and formerly of CHEM. & MET.; *Canada* was Mr. Shaver of *Engineering News-Record*; *Civil Service* was Mr. McNamara of *Engineering News-Record*; the *Italian waiter* was our own business manager, Mr. Fellner; the *American chemist* was Mr. Spooner, also of CHEM. & MET., and *Quickturn Capital* was Dr. Hendrick. The two alchemists who carried the banner were respectively Mr. Wills and Mr. Kirkpatrick, our assistant editor.

The play was followed by two professional acts, and the singing of several parodies of songs relating to various prominent members and visitors concluded an enjoyable evening.

International Meeting

The international meeting was held Thursday, Sept. 8, in the Great Hall of the College of the City of New York. Dr. Edgar Fahs Smith presided. "Chemistry and Civilization" was the subject expounded from different viewpoints by Drs. Charles Baskerville, A. D. Little, L. H. Baekeland, Sir William J. Pope, W. R. Whitney, C. E. K. Mees, Ernst Cohen and W. D. Bancroft.

SCIENCE AND CIVILIZATION

Dr. Charles Baskerville spoke on "Science and Civilization," with particular reference to the value of chemistry as a civilizing influence. He called attention to the remarkable progress of the world during the past 150 years, stating that more had been done during that time than in all previous centuries combined. After outlining the development of learning from early times and proving the part which research and science had in this development, Dr. Baskerville concluded by stating that chemistry must play a great rôle in preparing the "cement" which will bind mankind in brotherhood.

ENERGY: ITS SOURCE AND FUTURE POSSIBILITIES

In his paper on "Energy: Its Source and Future Possibilities," Dr. Arthur D. Little outlined the vast work to be done to brace up our broken civilization and the immense requirement of energy to accomplish the undertaking.

The energy available from sources at hand is inconceivably greater than human needs—if we but knew the art of capturing it. There is, for instance, the radiant energy of the sun, of which Sir Oliver Lodge says the earth receives but one one-hundred-and-fifty-millionth part. It is only three small calories per minute per square centimeter of the earth's surface; but Ciamician has calculated that a surface of only 10,000 square kilometers, assuming six hours as the effective day, receives in a year the quantity of heat that corresponds to the burning of 3,650 million tons of coal, or more than double the world's production. The desert of Sahara with its 6,000,000 square kilometers receives daily the solar energy equivalent to 6 billion tons of coal. The world awaits the genius who will convert the radiant energy of the sun into electric current. Of the minute portion of solar energy received by the earth, only one three-hundredth part is stored up in plants. They, nevertheless, according to Ciamician, produce 32,000,000,000 tons of vegetable matter which,

if burned, would develop a quantity of heat equal to that derived from 18,000,000,000 tons of coal.

The energy of the earth's rotation has thus far been used only in the application of the gyroscope. That of the wind and waves is too uncertain and diffused to encourage extensive exploitation. There are two extensive tidal power developments under construction, at St. Malo in France, and at the mouth of the Severn River in England. The latter will provide 437,000 continuous horsepower. The continuous tide power of the British Isles has been computed to be 2,250,000. The capital requirements for such installations is naturally more than double that required for continuous falling water.

In Italy a 30,000-hp. steam turbine installation has been made for which the energy is derived from steam issuing from the vents in the side of a volcano.

Sir Ernest Rutherford has said that "the human race may date its development from the discovery of a method of utilizing atomic energy."

Our civilization is based on coal. In 1913 the world's resources were summarized as follows: Including 3,000,000 units of lignite, the total reserves are 7,400,000 units, of which 5,000,000 are in North America, 1,280,000 in Asia, 784,000 in Europe, 50,000 in Africa, and 25,000 in South America.

One-tenth of the population of the United States is dependent on natural gas. In 1917 we used 800 billion cubic feet and wasted 800 billion more. In 1920 our production was below 650 billion. Our misuse of this is an indictment of individualism.

Of petroleum the United States now produces 70 per cent of the world's supply. Our reserves are nearing depletion and we can scarcely maintain the present rate for twenty years more. We need an intelligent economic petroleum policy in the United States and the power to enforce it.

Shale oil is a resource for the future, and so is our peat supply, and so too are the striking possibilities in the production of power alcohol.

The water power of the United States is sufficient to drive every factory and light every building in the country, but development is inhibited by the cost to construct, inasmuch as bond interest represents 77 per cent of operating costs.

Coal must remain for generations our chief energy resource.

THE ENGINEER: HUMAN AND SUPERIOR DIRECTION OF POWER

"The forces of nature are the most enduring wealth of mankind. To know their laws and to learn how to apply them has made of a puny little being of about 130 or 200 lb. of flesh and bone—three-fourths of which is merely water—a giant of which Gulliver's tales have no equal." This was the opening remark of Dr. Leo H. Baekeland, in his address on "The Engineer: Human and Superior Direction of Power."

He stated further that there are few who fully realize that a co-ordination of the thoughts and work of the chemists and chemical engineers is indispensable for the successful practical progress of the chemical industry. The chemist is a scientist. By direct observation or experiment, and aided by theoretical reasoning, he tries to correlate observed facts until he believes that he is warranted to generalize thereon. He thus helps to discover new truths or laws of nature which in their turn will permit him to predict facts

in advance. But the experience of many a scientist has been confined exclusively to laboratory work, or to purely chemical subjects, and this is frequently the reason for his weakness in dealing with practical matters. The ways of thinking and acting of a chemist and those of an engineer are often along decidedly different points of view. Yet, if these points of view can be compromised or harmonized, they bring forth good chemical engineering.

CHEMISTRY AND LIFE

Sir William J. Pope, in speaking of chemistry in relation to life, said that during the last fifty years the organic chemist has forged for himself new tools in which low potential energy is applied and induced to take part by the presence of the so-called catalyst. Obviously organic chemistry is approximating in its experimental methods those which occur exclusively in plant and animal life.

When we possess full working details concerning the plant leaf process for converting carbon dioxide and water into formaldehyde and oxygen by utilizing the sun's energy, when we can make indigo and quinine by the identical processes carried on in the plant, chemical technology will be an entirely different proposition from the one it now represents.

We must also recognize that wide economic differences exist between a self-contained European country and others which have the whole tropical world within their range, and that entirely distinct types of problems are in consequence presented to their chemical technologists. It is for us to realize all the bearing of these differences upon chemical science and chemical industry and to see that we neglect no means for applying the great opportunities within our reach in the service of mankind and of our respective countries.

THEORIES

A system of theoretical mythology was advanced by Dr. Willis R. Whitney, in an address on "Theories." Whitney avers that Prometheus was the first theorist, and his daring conceptions and swift conjectures gave early man many of his comforts and necessities. But unfortunately, his theories were too daring, often disregarding fact, and he was finally chained to a mountain top so he could keep at least one foot on the ground. His slow-witted brother Epimetheus was also a theorist, but better, he was in addition the first experimenter. His first investigation consisted in opening Pandora's box, and disclosed not woes to afflict the race, as claimed by some, nor blessings ever lost, as maintained by others, but in fact nothing but enigmas, which the finder and his descendants have since been striving to solve. All theorists and experimenters have since been disciples of Prometheus and Epimetheus, and all theories God-given or earth-born are of value, even if the latter sort are finally disproved, for they lead to further experiments.

RESEARCH APPLIED TO THE WORLD'S WORK

If we all had enough there would be no need for unrest and hence no great inducement for research and advancement. This is the first major thought in C. E. K. Mees' address, "Research Applied to the World's Work." However, with education comes a demand for the opportunity to insure one's own future. Fail to satisfy this demand and a chaos of unrest will follow.

The modern world, the world as it is, is the creation

of a very few years of technical discovery and development. Modern wealth, especially of the United States, has been produced as the result of technical and scientific progress in research.

The function of a research laboratory is "to supply the technical information on which an industry is operated." This applies as well to sales or utilization of products as to production. It thus serves as the intelligence department in industry, supplying the information on which decisions are made, not only those of advance or new development, but also those to withdraw from or avoid technically unpromising lines.

PROBLEM OF DIFFUSION AND ITS BEARING ON CIVILIZATION

Dr. Ernst Cohen, famous Dutch chemist, and professor of chemistry at the University of Utrecht, addressed the meeting on the subject of "Diffusion and Its Bearing on Civilization." The history of the process of diffusion was traced from its discovery in a French abbey in 1770 to its final explanation by van't Hoff in 1885. The development of physical chemistry may be said to have dated from the work of this great Dutch chemist. Prof. Cohen declared that realization of the important rôle of diffusion in the processes of living matter is the foundation on which we may hope some day to build up a complete understanding of life's processes. In concluding his address, the speaker referred to the work which is being done at the University of Utrecht in connection with the accurate determination of the coefficients of diffusion. He intimated that the final publication of the results of this research will reveal that many of these important physical constants, as previously determined, are in error because they were obtained in buildings and apparatus subject to vibration.

CATALYSIS: THE NEW ECONOMIC FACTOR

War's destruction of capital must be restored if nations are to continue to progress, and Prof. Wilder D. Bancroft declared in his address that chemistry, better applied through the use of catalysis, is the most promising means of accomplishing this end. Catalytic agents may prove to be the important economic factors which will some day produce liquid fuel from coal or light without waste of heat and energy, scientifically control the rain from the clouds, and finally render solar and atomic energy completely useful to man.

Organic chemistry in the past has failed to use catalysis to any great extent, but the work of Sabatier, J. J. Thompson and the recent data of Reed of Johns Hopkins indicate that the trend is in this direction.

Presidential Address—Progress in Chemistry

Those who were fortunate enough to hear the presidential address of Dr. Edgar Fahs Smith cannot but marvel at his remarkable insight into the history of chemistry in America. Choosing as his text the words of Berthollet, "Chemistry has become regularly and philosophically progressive," President Smith traced step by step the inspiration and impetus given to those who have contributed to the advance of American chemistry. Over a century and a quarter ago the pioneer chemical society of the world—the Chemical Society of Philadelphia—was assembling and disseminating information relative to the manufacture of niter, even as American chemists of 1914 to 1918 harkened to the call of their country in its hour of peril.

However, not all of the thoughts of our chemical fathers were of the implements of warfare, for, as Dr. Smith affirmed, many domestic industries had their conception in the minds of these pioneers. The making of sal-ammoniac, glauber's salt, oil of vitriol, prussian blue and numerous other pigments, and in fact even a few American dyes was well under way over a century ago.

Furthermore, these early investigators "felt it their duty to publish and disseminate the knowledge they were acquiring through their investigations. They did not seek to hide their discoveries. They believed in publicity. They desired that their science might receive honor, but also that their country might be assisted in winning its way among the nations looking down upon it.

"My desire is that we have no East, West, North or South in chemistry, but one united body from all sections eager to carry the science into every walk of life—even into the halls of government, that their occupants may understand how intimately chemistry is interwoven with the laws and welfare of the land."

Division of Dye Chemistry

The Dye Division convened Thursday morning with A. B. Davis in the chair and R. Norris Shreve as secretary.

The meeting was well attended and the papers contained information of value.

A few of those having general interest are noted here.

W. F. Prescott, of the Sherwin-Williams Co., spoke on the dye situation in Canada. He said there were 80 woolen mills, 20 cotton mills, 80 knitting mills, 8 silk mills, 130 leather plants and 50 paper plants in the dominion, producing about \$220,000,000 worth of goods annually, against about \$55,000,000 worth in 1911. In regard to dyes, they do not expect to produce intermediates or many varieties of dyes. Their imports for the year ended March 1, 1921, were \$630,000 worth from England, \$2,500,000 from the U. S. and \$200,000 from Germany and Switzerland. He was of opinion that considerable German dyes came in as Swiss.

J. P. Schmidt, of the Monsanto Chemical Co., presented a paper on lakes prepared from para-phenetidine. There are fifteen to twenty colors of this type made from phenacetine as the basic intermediate. Para-phenetidine coupled with beta-naphthol gives a beautiful bluish red which, precipitated on chalk, was exposed to varying weathers for three months during the spring and held remarkably well, showing great fastness to light. It is somewhat soluble in oil, which makes it available for shoe polish, wood stains, etc., or wherever solubility in oil is desired. By diazotation the solubility in oil is overcome and a series of colors from orange to bluish reds is obtained.

E. R. Harding, also of the Monsanto company, spoke on the synthesis of anthraquinone from phthalic anhydride and benzene. The only available crude for anthraquinone heretofore has been anthracene, but the claim has been made that the removal of this crude, needed for many of the most desirable vat dyes, from pitch renders the pitch unavailable for roofing and road making.

Dr. J. L. Bulloch, of the Uniform Chemical Products Co., read a paper on "Improving the Yields and Quality of Our Dyes and Reducing their Cost." He emphasized the need of thorough knowledge of intermediates and the requirement for greater precision in quality tests.

Dr. L. A. Olney, of the Lowell Textile School, told of the "Extraction Process for Degreasing Wool" instead of the usual method of scouring by emulsion with soaps. A plant of sufficient size costs several hundred thousand dollars. The Arlington Mills, which has the only installation in the country, applied an invention of Emile Martens of Providence, which has proved excellent, using petroleum naphtha. It has been in use for twenty-five years without an accident, all the potash is recovered and over 1,000,000 lb. of raw wool per week is treated. The wool so extracted is much purer than that scoured in the ordinary way with soap and it takes up dye so fast that it may not be successfully dyed when mixed with that scoured in the usual manner.

Dr. Leon W. Parsons and W. A. McKim, of the Massachusetts Institute of Technology, contributed a paper on "The Effect of Dye Structure on Dye Adsorption." This was in accord with Langmuir's theory in regard to the relation of the structure of molecules to color and shade and the effect of fields of force due to internal structure extending beyond the confines of the molecules, on their behavior.

Dr. J. Merritt Matthews, editor of the *Color Trade Journal*, asked, "Is an Export Trade Necessary to Our Dye Industry?" The United States consumes about 12 per cent of the world's production of dyes. No embargo can last over a few years. Is there enough in the American market to keep the industry flourishing? Some dyes can be made profitably under fair conditions, but others are not used enough to make it worth while to produce. He held it desirable to recapture foreign trade which is now fading away and noted the Department of Commerce is ready to co-operate.

Oscar R. Flynn, of the Walderich Bleachery, discussed the fastness of dyed textiles to stoving, which would appear to be the opposite of fastness to light, but which he regards as having to do with conditions of air which envelops the fabric, some of which is prevented by containers from the usual measure of diffusion.

Gaston du Bois spoke on the features of cost and pointed out the effect of high costs on exports. The United States exported dyes as follows:

1917	\$7,548,000	January, 1921,	\$1,292,709
1918	15,266,000	February, 1921,	467,764
1919	15,728,000	March, 1921,	670,261
1920	29,823,000	April, 1921,	365,010

More than half of the above went to Asia and South America, but owing to high costs Germany is rapidly recapturing those markets. Our costs are from two to three times those of Germany today. Wages and salaries are seven times as high, but these are unimportant compared with volume, yield and experience. He favored a good downward revision of investment accounts.

C. R. DeLong of the Tariff Commission spoke of "The Present Status of the Domestic Coal-Tar Products Industry." From 1917 to 1920 inclusive the output of the United States was approximately doubled. Indigo increased from 275,000 lb. in 1917 to 18,000,000 lb. in 1920—nearly double the pre-war importation. Average price in 1917 was \$1.24, against 74c. in 1920. Now it is 40c. Vat dyes other than indigo increased from 15,000 lb. in 1917 to 1,160,000 in 1920. Coal-tar medicinals doubled, to 5,000,000 lb., in 1920, and perfume materials increased from 19,000 lb. to nearly 100,000 lb. in 1920. Synthetic resins reached 4,500,000 lb. and synthetic tanning materials 3,000,000 lb. Triphenyl and

tricresyl phosphates were introduced as camphor substitutes in pyroxylin plastics.

In the coal-tar products industry between 10 and 11 per cent of the men employed are chemists. The cost of research from 1917 to 1920 inclusive has been materially over \$15,000,000.

Greatly needed in the dye industry is a standardization of dyes and a revision of the present conflicting and bewildering nomenclature of these products.

Division of Industrial and Engineering Chemistry

The meetings of the Division of Industrial and Engineering Chemistry were held Wednesday, Thursday and Friday. There was a symposium on filtration, one on gases and fuels, and general papers.

SYMPOSIUM ON FILTRATION

D. R. Sperry acted as chairman of the Symposium. Sixteen papers were presented.

In his paper on the fundamental laws of filtration with suggestions regarding research work, Mr. Sperry called attention to the fact that filtering has not been developed on a scientific basis and that the fundamental laws must therefore be studied.

The three essentials involved are the filter base, a difference of pressure, and a filter or mechanical device for containing the operation. Studies have shown that the flow of liquid through a porous mass varies directly as the pressure and inversely as the thickness of the cake. One series of tests led to the conclusion that the flow varies as the first power of the pressure, denoting capillary phenomenon.

Eustice A. Alliot, a visiting member from Great Britain, gave another of the papers on fundamental data which he has worked out in the study of washing and washing ports used with chamber and frame types of filter presses. The following paragraphs cover a short abstract of his work.

Nominally, washing consists of the displacement of mother liquor from pores between particles by an equal volume of wash, in which case little mixing of wash and mother liquor takes place. Such perfection is theoretical, and various disturbing factors enter, the chief ones of which are:

1. Adsorption,
2. Capillary diffusion,
3. Formation of chemical compounds,
4. Colloid formation on the removal of electrolytes.

Adsorption is the unequal distribution of the solubles at the boundary between solid and liquid phases of the cake owing to surface energy effects. A large excess of solubles is retained in the surface film and will not wash away. The effect is proportional to the area of boundary surface and is most important in finely divided or gelatinous precipitates. The washings may be graded and used in succession, finishing with a small proportion of pure wash.

Absorption of mother liquor by capillary diffusion into the pores of the cake particles requires a dilute wash to be effective and a time factor comes into play. In the case of iodine and charcoal, weeks may be required before an equilibrium is established. The effects are similar to but more complex than adsorption, involving more wash and longer time.

Chemical combination with the substance of the filter particles where such compounds are stable only when the concentration of the liquid phase is in excess of the critical amount often occurs in fine chemical

manufacture. In such conditions the excess of wash required varies directly as the quantity of solubles retained and inversely as the critical concentration.

Some precipitates are held in the coagulated state only in the presence of suitable electrolytes. When these are removed by wash water a finer structure of cake results or it may even disappear entirely. Stage treatment with washes of graded strength may be used so that the entering wash always contains a little electrolyte.

In obtaining best results for thorough washing, it appears necessary to have a plate and frame press, a means for air elimination, and the wash must leave at the top of the press so that the cakes remain immersed in the bath of wash eliminating unbalanced hydrostatic head.

It cannot be too clearly understood that good results depend not merely on the mechanical arrangement of the press but almost more on the attention paid to getting proper physical condition of the material and delivering it in a suitable manner to the press. Every detail of the operation should be correct.

OTHER PAPERS IN FILTRATION SYMPOSIUM

Alvin Allen Campbell, of the Newark Wire Cloth Co., compared the animal and vegetable materials for the production of filter cloth with the metals. Cotton duck has been used, but together with wool, hemp, jute, etc., is too slow. Strength is an important essential of a filter base, but the greatest difficulty encountered is with leakage.

H. D. Atkins described an automatic filter press which is pivoted near the center of its length. When the cake has been formed the press is turned on the pivots to a vertical position, so the cake may be removed without opening the leaves.

H. A. Vallez, of Bay City, Mich., described a new rotary filter which consists of a cast-iron cylindrical shell arranged in the horizontal position and completely housing the filter elements which revolve on a hollow shaft. Sprays remove the cake from these elements and it falls to a screw conveyor on the lower side. The driving gears are placed at one end of the casing and the filtrate discharge at the other.

H. C. Beckman, of the De Laval Co., outlined the four uses of centrifugals as pertaining to extraction, separation, clarification and filtration. Filtration by centrifugal was first tried in perforated drums, but it was found that the cake became quickly compressed until it was impervious. The non-perforated rotor consisting of a series of drums or shelves mounted on a vertical axis and revolving at a speed of 6,000 r.p.m. was then developed.

Arthur Wright classified industrial filter media, in the main consisting of fabrics used with corrosive and non-corrosive materials. Cotton is largely employed for non-corrosive liquids. There is need for standard methods in specifying filter cloth. It should be known by the size of yarn, the number of threads per inch in warp and weft, and by the weight per unit of area.

Cotton and wool fabrics will not stand strong caustic solutions. Wool will resist acids, though cotton is sometimes better where necessary care is employed. Tests should be made to determine the best filter medium for each problem.

E. E. Finch spoke on the development of filtermass filters in the brewing industry and the subsequent applications for clarifying vinegar and food products.

C. P. Derleth and G. M. Hickey covered the use of FilterCel as an aid to filtration and its specific application in several industries.

G. D. Dickey described the machines marketed by the Industrial Filtration Corporation, showing numerous slides of all types.

Robert C. Campbell gave an illustrated talk on the apparatus manufactured by the United Filters Corporation, which includes the Sweetland and Kelley presses and the American continuous vacuum filter.

SYMPOSIUM ON THE CHEMISTRY OF GASES AND FUEL

The four principal topics for discussion at the symposium on the chemistry of gases and fuel were: (a) Coke-oven problems, (b) low-temperature carbonization, (c) gas works control, and (d) gas analysis and its applications. C. H. Stone of the Rochester Gas & Electric Co. acted as chairman, R. S. McBride, secretary.

According to F. W. Sperr, Jr., who opened the discussion on coke-oven problems, the fundamental research needed is now more appreciated than ever before. Knowledge of the constitution of coal is one of the outstanding needs in connection with the fuel supply itself. In the case of coke the past work has dealt mainly with the question, "How to make it?" Now the need is to answer, "What is it?" Specific heat and heat conductivity data, among other physical constants, are much needed, as are further facts as to the sulphur forms in both coal and coke. The byproducts other than coke of course afford an unlimited field for investigation.

Low-temperature carbonization of coal was discussed by Horace C. Porter. In his opinion the largest opportunity today for low-temperature work is as an adjunct to gas works, especially where the complete gasification of the fuel can be had through some "double-gas" system, the coke from the first stage being used in a form of water gas machinery for the second.

The discussion of needed carbonization investigations included reference to the study of the thermal history to which fuels are subjected during processing and extensive investigation needed for determination of thermochemical data. It was made clear by Dr. Fieldner that only through a full knowledge of how coke of various types can best be used will it be possible to persuade the blast-furnace operator to take any type of coke which can best be made in view of the current market requirements for byproducts.

Chemistry in gas works control was discussed by E. C. Uhlig, who pointed out the large opportunity for further chemical investigation in theoretical lines which undoubtedly would afford sound basis for industrial development of the future. C. H. Stone brought out clearly the numerous miscellaneous problems which are presented to the gas works chemist for solution.

Arthur L. Davis described two methods for determining light oil in coke-oven gas. The first covered the absorption of the light oil in charcoal, but distilling with cresol or cresylic acid instead of glycerine. The second is a method of absorbing light oil in cresylic acid which has been developed in France on a commercial scale. A plate and bell tower with ten plates and bells is used with countercurrent flow.

George C. Brown, Jr., gave an exhaustive paper on the chemically controlled automobile. He showed methods of analysis, stated that 30 per cent of the gasoline passes out the exhaust in unburned gases and

finally that too much stress had been laid on the mechanical features of the gas engine when the big losses involved chemical engineering. In another paper Mr. Brown gave short-cut methods for calculating the temperatures of combustion.

The members present voted to request the secretary of the Division of Industrial and Engineering Chemistry to undertake to determine whether the organization of a section on the chemistry of gases and fuel would be justified, and if so to formulate a request to the proper officers of the society.

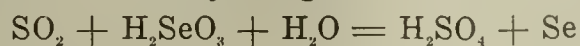
GENERAL PAPERS

E. F. Collins, of the General Electric Co., abstracted an able paper on electric heat for thermal processes, showing numerous slides of industrial electric appliances. He stated that considerations of other features than the cost per B.t.u. play an important part. Electrical heat gives safety, more uniform temperature and economy of labor in operation.

Robert E. Wilson gave data determined and collected on the humidity equilibria of common materials. Tests were made at M. I. T. on substances with the humidity of the air at 15, 30, 50, 70 and 95 per cent. Curves plotted for each substance showed that most common ones lie between the sulphuric acid curve and the amyl alcohol curve.

Robert E. Wilson, William H. McAdams and M. Seltzer have made a study of the frictional resistance to the flow of viscous liquids through pipe elbows and compiled data from a series of 200 tests. There is no important difference between the flow in common smooth pipe and glass tube. In turbulent flow the resistance of an elbow was confirmed to require an additional correction of length of pipe corresponding to 35 pipe diameters, while with viscous flow only 4 or 5 pipe diameters need be added to length to correct for resistance of the elbow.

P. C. Haeseler described a new process developed at Columbia University and later tried on a commercial scale for the manufacture of sulphuric acid. It is noted that selenium is involved in the reaction but is not a contact or catalytic agent. The reaction used is



Selenium is roasted in a furnace to SeO_2 and passed into a tank of water to form H_2SeO_3 . This is slowly sprayed in very finely divided state into the top of a chamber where the SO_2 gas is introduced. Sulphuric acid, about 50 per cent strength, forming a slurry with selenium, is drawn off at the bottom and passed through rotary filter having Monel metal screen. The filtrate is ready for the market as 50 per cent H_2SO_4 or sent to the concentrating plant. The sludge of selenium is returned to the roaster.

C. J. Rodman determined that mineral and chlorinated oils were ruptured with an electric arc of 100,000 volts, 333 cycles, by temperature and pressure effects rather than by sympathetic vibration.

H. P. Holman abstracted his paper covering the effects of waterproofing materials upon the tensile strength of cotton yarn. Bituminous materials are the best treating compounds as regards the effect on tensile strength. Raw drying oils are not so good as those mixed with metallic compounds. Rosin reduces tensile strength and yarn treated with cold vulcanized rubber shows an immediate and marked deterioration. Oleic acid causes deterioration and lead oleate is poorer than other oleates.

E. C. Bingham held the chair for the discussion of special order on world standardization, which was an informal symposium on the adoption of the metric system in the U. S. The report of the committee for the adoption of standard metric units for the purchase of chemical apparatus and supplies showed that out of 600 universities and colleges questionnaired about 150, including large institutions, have signified their intention of purchasing by the metric system. Twenty-four dealers are willing to supply in both English and metric units. Some of these will feature the fact in their advertising. W. A. Noyes moved that the division ask the advisory committee of the A.C.S. to indorse House Bill 10. The slogan for the chemists is to be, "Pure chemicals purchased by the metric system, in standard packages."

The officers and committees of the division for the coming year were elected as follows: Chairman, Warren K. Lewis; vice-chairman, D. R. Sperry; secretary, H. E. Howe; assistant secretary, E. M. Billings; executive committee: W. F. Hillebrand, Edward Malinckrodd, Jr., F. M. DeBeers, Alexander Silverman, Herbert R. Moody, C. E. Coates, W. D. Richardson, F. E. Breithut, C. O. Johnes.

Division of Physical and Inorganic Chemistry

A well-rounded program of nearly fifty papers occupied the attention of the physical and inorganic chemists during Wednesday, Thursday and Friday. H. N. Holmes was chairman and S. E. Sheppard secretary.

It is impossible here to summarize all of the many papers presented but a number of the most interesting are briefly referred to in the following paragraphs:

The increasing interest in this field was evidenced by the presentation of papers on the transitional temperature of gelatin and the swelling and gelation of gelatin by Dr. B. H. Bogue of Mellon Institute; the fluidity-pressure curves of gelatin solutions by Dr. S. E. Sheppard and his co-workers of the Eastman laboratories, and on the plasticity of colloids by Prof. E. C. Bingham of Lafayette College and Prof. Robert E. Wilson of Harvard University. Dr. Bogue presented evidence favoring a concentration-variable transition area between the sol and gel states. In the discussion E. T. Oakes stated that certain of his data indicated a concentration-invariable transition point. Dr. Sheppard declared that he had obtained confirmation of both points of view but found difficulty in bringing the two into complete harmony. Bingham pointed out the co-ordination of Bogue's data with those obtained by R. A. Gortner on flours and by himself on clays.

Messrs. Lichtenwalner, Flenner and Gordon sought to determine the maximum adsorption of solutions of calcium, magnesium and potassium acid phosphates by iron hydrogel and aluminum hydrogel. The sulphates of these metals were also used with iron gel. In both instances the calcium salts were adsorbed to the greatest extent, while those of potassium were least adsorbed.

Electrometric titration methods were used by W. Mansfield Clark and his co-workers in a study of oxidation-reduction equilibrium with a view to developing a series of indicators similar to the acid-base indicators of Lubs and Clark. The reduction of various indigo sulphonates, methylene blue and its homologues, and of the different indophenols by means of titanium citrate were studied. In general p_H was held constant for each determination by the use of a buffer agent.

Prof. Harold A. Fales and Harold E. Robertson of

Columbia University ask the question: Are electrolytes completely ionized at infinite dilution? The preliminary report on their work on this subject apparently answers this question in the negative.

Dr. Saul Dushman of the General Electric Co. and Miss Mary A. Andrews reported on the reaction between tungsten and hydrocarbon vapors. This phenomenon is of importance, because the oil pumps used for evacuating incandescent lamps give off hydrocarbon vapors which under the conditions of high temperature and vacuum have a deleterious effect on the tungsten filaments. Using naphthalene vapor, it was found that at constant temperature of filament and pressure of naphthalene the conductivity of the filament decreases uniformly with the time, until a minimum point is reached at which, as shown both by the hydrogen evolution and chemical analysis of the filament, the filament is completely converted to W_2C (corresponding to 3.18 per cent C). The conductivity of this carbide is only 8 per cent of that of pure tungsten. Further decomposition of the naphthalene leads to the formation of the higher carbide WC , the conductivity of which is about 40 per cent of that of pure tungsten.

Dr. A. P. H. Trivelli, with E. P. Wightman and S. E. Sheppard of the Eastman laboratories, reported on the results of the pioneer work they are doing in the investigation of the photochemical properties of photographic emulsions.

In order to do away with the dielectric, which is one of the principal causes of the unreliability of commercial ozonizers, Dr. F. O. Anderegg of Purdue University has studied a high-frequency discharge apparatus for the production of ozone. Its chief advantage lies in the fact that it is impossible to maintain a high-frequency arc. An aluminum tube 5 x 190 cm. with a concentric wire was used for the discharge. Current was supplied up to half an ampere and 7,000 volts at about a million and a half cycles frequency by a small Tesla coil. The highest yields were obtained with a rather large wire provided with numerous small points so that the discharge should be made up of many brushes. The ozonized air contained but small amounts of nitrous oxides, although on raising the voltage till the discharge was filled with sparks about 0.02 per cent was obtained. Numerous curves have been worked out showing the relationships between the different variables, which are usually similar to those obtained in low-frequency ozone production.

Prof. Alan W. C. Menzies described an ingenious differential thermometer which he devised for use in ebullioscopy. In its simplest form it consists of a small glass U tube filled with water. The lower arm of the tube is closed to form the bulb of the thermometer, and to other, which has a closed reservoir at its tip, consists of a carefully calibrated capillary tube. A degree rise in temperature will cause as much as 200 mm. rise in the water in the capillary.

Claude H. Hall, Jr., has repeated and confirmed the work of Patterson on the decolorizing action of bone black. By extraction of hydrochloric acid washed bone black with sulphuric acid an extremely active decolorizing agent was prepared. By precipitating this compound on wood charcoal or other porous substances, a material identical in chemical action with bone black was obtained. This active principle was found to be a mixture of nitrogenous decomposition products of bone cartilage.

C. R. McCrosky and A. J. King discussed the prepara-

tion of the selenides of ammonia. They have found that when ammonia is present in excess in the reaction between ammonia and hydrogen selenide, a colorless liquid containing selenium equivalent to normal ammonium selenide is formed. This compound freezes at 10 deg. C. On losing ammonia it changes to a white crystalline compound corresponding to the biselenide, NH_4HSe .

R. A. Gortner and W. F. Hoffman, in a paper entitled "An Interesting Colloid Gel," pointed out that gelatin, agar agar, and even silica gels were not always satisfactory as standard gels due to variation in quality. It was pointed out that a rigid gel can be prepared from dibenzoyl cystine containing as little as 0.15 per cent of the compound. Viewed by dark field illumination, this is apparently a crystal gel. It is suggested that this material may assist in studies regarding gel structure.

Dr James W. McBain, professor of physical chemistry at the University of Bristol, England, in his studies of the adsorption of toluene and acetic acid by carbon has obtained results which appear to substantiate the theory that adsorption consists in the formation of a monomolecular film entirely covering the surface of the carbon. By diminishing the temperature difference between the carbon and the toluene, equilibrium was reached between the two and a definite value obtained

for $\frac{x}{m}$; the measure of adsorption.

The preparation of a ferric hydroxide gel as an absorbent for gas defense was described in a paper by Messrs. Robert E. Wilson, William B. Ross and Leon W. Parsons. Using 6 per cent solutions of ferric chloride and sodium hydroxide, a dark brown gel was obtained by complete precipitation. After washing by decantation, it was filter-pressed and vacuum-dried to a moisture content of about 10 per cent.

NEW OFFICERS ELECTED

Following the formal presentation of the papers, a business session was called. The nominating committee reported the following officers for the new year, and they were duly elected: Chairman, Dr. S. E. Sheppard; secretary, Prof. Robt. E. Wilson; executive committee, Messrs. Blum, Hildebrand, J. H. Mathews, and Weiser.

TO CONTINUE THE "JOURNAL OF PHYSICAL CHEMISTRY"

At the meeting on Friday the chairman, Prof. H. N. Holmes, called the attention of the division to the statement by Dr. Bancroft that he would be unable to continue the publication of the *Journal of Physical Chemistry* after December of this year. It was the opinion of the meeting that this action would be of the nature of a catastrophe to investigators in the field of physical chemistry. The chairman appointed a committee consisting of Messrs. Bingham, Abbot, Menzies, Kendall and McBain and instructed them to report a definite plan of action. This committee subsequently recommended that the division urge Dr. Bancroft to continue to edit the journal for another year and that in the meantime a representative committee should be appointed to devise a permanent plan for continuing this or some similar journal. It was suggested that the committee look to the British for co-operation with the idea of creating an international medium. The report of the committee was accepted and plans were formulated for organizing the work of the large committee.

Division of Leather Chemistry

The meetings of the Division of Leather Chemistry were held during Wednesday, Thursday and Friday, Sept. 7 to 9, under the chairmanship of John Arthur Wilson.

Among the papers presented were the following:

COLOR MEASUREMENT OF VEGETABLE TAN LIQUORS

The difficulties encountered in attempting to measure the colors of vegetable tan liquors were discussed in a paper sent in by Prof. Henry Richardson Proctor. The applications of the colorimeter, tintometer, brown-yellow glasses and iron alum solutions were all considered. It was suggested that the most satisfactory method might be to determine the depth of solution necessary to absorb one-half of the light from several different parts of the spectrum.

COLOR VALUE OF TAN LIQUOR AS FUNCTION OF p_H

John Arthur Wilson and Edwin J. Kern found that the natural coloring materials in vegetable extracts act like indicators with changes in the reaction of the liquor. The color is a function of the hydrogen-ion concentration. Thus a series of gambier and quebracho extracts varied in color from a pale straw at a p_H of 3 to a dark red at a p_H of 12. This change in color is completely reversible if the liquors are not long exposed to air. In a similar manner the color of the leather varies directly with the p_H of the liquor used.

Upon exposure to air the liquors darken and this oxidation progresses more rapidly in the liquors having the higher p_H values. In this case the color change is not reversed by lowering the p_H .

CHEMICAL COMBINATION IN CHROME TANNING

Two papers of a series establishing the chemical nature of the combination of chromium with hide substance were presented by Arthur W. Thomas and Margaret W. Kelly, "The Equilibria Between Tetrachrome Collagen and Liquors of Different Chrome Content" and "Adsorption of the Constituents of Chrome Liquor at Various Concentrations After Nine Months' Contact."

Continuing the work which proved the formation of a tetrachrome collagen compound, the authors were able to prepare an octachrome collagen, which would indicate that collagen had a combining weight of 93. It was further possible to prove that the formation of these chromium:collagen compounds is a reversible process, and that chrome tanning is essentially a chemical process.

INFLUENCE OF CERTAIN NEUTRAL SUBSTANCES ON CHROME TANNING

Arthur W. Thomas and S. B. Foster studied the influence of sodium sulphate, sodium chloride and sugar upon the combination of hide substances with chrome. The fact that chrome liquors can be made more basic without precipitation in the presence of certain salts and substances has been explained by the ion hydration theory. This theory does not, however, account for the difference in the action between NaCl and Na_2SO_4 . When the concentration of NaCl is plotted against mg. Cr_2O_3 per g. hide substance, the curve passes through a minimum and then rises to practically the original value. With Na_2SO_4 there is a continuous drop and no recovery.

Experiments with sucrose (which is known to hydrate in solution) showed almost no influence until the solution became quite concentrated. Hence the authors conclude that the initial action of NaCl is due to the formation of an addition compound and that the recovery

is accounted for by the later predominating influence of hydration, while in the case of Na_2SO_4 , which does not hydrate, there is no recovery.

PHYSICAL MIXTURES AND CHEMICAL COMPOUNDS

Dr. Jerome Alexander discussed in a most interesting manner the question of differentiation between physical mixtures and chemical compounds. As in similar problems, there is no sharp line of demarkation and the whole matter rests upon the acceptance of a set of definitions by all interested in the controversy.

EFFECT OF p_H UPON DIFFUSION OF TAN LIQUOR

As ordinarily used in tanning, gambier and quebracho extracts show marked differences in the rate of tanning and of penetration into the hide. In a paper on the "Effect of Change of Acidity Upon the Rate of Diffusion of Tan Liquors Into Gelatin Jelly," John Arthur Wilson and Edwin J. Kern showed that the rate of penetration is a function of hydrogen-ion concentration as well as of the non-tannin content. A sample of gambier penetrated the jelly only at p_H values above 3.0, but a sample of quebracho only at p_H values above 4.7. Above 9.0 the quebracho penetrated more rapidly than the gambier.

CHEMICAL CONSTITUENTS OF SKIN

The chemical constituents of the skin were considered in some detail by Frank L. Seymour-Jones. Of the many compounds present in skin, collagen is the most important. Its chemical structure is still a matter of doubt. The fact that it hydrolyzes to gelatine would seem to indicate that collagen is the anhydride of gelatine. Gelatine when heated yields a substance resembling collagen, but this product does not hydrolyze again to gelatine.

PROPERTIES OF ENZYMES

Joseph Turney Wood, director of Turney Bros., Ltd., of Nottingham, England, contributed a paper on "Properties and Action of Enzymes in Relation to Leather Manufacture." Enzymes apparently differ from inorganic catalysts in that they may start a reaction as well as simply accelerate it.

Enzymes are encountered at many stages in leather manufacture. Those in the soaks and limes are mainly of a proteolytic nature. Many varieties are found in dung bates and commercial bates usually contain pancreatin.

In the drenching process the presence of an amylolytic enzyme is essential. Starches are transformed into dextrine and glucoses, which are subsequently fermented into organic acids.

A CRITICAL STUDY OF BATING

Through the use of the microscope and the hydrogen electrode, John Arthur Wilson and Guido Daub have obtained evidence which proves conclusively that the functions of bating are two—reduction of the skins to a condition of minimum swelling and solution of the elastin. The removal of elastin, which is the primary function of bating, results from the digestive action of the pancreatic enzymes in the bate. Elastin digestion may be followed microscopically by selective staining.

Experiments with pancreatin on strips of limed and un haired calfskin gave the following results:

Elastin removal depends upon the hydrogen-ion concentration of the solution. With a solution containing 0.1 g. pancreatin per liter complete digestion of elastin was effected only when the p_H value of the solution lay

between 7.5 and 8.5—a very narrow margin—but when the concentration was increased to 1 g. per liter the active range was extended to 5.5 to 8.5.

The rate of elastin removal is a function of the concentration of enzyme and of the time of digestion.

Ammonium chloride shows an activating effect in concentrations up to 0.5 g. per liter and a marked inhibitory effect in higher concentrations. It was thought that this latter observation might explain the negative results obtained with several commercial bates. Accordingly samples of commercial bates were dialyzed in order to remove NH_4Cl , earlier experiments having shown that dialysis had no effect upon the activity of pancreatin itself. The results were still negative, however. It was then found that the woody fiber used as a filler in the commercial bates adsorbed the enzyme so strongly that it was unable to function.

From tests made with calfskin, the authors conclude that the value of bating depends entirely upon the properties desired in the finished leather. By applying the principles outlined in this paper, complete scientific control of the bating process is now possible.

ISOELECTRIC POINT OF COLLAGEN

Experiments by Arthur W. Thomas and Margaret W. Kelly indicate that the isoelectric point of collagen is at a hydrogen-ion concentration of 10^{-5} mols per liter.

PHYSIOLOGICAL AND HISTOLOGICAL OBSERVATIONS ON SKINS

A paper on "Physiological and Histological Observations of the Flayed Skin Entering Into the Art of Leather Manufacture," by Alfred Seymour-Jones, was read by his son, Frank L. Seymour-Jones.

The true skin consists of four distinct layers, differing considerably structurally and chemically.

The topmost layer is the grain membrane, which varies considerably in feel and texture with different animals largely according to the type of hair or wool. Just below it lies a thin layer, the cutis minor, vitally important in the manufacture of good leather. Below again is the fatty layer, largely consisting of groups of fat cells, resembling in appearance bunches of grapes. The last layer is the cutis major, which forms the major part of the whole skin. It is composed of white collagen fibers, intertwining in every direction to form a firm and inextensible coat for the body.

In the grain membrane and cutis minor the white fibers are supported by yellow elastic fibers. When, as in bating, the elastic fibers are removed, these two layers become soft and extensible, and the skin "falls."

THE CHEMISTRY OF LIME LIQUORS

W. R. Atkin, instructor in the chemistry of leather manufacture at the University of Leeds, extended the theories of Procter and Wilson and of Loeb to the alkaline swelling of hide in lime liquors. The real reason why such sharpening agents as sodium sulphide and sodium carbonate produce greater swelling than lime alone is that the osmotic pressure which causes swelling is greater for sodium collagenate than for calcium collagenate at the same p_{H} value. The smooth grain of skins unhaired in limes containing arsenic sulphide is due to the fact that calcium collagenate only is formed.

DETERMINATION OF TANNIN

John Arthur Wilson and Edwin J. Kern have succeeded in improving the procedure of their new method of tannin analysis. The revised procedure gives the

same results as the original, but saves a great deal of time and labor and increases the accuracy for unskilled analysts. To make a determination by the revised procedure, it is necessary merely to shake a fixed amount of hide powder with a solution containing a known amount of the soluble matter of the tanning material until all tannin is removed from solution, washing the tanned powder in a special device which prevents the loss of anything but matter in solution, drying the washed powder and weighing it. The increase in weight of the dry hide powder is a measure of the tannin content.¹ All criticism raised against the new method thus far has been refuted.

THROUGH THE TANNERY ON THE INSIDE OF A CALFSKIN

This lecture by John Arthur Wilson consisted of a series of remarkably beautiful sections of calfskin projected upon the screen at a magnification of 2,000 diameters, thus permitting a detailed and critical study of the changes at each stage of the tanning process.

In fleshing, the adipose tissue is cut away just under the flesh layer of elastin fibers. During liming, the substance of the malpighian layer of the epidermis is slowly digested, thus effectively separating the corneous layer of the epidermis and the hairs from the dermis. In bating, the elastin fibers are digested by pancreatic enzymes. After bating, only the grain membrane, collagen fibers, erector pili muscles and a few blood vessels are left. The tannin combines chemically with the collagen fibers. The fat-liquoring process distributes oil uniformly over the surfaces of the fibers. Coloring and the application of finishing materials complete the process of addition.

ASTRINGENCY OF VEGETABLE TANNING EXTRACTS

The reasons for the different degrees of astringency of various vegetable tanning extracts have been long a matter for speculation. The problem has been attacked from a colloid chemical point of view by Arthur W. Thomas and Stuart B. Foster, with the result that astringency has been indicated to be a function of the electrical charge of the tannin particles. The higher the charge the greater is the astringency.

ACTION OF VEGETABLE TANNING MATERIALS

A paper by Arthur W. Thomas and Margaret W. Kelly on "The Time and Concentration Factors in the Combination of Tannin With Hide Substance: 1, Gambier, 2, Quebracho," was the first of a series of studies of the action of vegetable tanning extracts in the formation of leather. It brings out clearly the difference in behavior of an astringent tanning agent and of a mild one. Gambier shows slow regular increase in the amount of tans fixed by hide as the concentration of the extract and the time of reaction are increased. Contrasted to this behavior, quebracho shows a rapid and larger amount of tan fixed than gambier does, accompanied with a sharp maximum followed by an abrupt drop in the fixation.

ELECTION OF OFFICERS

At the business meeting, the following officers were elected: John A. Wilson, chairman; J. S. Rogers, vice-chairman; Arthur W. Thomas, secretary-treasurer; F. Seymour-Jones and C. R. McKee, executive committee. It was voted to hold the next meeting of the division in connection with the 1922 fall meeting of the society.

¹For full details see *J. Ind. Eng. Chem.*, vol. 13, p. 772, September, 1921.

Division of Sugar Chemistry

The Division of Sugar Chemistry met Wednesday and Thursday, C. A. Browne, chairman, and Frederick Bates secretary. A number of the papers presented were of a general interest nature, and others dealt primarily with improvements in analytical methods.

Some Studies on Decolorizing Chars.—Dr. C. E. Coates discussed in a general way the work on decolorizing chars at the Louisiana State University and the Sugar Experiment Station. Many inexpensive raw materials are to be found in Louisiana, and much investigational work has been done on these for the purpose of developing satisfactory methods of manufacture.

The Comparison of Various Blacks Upon the American Market.—C. E. G. Porst and J. M. Krno in their paper on the comparison of various blacks upon the American market stated that the efficiency of various carbons in decolorizing glucose liquors was determined by comparative laboratory tests in which not only the initial but also the total decolorizing power was considered. They also studied the relationship between fineness of mesh and decolorizing efficiency.

Adsorption Isotherms of Some Decolorizing Carbons.—F. W. Zerban and S. Byall using various commercial carbons and blackstrap molasses, made experiments to determine whether decolorization follows the adsorption formula of Freundlich. A Hess-Ives tintometer was used, and Mead's units for expressing the color. Different curves were obtained for different concentrations of molasses.

Decolorizing Carbons and an Inquiry Into Fundamentals of Sugar Colorimetry.—H. H. Peters reported the results of his studies on the decolorizing efficiency of several carbons. The author used optically clear filtrates for the determination of remaining color. It was pointed out in the discussion that there is need of an absolute method for measuring color, but very great difficulty in developing such a method.

Mechanical Clarification of Cane Juice Liquors.—A. S. Elsenbast spoke about the growing use of filter aids, such as Filter-Cel, and the results obtained in factory practice in Louisiana during last year's grinding season were given in considerable detail.

Rôle of Fermentation in the Deterioration of Cane Sugar Products.—C. A. Browne, C. A. Gamble, G. H. Hardin and M. H. Wiley have studied the rôle of fermentation in the deterioration of cane sugar products. Analyses were made of molasses, soft refined sugar and various grades of raw sugar. The average moisture content and percentage of invert sugar were higher for the deteriorated sugars. Slow inversion, with subsequent destruction of invert sugar by the micro-organisms associated with deterioration is apparently the explanation. The best remedy is believed to be more thorough drying.

Purification and Concentration of Enzyme Solutions for the Rapid Analysis of Sugars by Enzymotic Hydrolysis.—A method for preparing highly active enzyme solutions of great stability was described by F. W. Reynolds. The process may readily be adapted to the manufacture of enzymes on a large scale, and therefore encourages the more widespread use of the enzyme method of analysis.

Precipitation of Gum From Beet Molasses.—H. S. Paine and C. F. Walton, Jr., described a small-scale process developed primarily for the purpose of preparing sufficient beet gum to permit a study of its

properties. The difficulty in eliminating this non-sugar economically on a factory scale, either by precipitation or by adsorption by decolorizing carbon, was strongly indicated.

Chemical Properties of the Gum From Cane Affected by Cobb's Gummy Disease and Its Influence in the Sugar-House.—C. F. Walton, Jr., and O. S. Keener reported their observations in Porto Rico. They stated that the real remedy without question would seem to be the eradication of the disease in the field. A purified solution of the gum was found to be optically active, but since it was completely precipitated by basic lead acetate, as in the usual method of analysis, the inference was drawn that the presence of the gum in cane juice does not interfere with the laboratory analyses.

OFFICERS ELECTED

The following officers were proposed by the nominating committee and unanimously elected by vote of the members present: Chairman, S. J. Osborne; vice-chairman, F. W. Zerban; secretary and treasurer, F. J. Bates; executive committee: C. A. Browne, C. E. Coates; W. D. Horne, W. B. Newkirk, H. S. Paine, H. E. Zitkowski. A rising vote of thanks was given Dr. C. A. Browne, the retiring chairman, for his service to the section.

Section of Cellulose Chemistry

The meetings of the Section of Cellulose Chemistry were held Wednesday and Thursday, Sept. 7 and 8, under the chairmanship of Harold Hibbert, with G. J. Esselen, Jr., as secretary. Among the papers presented were the following:

A preliminary communication by Walter Russell and Louis E. Wise on "Acetolysis of Wood Cellulose" indicated a mode of attack on the question of the "normal cellulose" content of wood pulp and led to a discussion as to the reason why nitrated pulp cannot be used for the manufacture of celluloid. It was apparent that a closer definition of so-called "normal cellulose" is necessary, and it is expected that the committee appointed to supervise the manufacture of pure cellulose for purposes of scientific research will give attention to the matter.

"The Constitution of Cellulose" was discussed by Harold Hibbert in the light of the recent work of Karrer and Widmer, Freudenberg, Irvine and Monier-Williams, the evidence of the two former investigators indicating the probable incorrectness of Hess' formula. An explanation was given, in the light of the Hibbert formula, of the connection between cellulose, cellobiose and dextrose in their various modes of transformation into one another, and the forecast made of the probable synthesis by workers in this field of a wide variety of new cellulose derivatives of industrial importance.

The paper by Alfred Tingle on "The Alleged Adsorption of Alumina From Solutions of Aluminum Sulphate by Cellulose" occasioned an animated discussion, most of which was apparently opposed to the negative view taken by the author, so that the details of the paper will be awaited with interest. One point developed in the discussion was the admission that no satisfactory titration method existed for the determination of the basic aluminum hydroxide in aluminum sulphate, a point which is to be investigated by those interested.

The rôle of cellulose in plant life was reviewed by R. W. Thatcher, two points being strongly emphasized: On the one hand the absence of cellulose splitting

enzymes in the early stages of plant growth and the other that cellulose serves one function only—namely, that of a structure-forming material.

The determination of methoxyl groups in wood-distillation products by L. F. Hawley and Subramanya Aiyar was a continuation of the Forest Products Laboratory investigation on the action of small amounts of sodium carbonate in increasing the yield of methanol in wood distillation. It is no secret that Hawley's process is now being tried out on the commercial scale and with promise of success.

The technique of preparing viscose solutions for laboratory experiments was given by W. O. Mitscherling, while some new light was thrown by H. E. Wilkie on the commercial possibilities of ethyl acetate as a solvent for nitrocellulose and cellulose acetate.

The question of the most suitable type of monograph on cellulose chemistry led to considerable discussion following the review contributed by Dr. Louis E. Wise. The chairman was requested to forward Dr. Wise's paper to Dr. John Johnston as representing in general the views of the section.

The committee on viscosity standardization reported favorable replies from fifteen out of eighteen different manufacturers. They recommended the adoption of the "dropping-ball procedure," the details to be worked out by the committee with facilities offered by the du Pont company.

The committee on preparation of standard cellulose suggested that Dr. Bjarne Johnsen be asked to have his method for cotton purification printed in one of the technical journals, reprints of which are then to be submitted to the members of the section for criticism and comments.

Both reports were adopted unanimously.

In view of the different analytical methods at present in use in cellulose investigations, a committee was appointed to report on the best available methods.

Section of Petroleum Chemistry

The meetings of the Section of Petroleum Chemistry were held Wednesday, Thursday and Friday, Sept. 7, 8, 9, under the chairmanship of T. G. Debridge, and with W. A. Gruse secretary. Of the sixteen papers presented seven constituted a symposium on emulsification problems in the petroleum industry.

No papers were read Wednesday, as all the time was taken up by discussions concerning just what the section could do to bring about work on the fields of research.

Dr. Van H. Manning, director of research for the American Petroleum Institute, took part in this discussion, pointing out the necessity for educational work and standardization of testing methods.

A number of subjects were listed, and it was decided that an effort be made to bring together the academic and the technical research men in such a way that university research work on the physics and chemistry of petroleum might be stimulated. Dr. B. T. Brooks pointed out the absence in this country of the benevolent activities of such a firm as the Nobel Bros. Co. in pre-war Russia, which subsidized a great deal of purely academic work and helped put Russian petroleum chemistry in the high position it occupied before the collapse of that country.

On Thursday morning Peter Kerr, of London, one of the Society of Chemical Industry visitors, presented a letter of greeting to the Petroleum Section from Presi-

dent J. S. S. Brame of the Institution of Petroleum Technologists. Mr. Kerr spoke briefly and was an interested participant in the sessions.

The program opened with a paper by E. M. Johansen on iodine and bromine values of petroleum products. Mr. Johansen presented a large amount of very valuable work on this puzzling question and recommended a new reagent.

Thomas Midgley, Jr., presented some observations on the polymerization of amylene. As cracked gasolines are more plentiful in our motor fuels and the removal of the gum-forming constituents therein more important, it is clear that we need to know more about the chemistry of the unsaturated compounds from which the gums are formed.

R. E. Wilson and D. P. Barnard, of the Massachusetts Institute of Technology, supplemented papers presented to the section at Rochester by one on total heats of motor fuels.

SYMPOSIUM ON EMULSIFICATION PROBLEMS IN THE PETROLEUM INDUSTRY

The symposium on emulsification problems in the petroleum industry drew much attention. The material which the oil producer knows as "B.S.," or bottom settlings, may contain from 20 to 80 per cent good oil, and many new fields, such as the El Dorado, in Arkansas, produce much of this material; in addition, it collects at the bottom of nearly every storage tank in the mid-continent and other Western fields.

Dr. L. W. Parsons presented a detailed study of laboratory emulsions made with Nujol and mono- and di-valent soaps as emulsifiers; the inversion of phases was studied and a definite concentration found for the salting out of oil-in-water emulsions.

Prof. T. R. Briggs, of Cornell University, discussed emulsions with finely-divided solids. The author showed antagonisms between different finely-divided solids paralleling those between the different types of soaps.

Dr. J. L. Sherrick's paper presented the idea that the active agent in making oil-field emulsions is a film of finely-divided silt or clay, carrying adsorbed asphaltic matter. There was an interesting correspondence between this paper and that of Dr. Briggs.

E. E. Ayers, Jr., discussed the common characteristics of petroleum emulsions. He remarked on the rather striking uniformity of oil-field emulsions, told why it is a mistake to try to break up an emulsion by heating with a closed steam coil, and touched on such new topics as resolution of emulsion by filtration through media which are selectively wetted.

Practical methods for resolving emulsions as now used in the oil fields were presented in papers by R. R. Matthews and P. A. Crosby and by Dr. Sidney Born. The former paper was confined to a particular kind of chemical process, while the latter covered briefly the electrical, chemical and thermal methods, as well as the use of the supercentrifuge.

In the discussion following the symposium, H. C. Eddy gave a detailed account of the Cottrell process as commercialized, and Dr. F. W. Lane explained recent developments in low-voltage resolution.

The last action of the section before adjournment was to vote that the question of making the section a division as soon as possible be taken up; it was generally felt that this action was justified by the continued interest shown in the meetings of the section and its rapid growth since its formation in the spring.

Welding; Particularly Hammer Welding

Brief Discussion of Various Modern Methods of Welding, Indicating Advantages and Limitations of Each, and the Field for Hammer Welding Heavy Pressure Vessels—
Operations Necessary for Hammer Welding Steel Sheets

By ERNEST EDGAR THUM

METALS can be joined together in many ways. Even after excluding the various mechanical splices, riveted, bolted or keyed together, two pieces of like or unlike metals may be joined by several methods so that their substance is continuous.

A few years ago "welding" meant blacksmithing; to city dwellers with broken automobiles it now means some mysterious manipulations with a harmless looking torch or a sputtering electric arc. Soldering and brazing are less like these operations, but they also join metals into a continuous substance. Welding, therefore, is rather a broad term if it is to include all methods of making metals cohere.

MOLECULAR COHESION NECESSARY FOR WELDING

High heat is not always essential. An autogeneous joint can be made between two pieces of gold or lead by strongly pressing them together at room temperature. In some cases pressure is not needed if the temperature is high enough—notably in thermit or other methods of "fusion welding." Even tool steel may weld to a certain extent by heating freshly fractured surfaces in contact after wrapping the joint in platinum foil and heating to a low red. The main thing seems to be to get intimate contact—molecular contact in fact—between the two sides of the joint.

When such a union is examined even under the microscope, it is very difficult to determine where the one piece stops and the other starts; there is a certain amount of actual interpenetration in all good welds. In fact the former junction surface is now crossed by metallic crystals, portions of which came from one piece of metal and portions of the same crystals from the other. Hence follows Stead's law of welding: "Unless the crystals become common to the two pieces there is no welding."

Heat is undoubtedly the handiest method of securing such molecular interpenetration. As noted above, many modern methods use heat alone, actually melting the metal at the joint, just as in soldering. However, heating to high temperatures is accompanied by two major difficulties: Even the best and purest metals are subject to rapid and profound physical changes at elevated temperatures; furthermore their chemical activity is enormously increased. The former rearranges the crystalline structure of the underlying layers of metal with an accompanying change in strength and ductility. The latter difficulty is responsible for rapid oxidation of some major component of the alloy being welded, and the resulting oxide must be got rid of in some manner or the joint will be unreliable.

SOLDERING AND BRAZING

Such inherent disadvantages of high temperature may be dodged by soldering and brazing.¹ Here the cleaned surface is covered with a thin film of fusible solder so selected as to form low-melting alloys with the underlying piece at the moderate temperature employed (Fig. 1). Thus a true weld is formed between piece and solder. Two pieces, prepared in the same way, are then held together, merely warmed to the melting point of the solder, and presto, they are joined.

Unfortunately, all low-melting alloys now available for soldering are deficient in strength. The joint is by no means as reliable as the pieces joined. It has an entirely different chemical and metallurgical nature, and can never approach the welder's ideal—to produce a joint which cannot be located because it is exactly like the pieces joined. In avoiding the dangers of oxidation, even greater chemical heterogeneity is produced.

CLASSIFICATION

A workable compromise between high heat and no pressure and no heat and high pressure has been used since prehistoric times by the worker in wrought iron.

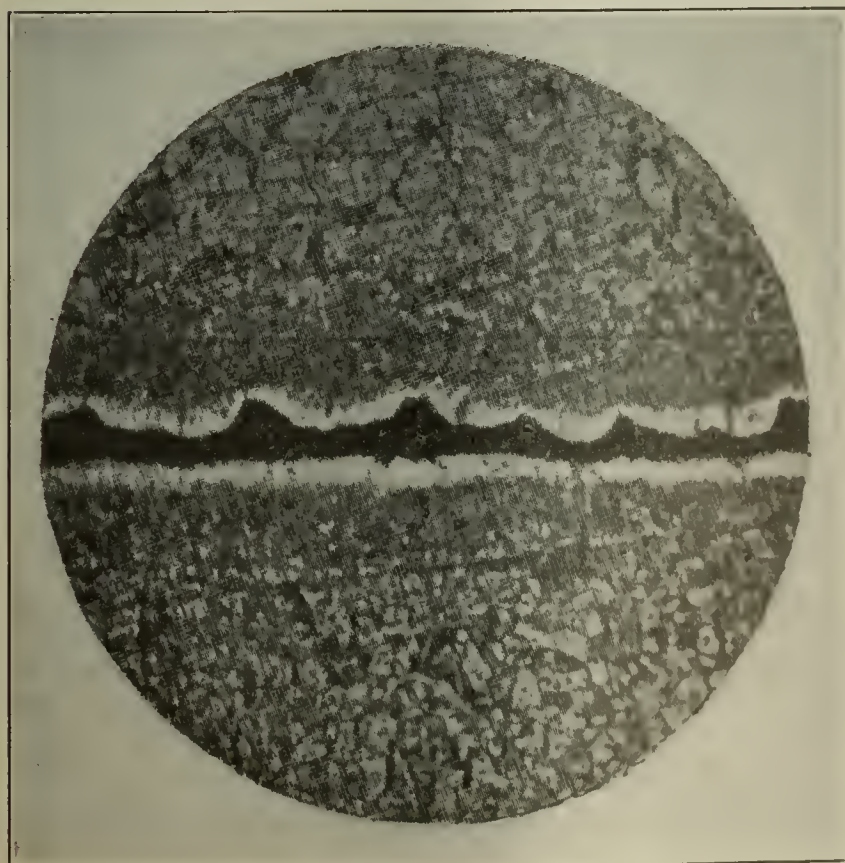


FIG. 1.

Section across soldered joint of two pieces of copper. Etched with ammonia. The solution of the tin in the copper is indicated by the light unattacked border along each side of the joint. Magnified 100 diameters.

¹Groets, "Metallography and Heat-Treatment of Metals Used in Aeroplane Construction," CHEM. & MET. ENG., vol. 19, pp. 317, 583.

Only in comparatively recent years, however, have inventors provided other methods of producing heat than an open fire; these have been utilized in new welding methods. Excluding soldering and brazing, the following is a somewhat loose classification of the important ways of making coherent metallic joints in iron and steel, and their principal uses.

Class	Principal Utility
Electric Resistance Welding	
(1) Butt welding	Bars and wires
(2) Spot welding	Lap seams
Fusion Welding	
(1) By electric arc	} Butt seams
(2) By gas flame	
(3) By thermit	
	Heavy castings, shafting and forgings
Forge Welding	
(1) In smithy	Bar iron and steel
(2) By special machinery	Heavy tanks and pipe

ELECTRIC-RESISTANCE WELDING

Electric-resistance welding utilizes the fact that even though good conductors of electricity, metals offer some resistance to its flow. In overcoming this resistance heat is generated. If now a sufficient electric current can be concentrated and forced to cross a joint to be welded, the joint can be heated to a temperature where moderate pressure will cause a true weld.² Practically all metals and a great many alloys can be welded by this process, as well as combinations such as brass to copper, silver or gold, mild steel to tool steel, steel to platinum. It is not suited for cast iron. Metals of relatively low melting point, zinc, lead, tin and aluminum, may be welded by taking the proper precautions; even magnesium has been welded.

As noted in the classification, two principal methods of resistance welding are in common use. The usual butt-welder consists of a pair of heavy copper vises

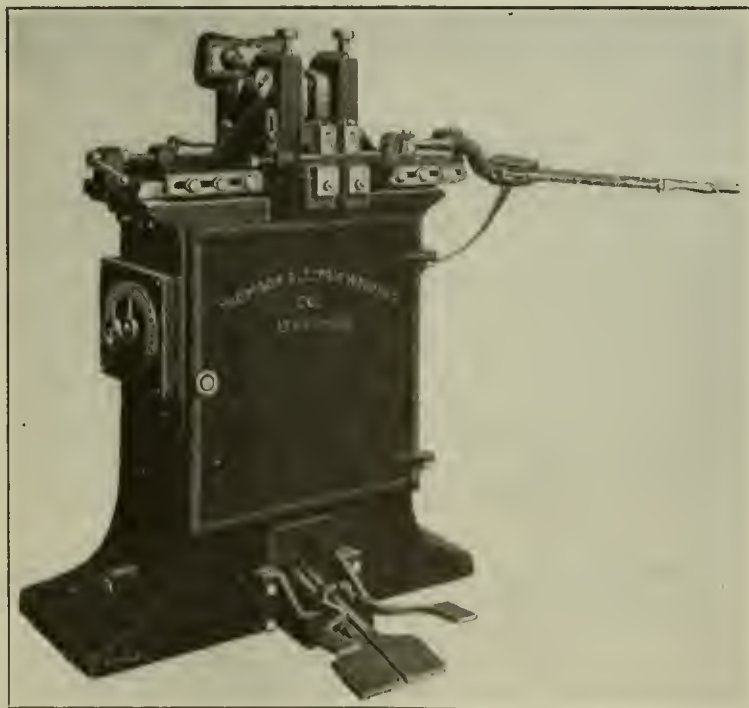


FIG. 2. BUTT WELDING MACHINE CAPABLE OF WELDING STEEL PIECES UP TO 0.5 SQ. IN. CROSS-SECTIONAL AREA

(Fig. 2), one fixed and the other on a slide so it can be thrust toward the other at the moment of welding. The two bars to be joined are shown clamped (abutting about midway between vises) and serve as part of the secondary circuit of an alternating current transformer built into the base of the machine. A small amount of current is drawn from the supply line,

transformed into low-voltage, high-amperage current flowing through the iron bars, heating them to the correct temperature. Pressure applied by the hand lever through the movable vise then forces the hot plastic metal into molecular contact, upsetting it a little into a rounded bulge. If the pressure and current are held a longer time some white-hot metal is extruded as a perpendicular fin. Cooling takes place immediately after the current is shut off. The weld is usually annealed by a low current, and excess metal pressed down or the flash cut off.

This is in every respect the best way to join rods or bars end to end, especially in repetitive work on material less than 2 in. diameter. Fencing and cables can be made of endless wires, by merely butt-welding

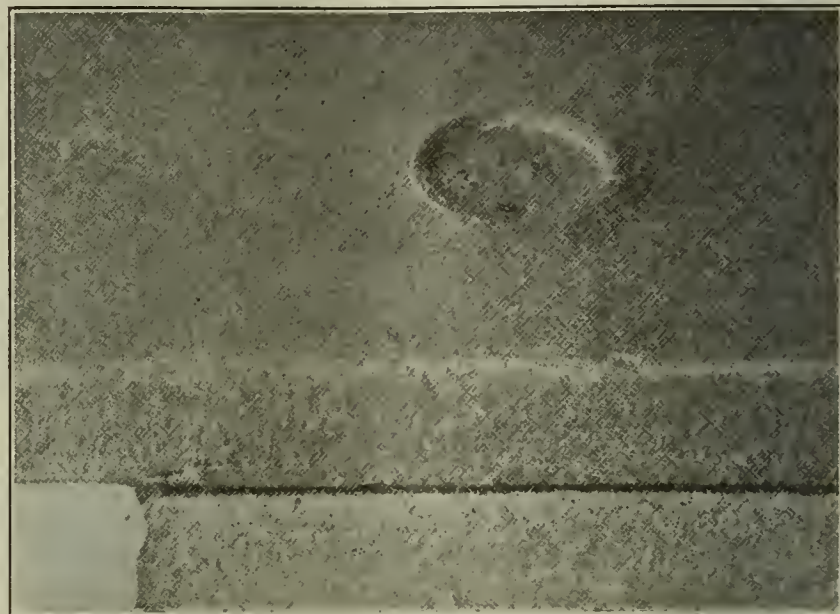


FIG. 3. CRATER FORMED BY SPOT WELDER WHEN JOINING TWO STEEL SHEETS

successive coils. Forged ends or steel of special analysis can be welded to stock rods. Other manufacturing processes readily suggest themselves.

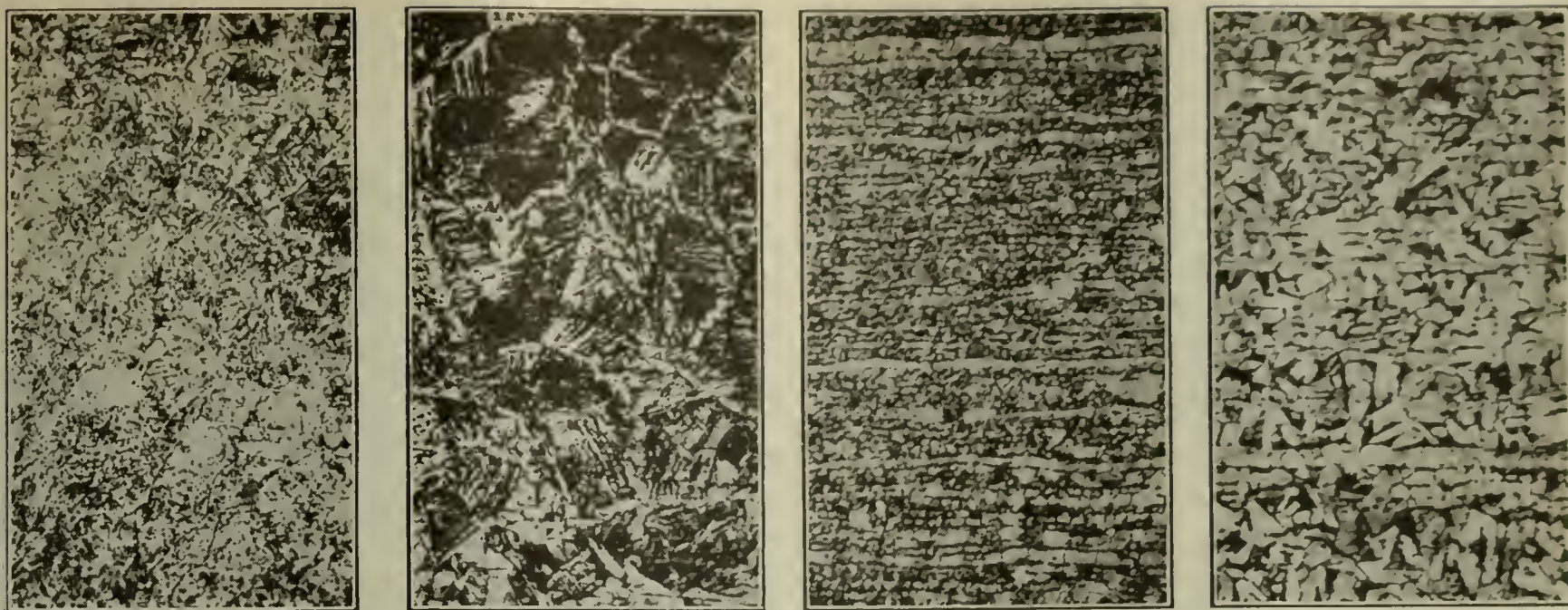
It is necessary to anneal these welds if they are to withstand shock, since the metal at the joint is heated intensely in the few seconds the current is on, and then cooled very quickly (in fact "quenched") by the cold underlying metal.

This means that the bar at the weld and for perhaps half a diameter on either side is in a hardened condition; its strength and brittleness increase with the carbon content of the stock. The heat is extremely short and under close control, however, and there is no excuse for extreme grain growth, "burnt" steel, slag inclusions or blow-holes. Unfortunately, the operation is in the open air, and high-carbon steel will lose up to one-half its carbon content throughout a thin layer at the weld. It is not necessary to dilate upon the harmful effect of this decarburization, despite any subsequent heat-treatment.

SPOT AND PERCUSSIVE WELDING

Spot welding uses the same electrical principles to weld small areas and to replace rivets when joining sheets or shapes. Imagine a yoke riveter with "snap" and "dolly" replaced by thick copper pencils, and with correct connections for high amperage electrical currents, and you have the essentials of a spot riveter. Two or more pieces are assembled and squeezed between these copper terminals and sufficient current passed across the joint to weld the adjacent surfaces over a small area, somewhat larger than that of an

²See "Electric Welds," by E. E. Thum, CHEM. & MET. ENG., vol. 19, p. 301 (Sept. 15, 1918).



FIGS. 4 TO 7. MICROSCOPIC STRUCTURE OF ARC WELD (RUDER). ALL MAGNIFIED 75 DIAMETERS
 Fig. 4. Deposited metal at center of weld. Fig. 5. Coarsened grained adjoining weld. Fig. 6. Refined zone adjoining weld. Fig. 7. Original plate unaffected by heat.

appropriate rivet (Fig. 3). Pressure and current are then released, and the work shifted for another "spot."

It is rather strange that so excellent a process has not been put into as wide use in structural and plate work as it has in the manufacture of racks and gratings. Plain pieces of plates and angles can be stitched together without the labor of templet making, laying out, punching, reaming and rivet heating. The method makes a weld over a small round area which approaches the ideal; if the plates are clean there is very little decarburization, no blow-holes or slag, while the hardening caused by rapid cooling of the spot by surrounding cold metal is of minor moment in a connection between mild steel pieces.

The electro-percussion method depends upon sending a heavy current from a highly charged condenser through the points of contact of the metals to be welded at the instant they touch as they are brought together with more or less impact. The intense heat is developed so quickly that it is confined to the surfaces as they fuse together. It is used a great deal for joining wires and can be employed for practically all metals and alloys as well as for combinations. One of its chief uses at present is the uniting of copper and aluminum wires, which can be done in no other way with uniformly satisfactory results. Metals of widely varying melting points—for example, tin and platinum—can be welded by this means. It also finds many applications in the jewelry trade. The method has not yet been developed for anything but small pieces.

FUSION WELDING BY ELECTRIC ARC

Fusion welding, as the words imply, utilizes a much higher temperature than will produce the pasty state needed for resistance welding. The material at the joint is actually melted. Thus it is like soldering. It is further like soldering in that a space between the pieces is filled with fresh metal, seldom of the exact composition as that which it joins.

Either an electric arc or certain gas flames may be used to produce enough heat for local fusion. Such welds are usually made by filling up a notch or corner between the two pieces with molten steel, added a little at a time.

If the work is grounded and an arc struck from a

steel wire, a small spot is raised to incandescence and builds up liquid metal acquired from the electrode. Metal is transferred through the arc, partly as a true vapor, partly as hot particles driven off by explosive expansion of gas occluded in the wire, but mostly as larger droplets, melted from the end. Such a deposit is gradually built up in layers, until the joint is filled from end to end. In view of the fact that the arc is a region of intensely hot gases (oxygen, nitrogen and iron) mounting up to 3,500 deg. C. or more, it is not surprising that the deposited metal will have lost much of its carbon, silicon and manganese and acquired oxygen and nitrogen. As ordinarily made at the present time it is in fact a low-carbon casting (Fig. 4) made and cast continuously under unfavorable conditions, containing many blow-holes and unusual compounds, whose specific effect is not as yet thoroughly explained (Fig. 8). Rawdon and others at the Bureau of Standards have cut test-bars from heavy deposits of weld metal³ made from low-carbon iron and steel welding wires and find that while possessing fair ultimate strength (50,000 lb. per sq.in.) it is likely to be quite deficient in ductility.

Great variation existed in these tests; the best ultimate strength was 54,500 lb. per sq.in., the highest yield point 36,250, the best elongation 15.0 per cent and the best reduction in area 23.0 per cent. It seems fair to conclude, therefore, that perfection of operating methods and increase in operator's skill will result in much better fusion welds than have been made in the past. The use of proper alloy steels as welding wires is a line of development which as yet has been hardly touched, but holds out promise of successfully making weld metal of high strength and toughness.

Unfortunately there is little opportunity for working or heat-treating these welds—they are usually performed on fixed objects, or as emergency repairs and must ordinarily be used as made. Actual fusion of the original metal at the weld causes other metal in the immediate vicinity to be overheated, resulting in a coarsening of the grain with its characteristic ferrite envelopes (Fig. 5). This state of affairs, accompanied

³See Rawdon, "Physical Properties of Arc-Fused Steel," CHEM. & MET. ENG., vol. 23, p. 677 (Oct. 6, 1920). Also Bureau of Standards Technologic Paper 179.

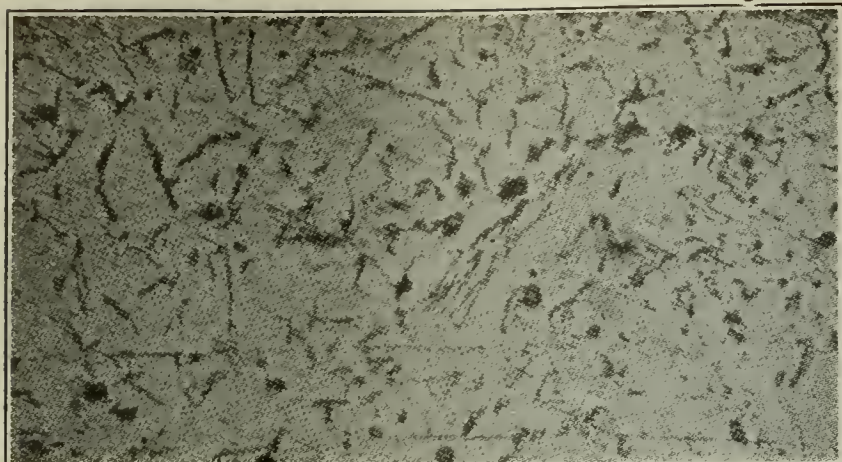


FIG. 8. ELECTRIC ARC WELD IN 1/4-IN. BAR STEEL.
× 600. (MILLER)

as it is by oxygen penetration, reduces the ductility and resistance to shock, and induces intergranular fracture; consequently if a well-made weld is tested to destruction it would probably fail in the underlying layers, rather than in the weld.⁴ Such physical defects, if not too pronounced, can be cured by proper heat-treatment—in fact, they are partly corrected in a crude and uncontrolled way by the heat of successive passages of the arc, a factor difficult to appraise (Fig. 6). Extensive and accurate heat-treatment probably combined with mechanical work would be necessary to correct the major defects of a fusion weld.

On account of the nature of the radiation from the arc, it is necessary that the operator be carefully protected. Simply shielding the eyes is insufficient, the head and hands must be protected from the ultraviolet rays which form a large proportion of the radia-



FIG. 9. PIPE JOINT BEING MADE BY GAS WELDING.
(OXWELD ACETYLENE CO.)

tion emitted by the arc. A special glass window which not only shields the eyes from the heat and intense light but also cuts out the ultraviolet (invisible rays) is a necessity.

Many of the same difficulties beset welding with a

gas flame, commonly acetylene burning in pure oxygen. The temperatures are 1,000 deg. less,⁵ but still far above the melting point of iron or steel, and in a range where oxidation is rapid and excessive. Metal is filled into the notch by melting off the end of a wire, held close to the work (Fig. 9). Fortunately the liquid iron is somewhat protected from atmospheric oxygen and nitrogen by a rather thick "envelope" flame. It is commonly known that a typical oxyacetylene torch produces an inner cone of white-hot carbon burning to CO. Outside this is the envelope of burning CO and H, which spreads out and heats the underlying metal for some distance on all sides. Due to this extensive spread, gas welding overheats the work more extensively and is perhaps less suitable for thick plates or structures which are rigid and may be buckled by

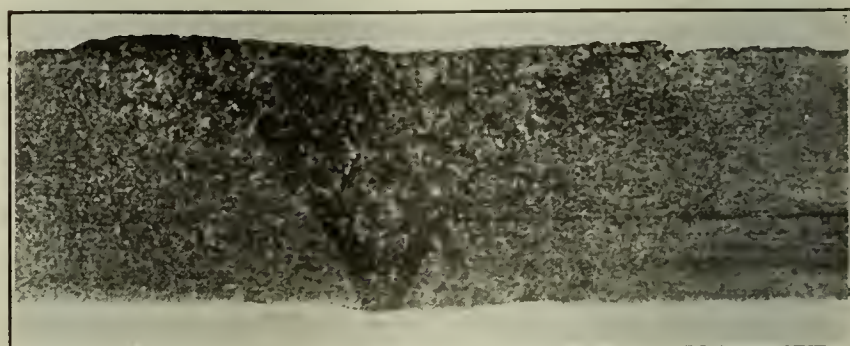


FIG. 10. WELD MADE IN MILD STEEL, ETCHED WITH
AMMONIUM PERSULPHATE. FULL SIZE

the heat than the electric arc, but it is more suitable for cast-iron⁶ or thin steel sheets. But even at best the weld metal is a casting, it contains more or less oxide, and the underlying grain is severely coarsened. Figs. 4 to 7 are typical of the microstructure of all untreated fusion welds; they comprise a central portion of deposited metal, bordered by original metal reheated to various degrees. All metal heated beyond the critical temperature has recrystallized, resulting first in a refinement (Fig. 6) or coarsening (Fig. 5) as the heat goes up. In gas-welded plates the distance from the edge of the filled-in metal to the unaltered stock will equal four times the thickness of the plate, while such a zone is confined to 1/8 in. in an electric weld.

Figure 10 is a macrograph of a weld made at the Union Carbide and Carbon Research Laboratories in mild steel with a low carbon filler rod, later cut, polished and etched with ammonium persulphate. Disregarding the long "ghost," the clean even line at the weld junction, and the solid, homogeneous nature of the filled metal shows what can be done by a skilled operator. Fig. 11 shows test pieces bent back upon themselves, with the bottom of the V-notch inside, and Fig. 12 is the microstructure at the original edge of the plate.

Many of the remarks made under electric arc welding about variation in strength of welds and weld metal depending upon the operator's skill apply with equal force to variation in the quality of gas welds. The Union Carbide and Carbon Research Laboratories have made many tests on bars cut from deposited metal, the welding being done under a wide variety of conditions, and find that the resulting deposit possesses quite uniform physical properties when made by reliable workmen. Typical results of metal de-

⁴Rawdon reports tests on ten superior welds averaging an ultimate strength of 55,650 lb. and elongation of 7.5 per cent. The best broke at 59,470 lb. per sq.in. and the best elongation was 14 per cent. These joints were in ship plates having an ultimate strength of 68,000 lb. per sq.in. and elongation of 22 per cent.

⁵Bureau of Standards Letter Circular VIII-8 gives the temperature of the oxyacetylene flame as 2,400 deg. C., and the oxyhydrogen flame as 2,000 deg. C.

⁶Cast iron must be preheated.



FIG. 11. COLD BEND IN PLATES WELDED BY OXYACETYLENE FLAME

posited from well-known filling rods follow; each figure representing the average of five:

Metal	Ultimate Strength
No. 1 Filler.....	55,600 lb. per sq.in.
No. 2 Filler.....	59,340 lb. per sq.in.
No. 3 Filler.....	64,500 lb. per sq.in.

Either the arc or flame weld is very good for repairs on parts enduring static loads which have a considerable excess of strength or for building up worn or missing metal. An oxyacetylene outfit especially is portable and if necessary may be taken to the work rather than *vice versa*, and with another torch supplying a separate stream of oxygen can be used for cutting metals as well, thus making it a most useful shop tool. It is also used for welding copper and its alloys, aluminum and its alloys, malleable and cast iron. Under the name "lead burning" it is used for welding lead pipe, sheet lead, etc. It is only necessary to protect the eyes with dark glasses, as shown in Fig. 9, owing to the lower actinic value of the flame as compared to the radiations from an arc.

As is well known, much work was done during the war to determine whether fusion welding could be used in hulls to replace riveting, but it has not found great favor among shipbuilders or boiler makers, except to fix small fittings, probably due to the fact that so much depends upon the skill and care of the workman, and the difficulty of inspection. Besides repair work it is

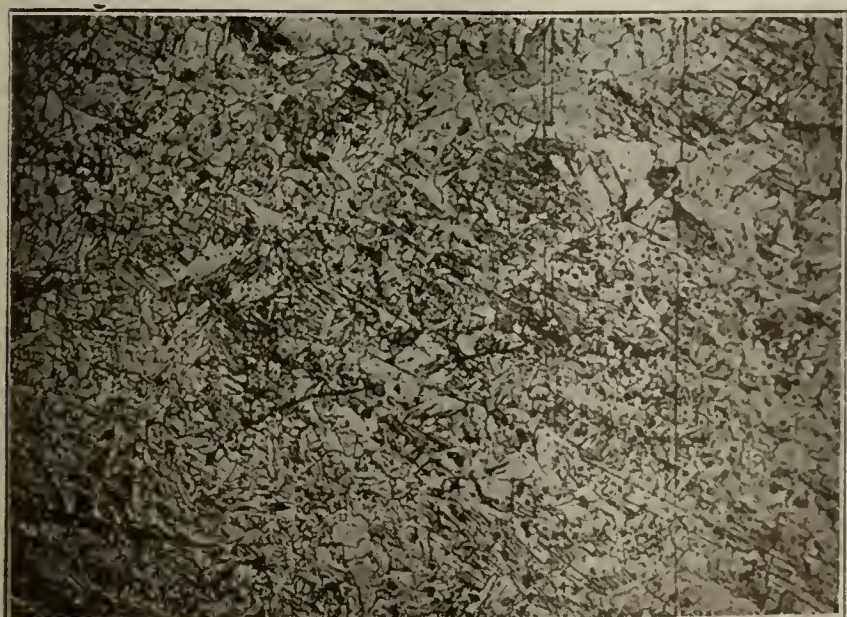
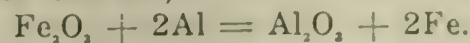


FIG. 12. MICROSTRUCTURE OF FILLED METAL NEAR ORIGINAL EDGE OF PLATE, ETCHED WITH 5 PER CENT. HNO_3 IN ALCOHOL. $\times 100$

largely used for manufacturing low-pressure tanks and barrels, structural tubing and for sheet or seam welding wherever met with.

WELDING WITH THERMIT

Fusion welding may also be done with thermit. A thermit crucible is nothing more than a small furnace producing steel by the reaction between finely divided aluminum and iron ore,



The aluminum burns in the oxygen from the ore, producing sufficient heat to liquefy the whole mass, which is then tapped directly into a sand mold formed around the broken casting (Fig. 13). The broken ends have previously been heated by a torch and at the moment when the white hot liquid metal arrives are themselves at a red heat, and actual melting takes place for a slight depth.

Since the added metal may be alloyed or carbonized to suit, and molding and casting are done by exactly the same principles as those underlying steel founding,

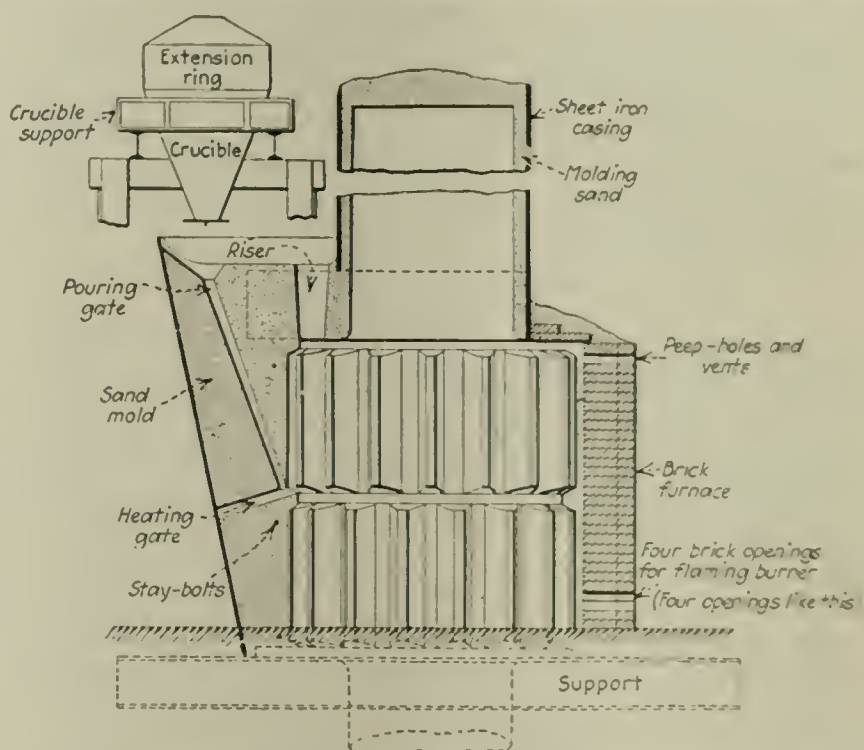


FIG. 13. ASSEMBLY OF EQUIPMENT FOR REPLACING BROKEN TOOTH ON A HEAVY PINION BY THERMIT WELDING

it follows that a well-made thermit weld may have the same composition and structure as the steel casting it joins. Care, of course, must be exercised to prevent any slag contamination, or oxidation or carbonizing at the solid ends during preheating. There will also be a grain refinement in any adjacent metal which has been heated above the critical temperature; but this is an improvement rather than a detriment.

Without doubt, thermit welding is the best method for repairing heavy steel castings. It is also the only practicable method for extremely heavy forgings. Its use here presents the obvious deficiency that two forged pieces are joined by a casting. Even though the chemical composition may be the same, it would seldom be possible to subject the joint to the work and heat-treatment necessary to make the repaired unit a homogeneous structure. Such an operation would probably cost as much and require more time than a new piece; consequently thermit repairs on forgings are best adapted for quick repairs on busy machinery whose broken part if a forging ordinarily works under a considerable margin of safety.

It may be inferred that these new styles of welding have not seriously encroached upon the wide range of hand work done in soft steel and iron by the expert blacksmith. With perhaps the single exception of butt welders, they have extended the usefulness of the welding operation to fields where it had seldom been employed. Thus, spot welding and fusion welding in their largest use replace riveting in plate work, while thermit negotiates tasks far too heavy for the ordinary forge shop. They all do work or join metals which would not be attempted by the blacksmith; on the other hand nearly all of them have drawbacks which limit their usefulness. For instance, butt welding is accompanied by deep-seated decarburization, arc or gas welding sticks on tabs of metal quite likely to be "gassy" and deficient in ductility. On the other hand, forge welding is limited to wrought iron or low-carbon steels. None of them have solved the problem of producing a safe, "seamless" pressure vessel, or one often subjected to wide variations in temperature or stress. A riveted tank working under those conditions will not remain tight even by most expert riveting and caulking. Instances are autoclaves, drums for cracking gasoline, and boxes for annealing light sheets. If some thoroughly dependable method for making such welded seams could be devised, undoubtedly a wide variety of pressure vessels, boilers and pipe will eventually be made in that manner.

WELDING BY MACHINERY

Consequently for some years, engineers at various places have been working on the problem of translating the art of the blacksmith to the modern factory with its labor-saving machinery of high power. There seemed to be no inherent obstacle preventing a 100 per cent joint in wrought iron or mild steel. Wrought iron when originally taken from the puddling furnace is a sponge of metal, yet it welds easily in the rolling mill or under a hammer into a tough, strong bar, composed of elongated strings of crystals of nearly pure iron together with a certain quantity of slag drawn out into threads. Yet this welded material has nearly the same tensile properties as open-hearth iron, cast liquid from the furnace and rolled exactly like steel products. In other words, particles of ferrite can be properly welded into a bar as strong as one of nearly pure ferrite, cast and worked from the ingot. Why, then, should not a welded joint develop an efficiency of 100 per cent?

One variety of thoroughly reliable machine-welding has been known for nearly a century and practiced in the manufacture of pipe or tubes, first of wrought iron and later of low-carbon steel. It is well known that small pipe is made by pulling white-hot "skelp" (plates of the correct width and thickness) through a die or bell having an opening of the exact size of the outside of the pipe, the bell at the same time forming the tube and pressing the edges into welding contact. Pipes larger than 3 in. are lap-welded. The skelp is scarfed on the edges, heated and bent into the approximate cylinder, reheated, and rolled at a welding temperature over a mandrel, and finally straightened before becoming cold. Such methods serve to make pipe up to 30 in. in diameter. These longitudinal seams are not as strong as the metal comprising the rest of the pipe wall, as shown in Table I. However, the characteristics of welded pipe as manufactured in modern plants are well known to the engineering profession, and they are as

dependable as any other metallurgical product. One in five burst lap-welded tubes will be found to have failed by some defect in the pipe wall, rather than in the joint.

This digression is warranted as an indication that it is not unreasonable to extend further the principles of "fire welding" to hitherto untouched fields. Of course not all metals or even iron alloys can be welded by forging. Weldable metal must lose its brittleness, becoming soft and "sticky" some little distance below the melting point, or even the "burning" point—that temperature where some constituent is rapidly oxidized. Wrought iron is an excellent material for welding because it becomes soft (in this sense) 200 deg. below its melting point, and it may readily be heated to 1,400 deg. C.—100 deg. below its melting point—without danger of burning. This safety is in turn due to the fact that the metallic part of wrought iron is pure metal, and it contains only a minute amount of fusible eutectics which allow penetration of oxygen at high temperature, with consequent damage resulting in intercrystalline weakness. Furthermore, the contained slag undoubtedly melts and flows over the exposed metal surfaces, thus protecting them from oxidation, and dissolving any oxide which might previously have been formed. It is well known, for instance, that the welder, when making wrought-iron pipe, judges the correct temperature by observing when the white hot skelp becomes wholly covered with a glassy sheen—gets "greasy," as he says. This indication occurs at a definite temperature, and is quite apparent even to the unpracticed eye.

TABLE I. ULTIMATE STRENGTH OF PIPE WELDS

	— Steel Pipe ⁷ —		— Wrought Iron — Pipe	
	Butt- Welded Lb. per Sq. In.	Lap- Welded Lb. per Sq. In.	Butt- Welded Lb. per Sq. In.	Lap- Welded Lb. per Sq. In.
Average strength of metal.....	57,000	57,000	.....	.....
Average strength of weld.....	41,600	51,700	29,050	29,460
Maximum strength.....	58,160	59,540	.....	.....
Minimum strength.....	33,030	47,030	.....	.....
	per cent	per cent		
Average efficiency of joint.....	73	92	.....	.....

Ferrite itself oxidizes very easily and at low temperatures. Beginning at 200 deg. C. occur the iridescent "temper colors" known to the forge shop, really due to thin films of oxide. Oxide is brittle and unweldable at all temperatures and melts at 1560 deg. C., which is some 30 degrees above the melting point of pure iron. Therefore it can not be squeezed out of a hot weld unless fluxed into a fusible slag. Nor can it be left in the joint with impunity. Fortunately, low-carbon steel especially made for pipe welding acts very much like wrought iron as it approaches the welding temperature. It contains enough silicon, or picks up enough silica, alumina and lime from the furnace bottom, to lower the melting point of the scale to below the "burning" temperature. The pipe maker in this case also watches for the time when the skelp becomes "greasy," and immediately draws it into the welding die.

It is more than a coincidence that wrought iron, the smith's universal metal, is the metal which welds best and easiest. Wrought iron has always been made in crude furnaces, from which it is drawn as a spongy mass. Despite exposure to the air, it welds readily into a bar, tough and strong regardless of crude manipulation. Wrought iron is a weldable material from the first; if it were not capable of being welded

⁷R. T. Stewart, "Strength of Steel Tubes, Pipes and Cylinders Under Internal Fluid Pressure," *Journal, American Society of Mechanical Engineers*, April, 1912.

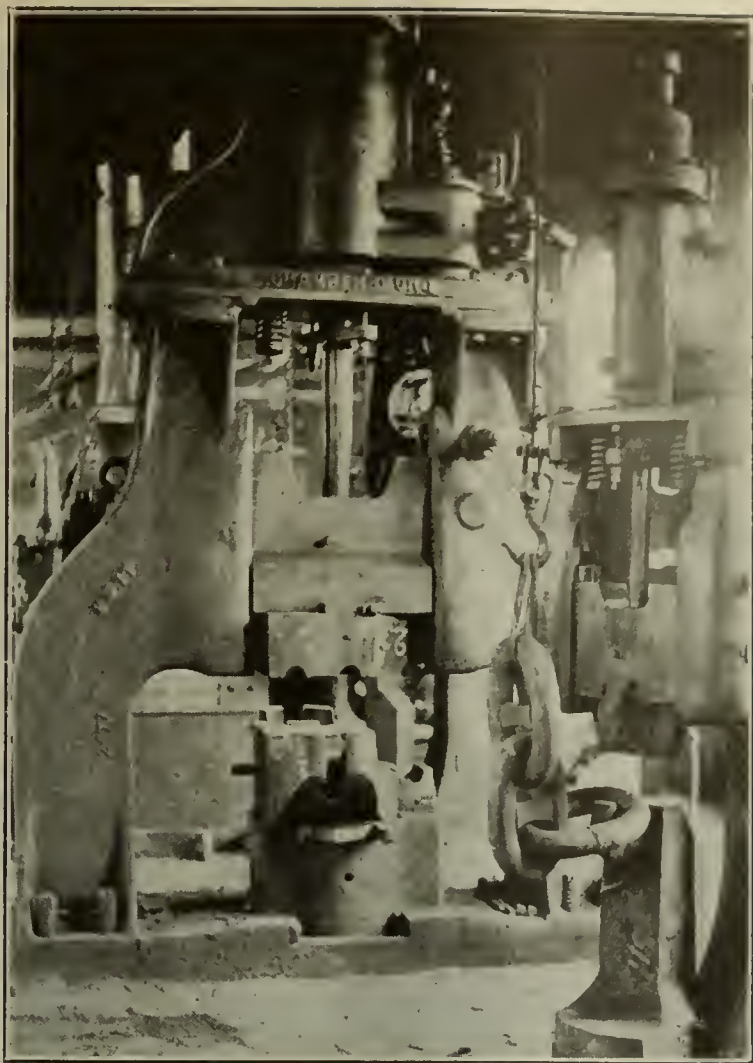


FIG. 14. WELDING HEAVY WROUGHT-IRON CHAIN IN DOLLY DIES AT THE BOSTON NAVY YARD

by the smith, it would never have been more than a useless lump, a conglomerate of iron and slag particles, a thing to be avoided rather than produced.

Soft steel is less easily welded, except when occasionally made with this end in view, but most of the so-called "iron" on the market in bars and pipe is really steel. It may not be heated so high—with increasing carbon the forging temperature is lowered, the pasty stage narrowed and danger of burning (by melting of some fusible segregates) increased. A high-carbon steel will "burn" before it loses its brittleness and before the scale can be fluxed into a fluid covering, and consequently is unweldable by this slow-heating process.

EFFICIENCY OF FORGE WELDING

In order to get an idea of the strength of commercial welds, Bauschinger's series of tests may be noted. He examined some carefully made welds, with the result that hand-forged welds of wrought iron gave an average efficiency of 87.9 per cent; when forged under the steam hammer they averaged 91 per cent of the strength of the original bar. With soft steel the hand-forged welds had an average efficiency of 84 per cent, while the power-forged welds developed 97.2 per cent. Hand-made welds have been variously reported to possess from 30 to 100 per cent of the strength of the parts joined, a great variation depending upon the skill of the smith, his methods and the difficulties of the job. Such great variation is doubtless responsible for the conservative attitude of various boiler codes toward welded joints. For instance, the American Society of Mechanical Engineers' code allows no more than 28,500 lb. per sq.in. as ultimate strength in a wrought joint in plate steel having a minimum strength of 45,000 lb. per sq.in., an efficiency of no more than 63 per cent. Welded pressure vessels are now regularly made which are

guaranteed to have 90 per cent joints, and no difficulty is experienced in getting insurance underwriters to accept them at that rating. Tests to be quoted in a later article also show that 90 per cent is a conservative value for longitudinal seams in large piping.

That very high-grade work can be regularly done even with simple equipment is evident from the fact that hand-welded chain is universally regarded as being one of our most dependable tools. The problem is therefore to study the technique of hand-forging and to develop machinery which will prevent or minimize those occurrences which produce weak or variable joints.

A smith prepares his weld by upsetting or scarfing the pieces to be joined. He provides extra section so that it can be thoroughly hammered and yet not be undersize. He also shapes his pieces to be joined so that first contact during forging is over a relatively small area; the pieces are then gradually forced together, squeezing any fluxed oxide or slag out of the joint. He heats the parts in a clean fire, making sure that the metal is clearly heated through, yet without burning on the edges. When a proper heat is had, he dashes on a certain amount of sand, places the pieces one against the other on the anvil, holds them firmly in place and quickly and vigorously hammers them together, continuing the work on the weld and on the hot regions abutting until the metal has passed through the recalcence temperature, when danger of grain growth no longer exists.

A mechanical welding operation, simulating hand-forging, must therefore heat the pieces rapidly to the correct temperature without oxidation, and quickly hammer the hot metal together, continuing the work through recalcence. Transfer of tools or heated metal must be very rapid. The work must be firmly held. Finally the completed article must be bodily put into an annealing furnace, to relieve internal strains and refine the grain.

It must remove as many as possible of those empirical conditions which are so difficult to control in hand-work and which make it remarkable that so many welds are good, not that a few are very bad. A weld may appear under certain test conditions to be actually stronger than the welded part, but that is because the adjacent parts have been badly overheated and not hammered, or because the joint has been carburized by the fire. Both of these conditions are due to negligence, and cause an amazing paradox—the less skillfully the welding is done the better the weld may appear to be.⁹

CHAIN WELDING

A correct method was worked out and introduced in the Boston Navy Yard in 1914 for hammer welding the heavy chain cables used in the U. S. Navy.⁹ Briefly the process is as follows: The bars of double refined wrought iron, up to 3½ in. diameter, are sheared to the length necessary for one link, one end heated in an oil-fired muffle, then taken to a press where it is upset and scarfed. The other end is then heated, upset and scarfed in the same manner. The whole bar is then heated, and bent into the shape of a link by a special bending machine, threaded into the end of the growing chain, and the scarfs closed under a heavy steam ham-

⁹"The Welding of Steel in Relation to the Occurrence of Pipe Blowholes and Segregates in Ingots," by H. Brearley, *Jour. Iron & Steel Inst.*, 1921.

⁹C. G. Lutts, "Chain Cable by Power Welding"; *Trans., A.S.T.M.*, 1920 II, p. 81.

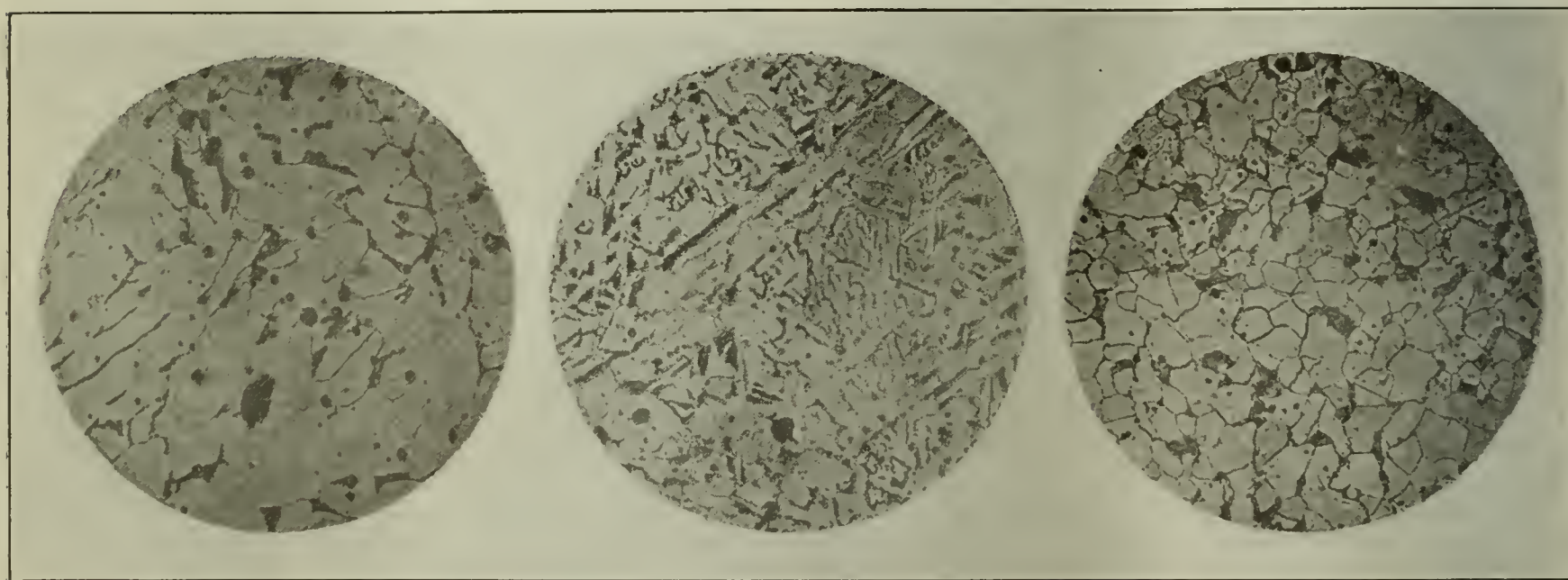
mer. The scarfs are then brought to a welding heat (about 1,350 to 1,450 deg. C.) in an oil-fired forge, and quickly removed while hot and dripping with slag and welded by drop forging under a fast-working 250-lb. steam hammer, as shown at the right of Fig. 14. Its final shape is given without reheating by dies under a heavy steam hammer in the background, the flash cut off with a chisel, the stud set in place and link closed in by the same hammer.

The use of heavy machinery in this manner permits much greater reduction during forging and a longer scarf than a hand-made chain, as well as less concentrated heat, and consequently a longer welded surface. Undoubtedly a better joint results. However, the tendency is to start and finish at a higher temperature, thus permitting the growth of a relatively coarse columnar grain (Figs. 15 and 16), closely related to that existing in overheated steel, especially in those regions containing an appreciable amount of carbon.¹⁰ Pearlite

heat-treatment is much like that for low-carbon steel: the rate of cooling after annealing is important—furnace cooling results in softness and low strength.

HAMMER WELDING

Mechanical welding, extending the principles of hand-forging to the commercial manufacture of very large pipes and tanks, originated in Germany. Recognizing the advantages of seamless construction in many power accessories, heavy steam drums and receivers have been made in this country for the past six or seven years. The Continental Iron Works, of Brooklyn, have made large tubes for many years, their principal use being for corrugated fireboxes for marine boilers. The American Welding Co., of Carbondale, Pa., and the American Spiral Pipe Works, of Chicago, have also plants for hammer welding; the former specializes in gas containers and bottles, while the latter operates on comparatively light plate. More recently the Blaw-Knox



FIGS. 15 TO 17. MICROSCOPIC STRUCTURE OF POWER-WELDED ANCHOR CHAIN.

(LIEUT. G. D. BARRINGER, U. S. N.)

Fig. 15. Usual appearance of metal at weld before annealing.

Fig. 16. Structure often associated with Fig. 15, differing in degree only.

Fig. 17. Structure of weld after annealing at 950 deg. C. and air-cooling.

then accumulates in angular patches between the elongated grains, the whole structure being definitely unreliable. It presents a minimum of grain interlocking, a maximum extent of crystalline cleavage planes, and is especially weak under shock or alternating stresses. Under tensile stress its most typical manifestation is a low yield point. (It may also be noted that Miller¹¹ finds that several brittle fusion welds had columnar grains.)

In welding chain links, this structure causes brittleness and stiffness. Under test the link is unable to stretch and adjust its shape, consequently it breaks in shear at the quarter points. If the completed chain is heated up to 950 deg. C. (requiring 3 hr. to get there) held for 10 min. at that temperature (slightly above A_c) and air-cooled, it restores equi-axed, normal sized grains shown in Fig. 17 and correct physical properties. The wrought iron from which the links are made at the Boston Navy Yard is quite irregular in carbon content, analyzing 0.05 to 0.08 per cent C, and containing patches two or three times as high. Consequently

Co. and the National Tube Co. have built modern hammer-welding plants in the Pittsburgh district for the manufacture of heavy seamless pots, tanks, pressure vessels and pipes of mild steel plate. Thus the process is gradually coming into use in this country, despite the rather meager amount of current information available about the methods.

It may readily be seen that though the principles involved and precautions necessary in forge welding of small bars, power welding of chain and hammer welding of plate work are the same, the fixtures are different, if for no other reason than adaptability to the shape and bulk of the work. In other words, whereas chain links can be rapidly swung from fire to hammer, a 10 x 20-ft. boiler must be held nearly stationary and the fire, hammer and anvil brought to it.

Briefly, the method is as follows: The various plates, bent or pressed to shape, are assembled with lap joints, and stitched together here and there by a short torch weld on the edge. The assembly is then placed on a carriage, joint up. A pair of gas flames are held one above the seam and the other directly below. When that region has been brought to a proper heat, the upper and lower torches are quickly replaced by an air hammer and anvil respectively, and the hot spot welded and

¹⁰"Heat-Treatment of Wrought-Iron Chain Cable," by W. W. Webster and E. L. Patch, *Trans., Soc. Mech. Engrs.*, 1916, vol. 38, p. 1159.

¹¹"Path of Rupture in Steel Fusion Welds," Bulletin 146, Am. Inst. Min. Engrs., p. 311.

worked down flat. This cycle is repeated until the seam is welded continuously from end to end. When all the seams are finished, the whole article is annealed; all fixtures applied, and if it is a pressure vessel, it is subjected to hydraulic test.

Such operations can best be described by tracing the course of a job through the shop. This will be done in two subsequent articles, descriptive of the plant and practice of the Blaw-Knox Co. and the National Tube Co. respectively. However, it may be noted here that the excellence of well-made seams welded in this manner has been often proved and is now generally accepted. Various names for the process have been used, such as "forge welding," "pressure welding," "fire welding" or "horn welding." The Germans use the term "Wassergas-schweisserei" (water-gas welding). But in all cases their distinguishing characteristic is that they describe a wrought joint, a joint guaranteed by its makers to develop at least 90 per cent of the strength of the plate.

Open-hearth firebox steel is quite suitable for hammer welding. The American Society for Testing Materials has issued tentative specifications¹² covering plates for forge-welded tank cars and similar containers. One of the leading manufacturers of seamless tanks feels that the chemical analysis, especially the silicon content, is very important, and insists on lower limits than the above-mentioned specification. The properties of this plate and a satisfactory weld are as follows:

Carbon.....	0.18 max. (no 25 per cent excess allowed)	
Phosphorus.....	0.035 max.	
Sulphur.....	0.035 max.	
Manganese.....	0.40 to 0.60	
Silicon.....	0.04 max.	
Copper.....	0.04 max.	
Nickel.....	0.05 max.	
Chromium.....	0.05 max.	

	Plate	Weld
Elastic limit.....	32,500	24,000
Ultimate, minimum.....	50,000	
average.....	52,000	48,000
Reduction in area.....	60%	40%
Elongation.....	26% in 8 in.	15%

Since the efficiency of a joint in lap-welded pipe is somewhat lower than that of hammer-welded seams, it is only natural that the weld would be easier to detect in the former. A polished section of lap-welded pipe usually has the weld line visible to the unaided eye, marked by fine specks of included slag. Hammer welds must ordinarily be deeply pickled with strong acid before showing a similar alignment of tiny pits. Fig. 18¹³ shows the appearance after pickling of a hammer-welded plate. The utter elimination of slag inclusions is perhaps impossible, but in a weld having 95 per cent strength or more they must be held to the extreme minimum.

Experience has shown that defective welds can be

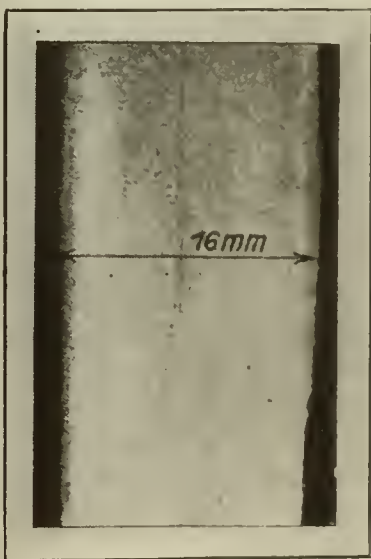


FIG. 18. LOW-CARBON
PLATE WELDED
AFTER HEATING
WITH WATER
GAS. $\times 1.5$

traced to (a) the welder, (b) the weld itself, (c) thermal disturbance in the stock. Labor-saving equipment in the hammer-welding plant evidently reduces the liability that the work will be slighted by the operator—his own personal equation is almost eliminated. Temperatures of the sheet can readily be controlled by pyrometer, the heating flame is clean and its composition under close control, while an air compressor assumes the labor of heavy sledging. Hence there is little excuse for wrong heat or insufficient work or dirty welds, those most prolific causes of weak joints. Finally, thermal disturbance in the underlying metal is reduced to a minimum by the concentration of the flame, by the ease with which the object is manipulated so that any desired spot can be worked under the hammer, and especially by the annealing given the completed piece. Under these conditions it is not surprising that a joint having much higher efficiency than a riveted joint is regularly produced.

FIELD FOR HAMMER WELDING

A great many common operations in the chemically controlled industries require dependable pressure vessels which are subjected to sudden and rather wide variations in temperature, and yet contain volatile substances which penetrate almost microscopic openings. Riveted stills, for instance, are continually being caulked. Again, annealing pots for use in sheet and tin plate works or wire mills must be subject to wide temperature ranges and yet be absolutely gas tight and free from those cracks which rapidly grow in cast boxes. Cyanide hardening pots are also exposed to severe temperature stresses and corrosive action. Cast vessels now in use are very expensive, brittle and unsafe against heavy pressure. Riveted joints are leaky and often present a concentration of metal where it is least desired. Hammer welding thus seems to have a certain exclusive field. Furthermore, it is of great promise in plain welding work and in manufacturing large-diameter hydraulic lines.

It is also obvious that welded pipe lines, with smooth interior surfaces, will carry a greater amount of fluid for a given pressure head than a line which is roughened by a multitude of rivet heads. This combines with the increased joint efficiency in making a very material saving in weight in pipe lines performing a specified duty on hydroelectric installations, irrigation and aqueduct lines, high-pressure fire lines, and conduits for air, gas and steam.

Hammer welding thus seems to have a certain unique application to the needs of modern industry not now adequately met by any other style of joint.

Commercial Possibilities of the South Sea Islands

Greater interest is constantly being manifested in the commercial possibilities of the South Sea Islands, according to a recent issue of the *World Salesman*. Hardware, including such articles as mugs, iron pots and pans, bedroom ware, and similar goods, is in constant and growing demand in Tonga. In Samoa American exporters have gained the trade formerly conducted by Germany, while in Tonga recent figures show that American firms are taking a good share of the trade, and in Fiji the steadily growing participation of the United States in the copra trade is paving the way for larger importation.

¹²Proceedings, American Society for Testing Materials, vol. 19, part I, p. 150.

¹³Reproduction of Flg. 399, Bach and Baumann, "Konstruktionsmaterialien."

Glimpses of Ohio Ceramic Industries—I

Ohio the Largest Producer of Ceramic Ware — Work of the Bureau of Mines and State University in Furthering Clay-Working Industries by Scientific Research and Training—Stoneware Plants at Akron and Near Roseville

BY CHESTER H. JONES

WHILE the ceramic industries fall under five general divisions—namely, clay products; cements, limes and plasters; glass; enamels for metals, and abrasives—the purpose of this article is to deal chiefly with descriptions of some Ohio plants which are in the first-mentioned class.

The total value of all ceramic products made in the United States in 1918, according to the Bureau of Mines, amounted to about \$447,000,000. Of this sum \$222,000,000, or nearly one-half, represented clay products. Of these clay products 76 per cent were embraced by brick, tile and other structural materials and 24 per cent by the finer grade wares classed as pottery. The four leading states in the percentage of the total valuation of each were: Ohio, 23.8 per cent; Pennsylvania, 18.2 per cent; New Jersey, 9.3 per cent, and Illinois, 5.6 per cent. Ohio produced as much as the states of New Jersey and Illinois combined, or an amount nearly equal to one-fourth of the nation's output.

The annual production of the white pottery classed as "tableware" in the United States was \$31,600,000, with Ohio's annual production at about \$16,500,000, or 52.2 per cent of the output. Summarizing, then, for the state there is produced annually 17.4 per cent of all ceramic products, including clay products; 23.8 per cent of all clay products, including white pottery; and 52.2 per cent of the white pottery, including "tableware."

The state has approximately 550 different clay-working plants with an average production of \$96,000 each annually. While nearly every county has one or more plants, the southeastern half is the more prolific territory for the clay-working industry. Because of the concentration and extent of these fields and the nature of the production processes there are more ceramic problems in Ohio needing solution, more opportunity for application of technical control and research in clay products than in any other state.

BUREAU OF MINES STATION

Ohio clay plants are particularly fortunate in having the Columbus Experiment Station of the U. S. Bureau of Mines located at Ohio State University, Columbus. The work at this station is devoted almost entirely to ceramics and because of its location, it is able to be of peculiar service to the district while developing facts for the industry in general. Research is carried out under the direction of R. T. Stull, and embraces the investigation of ceramic raw materials, their mining and utilization in the manufacture of finished products, the investigation of ceramic manufacturing problems with the object of finding ways of eliminating waste, to reduce the cost of production and to improve the quality of the products. Examples of the nature

of this work are found in reviewing one or two of these investigations.

RESEARCH ON GRAPHITE CRUCIBLES

Prior to 1914 practically all graphite crucibles manufactured in the United States were made from Ceylon graphite bonded with German Klingenberg clay, and the general belief among manufacturers and users was that good crucibles could not be made from American bond clays and graphite. The station undertook the investigation of American bond clays in order to determine their crucible-making properties, and after much work finally found twenty clays which appeared to be promising, eighteen of which were domestic products. Two of the latter were excellent for brass and eleven for steel melting. Over 40 per cent bond clay was used in the blend. The different phases of the work have been published and the crucible makers have been quick to profit by it. In so far as has been determined, no German Klingenberg clay is used in America at the present time and it is gratifying to note that some crucible makers advertise the superior quality of their crucibles as due to the use of the best American bond clay.

DOLOMITE REFRACTORIES RESEARCH

Large quantities of magnesite refractories are used for furnace linings in the metallurgical industry. Before the war substantially all the magnesite used for the manufacture of refractories came from Austria and Greece. When Austria entered the war the exportation of magnesite was cut off and soon afterward the exportation of the Grecian product stopped. The Columbus Station undertook research and patented processes of preparing dolomite for refractory purposes. It is hoped that firebrick can be made from dolomite that will compare with the magnesite firebrick, thus developing a new industry of far-reaching importance. Ohio, with its thousands of acres of dolomite to furnish the raw material for firebrick and its cast-iron and steel industry to utilize them, will profit more than any other state by this work when it is completed.

Investigations which have been running are still under way at this station and may be summarized as follows:

1. Physical properties of the white clays east of the Mississippi River as compared with the imported clays.
2. Tests on clays for the U. S. Geological Survey.
3. Co-operative investigation of Ohio fireclays.
4. Crucible-making properties of domestic bond clays and graphites as compared with the foreign.
5. Properties of dolomite as a refractory for furnace linings.
6. Brick suitable for malleable iron furnace bungs.
7. Load tests of firebrick at furnace temperatures.

8. Luster compositions for pottery decoration.

9. Physical properties of two California clays.

At the end of this article will be found a list of the publications which have been prepared at the Columbus Ceramic Experiment Station up to the present time.

OHIO STATE UNIVERSITY

The course in ceramics at the Ohio State University, which has the main object of developing ceramic engineers for the industry, was arranged to co-operate with the Bureau of Mines station with a view to increasing efficiency in the utilization of mineral resources necessary to the ceramic industry, stimulating and upbuilding this industry in the United States and substituting ceramic products of American manufacture for those now imported. Aside from the excellent work and service done with the bureau station, this school, under the direction of Prof. Edward Orton and Prof. A. S. Watts, produces engineers who are invaluable to the industry and upon whom depends its development in the highest sense.

In visiting the various plants briefly described in the following paragraphs it was pleasing to find that the executives and technical men therein all turn toward the Bureau of Mines station and the university for inspiration and help.

The U. S. Stoneware Co.

Located in Akron, Ohio, the U. S. Stoneware Co. has been known for more than fifty years as a producer of superior quality common stoneware. Twenty-five years ago it developed a chemical stoneware, which has high heat-resisting qualities as well as acid- and alkali-proof features. This last-mentioned line has been so greatly in demand it is now the major portion of the company's business. The raw clays from which both classes of ware are manufactured come mostly from mines owned by the company and located near the plant. They are properly blended during the refining process to get the required body for the final product. The company claims a superiority of ware due chiefly to the excellent and uniform quality of this clay, which is in thin veins so far below the surface that it must be mined through an entry slope, in much the same manner as coal is taken out.

CHEMICAL STONEWARE PROCESS

The raw material is brought from the mines both in automobile trucks and by rail. It is dumped into bins below the grade, whence it is drawn to the wet pans or chasers as the case may be, depending on the type of body desired.

Part of this clay is treated by the wet process and is dumped from the bins to an 8-ft. washer, where water is added during the mixing and grinding operation, the total time consumed per batch being about twenty minutes. From the washer it is transported to a blunger or agitating tank, where it is whipped to a fine creamy consistency in water solution. From the blunging operation this creamy slip is passed through a revolving screen, which removes any large or gritty particles. It passes from the screen to a large cistern, where it is kept in constant agitation until pumped through the plate type filter presses. The cake removed from these presses is the plastic material used in molding certain types of stoneware.

Various bodies and mixtures are required when ware

is to be produced for resistance to corrosive liquids, and for some purposes the raw clay is treated in the chaser mill. The time required for each batch is about two hours. It is ground very fine with a minimum amount of water added until a tough plastic material is made.

SHAPING

The company advocates the use of standard shapes in laying out chemical plants instead of the employment of special shapes to fit individual layouts. Large numbers of standard pieces are produced to fill orders from stock with greater dispatch. Molding of special shapes of stoneware where plaster of paris molds are employed becomes expensive because of the continual necessity for discarding the mold.

Much of the clay is hand-beaten or "batted out" just before shaping on the jollies, as in the manufacture of chinaware, to get a denser body. Special pipe shapes and fittings are also formed in molds. No chemical stoneware pipe is produced on the sewer pipe steam press, since it is essential that all chance of laminating the clay be avoided. The smaller pieces of stoneware are made on the jolly, a form of horizontal potter's wheel with mold of cup shape so as to give the outside contour desired while the inner surfaces are formed by the hand or tool as the whole turns on the vertical axis. Large pieces such as receivers, tanks, pipe and fittings, Cellarius tourills, tower parts and covers are molded in plaster of paris molds, the clay being worked into shape by hand. Large stoneware jars are thrown in a Week's jar machine. Carboy stoppers are pressed from a dry clay.

DRYING, GLAZING AND BURNING

All ware is given careful treatment during drying. The pieces are placed over grated floors beneath which steam pipes are laid. Although the body of the stoneware is acid-proof, additional protection is obtained by completely covering it with a special glazing material before burning. This glaze is made up according to a special secret formula which has been developed after considerable investigation and research. In appearance



FIG. 1. STONEWARE IN KILN, BEFORE BURNING

it resembles the original acid-proof clay. The various glazes used for chemical and common stoneware employ, as the principal apparatus used in the making, a Patterson pebble mill, where the wet grinding is carried out. For common stoneware, white glazes are made chiefly from kaolin and ball clay; the darker colors are obtained with Albany and Michigan slips. The chemical stoneware glaze gives a yellow color to the finished pieces.



FIG. 2. STONEWARE IN KILN, AFTER BURNING

Another product of this factory is the pot used in the manufacture of white lead by the old Dutch process. The lower portions of these pots where the acetic acid is held are covered with the acid-proof glaze.

The burning equipment consists of seven down-draft periodic kilns of 32 and 34 ft. diameter, which burn coal from the Ohio mines, owned by the company. Figs. 1 and 2 show pieces of common stoneware stacked in kilns before and after burning respectively. In Fig. 1 the bats separating the jars to prevent the glazed pieces from melting together are seen. These bats are simply small burned pieces of clay. The dark glaze on top and the lighter glaze on the bottom of inverted jars are seen in the left of this picture. Fig. 2, giving view of the partly emptied, finished kiln, shows how pieces of equal size are built in tiers up from the floor for equal distribution of draft with the odd shapes piled on the top to get the best heat zone without interfering with the draft. Cones are used in heat control.

Some of the common stoneware pieces are made on the steam sewer pipe press, others on the jar machine and the jugs and odd round pieces are thrown on jollies. A wide variety of chemical and common stoneware products are placed on both markets. Three switches lead trackage into the plant, giving connections for shipment on four different railroads.

Ramsbottom Bros.' Pottery Co.

The Ramsbottom Bros.' Pottery Co., located near Roseville, in the southeastern Ohio district, is one of the largest concerns engaged in the manufacture of common stoneware products. It was organized about ten years ago, the factory being constructed in the district where the necessary raw product was easily available. The native clay is mined in the vicinity of Rose-



FIG. 3. TRAM BUCKET HANDLING CLAY FROM PUG MILL

ville and Ironspot, being obtained by drifting into the hillside after the manner in which coal is mined. The overburden is so great that it is not possible to strip it off to get at the required seams. Some of these clays are said to be adapted for use in the manufacture of soft gardenware and chemical stoneware, although this company does not produce the latter class of product at the present time.

PROCESS OF REFINING

The clay is delivered on a platform at the plant, coming from the mines in automobile trucks. Three different grades of clay are blended by shoveling from the three piles into a three-way chain conveyor, which feeds each one into a common screw conveyor, where they are automatically mixed while being transferred to the battery of three blungers.

In the blunger the mixture is fed with water and is all whipped up by revolving paddles to a fine creamy consistency and subsequently pumped at 100 lb. pressure to the filter presses. The water from these filter presses is returned to a cistern, where it is kept in



FIG. 4. JIGGERS

constant agitation and again returned to the blungers for further mixture. From the filter presses cakes which have a consistency of putty are fed into the large pug mills.

While these mills are working out the air and extruding the finished powdered material at the far end, the clay is tempered with a clay slip in place of the clear water commonly used. This clay slip is the type of material that is taken from the blungers to the filter presses. The consumption of raw clay at this plant is about 80 tons per day.

Common practice in most pottery plants is to transport the tempered clay from the pug mill to the jiggers and molding rooms by wheelbarrow. It is in this feature, as well as in other mechanical equipment, that the company has improved over the practice at other plants. Fig. 3 shows an operator at the delivery table of the pug mill in the act of starting off a bucket of

clay to the modeling room. The entire output of the plant is handled by one man, who throws batches of clay either into the tram buckets or onto a shelf elevator, the latter of which delivers clay to the jar machines on the upper floors.

This aerial tram is fashioned after the manner of a mining type or hay-transporting type of equipment and travels along a cable directly over the row of workmen's benches. When the workman desires an additional supply of clay for his molding or jiggering operations he simply throws in a lever which stops the bucket and automatically dumps it. It is then returned to the pug mill for another load. The clay which is sent up on the shelf elevators to the jar-throwing machine is automatically cut at the pug mill to furnish just the



FIG. 5. FILLING MOLD ON JIGGER

right amount of clay for each jar. These jar machines are essentially steel-cased jiggers operated by an interior rolling device for running the clay up the side of the jigger.

Fig. 4 shows a row of jiggers for casting jugs, butter jars, etc. The clay tram is seen just dumping at one of the benches. Fig. 5 shows an operator placing the clay in the interior of the plaster of paris mold on the potter's wheel before he brings down the jigger lever to the left for forming the true interior of the piece. Common stoneware jugs are made in two pieces, the top being separate from the bottom and the two parts of clay later joined and worked together by the hand. The jug handle is later placed on by hand, the clay being wet down to cause it to form one piece with the side of the jug.

The steel jiggers for producing the big jars are lined with paper to prevent the paper from sticking to the metal. These particular Week's machines have revolutionized the industry so that one man can do the same amount of work in twenty-four hours that was previously done by five. Different steel molds are used for producing sizes from 5 to 50 gal. capacity.

STEAM AND POWER

Power for operating the various machinery around the plant is furnished by a 60-hp. induction motor, which drives the shafting for one section of the plant, and the remainder is driven by a 125-hp. steam engine. The total boiler installation is 300 hp. The steam from

these boilers, after passing through the engine, is conducted in the steam piping to the rooms for drying the ware. The coal supply for the boilers is mined from the same locations as the clay properties.

DRYING

The drying rooms are located adjacent to the jiggers and molding rooms and consist, on the first floor, of a series of steam pipes overlaid with a wooden grating. Above this grating is located the shelves upon which the ware is placed. The heat from the drying room on the first floor is carried through openings to the second floor, where the larger pieces from the jar machines are placed. This upper compartment consists of a large open room with a low roof. It is in this room that the plaster of paris molds are made for use on the jiggers. Each mold gives about one year of service before it has to be replaced.

GLAZING

Two general types of glazes are used for the stoneware, one the dark color and the other the white glazes. Feldspar, zinc, whiting and ball clays are used in the manufacture of these plain glazes, and Albany and Michigan clays are used for colored glazes. The dried ware is glazed on the outside by dipping into a vat and on the inside by inverting a jug over a spigot, for instance, and pushing down a lever which sprays the inside of the piece, entirely covering it with glaze. After this is done the bottoms of the pieces are washed off to prevent them from sticking in the kiln.

BURNING

The kiln room equipment consists of thirteen down-draft periodic kilns 30 ft. in diameter. A battery of four kilns is exhausted through a common stack. Natural gas is used for fuel, coming from the Ohio Fuel Supply Co., which taps the West Virginia field. Fig. 6 shows kiln under fire with large stack on the left.

The ware is loaded into the kiln in all sizes, the larger pieces being separated by bats or small pieces of burned



FIG. 6. DOWN-DRAFT PERIODIC KILN UNDER FIRE

clay, to prevent the glazes from sticking during the burning operation. No saggers are employed. The time required for burning is a three-day cycle. Only one burning is required for both body and glaze, the temperature reached varying from cone 8 to cone 9.

The scrap, or refuse, from molten stoneware in this plant is so completely vitrified as to make an excellent material for grog, and is sold by the carload to various

other clay plants. All the broken stoneware is dumped into a bin below the level of the kiln room floor, whence it is carried up by a specially designed Jeffrey chain elevator for dumping into wagon and automobile trucks and conveyances to the dumping platform on the railroad.

PRODUCTS

The chief output of this plant is stoneware jugs, flower pots, jars, cuspidors, frost-proof gardenware, butter jars, home brew jars and other domestic stoneware. It is extremely interesting, in looking over the products in the storage room, to note that an entirely different type of stone jar is manufactured for use in Pennsylvania as compared with those used in the southern section of the United States. The Pennsylvania jar is a rather tall rounding shape, with a comparatively small bottom, so that it may be placed in the running water at the dairy house, while the jar used in the South is provided with a groove below the lip so that a cloth cover may be tied over and secured by a string running around the groove. The entire output is marketed through the American Clay Products Association.

Not unlike many other clay-working plants, the morale of this organization is maintained by direct contact between the workmen and one of the partners, who acts as superintendent of the plant. There was considerable difficulty in this section recently in getting an adequate supply of labor. The workmen were lured away by the high prices paid in the coal mines in the same territory. Since the business depression, however, the workmen are gradually returning to the clay-working industry. Another feature worthy of note is the fact that about 45c. per thousand feet is paid for natural gas used in burning the ware. This charge is increasing every year, and it is only a question of a short time when the company will be forced to convert the kilns so that coal may be used as fuel.

It is predicted that it is only a question of time when the wet process of producing the tempered clay for pottery work will be replaced by the dry process, where the clays are ground to pass a 100-mesh screen and stored away for aging for a period of from thirty days to three months. This aging destroys the effect of lining and breaks up the otherwise hard lumps in the clay, so that eventually more plastic material is produced.

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"The Properties of Some Ohio and Pennsylvania Stoneware Clays," *Journal, American Ceramic Society*, vol. 1, No. 4 (1918).

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"Tests on California Refractory Clays," *Journal, American Ceramic Society*.

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"Behavior of Bond Clays in Crucibles Under Brass- and Steel-Melting Practice," *Journal, American Ceramic Society*.

"The Use of Electrolytes in the Purification and Preparation of Clays," Bureau of Mines Bulletin.

"White Clays East of the Mississippi River," Bureau of Mines Bulletin.

"Preparation of Dolomites for Refractory Purposes," Bureau of Mines Bulletin.

"Crucible-Making Properties of Graphites and Bond Clays," Bureau of Mines Bulletin.

"Aventurine Glazes," Bureau of Mines Technical Paper.

"The Application of a New Principle to Clay Washing," *Journal, American Ceramic Society*.

Treated Wood Gives Increased Yield of Methanol*

An increase of 50 per cent in the yield of methanol may be obtained by means of an inexpensive treatment consisting of the addition of a small percentage of sodium carbonate to the wood before distillation. Experiments show that this increased yield may be obtained without diminishing the yield of acetic acid. Contact of the carbonate with all of the wood is necessary to obtain the full benefit of the treatment; hence the method is likely to prove the most valuable in connection with the distillation of sawdust or small blocks, because of the difficulty of getting thorough impregnation with larger pieces. Saturation with a solution of the carbonate is a sufficient treatment for the sawdust, but a pressure treatment is necessary to impregnate the wood blocks.

Below are some of the actual results obtained at the laboratory.

SAWDUST UNTREATED AND TREATED WITH SODIUM CARBONATE AND BRIQUETTED

Species	Catalyzer	Yield in Per Cent of Original Weight		Remarks
		Alcohol	Acetic Acid	
Maple.....	None	1.61	5.22	Average of 4 runs
Maple.....	1.5%	2.39	5.26	Average of 3 runs
White oak.....	None	1.17	4.91	Average of 2 runs
White oak.....	0.5%	2.58	5.09	

BLOCKS OF WOOD UNTREATED AND TREATED WITH SODIUM CARBONATE

Species	Catalyzer	Alcohol	Acetic Acid	Remarks
Maple.....	None	1.67	7.65	
Maple.....	1.12%	2.16	6.74	Pressure treatment
Oak.....	None	1.20	5.56	
Oak.....	1.03%	1.79	5.58	Pressure treatment

Other amounts and other chemicals were tried, but the results given are the most promising of any.

*From U. S. Forest Products Laboratory *Technical Notes*.

Improved Method of Electrolytic Etching for Microstructure

BY W. VELGUTH

ELECTROLYTIC etchings are usually very flat, of one uniform color as shown in Fig. 1, and while this method of etching brings out a good structure, better results can be had by cleaning the specimen to be etched. The true orientation of the grain structure can be brought out more clearly by first cleaning the specimen electrolytically in a caustic solution or in a solution of sodium thiosulphate, and then etching electrolytically in acid.

In determining the microstructure of the nickel alloys used for negative terminal of base metal thermocouples both these electrolytes were used to good advantage, as can be seen from the accompanying micrographs. Using a 10 per cent solution of sodium thiosulphate as the electrolyte, the polished specimen is made the cathode and a carbon rod the anode. On a 10-volt, direct-current circuit, with a current density of 1.55 amp. per sq.in., the specimen is cleaned in five to ten seconds. With a drop of the thiosulphate solution adhering to the polished surface, the sample is transferred to a 10 per cent solution of hydrochloric acid. The sample is now made anode and a carbon rod is the cathode. With a current density of 0.62 amp. per sq.in., most of the microstructure shown in Fig. 2 can be developed in eight to ten seconds. Contact was made with the specimen before it was lowered into the acid. If the sample was washed free of thiosulphate before it was transferred to the acid, results were uncertain.

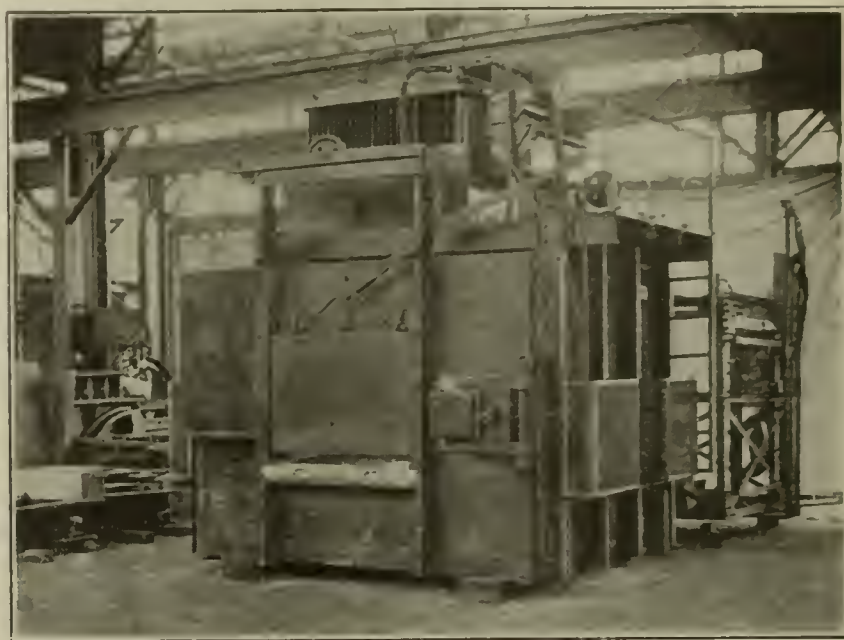
When the etched specimen is removed from the acid, the surface will be a dull gray or blue. Wash it gently in a stream of water; shake off all surplus water, and dry in a blast of warm air. The surface now takes on various shades of color, and is bright and clear. Some of the etchings were shades of blue, purple, green or red, while again in some instances each grain area had a different color. This coloring in no way interferes with the details of the microstructure.

Cleaning the specimens electrolytically in a 10 per cent caustic solution also gave good results when followed by electrolytic acid etching (Fig. 3). but the colors produced were shades of yellow only.

Resistance Type Electric Furnace for Sheet Heating

In the manufacture of automobile body and fender stampings it is of the highest importance that the heating operations be conducted with as little scaling as possible, for any pitting due to this action requires considerable additional labor in getting the defects sand-blasted to sufficient extent to get a good finish on the part.

The Mullins Body Corporation, Salem, Ohio, with this in mind recently installed in its new plant a Baily electric furnace specially designed for this work. Since a large part of pressing or drawing to shape done by this concern is performed cold and only one or two hot runs are required for perhaps six or seven cold operations on the press, it was desirable to build a furnace of



ELECTRIC FURNACE FOR SHEET HEATING

the portable type which could be handled by a crane and taken from place to place so that there would be no idle furnaces while the material was receiving its cold runs. This necessitated a furnace with four eye-bar connections at the top, one at each corner, for hooking on the crane chains; and also that the transformer and control equipment be located on the top of the furnace, as is shown in the photograph.

The furnace is rated at 100 kw. in electrical capacity, and has a hearth 3 ft. 4 in. wide x 6 ft. 5 in. long with

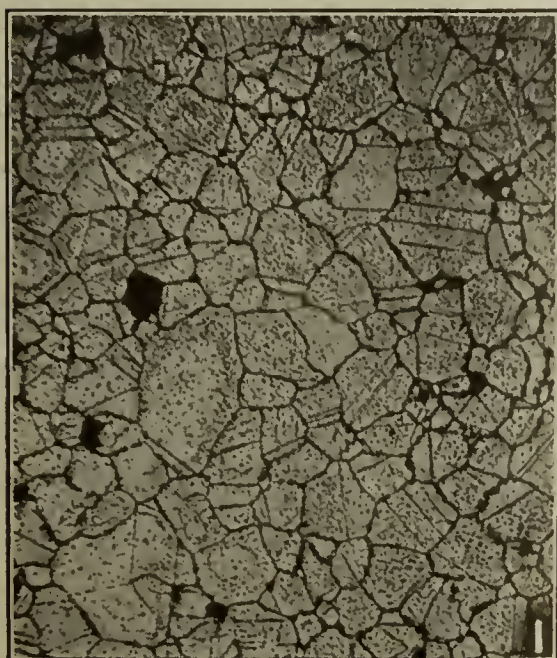


Fig. 1. Electrolytic etching in acid solution.



Fig. 2. Cleaned in sodium thiosulphate before acid etch.



Fig. 3. Cleaned in caustic solution and etched in acid with current.

FIGS. 1 TO 3. MICROSTRUCTURE OF NEGATIVE THERMOCOUPLE WIRE AS DEVELOPED BY DIFFERENT ELECTROLYTIC METHODS

a door opening 3 ft. 4 in. wide x 2 ft. 2 in. high. It has a capacity for heating 750 lb. of material to 1,800 deg. F. per hour. In plants where a crane is not available for moving the furnace the equipment is designed for mounting on a car which may be moved at the will of the operator on a track running parallel to the battery of presses.

One of the notable features of this equipment is the remarkable uniformity of temperature obtained on the sheets. Scaling is also reduced to an almost negligible item.

Synopsis of Recent Chemical & Metallurgical Literature

Nitrogen Products.—A statistical supplement to the final report of the Nitrogen Products Committee of the British Ministry of Munitions has recently been compiled by Dr. J. A. Harker, the former director of the Nitrogen Research Laboratory. In addition to bringing all of the statistical information up to date, the supplement presents a concise and interesting review of recent developments in the world's nitrogen industry. The former report had been prepared during the war period and did not cover the latter half of 1919 nor any of 1920.

It is of interest to compare the situation as regards the sources of the world's nitrogen supply before the war and at the present date. In 1912 the output of Chilean nitrate was 2,586,975 metric tons, equivalent to 411,329 tons of nitrogen. This was 57.5 per cent of the total world's production. The byproduct industry produced 1,229,773 tons sulphate of ammonia (containing 24.5 per cent ammonia), or 272,007 tons of nitrogen (38 per cent of total). The fixed nitrogen industry's output was as follows: (a) Cyanamide (assumed 18 per cent N) 126,538 tons, nitrogen 22,435 metric tons (3.1 per cent of total); (b) nitrate of lime and arc process (assumed 13 per cent N) 75,000 tons, nitrogen 9,907 metric tons (1.4 per cent of total); (c) synthetic ammonia, nil; total of fixation industry 201,538 tons, nitrogen 32,342 metric tons (4.5 per cent of total). Grand total, 4,018,286 tons of product, nitrogen 715,678 metric tons.

Comparing with the above the productive capacity existent in the world in 1920, that of the Chilean nitrate industry is given as 2,966,061 tons, the productive capacity of nitrogen being 471,000 metric tons, or 30.2 per cent of the world's total. The byproduct industry, 2,015,440 tons, nitrogen 413,000 metric tons (26.6 per cent of total). The fixation industry: (a) Cyanamide 1,777,000 tons, nitrogen 325,000 metric tons (20.9 per cent of total); (b) nitrate of lime and arc process 290,400 tons, nitrogen 38,300 metric tons (2.5 per cent of total); (c) synthetic ammonia 1,503,000 tons, nitrogen 308,000 metric tons (19.8 per cent); total of fixation industry 3,570,400 tons, nitrogen 671,300 metric tons. Grand total, 8,551,900 tons of product, nitrogen 1,555,300 tons.

Allowance must be made for the fact that the 1912 figures are for actual production, while those of the later year are for productive capacity. It is particularly significant, however, that during this period the world's nitrogen resources have doubled; and that while the percentage of the total contributed by Chilean nitrate *decreased* to one-half, the output of the fixation industry has *increased* almost tenfold, or from 4½ per cent of the whole in 1912 to 43 per cent in 1920. The fixation industry is now the largest single contributor to the nitrogen requirements of the world. It is interesting to note, too, that in spite of the much-talked-of developments in synthetic-ammonia manufacture, the cyanamide installations during the war period have made this process the largest of any of the fixation methods.

Synthetic Acetic Acid.—The manufacture of synthetic acetic acid from calcium carbide is described at length by Maurice Deschiens in a series of three articles published in the March, April and May, 1921, issues of *Chimie et Industrie*. A flow sheet shows the importance of acetylene as a raw product for the manufacture of some of the long series of commercial organic chemicals. The manufacture of calcium carbide, generation of acetylene, hydration of the acetylene to acetaldehyde and the oxidation of acetaldehyde to acetic acid are described.

Manufacture of Calcium Carbide.—After giving the average analysis of the raw materials (limestone, anthracite, coke) used in Europe, United States and Canada, he describes the operations of the Hafslund furnace (Norway) and of different other furnaces of the single-, two- and three-phase types.

Generation of Acetylene.—He describes in detail the Grivel process used in France and then outlines a series of the processes used in Switzerland, United States, Canada and Germany.

Hydration of Acetylene to Acetaldehyde.—After outlining the preparation of mercuric oxide which is used as catalyzer and describing in detail a process for the preparation of acetaldehyde and rectification to 99.8 per cent purity, he passes in review a long series of other processes used, giving the sources where they are described somewhat more in detail.

Oxidation of the Acetaldehyde.—For the oxidation of the acetaldehyde he follows the same rule as for the hydration of acetylene to acetaldehyde—namely, by first describing in detail a typical process and then outlining a long series of other processes, here also giving the sources where they are described more in detail.

He concludes by giving a brief outline of the potentialities of the synthetic acetic acid industry and by tabulating a long series of articles and patents (German, English, American and French) on synthetic acetic acid.

Wheel Burnt Rails.—C. P. Sandberg read a paper before one of the engineering conferences held by the British Institution of Civil Engineers, June, 1921, entitled "Damage to Tires and Rails by Brakes or Slipping Wheels," in which he described the same phenomena discussed by J. E. Howard¹ in a report to the Interstate Commerce Commission. Sandberg finds a hardened surface, crossed by a multitude of transverse cracks, on tires, brake shoes, tramway and railroad rails, all caused by intense local heating by friction. He agrees with Howard that they are potential causes of failure to railroad rails, which, being supported at intervals, readily allow growth of the damage inward. Tramway rails and wheel tires, however, being solidly supported throughout, are not liable to "detail fracture" from such causes. The author describes the formation of the surface cracks thus: "Sliding of one surface over the other proceeds to a point at which both are hot, soft and plastic, and tend to seize together momentarily at numerous points. While so united the surface layers are dragged bodily forward, forming an overlap in advance of each area of adhesion and a tear behind it. Alternating seize and slip probably occurs many times per second during the application of brakes, producing a series of surface tears or cracks in both brake and wheel, at right angles to the direction of motion."

Latest About the Basset Process.—On the subject of the Basset process the *Iron Trades Review* of Aug. 19, 1921, states that according to the recent annual report of the Ougrée Marihay Co., which is interested in the Société Française des Aciéries Basset, the process has not yet reached a phase of development which would enable one to arrive at an estimate of the costs of production or to form an opinion as to the value of the process. At the recent general meeting of the Ougrée-Marihay Co. a shareholder asked the chairman as to the exact meaning of this passage, and whether any new trials have been made since the date of the annual report. He was told that the process was still in its experimental stage, and that since the drafting of the annual report no new experiments have been carried out.

¹CHEM. & MET. ENG., vol. 24, No. 19, p. 850 (May 11, 1924)

Current Events

in the Chemical and Metallurgical Industries

American Electrochemical Society to Hold Meeting at Lake Placid

The fortieth general meeting, marking the end of the second decade since the organization of the American Electrochemical Society, will take place at the Lake Placid Club, in the Adirondacks, Sept. 29, 30 and Oct. 1.

The technical program will be featured by two symposia, on non-ferrous metallurgy and electrodeposition. The program of the meeting is shown below:

WEDNESDAY, SEPT. 28

6 p.m. Registration at Lakeside Clubhouse.

THURSDAY, SEPT. 29

9 a.m. Presentation and discussion of papers.

Charles Vickers: Experience With Alkaline and Alkaline Earth Metals in Connection With Non-Ferrous Alloys.

W. A. Cowan, L. D. Simpkins and G. O. Hiers: The Electrolytically Produced Calcium-Barium-Lead Alloys Comprising Frary Metal.

Colin G. Fink and Charles H. Eldridge: The Electrolytic Corrosion of Lead-Thallium Alloys.

J. Newton Friend: A New Theory of the Corrosion of Iron.

Haakon Styri: Rust Prevention by Slushing.

C. J. Rodman: Transformer Oil Sludge.

Raymond Freas: The Electrolysis of Organic Compounds.

Alexander Lowy and E. H. Haux: Electrolytic Oxidation of the Leuco-Base of Malachite Green.

N. Kameyama: The Electrolytic Dissociation of Cyanamide and Some of Its Salts in Aqueous Solutions.

P. C. Alsgaard: Electrolytic Production of Sodium Perborate.

H. M. Goodwin and C. E. Walker: Electrolytic Production of Perchlorate.

B. G. Worth: Graphic Control of Electrolytic Processes.

2 p.m. Sports and recreations. Golf match under the direction of Mr. Dorr, chairman of golf committee.

A boat ride has been planned for this afternoon for the benefit of those not participating in golf. There will also be other entertainment under the direction of Mr. Corse, chairman of committee on arrangements. Additional information available at the registrar's desk.

6:30 p.m. Board of directors' meeting, at dinner, for the transaction of usual business.

8 p.m. Meeting in the music room of the Forest Clubhouse.

Lecture by Prof. Harlow Shapley, of the Harvard University Observatory, on "Chemistry and the Stars."

FRIDAY, SEPT. 30

9 a.m. Reading and discussion of papers.

Symposium on Non-Ferrous Metallurgy

H. M. St. John: The Influence of the Electric Furnace on the Metallurgy of Non-Ferrous Metals.

E. A. Smith: Modern Developments in the British Brass Industry.

T. F. Baily: Resistance Type of Electric Furnace in the Melting of Brass and Other Non-Ferrous Metals.

N. K. B. Patch: Comparison of Electric Furnace Practice With That of Fuel-Fired Furnace Practice.

H. A. DeFries: Electric Silver Melting.

F. C. Thompson: Electric Furnace Melting of Nickel-Silver.

H. A. Winne: Recent Developments in Electric Furnaces of the Muffled Arc Type.

J. G. Thompson: Electric-Furnace Purification of Zirkite.

M. L. Hartmann and W. A. Koehler: Physical Characteristics of Specialized Refractories. Part IV.—Cross Breaking Strength at 20 Deg. and 1,350 Deg. C.

2 p.m. Sports and recreations. Continuation of golf match of previous afternoon.

Mountain hiking and other sports, under direction of Mr. Hinckley, chairman of other outdoor sports committee.

Indoor sports will be taken care of by Mr. Crosby, chairman of that committee.

8 p.m. Lecture by Colonel T. S. Woolsey, Jr., on "Practice of Forestry on National Forests"; to be held in the music room of the Forest Clubhouse.

SATURDAY, OCT. 1

9 a.m. Reading and discussion of papers.

Symposium on Electrodeposition

F. A. Lidbury and F. A. Stamps: An Electric Steam-Generator for Low Voltage.

W. E. Hughes: Researches on the Electrodeposition of Iron.

T. R. Briggs: Electrolytic Solution and Deposition of Copper.

W. R. Ingalls: Electrometallurgy of Zinc.

C. J. Wernlund: Deposition of Zinc From the Zinc Cyanide Solution.

William Blum and H. E. Haring: The Electrodeposition of Lead-Tin Alloys.

William Blum: The Structure and Properties of Alternately Electrodeposited Metals.

2 p.m. Golf finals for the society championship, those having qualified in the matches of the two previous days will participate.

Motor bus ride to the Club Farms.

Claim Large Saving for New Phosphoric Acid Process

The Department of Agriculture is sending to all newspapers in the country the following statement with regard to its work on phosphoric acid recovery:

The United States owns the richest and most extensive phosphate fields in the world. Heretofore heavy annual wastes of valuable phosphatic material have occurred during the mining and manufacturing processes. A new method of controlling these losses devised by the United States Department of Agriculture consists in mixing the "run-of-mine" phosphate with sand and coke and smelting the mass in an electric or fuel-fed furnace. In this process the phosphoric acid is driven off as a fume and may be readily collected in concentrated form. Millions of tons of phosphates previously wasted will be saved potentially as a result of the perfection of this new reclamation system.

Society of Textile Chemists Proposed

The organization of a society of textile chemists was considered at a meeting held in the Chemists' Club Sept. 13. A number of representatives of this branch of the chemical industry attended and Prof. L. A. Olney of the Lowell Textile School was elected chairman. From the expressions of opinion there seemed to be little doubt that an organization of this character was a very feasible proposition. Accordingly a representative committee was appointed to study the possibilities in this direction.

List of Research Chemicals in Preparation

In our issue of July 6, p. 35, attention was called to a forthcoming publication of the National Research Council in which research chemicals and others not commonly available will be listed. Dr. C. J. West now requests that all those desiring a copy of this publication notify him at the National Research Council, 1701 Massachusetts Ave., Washington, D. C.

Gypsum Industries' Association Cited for Unfair Competition

The Gypsum Industries' Association, Chicago, Ill., its officers and members have been cited in complaint of unfair competition by the Federal Trade Commission. Thirty days are allowed to file answers to the complaints, which are issued after preliminary inquiry by the commission upon petition filed with it. After answer the cases come on for formal trial on the merits, full opportunity being afforded the companies to refute the allegations of the complaints, to present their witnesses, introduce evidence, etc. Those cited are:

(1) Gypsum Industries' Association, Chicago, Ill., a voluntary unincorporated association, composed of persons, partnerships, and corporations engaged in many of the states in manufacturing and selling gypsum products.

(2) The executive officers and members of standing committees: Ray C. Haynes, president and member of the executive committee, which committee is ex officio the board of directors of said association; James Leenhouts, vice-president and member of the executive and trade relations committee; R. G. Bear, treasurer and member of the executive and trade relations committee; H. H. McDonald, secretary; M. A. Reeb, member of the executive and trade relations committee; A. R. Black, L. E. Armstrong, A. A. Wolf, J. C. Seguire and W. E. Shearer, members of the executive committee; H. W. Blackson, Warren Hanley, E. G. West, H. C. Hamilton and F. G. Ebsary, members of the trade relations committee.

(3) Members of the Gypsum Industries' Association as follows: Acme Cement Plaster Co., St. Louis, Mo.; American Cement Plaster Co., Chicago, Ill.; American Gypsum Co., Fort Clinton, Ohio; Cardiff Gypsum Plaster Co., Fort Dodge, Iowa; Centerville Gypsum Co., Centerville, Iowa; Colorado Portland Cement Co., Denver, Col.; Connecticut Adamant Plaster Co., New Haven, Conn.; Dakota Plaster Co., Rapid City, S. D.; Ebsary Gypsum Co., Rochester, N. Y.; Empire Gypsum Co., Rochester, N. Y.; Grand Rapids Plaster Co., Grand Rapids, Mich.; Higginson Manufacturing Co., Newburgh, N. Y.; Kelley Plaster Co., Sandusky, Ohio; J. B. King & Co., New York; Alabastine Co., Grand Rapids, Mich.; Nephi Plaster & Manufacturing Co., Salt Lake City, Utah; Niagara Gypsum Co., Buffalo, N. Y.; Overland Cement Plaster Co., Laramie, Wyo.; Pacific Coast Gypsum Co., Tacoma, Wash.; Plymouth Gypsum Co., Fort Dodge, Iowa; Rock Plaster Manufacturing Co., New York; Southern Gypsum Co., Inc., North Holston, Va.; United States Gypsum Co., Chicago, Ill.; Wasem Plaster Co., Fort Dodge, Iowa.

The basis of the complaint, briefly stated, is the alleged concerted activities of the association members to eliminate mail order competition by restricting sales to dealers maintaining retail establishments, and by a division of territory among members so as to limit each member's sales to the territory reached by delivery trucks of retailers to whom he sells.

Want Alcohol Tax to Stay

The removal of the tax on alcohol would flood the country with fly-by-night concerns making carloads of alcoholic medicinals to sell for beverage purposes, it is contended by the American Drug Manufacturers' Association. The pharmaceutical manufacturers are taking active steps to block the campaign now being launched looking to the removal of the tax on alcohol. They declare that thousands of irresponsible men are being kept out of the manufacture of alcoholic medicinals because of the existence of this tax. A statement issued from the Washington headquarters of the American Drug Manufacturers' Association reads in part as follows:

It is supposed that the removal of the tax would result in a lowering of the cost of medicines, but when you think of the comparatively small amount of a given medicine that goes into a prescription you will realize that the ultimate consumer would not appreciably benefit.

On the other hand, the removal of the tax would simply add to the present depression. The pharmaceutical manufacturer has paid the equivalent of the tax not only on the alcohol now in his warehouse but likewise on the alcohol in the preparations in process

of manufacture, in the finished stocks on his shelves and in his unsold product in the hands of the wholesale druggist and corner drug store. The moment the tax is removed the market value of these products, as well as alcohol, will shrink, and since the wholesaler and retailer would look to the manufacturer for credit on the shrinkage of the stocks in their hands, the manufacturer would be called upon to bear this enormous loss alone, a situation that would probably drive some of them to the wall.

It should be borne in mind, too, that the Government would be deprived of revenue at a time when it is called upon to make other important reductions.

From the Government's standpoint there is likewise the objection that the removal of the tax might prejudice the validity of several features of the Volstead act which do not rest upon the Eighteenth Amendment. The Eighteenth Amendment deals only with the use of intoxicating liquors for beverage purposes and the constitutionality of provisions of the Volstead act regulating the manufacture and sale of liquor for other purposes rests upon the power given Congress in the Constitution to raise revenue.

Tenth Annual Congress of the National Safety Council

The tenth annual congress of the National Safety Council will be held in the State House, Boston, Mass., Sept. 26 to 30, 1921. The following is the summarized program:

MONDAY, SEPT. 26

Forenoon: Annual meeting of members, address by Gov. Channing H. Cox, president's address, reports of officers and committees, election of directors.

Afternoon: General session on public safety and education. First aid demonstrations and motion pictures of first aid contests will be shown.

The reception and dance will be given in the evening at the Copley-Plaza Hotel.

TUESDAY, SEPT. 27

General round table and meetings of the following sections: Automotive, Chemical, Construction, Education, Electric Railway, Engineering, Metals, Mining, Packers and Tanners, Paper and Pulp, Public Utilities, Rubber, Steam Railroad, Textile and Woodworking.

There will also be a meeting of the A B C section and of the local council officers. A series of motion pictures on safety will be shown late in the afternoon.

WEDNESDAY, SEPT. 28

Meetings of the following sections: Automotive, Chemical, Construction, Electric Railway, Metals, Mining, Packers and Tanners, Paper and Pulp, Public Safety, Public Utilities, Rubber, Steam Railroad, Textile, Women in Industry and Woodworking.

There will also be a general session under the auspices of the Engineering Section, on engineering and safety, and the second session of the local council officers.

THURSDAY, SEPT. 29

Meetings of the following sections: Health Service, Mining, Public Safety, Steam Railroad.

There will also be a joint meeting of manufacturing sections and a general session on health and sanitation.

In the evening a shore dinner will be given to the delegates.

FRIDAY, SEPT. 30

Meeting of the following sections: Automotive, Health Service, Mining, Packers and Tanners, Public Safety, Rubber, Steam Railroad and Woodworking.

There will also be a women's mass meeting on the subject of safety of the child and a New England conference on motor traffic problems.

Domestic Potash Industry Marking Time

With the exception of two cement mills and two alcohol plants, no enterprise in the United States is producing potash at this time. The domestic industry is marking time awaiting the final action of Congress on the diminishing temporary tariff described in the tariff bill which has passed the House of Representatives. The plants that are idle represent an investment of more than \$30,000,000.

Coking Studies at Ohio State University

The department of metallurgy of the Ohio State University, under the auspices of and with the funds provided by the Engineering Experiment Station of the university, has installed a full scale 1-ton vertical coal retort, a complete byproduct recovery system equipped with gas meters, pyrometers and recording calorimeters. With this equipment the entire coal resources of Ohio are being surveyed with the view of obtaining accurate information concerning the possibilities of utilization of Ohio coals for gas making, byproduct recovery and coke production. Five-ton samples of each coal to be tested are obtained, duplicate 1-ton samples of this are carbonized under ordinary vertical retort conditions, the tar, ammonia and light oil recovered and analyzed, and the coke made is obtained and its quality determined by chemical analyses and physical tests. The gas made is measured in a recording and integrating Bailey gas meter and its heat value recorded in a continuous recording Smith gas calorimeter. Also a sufficient amount of each coal is crushed, sized, the coarser sizes jigged and the finer sizes tabled on a Wilfley table. The clean coal is then dried and retorted. In this way it is expected that the most complete information possible will be obtained on all of the Ohio coals. Tests will also be made on mixtures of Ohio coals with coals from other states. It is hoped to get all this information so that the cities of the state can make the most intelligent selection of coals for the production of artificial gas to supplement the waning natural gas supply.

Interest in Tariff Unprecedented

Greater interest is being manifested in the Fordney tariff bill than in any other tariff measure ever presented to Congress. An indication of this is the unprecedentedly large number of briefs which have been filed with the Committee on Finance of the Senate. A large force is required to digest and classify the vast amount of material being sent to the committee.

The unusual amount of interest in this tariff bill is accounted for primarily by the fact that American industry has expanded and is much more extensive than it was in 1909, when the Payne-Aldrich bill was under consideration, or in 1913, when the Underwood bill was passing through its various legislative stages. There are additional reasons, however, for the interest that has been aroused by the Fordney bill. The demoralized commercial situation of Europe has given rise to many uncertainties which have stimulated interest in tariff matters. The whole subject of foreign trade has been receiving unusual attention. Interest has been intensified by the consideration of new policies, such as American valuation and the dye embargo. Considering that valuations are to be on an American basis, many of the rates in the Fordney bill are regarded as being very high. This has resulted in the most determined opposition on the part of the interests which would be affected.

Consumers of kaolin have submitted a brief which attempts to establish that the present duty of \$1.25 per ton on English china clay should not be increased. If this duty is advanced to \$2.50, as prescribed in the Fordney bill, it will have the most adverse effect on the paper, pottery and other industries, it is declared.

A very determined effort is being made on the one hand to make graphite dutiable at rates much higher than the rate approved by the House, which is 10 per cent ad valorem. The steel industry and other consumers of graphite, on the other hand, want it to remain on the free list. The domestic producers of graphite propose that ore under 50 per cent graphite content pay duty at the rate of 1c. per lb.; ore over 50 per cent graphite content, 2c. per lb.; lump and chip, 3c. per lb.; flake, graphite content, 6c. per lb.; manufactured graphite products, graphite content, 5c. per lb. and 20 per cent ad valorem.

One of the most carefully prepared briefs which has been submitted to the Finance Committee is that of Roy N. Bishop, for the Western Magnesite Association and for the Northwest Magnesite Co. It is contended that a duty of 1c. per lb. on the ore, 1c. per lb. on calcined magnesite and 1c. per lb. on magnesite brick are necessary to protect the

industry. In the Fordney bill, calcined, dead-burned and grain magnesite are given a duty of 1c. per lb., while crude or ground magnesite is given a rate of 1c. per lb. Even with the duties requested, the American producers contend that the Austrian mines will furnish fully 50 per cent of American requirements.

On antimony, the Fordney bill prescribes a duty of 1c. per lb. on regulus, or the metal. The domestic producers of antimony ask 10c. per lb. upon antimony salts, 10c. per lb. on regulus, metal or matte and 8c. per lb. on the antimony content of ores.

On arsenic, the Fordney bill provides 25 per cent ad valorem on arsenic acid, arsenious acid or white arsenic. The industry asks for a duty of 5c. per lb. on white arsenic.

On barytes, the Fordney bill carries a duty of \$4 per ton on the crude ore, \$7.50 a ton on ground or manufactured barytes and 1c. per lb. on precipitated barium sulphate. The domestic industry asks 1c. per lb. on crude barytes, 1c. per lb. on ground barytes, 1c. per lb. on barium sulphide, 2c. per lb. on barium carbonate, 2c. per lb. on barium dioxide, 2c. per lb. on barium sulphate, 2c. per lb. on barium chloride, 2c. per lb. on barium lithopone, 5c. per lb. on barium nitrate, 8c. per lb. on barium peroxide and 25 per cent ad valorem on all other barium compounds.

Bismuth is on the free list in the Fordney bill. The domestic industry is requesting a duty of 25c. per lb. The same is true of cadmium.

Feldspar is made dutiable at \$1 per ton in the Fordney bill. The duty asked is \$2 per ton on crude and \$6 per ton on the ground or manufactured product.

Fluorspar, in the Fordney bill, takes a duty of \$5 per ton for the first year after the passage of the bill, after which it is to be dutiable at \$4 per ton. The domestic industry asks that the rate of duty be \$6 per ton on material running 80 per cent CaF_2 or better.

Among the other items that are being hard fought is gypsum. The Fordney bill provides a duty of 25c. per ton on the crude material, \$1.40 per ton on ground or calcined gypsum, 8c. per 100 lb. on white portland cement and from \$3.50 to \$14 per ton on Keene's cement.

Farmers to Demand Free Fertilizers

Headed by the Farm Bureau Federation, all the agricultural organizations maintaining headquarters in Washington are uniting in a drive on proposed duties on fertilizer materials. Potash and sulphate of ammonia are made dutiable in the bill that passed the House. Pyrites is on the free list of the Fordney bill, but an effort is being made to have the Senate committee amend the bill so as to provide a duty of \$4 a ton on this material.

The agricultural organizations are preparing their case with great care. A report and recommendations in the matter will be prepared by the Finance Committee and also will be placed in the hands of the agricultural bloc in both the Senate and in the House.

Oil Claims Staked During Winter at Fort Norman

When the first steamboat arrived at Fort Norman it was found that about 700 miles of territory along the Mackenzie River had been staked during the winter months. It appears that half-breeds have been spending the winter staking ground, which they were anxious to transfer to the first comers at a small consideration. Much of this ground is said to have been staked inaccurately, and it is feared there will be found to be considerable overlapping and general confusion that will lead to considerable litigation.

To Develop Sulphur Deposits

The Texas Co., Houston, Tex., is developing plans for the utilization of its sulphur properties in Mexico, totaling about 28,000 acres of land. The property is rich in deposits of this material and it is said that preliminary surveys indicate that it can be mined at a cost closely approximating \$3 a ton, as compared with a present market price of from \$14 a ton and upward for crude material, according to location. It is said that a subsidiary company will be organized to carry out the proposed development.

Stock Promotion and Potash in West Texas

To protect the public from misrepresentation and fraud by unscrupulous promoters and sellers of stocks based on potash deposits in western Texas the United States Geological Survey states that the potash deposits there, instead of being 1,100 or even 300 ft. thick, as represented by the promoters, have not yet been proved to be of workable thickness or of commercial value. Rich potash salts, comprising the mineral polyhalite, which were deposited in association with great thicknesses of rock salt and gypsum in "red beds," as in Germany and in fact at the same time as the German deposits, have been discovered by representatives of the Geological Survey and the Texas University Bureau of Geology and Technology in a co-operative search, but though this discovery, which was made public early in June, is encouraging and interesting, the practical question whether the deposits are thick enough to mine—that is, whether they are worth anything—is yet to be answered.

The results of the tests of the borings from three wells, of which those that are farthest apart are distant from each other about 125 miles, are certainly encouraging, but the Government geologists warn the public that the conditions of drilling and sampling at all three points are so unsatisfactory that it still remains to be seen whether the beds that are rich in potash are thick enough to justify their commercial exploitation. Considerable drilling, including wells in new areas, as well as careful examination, will evidently be necessary to determine the thickness of the potash deposits in any of the areas with the accuracy necessary for sound commercial computations. The potash content of the salts must of course also be taken into consideration. Some other area in the "red beds" region not yet drilled or not properly tested if drilled is likely to contain the maximum thickness of potash deposits. Drill cores are needed instead of the unsatisfactory samples brought up by the bailer, or, worse yet, washed up by the rotary rig without means of accurate determination of the actual thickness of the layer of potash or of its exact depth. Thorough tests with the core drill are justified by the tremendous importance to the whole United States of the discovery of commercial deposits of potash in this region—a discovery of far greater value than that of an oil pool.

T.A.P.P.I. Meeting Postponed

At a meeting of the executive committee of the Technical Association of the Pulp and Paper Industry held Sept. 15, it was decided to cancel the proposed fall meeting at Washington and other points, Oct. 18 to 21. Owing to conditions in the paper industry, it was considered advisable to postpone this joint meeting of T.A.P.P.I. and the American Pulp and Paper Mill Superintendents' Association until some time in 1922.

SECRETARY'S OFFICE NOW WITH A.P.P.A.

The office of the secretary has been removed from 542 Fifth Ave. to the general offices of the American Paper and Pulp Association, 18 East 41st Street, New York, where quarters have been provided on the sixth floor by Executive Secretary Baker.

Japanese to Manufacture Synthetic Ammonia Under Claude Process

A Japanese company has just taken up an option for the manufacture of synthetic ammonia under the Claude process, according to a cable dispatch from Lyons, France. Under the terms of the option the Nipponese firm will pay 7,000,000 f. to the Société de L'Air Liquide.

An English group is also negotiating with the French society for the purchase of a license, for which not less than 10,000,000 f. will be paid.

Britain Removes Embargo on Export of Sulphate of Ammonia

The Board of Trade has lifted the embargo on the export from England of sulphate of ammonia, according to a cable dispatch from London.

Book Reviews

THE JOURNAL OF THE INSTITUTE OF METALS, Vol. XXV. Cloth, pp. xiv+522, with 27 plates, 8vo. Edited by G. Shaw Scott, M.Sc. 1921. London: Institute of Metals, 36 Victoria St., S.W.1. Price 31s. 6d. net.

This book contains papers and discussions presented before the annual meeting held in London during March, 1921 (publication committees of American Engineering Societies please notice the date), and, in addition, 120 pages of closely set type containing abstracts of current literature relating to non-ferrous metals and industry. The latter section has become especially important and must represent a great deal of painstaking labor on the part of the half dozen metallurgists who are responsible for the work. No less than 150 publications are regularly examined, from which about 300 articles have been abstracted. Members of the Institute have the privilege of obtaining separate reprints of all these abstracts, printed on one side of the paper only and suitable for separate filing, for a small sum of money.

A paper by Moore, Beckinsale and Mallinson on "Season Cracking of Brass and Other Copper Alloys," together with a voluminous discussion, occupies 115 pages in the book. This paper was abstracted at length in CHEMICAL & METALLURGICAL ENGINEERING, June 1, 1921 (vol. 24, p. 976). A contribution by P. H. Brace, "Some Notes on Calcium," was also reprinted July 20, 1921 (vol. 25, p. 105).

Another paper which created a great deal of discussion was by Prof. Carpenter and Miss Elam, continuing their observations on recrystallization and grain growth. John L. Haughton, of the National Physical Laboratory, also completed the presentation of his very painstaking and accurate work on the copper-tin equilibrium diagram.

E. E. THUM.

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THE WORLD'S CHEMICAL INDUSTRY AND TRADE, 1913-14 TO 1919-20. By Dr. W. A. Dyes. Vol. I, Edition E. xx+752 pp. 1921. Hopf'sche Verlagsbuchdruckerei, Gebr. Jenne, Wittenberg, near Halle, Germany. Price, \$5.

Dr. Dyes has felt the need for a yearly international handbook in which to place before the readers abstracts of the literature published in leading periodicals and trade papers of the world on subjects dealing with the economic phases of the chemical industries. With this in view he has compiled the first volume of such a work in which the period from 1913 to September, 1920, has been covered. The abstracts are, more correctly speaking, extracts, since they are paragraphs lifted bodily from the original articles; the book is thus a compilation of clippings from literature published mainly in German and English. Articles published in other languages are condensed, as a rule, into a few lines of German.

An English index of subject matter, an arrangement of main text in German, English and French, a list of some individuals and firms, and finally an index by countries occupy pp. vii to xx. The main text, pp. 1-669, is arranged in alphabetical order with subject headings in German, English and French. Pages 670 to 752 contain an alphabetical list of 461 German companies (Aktiengesellschaften), 1,548 German corporations (G.m.b.H.), 773 British and 561 French companies.

The compilation shows that the selection of the material has been both careful and comprehensive. With the exceptions of the references taken from English literature, however, the handbook will not be of much tangible use to those readers who are not familiar with the German language.

After a general survey of the great mass of subject matter covered it is evident that Dr. Dyes has succeeded in compiling a book which will prove useful to those who wish to obtain information on the economic status of chemical products or on what he calls the "new science of chemistry."

Personal

Lieutenant H. B. BRAMLET, Chemical Warfare officer at Camp Meade, has been transferred to Edgewood Arsenal.

Dr. J. B. BROWN is to do research, with Prof. Richards, in the pharmacology department of the University of Pennsylvania.

Dr. A. W. DAVISON has been appointed professor of chemistry at the Rensselaer Polytechnic Institute, succeeding Prof. A. T. Lincoln, who has resigned to join the faculty of Carlton University, Minnesota. Captain Davison was professor of physical and electrochemistry at the University of Cincinnati previous to the war; he entered the Chemical Warfare Service and was in charge of the 50-ton mustard gas plant at Buffalo. For the last two years he has been directing research work for the Virginia Haloid Co.

Dr. C. G. DERICK has severed his connection as chief of research of the National Aniline & Chemical Co. and has organized the company of C. G. Derick & Co., Buffalo, N. Y., and will engage in consulting work and special research.

CARL F. DIETZ, vice-president and sales manager of the Norton Co., Worcester, Mass., has resigned to become president and general manager of the Bridgeport Brass Co., Bridgeport, Conn., which position he assumes Oct. 1.

Major G. M. HALLORAN has been transferred from the infantry to the Chemical Warfare Service. Major Halloran was an instructor in the infantry service school at Camp Benning. He will be assigned to similar duties with the Chemical Warfare Service.

Dr. HARRY F. LEWIS, formerly of the research laboratory of the National Aniline & Chemical Co.'s Buffalo works, recently resigned and is now assistant professor in charge of physical chemistry at Cornell College, Iowa.

Dr. ERNEST E. LYDER, who received his Ph.D. degree at Columbia University last June, has joined the Catlin Shale Oil Co. of Elko, Nev., as refinery engineer. Dr. Lyder was formerly with the H. L. Doherty company.

Major W. N. PORTER has been transferred from the Coast Artillery to the Chemical Warfare Service. He will serve in the administration section.

Major A. L. ROCKWOOD has taken up duties in the supply division of the Chemical Warfare Service.

J. J. WARD has been appointed manager of Carrolton, Mich., plant of the Michigan Sugar Co., succeeding Frank D. Ewen, resigned. Mr. Ward has been connected with the Caro, Mich., works of the company for some time past.

DAVID WHITE, chief geologist of the U. S. Geological Survey, left Washington on Sept. 4, for an extended field trip, during which he will examine reported oil-shale deposits in the northern Appalachian region and will make several stratigraphic studies in the Pennsylvania system.

Obituary

LLOYD W. CHAPMAN, formerly Western editor of CHEMICAL & METALLURGICAL ENGINEERING, died very suddenly of spinal meningitis at his home in Berkeley, Cal., Sept. 6, 1921. He leaves a widow and two children. Mr. Chapman was born in Pepperell, Mass., thirty-four years ago, and was graduated from Amherst Agricultural College. He specialized in chemistry, and this, with a desire to grow up in the West, led him to accept a position as chemist in the laboratory of the Boston & Montana smelter at Great Falls, Mont.—now one of the plants belonging to the Anaconda company. His rise was steady, and when the war broke out he was acting as technical assistant to the superintendent of the large electrolytic copper refinery at that place. He then entered the employ of the du Pont company, and was assigned to work on the extensions to the smokeless powder

plant at Penns Grove, N. J. On completion of construction, he was made superintendent of the alcohol and ether department, a position he filled with signal success. When operations were curtailed after the armistice, Mr. Chapman was transferred to the research department and was given several problems in solvent recovery. The solution of one of these involved the design and construction of an entirely new machine for the manufacture of imitation leather, a machine which was installed at the Newburgh plant and surpassed expectations. A desire to enlarge his outlook and to get back in the West led him about two years ago to accept the position of Western editor of CHEMICAL & METALLURGICAL ENGINEERING, to be stationed in San Francisco, and about ten months ago he was transferred to the *Journal of Electricity and Western Industry*, a McGraw-Hill publication, published in that city. Mr. Chapman's business acquaintances will regret the passing of a man of particularly sound technical ability, and his many personal friends will mourn the death of a true gentleman.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, Sept. 19, 1921.

Business in heavy chemicals has shown a steady expansion during the past week, although activity in general is somewhat irregular. Buyers are becoming more confident of the firmness of price levels and are gradually increasing their stocks as consuming demand for their products increases. Buying is still of a conservative character, but individual transactions are gradually increasing and if the stability of prices is maintained, large operation should take place in the near future. Conditions that have persistently hampered trading during recent months seem to be showing signs of clearing up. Increased inquiries from home and foreign buyers are convincing that the last quarter of the year will make the most satisfactory showing. Mexico, South America, Japan and northern Europe are buying chemicals. German prices are firmer in spite of the recent slump in exchange rates, and it is expected that the recovery from this slump will force German exporters into a much firmer position, which will be reflected in prices here. English exchange is somewhat weaker, but prices named for English chemicals for import have not fallen; on the contrary, they are showing signs of greater firmness.

Among the week's developments was a stronger tone to the prussiate of soda market and an advance in prices at the close. Caustic potash also showed a tendency to work upward. Caustic soda continued firm without revealing much price change. Soda ash was somewhat weaker, with imported material a disturbing influence. Bleaching powder was in good request and higher on spot. In general, it may be stated that with the bottom practically struck in every important industry, the greatest era of expansion is plainly seen ahead by some of our leading captains of industry.

CHEMICALS

Imported 88-92 per cent caustic potash on spot has shown a stronger tendency during the week and offerings were not as free as noted a month ago. Continued heavy buying, principally by soapmakers, has absorbed a large portion of the available foreign material. Reports were also current that production abroad has been restricted on account of the low prevailing prices. At the close 4½c. per lb. was considered an inside price for goods ex-store, with sellers generally quoting 4½@4¾c. September shipment was quoted at 4½c. per lb., c.i.f. New York. Sales of imported chlorate of potash were reported during the week at 7½c. per lb. Shipments of foreign material were offered at 5½@6c. per lb., duty paid. Domestic producers reported no change in their prices from the 12c. level, f.o.b. works. Yellow prussiate of potash sold in a small way on spot at 20c. per lb. Sellers quoted the market at 20@21c. per lb. The red variety has not shown much activity during the past few days and the market is more or less nominal at

28c. per lb. Odd lot sales of *bichromate of soda* were recorded during the week at 7½@8c. per lb. The movement has been chiefly in small lots and the general quotation is 7½c. Supplies do not seem to be large, but the conservative character of buying at present is not sufficient to lift the market above its present level. *Solid caustic soda* is quoted at \$3.90@\$4 per 100 lb., although large sellers assert that the market is drifting nearer to the 4c. per lb. level. Small-lot sales have taken place at 4c. both for domestic and export use. Moderate inquiries continue to reach the market for export shipment. Producers' prices are repeated at 3½c. per lb., basis 60 per cent, f.o.b. works..

Importers of *barium nitrate* are weaker on this item and quote 7½@10c. per lb., according to quantity. Prices of imported *barium chloride* tend weaker, although still quoted at former levels of \$45@\$46 per ton. Arrivals are quoted below these figures. Other barium salts share in the weakness. Continued inactivity has forced further weakness in *white arsenic* prices, which are quoted at 6@6½c. per lb. *Red arsenic* is held firmly at 11@12c. per lb. The demand for *alums* has been fairly well sustained and prices are quite firm at recent quotations. *Lump ammonia alum* is quoted at 3½@3¾c. per lb. and *lump potash* at 3¾@4½c. Continued inquiry for *prussiate of soda* on the spot market and the relatively low supplies have been factors instrumental in bringing about a higher market for this chemical. Sales were reported late in the week up to 12½c. per lb., ex-store. At the close most dealers refused to shade 12¾c. Foreign shipments were quoted at 11¾c. per lb., c.i.f. New York. Prices on *formaldehyde* during the week have covered a range extending from 12@12½c. per lb. in barrels. Producers were able to place some business at the inside figure, f.o.b. works. The demand has shown a little more activity than noted a week ago. Spot *oxalic acid* is quoted at 16@17c. per lb., depending upon the brand and quantity. Irregular prices on *tartaric acid* are heard in the open market for imported material and the range extends from 25@26c. per lb. for crystals. The powdered variety is moving at 27@28c. per lb. Domestic material is being held at 35c. per lb., with small-lot trading through the regular consuming channels featuring. Buyers are not showing any unusual interest at present and the movement is mostly of a routine jobbing nature.

Business in *copper sulphate* is fair for this season of the year. August trade did not average up to a year ago. Inquiries are reaching the market for September shipment and it looks as though this month will prove satisfactory from a trade standpoint. There is a fair general demand from the textile, railroad and other consuming industries. Occasional sales go through for export to South America, but the abnormally low prices named for goods by foreign sellers is preventing European business. It is admitted that quite a bit of business for Italy and France could be placed if the price were low enough. Quotations are generally 5½c. per lb. or higher, but imported sulphate is offered in limited amounts as low as 5c. per lb. Lower prices are named in most quarters on *soda ash*, as the demand has been satisfied by imported material. Spot resale prices are lower at \$2 per 100 lb. Prices on imported *permanganate of potash* are lower at 22@24c. per lb., according to seller and quantity.

COAL-TAR PRODUCTS

Increased activity is noted in all branches of the coal-tar products market. Business during the past ten days has been picking up rapidly and buyers are entering the market more freely than at any time this year. The attitude of Congress seems to have had a great deal to do with the change, as the trade in general is coming to believe more firmly that the Fordney tariff bill will include protection of adequate nature when it is ultimately passed. The market is rapidly being relieved of the great resale surplus stocks that were available. Renewed activity in the textile industry is resulting in a better inquiry for dyestuffs and while large contract business has not developed as yet, there is a broader inquiry for small lots, showing that many mills are short of supplies. Refiners of *benzene* are quoting 27@33c. per gal. for future delivery. Spot supplies are scarce and odd lots command a premium, with some small sales recorded as high as 40c. per gal. Practically

no improvement in coke-oven operations has been made, and as a consequence no great relief can be expected for some weeks to come. Production at present is about 20 per cent normal. Some odd lots of *phenol* have sold at 8@8½c. per lb., but most prime goods are held at 9@9½c. on spot. Competition is keen and stocks are still large. *U.S.P. benzoic acid* is quoted at 70c. per lb. and technical at 50@60c., depending upon seller and quantity. Considerable activity is noted in the U.S.P., with the canneries taking the major part of the output.

Offerings of *aniline oil* as low as 18c. per lb. have been made by factors, with 20c. quoted in other directions. Resellers have made sales down to 17½c. per lb. The tone of the market is weak and some producers are showing a strong desire to liquidate their stocks. Supplies are more than sufficient to take care of the present moderate demand. Makers of *beta naphthol* quote up to 40c. per lb., but on actual business 32c. is the price usually named. Stocks are unusually large and the demand is far from active. Some producers are desirous of realizing cash on their holdings and are shading prices in an attempt to stimulate business. Resellers are quoting 32c. per lb., with a few odd lots recorded as low as 30c. The present prices are said to be below the cost of production and one prominent factor is said to have stopped producing and is supplying his customers from the open market.

Manufacturers of *dimethylaniline* quote 45c. per lb. and upward, depending upon the quantity and seller. The resale market is pegged at 42c. The demand is moderate and shows signs of slight improvement.

The St. Louis Market

ST. LOUIS, Sept. 16, 1921.

While there has been a steady improvement in activity in the drug and fine chemical market, with spot orders being more frequent, it must be granted that the expectations of two months ago have not been fulfilled. It seems that this year there will be no definite demarcation between the summer lull and the fall increase in activity as in former years, but that the improvement will be slow but steady. No further declines to any extent are looked for, as most items are down to prices based on actual costs, and a few are even being offered below the cost of production. The market on heavy chemicals maintains its improvement, with several chemicals enjoying a very strong demand.

ALKALIS

Caustic soda demand continues good and the price of \$4 per 100 lb., basis 73-75 per cent solid, f.o.b. point of production, is very firm. *Soda ash* demand is only fair, with manufacturers' schedule prevailing. *Bicarbonate of soda* and *sal soda* are in light demand, with the former holding at \$2.60@\$2.75 per 100 lb. in less than carlots.

INDUSTRIALS

Carbon bisulphide is scarce, with a very active demand for substantial quantities. The grain elevators are beginning to call for this and also *carbon tetrachloride* to combat the weevil. *Sulphur* is in fair demand, with price of \$2.10 per 100 lb. for the commercial in bags.

CHEMICALS, DRUGS, PHARMACEUTICALS

The demand for *bismuth salts* continues to be very active. *Cream of tartar* is in routine demand. *Ether* demand shows signs of activity, and *motor ether* is beginning to move in anticipation of the winter demand. *Iodides* have increased steadily in demand, and the same holds true for *sodium benzoate*. Prices on the above remain unchanged. *Caffeine alkaloid* is very weak. *Zinc stearate* has been enjoying an excellent demand. *Glycerine* has reacted from its low point of 14c., and now holds at 14½c. per lb., spot and contract, with routine demand.

ACIDS

Sulphuric acid demand is light. Several manufacturers have stopped production temporarily, and are taking care of orders from storage stocks. *Citric acid* demand is light, with price unchanged. *Tartaric acid* is in routine demand. *Pyrogallie* and *benzoic acids* are both having an active demand and good movement. There is a good demand for

the U.S.P. *carbolic acid*, while the large Government stocks still affect the technical, and demand on the latter is light. *Phosphoric acid* demand is routine.

VEGETABLE OILS

Linseed oil rose to a maximum of 80c. per gal. before resuming its present price of 78c., basis raw in barrels, ex-warehouse. Most of the demand is for spot oil. *Castor oil* continues in very good demand, with price firm at 11½c. per lb. in drums for No. 1 U.S.P. *Turpentine* demand is routine and the price has advanced to 69c., basis barrels ex-warehouse.

The Iron and Steel Market

PITTSBURGH, Sept. 16, 1921.

There has been no material increase in the past week in the total volume of demand upon the steel mills, but the improvement previously recorded has been held.

Demand is still so light by comparison with productive capacity that the relative increase in demand may be overlooked. A plain distinction must be made between the actual consumption of steel and the demand upon the mills, resulting in production and shipments. On account of the existence of stocks of steel in the hands of buyers, and of finished wares made from steel, the demand upon the mills fell far below a normal relation to the general business activity of the country.

Production constitutes an immediate reflection of the volume of demand, since all buying is of hand-to-mouth character and for the quickest delivery possible. In both sheets and tin plates production is at nearly 45 per cent of capacity, and the tin plate showing is particularly remarkable because normally the fore part of September is approximately the duller period of the year in tin plate. Pipe mills are operating at about 40 per cent, while wire mills are operating at about 50 per cent on an average. Bar production is at a lower rate, while production of plates, shapes and rails is very small.

STEEL PRICES

In view of the continued decline in steel prices for so many months, it was rather spectacular that wire products should advance in price but an advance of \$2 a ton in plain wire and \$3 a ton in barb wire and nails became a fact this week, the American Steel & Wire Co. (Steel Corporation) making the advance effective Monday, Sept. 12, while the independents followed. The new prices are: Plain wire, 2.60c.; galvanized wire, 3.10c.; painted barb wire, 3.05c.; galvanized barb wire, 3.55c.; cement coated nails, \$2.50; wire nails, \$2.90. An advance in wire prices, however, is not like an advance in steel prices in general.

Bars, shapes and plates are perhaps a shade easier than a week ago, 1.65c. being a more common price, while prices below that, possibly even below 1.60c., are reported as done on especially desirable orders. Sheets remain firm at 2.75c. for black and 3.75c. for galvanized. Two large independent mills, one in the Mahoning Valley and one in the Chicago district, have announced an advance in their prices of \$5 a ton, to 3c. and 4c. respectively, but in view of the strenuous competition it seems improbable that an advance of this size will be followed generally.

Prices on tubular products developed early in July were promptly shaded as to oil country goods, but held fairly well until recently as to standard steel pipe. The prospect now is that there will be a formal reduction in recognition of the shading, to a level that may hold.

Generally speaking, it is plain that finished steel prices on an average are very near their bottom with present wage rates and freight rates.

PIG IRON AND COKE

Pig iron inquiry is very light, but the little burst of activity recently may be repeated, as there was no forward buying. The market remains quotable at \$20 for bessemer, \$19 for basic and \$21 for foundry, f.o.b. valley furnaces.

Connellsville furnace coke is firm at \$3.25, with not much to be had at that level. A fortnight ago the market was \$2.90@3.

General Chemicals CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots	Less Carlots
Acetic anhydride.....lb.	\$0.12 - \$0.12	\$0.40 - \$0.45
Acetone.....lb.	2.75 - 3.00	1.13 - 1.13
Acid, acetic, 28 per cent.....100 lbs.	5.50 - 5.75	3.25 - 3.50
Acetic, 56 per cent.....100 lbs.	10.50 - 11.00	6.00 - 6.50
Acetic, glacial, 99½ per cent, carboys, 100 lbs.	12.25 - 13.00	11.25 - 11.50
Boric, crystals.....lb.	1.13 - 1.13	1.13 - 1.14
Boric, powder.....lb.	1.13 - 1.13	1.13 - 1.14
Citric.....lb.	1.13 - 1.13	1.13 - 1.14
Hydrochloric.....100 lb.	1.25 - 1.50	1.60 - 1.75
Hydrofluoric, 52 per cent.....lb.	1.11 - 1.11	1.12 - 1.12
Lactic, 45 per cent tech.....lb.	1.10 - 1.11	1.11 - 1.12
Lactic, 22 per cent tech.....lb.	0.41 - 0.51	0.06 - 0.07
Molybdic, C. P.....lb.	4.00 - 4.50	4.50 - 5.00
Muriatic, 20 deg. (see hydrochloric).....lb.	0.61 - 0.62	0.07 - 0.07
Nitric, 40 deg.....lb.	0.07 - 0.07	0.07 - 0.07
Nitric, 42 deg.....lb.	0.16 - 0.16	0.17 - 0.18
Oxalic, crystals.....lb.	1.13 - 1.13	1.14 - 1.18
Phosphoric, 50 per cent solution.....lb.	1.20 - 1.25	2.7 - 3.5
Picric.....lb.	1.25 - 1.90	1.75 - 1.90
Pyrogallol, resublimed.....lb.	11.75 - 13.00	13.00 - 15.00
Sulphuric, 60 deg., tank cars.....ton	18.00 - 20.00	22.50 - 23.00
Sulphuric, 60 deg., drums.....ton	21.00 - 22.00	22.50 - 23.00
Sulphuric, 66 deg., tank cars.....ton	21.00 - 22.00	22.50 - 23.00
Sulphuric, 66 deg., drums.....ton	21.00 - 22.00	22.50 - 23.00
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	21.00 - 22.00	22.50 - 23.00
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	23.00 - 23.50	24.00 - 24.50
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	31.00 - 32.00	33.00 - 34.00
Tannic, U. S. P.....lb.	0.45 - 0.48	0.75 - 0.85
Tannic (tech.).....lb.	0.45 - 0.48	0.50 - 0.55
Tartaric, imported crystals.....lb.	0.25 - 0.26	0.25 - 0.26
Tartaric acid, imported, powdered.....lb.	0.27 - 0.28	0.27 - 0.28
Tartaric acid, domestic.....lb.	0.27 - 0.28	0.27 - 0.28
Tungstic, per lb. of WO.....lb.	1.30 - 1.40	1.30 - 1.40
Alcohol, Ethyl.....gal.	4.65 - 4.90	4.65 - 4.90
Alcohol, Methyl (see methanol).....gal.	3.5 - 3.6	3.5 - 3.6
Alcohol, denatured, 188 proof.....gal.	3.7 - 3.8	3.7 - 3.8
Alcohol, denatured, 190 proof.....gal.	0.31 - 0.32	0.31 - 0.32
Alum, ammonia lump.....lb.	0.03 - 0.04	0.04 - 0.04
Alum, potash lump.....lb.	0.03 - 0.04	0.04 - 0.04
Alum, chrome lump.....lb.	1.10 - 1.11	1.11 - 1.12
Aluminium sulphate, commercial.....lb.	0.02 - 0.02	0.02 - 0.02
Aluminium sulphate, iron free.....lb.	0.03 - 0.03	0.03 - 0.04
Aqua ammonia, 26 deg., drums (750 lb.).....lb.	0.07 - 0.07	0.08 - 0.08
Ammonia, anhydrous, cyl. (100-150 lb.).....lb.	0.30 - 0.32	0.33 - 0.35
Ammonium carbonate, powder.....lb.	0.07 - 0.07	0.08 - 0.09
Ammonium chloride, granular (white sal ammoniac).....lb.	0.06 - 0.06	0.06 - 0.07
Ammonium chloride, granular (gray sal ammoniac).....lb.	0.06 - 0.07	0.07 - 0.08
Ammonium nitrate.....lb.	0.07 - 0.07	0.07 - 0.08
Ammonium sulphate.....100 lb.	2.20 - 2.25	2.30 - 2.40
Amylacetate.....gal.	3.25 - 3.50	3.25 - 3.50
Amylacetate tech.....gal.	2.50 - 3.00	2.50 - 3.00
Arsenic oxide, (white arsenic) powdered.....lb.	0.06 - 0.06	0.06 - 0.07
Arsenic, sulphide, powdered (red arsenic).....lb.	1.11 - 1.11	1.12 - 1.13
Barium chloride.....45.00 - 46.00	47.00 - 50.00	47.00 - 50.00
Barium dioxide (peroxide).....lb.	0.20 - 0.21	0.22 - 0.23
Barium nitrate.....lb.	0.07 - 0.08	0.08 - 0.09
Barium sulphate (precip.) (blanc fixe).....lb.	0.04 - 0.04	0.04 - 0.05
Bleaching powder (see calc. hypochlorite).....	.....	.....
Blue vitriol (see copper sulphate).....	.....	.....
Borax (see sodium borate).....	.....	.....
Brimstone (see sulphur, roll).....	.....	.....
Bromine.....lb.	0.27 - 0.28	0.28 - 0.30
Calcium acetate.....100 lbs.	2.00 - 2.05	2.00 - 2.05
Calcium carbide.....lb.	0.04 - 0.04	0.05 - 0.05
Calcium chloride, fused lump.....ton	23.50 - 24.00	24.50 - 25.50
Calcium chloride, granulated.....lb.	0.01 - 0.02	0.02 - 0.02
Calcium hypochlorite (bleach powder) 100 lb.	2.75 - 2.80	2.90 - 3.50
Calcium peroxide.....lb.	1.40 - 1.50	1.40 - 1.50
Calcium phosphate, tribasic.....lb.	0.15 - 0.16	0.15 - 0.16
Camphor.....lb.	0.70 - 0.73	0.70 - 0.73
Carbon bisulphide.....lb.	0.06 - 0.06	0.06 - 0.07
Carbon tetrachloride, drums.....lb.	1.10 - 1.10	1.11 - 1.12
Carbonyl chloride (phosgene).....lb.	0.60 - 0.60	0.60 - 0.75
Caustic potash (see potassium hydroxide).....	.....	.....
Caustic soda (see sodium hydroxide).....	.....	.....
Chlorine, gas, liquid-cylinders (100 lb.).....lb.	0.08 - 0.09	0.09 - 0.10
Chloroform.....lb.	0.38 - 0.43	0.38 - 0.43
Cobalt oxide.....lb.	2.00 - 2.10	2.00 - 2.10
Copperas (see iron sulphate).....	.....	.....
Copper carbonate, green precipitate.....lb.	0.19 - 0.19	0.20 - 0.21
Copper cyanide.....lb.	0.50 - 0.62	0.50 - 0.62
Copper sulphate, crystals.....lb.	0.05 - 0.05	0.05 - 0.06
Cream of tartar (see potassium bitartrate).....	.....	.....
Epsom salt (see magnesium sulphate).....	.....	.....
Ethyl Acetate Com. 85%.....gal.	1.00 - 1.10	1.00 - 1.10
Ethyl Acetate pure (acetic ether 98% to 100%).....lb.	1.12 - 1.12	1.40 - 1.42
Formaldehyde, 40 per cent.....lb.	3.25 - 3.75	3.25 - 3.75
Fusel oil, ref.....gal.	1.50 - 1.75	1.50 - 1.75
Fusel oil, crude.....gal.	1.41 - 1.41	1.41 - 1.41
Glauber's salt (see sodium sulphate).....	.....	.....
Glycerine, C. P. drums extra.....lb.	3.50 - 3.60	3.50 - 3.60
Iodine, resublimed.....lb.	1.10 - 1.20	1.10 - 1.20
Iron oxide, red.....lb.	18.00 - 19.00	20.00 - 21.00
Iron sulphate (copperas).....ton	10.1 - 10.1	10.1 - 10.1
Lead acetate.....lb.	0.09 - 0.09	0.10 - 0.11
Lead arsenate, paste.....lb.	0.15 - 0.20	0.15 - 0.20
Lead nitrate.....lb.	0.07 - 0.08	0.08 - 0.09
Litharge.....lb.	1.30 - 1.40	1.30 - 1.40
Lithium carbonate.....lb.	0.08 - 0.08	0.09 - 0.10
Magnesium carbonate, technical.....lb.	2.50 - 2.75	3.10 - 3.75
Magnesium sulphate, U. S. P.....100 lb.	1.10 - 1.10	1.10 - 1.10
Magnesium sulphate, technical.....100 lb.	0.66 - 0.68	0.66 - 0.68
Methanol, 95%.....gal.	0.70 - 0.72	0.70 - 0.72
Methanol, 97%.....gal.	0.12 - 0.12	0.12 - 0.12
Nickel salt, double.....lb.	0.14 - 0.14	0.14 - 0.14
Nickel salt, single.....lb.	0.40 - 0.41	0.42 - 0.45
Phosgene (see carbonyl chloride).....	.....	.....
Phosphorus, red.....lb.	0.30 - 0.35	0.30 - 0.35
Phosphorus, yellow.....lb.	1.11 - 1.11	2 - 1.12
Potassium bichromate.....lb.	.....	.....

	Carlots	Less Carlots
Potassium bitartrate (cream of tartar)..... lb.	\$. . . \$. . .	\$0.28½ - \$0.29½
Potassium bromide, granular..... lb.		.16 - .25
Potassium carbonate, U. S. P..... lb.	.35 - .40	.45 - .50
Potassium carbonate, 80-85%..... lb.	.05 - .05½	.06 - .06½
Potassium chlorate, crystals..... lb.	.07 - .07½	.07½ - .10
Potassium cyanide..... lb.		.26 - .28
Potassium hydroxide (caustic potash)..... lb.	.04½ - .04¾	.05 - .06
Potassium muriate, 80% K.C.L..... ton	42.50 - 45.00	
Potassium iodide..... lb.		2.75 - 3.00
Potassium nitrate..... lb.	.09½ - .09¾	.10 - .12½
Potassium permanganate..... lb.	.22 - .23	.24 - .25
Potassium prussiate, red..... lb.	.28 - .29	.29½ - .30
Potassium prussiate, yellow..... lb.	.20 - .20½	.21 - .22
Potassium sulphate (powdered)..... per unit		1.20 - 1.25
Rochelle salts (see sodium potas tartrate).....		
Salammoniac (see ammonium chloride).....		
Sal soda (see sodium carbonate).....		
Salt cake (bulk)..... ton		20.00 - 25.00
Silver cyanide..... oz.		1.35 - 1.38
Silver nitrate..... oz.		.41½ - .42
Soda ash, light..... 100 lb.	2.00 - 2.10	2.15 - 2.50
Soda ash, dense..... 100 lb.	2.35 - 2.40	2.45 - 2.70
Sodium acetate..... lb.	.04 - .04½	.04½ - .05
Sodium bicarbonate..... 100 lb.	2.00 - 2.25	2.50 - 2.75
Sodium bichromate..... lb.	.07½ - .08	.08½ - .08¾
Sodium bisulphate (nitre cake)..... ton	5.00 - 5.25	5.50 - 6.50
Sodium bisulphite powdered, U.S.P..... lb.	.04½ - .05	.05½ - .06
Sodium borate (borax)..... lb.	.05½ - .06	.06½ - .07
Sodium carbonate (sal soda)..... 100 lb.	1.90 - 2.00	2.10 - 2.40
Sodium chl rate..... lb.	.07½ - .07¾	.08 - .08½
Sodium cyanide..... lb.	.19½ - .21	.22 - .30
Sodium fluoride..... lb.	.10½ - .11	.11½ - .12
Sodium hydroxide (caustic soda)..... 100 lb.	3.90 - 4.00	4.10 - 4.60
Sodium hyposulphite..... lb.		.03½ - .03¾
Sodium nitrate..... 100 lb.	2.10 -	2.30 -
Sodium nitrite..... lb.	.07 - .07½	.07½ - .08
Sodium peroxide, powdered..... lb.	.25 - .26	.27 - .30
Sodium phosphate, dibasic..... lb.	.04½ - .04¾	.05 - .05½
Sodium potassium tartrate (Rochelle salts) lb.		.21 - .24
Sodium prussiate, yellow..... lb.	.12½ - .13	.13½ - .13¾
Sodium silicate, solution (40 deg.)..... 100 lb.	1.00 - 1.15	1.25 - 1.40
Sodium silicate, solution (60 deg.)..... lb.	.02½ - .03	.03½ - .03¾
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	1.50 - 1.75	2.00 - 2.25
Sodium sulphide, fused, 60-62 per cent (conc.) lb.	.04½ - .04¾	.05 - .06
Sodium sulphite, crystals..... lb.	.03½ - .04	.04½ - .04¾
Strontium nitrate, powdered..... lb.	.12 - .12½	.13 - .14
Sulphur chl ride, red..... lb.	.05 - .05½	.05½ - .06½
Sulphur, crude..... ton	18.00 - 20.00	
Sulphur dioxide, liquid, cylinders extra..... lb.	.08 - .08½	.09 - .10
Sulphur (sublimed), flour..... 100 lb.		2.25 - 3.10
Sulphur, roll (brimstone)..... 100 lb.		2.00 - 2.75
Tin bichloride, 50 per cent..... lb.	.18 - .19	
Tin oxide..... lb.		.38 - .40
Zinc carbonate, precipitate..... lb.	.16 - .16½	.17 - .17½
Zinc chloride, gran..... lb.	.09½ - .09¾	.10 - .11
Zinc cyanide..... lb.	.42 - .44	.45 - .47
Zinc dust..... lb.	.11½ - .11¾	.11½ - .12½
Zinc oxide, XX..... lb.	.07½ - .07¾	.08 - .09
Zinc sulphate..... 100 lb.	3.00 - 3.25	3.30 - 3.50

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude..... lb.	\$1.15 - \$1.20
Alpha-naphthol, refined..... lb.	1.35 - 1.40
Alpha-naphthylamine..... lb.	.35 - .40
Aniline oil, drums extra..... lb.	.17½ - .20
Aniline salts..... lb.	.24 - .26
Anthracene, 80% in drums (100 lb.)..... lb.	.75 - 1.00
Benzaldehyde U.S.P..... lb.	1.00 - 1.25
Benzidine, base..... lb.	1.00 - 1.10
Benzidine sulphate..... lb.	.75 - .85
Benzoic acid, U.S.P..... lb.	.70 - .72
Benzoate of soda, U.S.P..... lb.	.55 - .60
Benzene, pure, water-white, in drums (100 gal.)..... gal.	.27 - .32
Benzene, 90%, in drums (100 gal.)..... gal.	.25 - .28
Benzyl chloride, 95-97%, refined..... lb.	.25 - .27
Benzyl chloride, tech..... lb.	.20 - .23
Beta-naphthol benzoate..... lb.	3.50 - 4.00
Beta-naphthol, sublimed..... lb.	.70 - .75
Beta-naphthol, tech..... lb.	.32 - .35
Beta-naphthylamine, sublimed..... lb.	1.90 - 2.00
Cresol, U. S. P., in drums (100 lb.)..... lb.	.17 - .19
Ortho-cresol, in drums (100 lb.)..... lb.	.25 - .27
Cresylic acid, 97-99%, straw color, in drums..... gal.	.70 - .75
Cresylic acid, 35-97%, dark, in drums..... gal.	.60 - .65
Cresylic acid, 50%, first quality, drums..... gal.	.45 - .50
Dichlorobenzene..... lb.	.06 - .09
Diethylaniline..... lb.	1.20 - 1.25
Dimethylaniline..... lb.	.42 - .50
Dinitrobenzene..... lb.	.25 - .28
Dinitrochlorobenzene..... lb.	.25 - .30
Dinitronaphthalene..... lb.	.32 - .40
Dinitrophenol..... lb.	.37 - .40
Dinitrotoluene..... lb.	.25 - .30
Dip oil, 25%, car lots, in drums..... gal.	.35 - .40
Diphenylamine..... lb.	.60 - .70
H-acid..... lb.	1.10 - 1.20
Meta-phenylenediamine..... lb.	1.15 - 1.20
Monochlorobenzene..... lb.	.12 - .14
Monoethylaniline..... lb.	1.50 - 1.60
Naphthalene crushed, in bbls..... lb.	.06½ - .07½
Naphthalene, flake..... lb.	.06½ - .08
Naphthalene, balls..... lb.	.08 - .09½
Naphthionic acid, crude..... lb.	.70 - .75
Nitrobenzene..... lb.	.12 - .15
Nitro-naphthalene..... lb.	.30 - .35
Nitro-toluene..... lb.	.15 - .17
Ortho-amidophenol..... lb.	3.00 - 3.10
Ortho-dichlor-benzene..... lb.	.15 - .20
Ortho-nitro-phenol..... lb.	.75 - .80
Ortho-nitro-toluene..... lb.	.15 - .20
Ortho-toluidine..... lb.	.23 - .25
Para-amidophenol, base..... lb.	1.40 - 1.45
Para-amidophenol, HCl..... lb.	1.70 - 1.80

Para-dichlorobenzene..... lb.	.15 - .20
Paranitroaniline..... lb.	.79 - .82
Para-nitrotoluene..... lb.	.80 - .85
Para-phenylenediamine..... lb.	1.70 - 1.75
Para-toluidine..... lb.	1.25 - 1.40
Phthalic anhydride..... lb.	.40 - .50
Phenol, U. S. P., drums..... lb.	.08½ - .10
Pyridine..... gal.	2.00 - 3.50
Resorcinol, technical..... lb.	1.50 - 1.60
Resorcinol, pure..... lb.	2.25 - 2.30
Salicylic acid, tech., in bbls..... lb.	.18 - .20
Salicylic acid, U. S. P..... lb.	.20 - .25
Salol..... lb.	.60 - .70
Solvent naphtha, water-white, in drums, 100 gal..... gal.	.25 - .28
Solvent naphtha, crude, heavy, in drums, 100 gal..... gal.	.14 - .16
Sulphanilic acid, crude..... lb.	.27 - .30
Tolidine..... lb.	1.30 - 1.35
Toluidine, mixed..... lb.	.43 - .45
Toluene, in tank cars..... gal.	.25 - .28
Toluene, in drums..... gal.	.28 - .31
Xylidines, drums, 100 gal..... lb.	.40 - .45
Xylene, pure, in drums..... gal.	.40 - .45
Xylene, pure, in tank cars..... gal.	.45 - .
Xylene, commercial, in drums, 100 gal..... gal.	.33 - .35
Xylene, commercial, in tank cars..... gal.	.30 - .

Waxes

Prices based on original packages in large quantities.

Bayberry Wax..... lb.	\$0.20 - \$0.21
Beeswax, refined, dark..... lb.	.24 - .25
Beeswax, refined, light..... lb.	.28 - .30
Beeswax, white pure..... lb.	.36 - .42
Candelilla wax..... lb.	.25 - .26
Carnauba, Florida..... lb.	.48 - .50
Carnauba, No. 2, North Country..... lb.	.25 - .26
Carnauba, No. 3, North Country..... lb.	.15 - .15½
Japan..... lb.	.23 - .24
Montan, crude..... lb.	.05½ - .06
Paraffine waxes, crude match wax (white) 105-110 m.p..... lb.	.03½ - .03¾
Paraffine waxes, crude, scale 124-126 m.p..... lb.	.02 - .
Paraffine waxes, refined, 118-120 m.p..... lb.	.03 - .03½
Paraffine waxes, refined, 125 m.p..... lb.	.03½ - .03¾
Paraffine waxes, refined, 128-130 m.p..... lb.	.03 - .04½
Paraffine waxes, refined, 133-135 m.p..... lb.	.04½ - .05
Paraffine waxes, refined, 135-137 m.p..... lb.	.05 - .06
Stearic acid, single pressed..... lb.	.09 - .
Stearic acid, double pressed..... lb.	.10 - .
Stearic acid, triple pressed..... lb.	.11 - .11½

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on earload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl..... 280 lb.	\$5.40 - 5.50
Rosin E-I..... 280 lb.	5.50 - 5.60
Rosin K-N..... 280 lb.	5.75 - 5.90
Rosin W. G.-W. W..... 280 lb.	6.60 - 7.35
Wood rosin, bbl..... 280 lb.	6.25 - .
Spirits of turpentine..... gal.	.70 - .
Wood turpentine, steam dist..... gal.	.68 - .
Wood turpentine, dest. dist..... gal.	.66 - .
Pine tar pitch, bbl..... 200 lb.	. - 7.00
Tar, kiln burned, bbl. (500 lb.)..... bbl.	. - 11.00
Retort tar, bbl..... 500 lb.	. - 11.00
Rosin oil, first run..... gal.	.35 - .
Rosin oil, second run..... gal.	.37 - .
Rosin oil, third run..... gal.	.44 - .
Pine oil, steam dist., sp.gr. 0.930-0.940..... gal.	\$1.90 -
Pine oil, pure, dest. dist..... gal.	1.50 -
Pine tar oil, ref., sp.gr. 1.025-1.035..... gal.	.46 -
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla..... gal.	.35 -
Pine tar oil, double ref., sp.gr. 0.965-0.990..... gal.	.75 -
Pine tar, ref., thin, sp.gr. 1.080-1.960..... gal.	.35 -
Turpentine, crude, sp. gr. 0.900-0.970..... gal.	1.25 -
Hardwood oil, f.o.b. Mich., sp.gr. 0.960-0.990..... gal.	.35 -
Pinewood creosote, ref..... gal.	.52 -

Solvents

73-76 deg., steel bbls. (85 lb.)..... gal.	\$0.37 -
70-72 deg., steel bbls. (85 lb.)..... gal.	.35 -
68-70 deg., steel bbls. (85 lb.)..... gal.	.34 -
V. M. and P. naphtha, steel bbls. (85 lb.)..... gal.	.23 -

Crude Rubber

Para-Upriver fine..... lb.	\$0.16 - .17
Upriver coarse..... lb.	.09 - .09½
Upriver caucho ball..... lb.	.11½ - .12
Plantation—First latex crepe..... lb.	.14 - .
Ribbed smoked sheets..... lb.	.12 - .12½
Brown crepe, thin, clean..... lb.	.15 - .
Amber crepe No. 1..... lb.	.17 - .

Oils

VEGETABLE

The following prices are f.o.b. New York for earload lots.

Castor oil, No. 3, in bbls..... lb.	\$0.09½ - \$0.09½
Castor oil, AA, in bbls..... lb.	.10½ - .11
China wood oil, in bbls. (f.o.b. Pac. coast)..... lb.	.11 - .11½
Cocoonut oil, Ceylon grade, in bbls..... lb.	.10 - .10½
Cocoonut oil, Cochon grade, in bbls..... lb.	.10½ - .11½
Corn oil, crude, in bbls..... lb.	.08½ - .08¾
Cottonseed oil, crude (f. o. b. mill)..... lb.	.08 - .08½
Cottonseed oil, summer yellow..... lb.	.10 - .10½
Cottonseed oil, winter yellow..... lb.	.10½ - .11
Linseed oil, raw, ear lots (domestic)..... gal.	.77 - .78
Linseed oil, raw, tank cars (domestic)..... gal.	.71 - .72
Linseed oil, in 5-bbl lots (domestic)..... gal.	.80 - .81

Olive oil, Denatured.....	gal.	\$1.10	—	\$1.20
Palm, Lagos.....	lb.	.07	—	.08
Palm, Niger.....	lb.	.06	—	.06
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.08	—	.08
Peanut oil, refined, in bbls.....	lb.	.10	—	.10
Rapeseed oil, refined in bbls.....	gal.	.86	—	.88
Rapeseed oil, blown, in bbls.....	gal.	.90	—	.92
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.08	—	.08
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.06	—	....

FISH

Light pressed menhaden.....	gal.	\$0.40	—	....
Yellow bleached menhaden.....	gal.	.42	—	....
White bleached menhaden.....	gal.	.44	—	....
Blown menhaden.....	gal.	.48	—	....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$24.00	—	30.00
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	22.00	—	26.00
Barytes, crude, 88% @ 94% ba., Kings Creek.....	net ton	10.00	—	12.00
Barytes, floated, f.o.b. St. Louis.....	net ton	23.00	—	24.00
Barytes, crude, first grade, Missouri.....	net ton	7.00	—	....
Blanc fixe, dry.....	lb.	.04	—	.04
Blanc fixe, pulp.....	net ton	45.00	—	55.00
Casein.....	lb.	.06	—	.07
Chalk, Precipitated, domestic, extra light.....	lb.	.04	—	.05
Chalk, Precipitated, domestic, light.....	lb.	.04	—	.04
Chalk, Precipitated, domestic, heavy.....	lb.	.03	—	.04
Chalk, Precipitated, English, extra light.....	lb.	.04	—	.05
Chalk, Precipitated, English, light.....	lb.	.04	—	.05
Chalk, Precipitated, English, dense.....	lb.	.04	—	.04
China clay (kaolin) crude, f.o.b. mines, Georgia.....	net ton	6.50	—	8.50
China clay (kaolin) washed, f.o.b. Georgia.....	net ton	9.00	—	10.00
China clay (kaolin) powdered, f.o.b. Georgia.....	net ton	13.00	—	20.00
China clay (kaolin) crude f.o.b. Virginia points.....	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points.....	net ton	13.00	—	20.00
China clay (kaolin), imported, lump.....	net ton	12.00	—	20.00
China clay (kaolin), imported, powdered.....	net ton	25.00	—	30.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	net ton	5.00	—	7.50
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27.00	—	30.00
Fullers earth, f.o.b. Mines.....	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Pa.....	net ton	15.00	—	18.00
Fullers earth, powdered, f.o.b. Fla.....	net ton	18.00	—	....
Fullers earth, imported, powdered.....	net ton	24.00	—	27.00
Graphite, Ceylon lump, first quality.....	lb.	.06	—	.07
Graphite, Ceylon chip.....	lb.	.04	—	.05
Graphite, high grade amorphous crude.....	lb.	.00	—	.02
Kieselguhr, f.o.b. mines, Cal.....	per ton	40.00	—	....
Kieselguhr, f.o.b. N. Y.....	per ton	61.00	—	....
Magnesite, calcined.....	per ton	66.00	—	70.00
Pumice stone, imported, lump.....	lb.	.03	—	.40
Pumice stone, domestic lump.....	lb.	.05	—	.05
Pumice stone, ground.....	lb.	.06	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore.....	net ton	....	—	10.00
Quartz (acid tower) 1 1/2 @ 2 in., f.o.b. Baltimore.....	net ton	....	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	....	—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange fine.....	lb.	.50	—	.51
Shellac, orange superfine.....	lb.	.51	—	.52
Shellac, A. C. garnet.....	lb.	.44	—	.45
Shellac, T. N.....	lb.	.44	—	.45
Soapstone.....	ton	12.00	—	15.00
Sodium chloride.....	long ton	12.50	—	13.00
Talc, paper-making grades, f.o.b. Vermont.....	ton	11.00	—	18.00
Talc, roofing grades, f.o.b. Vermont.....	ton	8.50	—	13.00
Talc, rubber grades, f.o.b. Vermont.....	ton	11.00	—	18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	7.50	—	11.00
Talc, imported.....	ton	30.00	—	40.00
Talc, California talcum powder grade.....	ton	18.00	—	25.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	per ton	\$50.00	—	....
Carborundum refractory brick, 9-in.....	1,000	1250.00	—	....
Chrome brick, f.o.b. Eastern shipping points.....	net ton	52—55	—	....
Chrome cement, 40-45% Cr ₂ O ₃	net ton	30—32	—	....
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in car lots, f.o.b. Eastern shipping points.....	net ton	33—35	—	....
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	35—40	—	....
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	30—35	—	....
Magnesite brick, 9-in. straight.....	net ton	65—70	—	....
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	77	—	....
Magnesite brick, soaps and splits.....	net ton	98	—	....
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	40—42	—	....
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	42—45	—	....
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	35—38	—	....

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00	—	\$225.00
Ferrochrome per lb. of Cr. contained, 6-8% carbon, carlots.....	lb.	.11	—	....
Ferrochrome, per lb. of Cr. contained, 4-6% carbon, carlots.....	lb.	.11	—	.12
Ferromanganese, 76-80% Mn, domestic.....	net ton	65.00	—	67.00
Ferromanganese, 76-80% Mn, English.....	net ton	65.00	—	67.00
Spiegelisen, 18-22% Mn.....	net ton	25.00	—	27.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.25	—	....
Ferrosilicon, 10-15%.....	net ton	38.00	—	40.00
Ferrosilicon, 50%.....	net ton	60.00	—	65.00
Ferrosilicon, 75%.....	net ton	130.00	—	135.00
Ferrotungsten, 70-80%, per lb. of contained W.....	lb.	.40	—	.45
Ferroumium, 35-50% of U, per lb. of U content.....	lb.	6.00	—	....
Ferrovanadium, 30-40% per lb. of contained V.....	lb.	4.25	—	4.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content.....	net ton	\$8.00	—	\$10.00
Chromite ore, Calif concentrates, 50% min. Cr ₂ O ₃	ton	25.00	—	27.00
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard.....	ton	25.00	—	27.00
Coke, foundry, f.o.b. ovens.....	net ton	4.25	—	4.50
Coke, furnace, f.o.b. ovens.....	net ton	3.00	—	3.25
Coke, petroleum, refinery, Atlantic seaboard.....	net ton	14.00	—	15.00
Fluorspar, lump, f.o.b. mines, New Mexico.....	net ton	12.50	—	....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	20.00	—	22.00
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01	—	.01
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	.20	—	.21
Manganese ore, chemical (MnO ₂).....	net ton	50.00	—	55.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.55	—	.60
Monazite, per unit of ThO ₂ , c.i.f. Atlantic seaport.....	unit	30.00	—	....
Pyrites, Spanish, fines, c.i.f. Atlantic seaport.....	unit	.12	—	.12
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.12	—	.12
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.11	—	.12
Rutile, 95% TiO ₂ per lb. ore.....	lb.	.15	—	....
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	2.75	—	3.00
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	3.00	—	3.25
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	1.50	—	2.50
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.25	—	2.50
Vanadium pentoxide, 99%.....	lb.	12.00	—	14.00
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1.00	—	....
Zircon, washed, iron free.....	lb.	.03	—	....

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic.....	12.125
Aluminum, 98 to 99 per cent.....	24 5/8 @ 25
Antimony, wholesale lots, Chinese and Japanese.....	4 45 @ 4 50
Nickel, ordinary (ingot).....	41.00
Nickel, electrolytic.....	44.00
Monel metal, shot and blocks.....	35.00
Monel metal ingots.....	38.00
Monel metal, sheet bars.....	40.00
Tin, 5-ton lots, Straits.....	26.50
Lead, New York, spot.....	4.60
Lead, E. St. Louis, spot.....	4.40
Zinc, spot, New York.....	4 50 @ 4 55
Zinc, spot, E. St. Louis.....	4 175

OTHER METALS

Silver (commercial).....	oz.	\$0.63
Cadmium.....	lb.	1.00—1.25
Bismuth (500 lb. lots).....	lb.	1.50 @ 1.55
Cobalt.....	lb.	3.00 @ 3.25
Magnesium (f.o.b. Philadelphia).....	lb.	1.25
Platinum.....	oz.	72.00 @ 78.00
Iridium.....	oz.	160.00 @ 170.00
Palladium.....	oz.	52.00—55.00
Mercury.....	75 lb.	42.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled.....	19.50
Copper bottoms.....	27.00
Copper rods.....	18.00 @ 18.75
High brass wire.....	15.75
High brass rods.....	13.25
Low brass wire.....	17.25
Low brass rods.....	17.25
Brazed brass tubing.....	25.00
Brazed bronze tubing.....	29.75
Seamless copper tubing.....	19.50
Seamless high brass tubing.....	18.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current	Cleveland	Chicago
Copper, heavy and crucible.....	9.00 @ 9.25	9.25	9.50
Copper, heavy and wire.....	8.25 @ 8.50	8.50	8.50
Copper, light and bottoms.....	7.00 @ 7.25	7.50	7.25
Lead, heavy.....	3.00 @ 3.25	3.25	3.25
Lead, tea.....	2.25 @ 2.35	2.25	2.25
Brass, heavy.....	4.00 @ 4.25	4.50	5.00
Brass, light.....	3.00 @ 3.25	3.25	3.50
No. 1 yellow brass turnings.....	3.75 @ 4.00	4.25	4.50
Zinc.....	2.00 @ 2.25	2.00	2.25

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by 1/2 in. and larger, and plates 1/2 in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes.....	\$2.88	\$2.88	\$2.88
Soft steel bars.....	2.78	2.78	2.78
Soft steel bar shapes.....	2.78	2.78	2.78
Soft steel bands.....	3.42	3.48	3.48
Plates, 1/2 to 1 in. thick.....	2.88	2.80	2.80

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

BIRMINGHAM—The Wofford Oil Co., has plans under way for extensions and improvements in its plant to cost about \$750,000. A large portion of the work will cover the installation of equipment for gasoline production.

Georgia

COLUMBUS—The Columbus Sewer Pipe Co., manufacturer of vitrified pipe, is considering the rebuilding of the portion of its plant recently destroyed by fire with loss estimated at about \$75,000. Judson C. Buchanan is manager.

Kentucky

ASHLAND—The Norton Iron Works will commence the immediate construction of a new 2-story plant addition, 150 x 200 ft., for the manufacture of wire screen cloth and kindred products. T. M. Adams is president and general manager.

LOUISVILLE—The Progress Pressed Brick Co. has perfected plans for the erection of a 1-story addition to increase the plant capacity from about 20,000 to 45,000 bricks a day. A. P. Hildebrand is president.

Louisiana

NEW ORLEANS—The Maryland Refining Co. has broken ground for the erection of its proposed new oil refinery on site recently acquired, estimated to cost in excess of \$1,000,000 with machinery.

NEW ORLEANS—The Colonial Chemical Co. has acquired a local site and plans for the erection of a new plant. Headquarters are at Reading, Pa.

Maine

RUMFORD—Owing to labor troubles, the Continental Paper & Bag Co., is arranging for the removal of its local paper manufacturing plant to a new location. The mills will be dismantled at once.

Maryland

BALTIMORE—The United States Industrial Chemical Co., Curtis Bay, has filed plans for the erection of a new 1-story plant on Fairfield Ave. Work will be commenced at once.

Massachusetts

BELMONT—The Campbell & Wiswell Co., Boston, Mass., manufacturer of paints, varnishes, etc., has completed plans for the erection of a new 1-story, brick and reinforced-concrete plant on Hittinger St., about 60 x 90 ft.

Michigan

MONROE—The Monroe Paper Products Co. has commenced operations at its new local mill, recently completed, for the manufacture of folding boxboard and other paper products. The initial daily output will average about 75 tons, with the plant giving employment to close to 100 men. The company is said to have orders on hand to insure continuous production for an indefinite period. William R. Harris is president and Roy M. Sperry, secretary.

MONROE—The Consolidated Paper Co. has preliminary plans under way for the erection of a new mill for the manufacture of strawboard and affiliated paper products. E. C. Bauch is president.

DETROIT—The Solvay Process Co. has arranged for the resumption of production at its plant at Delray, near Detroit, following a shut-down for the past two months. The works will give employment to about 1,500 operatives for initial manufacture.

KALAMAZOO—Peter King, formerly president of the Monarch Paper Co., and associates are said to be planning for the organization of a new company, capitalized at \$20,000, for the erection of a local plant for the reclaiming of sulphite and ground wood from newspaper and other

grades of paper goods, the material to be used for the re-manufacture of paper products. The initial works will be equipped for a daily capacity of about 50 tons of material.

Mississippi

GREENVILLE—The Rainbow Oil Co., recently organized with a capital of \$500,000 by E. L. Wortham, El Dorado, Ark., and associates, has plans under way for the erection of a new oil-refining plant near Greenville.

Missouri

KANSAS CITY—The Corn Products Refining Co., 11 Battery Pl., New York, is planning for the construction of a new refinery at Kansas City. The plant will consist of a total of 16 buildings, with tanks and other miscellaneous structures, estimated to cost about \$5,000,000 with machinery. It will have an initial handling capacity of about 25,000 bush. of corn.

New Jersey

NEWFIELD—The Wilcox Durand Glass Co. is taking bids for the erection of a new 1-story plant extension, 31 x 101 ft., to be used for machine and other repair service. The W. P. Cameron Engineering Co., Witherspoon Bldg., Philadelphia, Pa., is architect and engineer.

KEASBEY—The National Fireproofing Co. has arranged for the resumption of production of hollow tile and other burned clay products, at its local plant, following a shut-down of several months' duration.

TRENTON—Fire recently destroyed a portion of the plant of the Acme Pottery Co., May and Beakes Sts., manufacturer of sanitary earthenware, with loss estimated at about \$50,000. The company is said to be planning for immediate rebuilding.

New York

NIAGARA FALLS—The Niagara Falls Felt & Paper Co., a subsidiary of the Niagara Falls Power Co., Canal Basin, has awarded a contract to the Read & Coddington Engineering Co., 238 Portage Road, for the erection of a new local plant, estimated to cost about \$300,000, including equipment.

TONAWANDA—Fire, Sept. 7, destroyed a plant portion of the plant of the Frontier Mfg. Co., Erie Ave., manufacturer of oil products, with loss estimated at about \$35,000.

Ohio

DAYTON—The Refiners Oil Co. has awarded a contract to the Dayton Asphalt Roofing Dayton, for the erection of a new 1-story plant on South Ludlow St., 60 x 100 ft.

TOLEDO—The Spitzer Paper Box Co., 3501 Monroe St., is planning for the erection of a new 3-story plant, 30 x 80 ft., on local site, estimated to cost about \$50,000. It will be used as an extension to the present works. George R. Rheinfrank, Gardner Bldg., is architect.

Oklahoma

HENRYETTA—The Henryetta Glass Co., recently organized with a capital of \$50,000, has acquired a local site, totaling about 2 acres, for the erection of its proposed new plant for the manufacture of globes, shades and other glassware for lighting services. H. L. Chambers is head.

Pennsylvania

PITTSBURGH—The Luzerne Cut Glass Works has resumed operations at its local plant following a shut-down of several months.

QUARRYVILLE—The Franklin Paper Bag Co., 305 Race St., Philadelphia, has plans under way for the erection of a new local plant about 50 x 75 ft., for the manufacture of its general line of paper products.

NEWCASTLE—The Universal Sanitary Mfg. Co., manufacturer of sanitary earthenware and other pottery products, is arranging for the immediate resumption of operations at its plant, following a shut-down

for a number of months past. The works will give employment to about 250 men.

DU BOIS—The Pittsburgh Lens Glass Co., Pittsburgh, will make a number of improvements and extensions at its plant at Falls Creek, remodeling certain portions of the works. It is planned to place the factory in operation at an early date.

DU BOIS—The Reliance Glass Co. will resume active production at its local plant at an early date, giving employment to about 250 men. Operations have been curtailed for a number of weeks past.

PHILADELPHIA—The Franklin Sugar Refining Co., South Orianna St., has awarded a contract to J. W. Paxson, 1021 North Delaware Ave., for the construction of a new building at its plant at Algon and Luzerne Sts., estimated to cost about \$85,000. The company will also make extensions and improvements in its power house at Reed and Meadow Sts. to cost about \$20,000.

NEW HOPE—The American Clay Products Co. is planning for the early operation of its new local plant, now in course of construction, for the manufacture of bricks. It is proposed to develop an initial output of about 250,000 vitrified bricks per day, and which amount will be increased at a later date. The plant will cost in excess of \$700,000.

Texas

FORT WORTH—The Texas Imperial Co., Fort Worth, is planning for the erection of a new oil refinery in the vicinity of Minerva, with initial capacity of about 100 bbl. a day.

STAMFORD—The Rule-Jayton Cotton Oil Co., recently organized with a capital of \$200,000, is planning for the erection of a large cotton oil mill on local site. C. M. Francis heads the company.

HOUSTON—The Texas Co. is arranging for the organization of a subsidiary organization for the development of sulphur properties in Mexico, comprising about 28,000 acres of land. It is proposed to establish a large production plant at the site.

SOMERSET—The Eggleston Oil Corp. is planning for the erection of a new oil refinery on local site to cost about \$60,000. It is proposed to develop an initial capacity of about 800 bbl. per day.

AMARILLO—The Plains Lubricating Co., recently organized, will operate a local plant for the production of lubricating oils. It is planned to operate on a basis of 50 drums of material per day.

Virginia

ROANOKE—The Roanoke Fiber Board Co. is completing plans for the rebuilding of its local plant, destroyed by fire last July. Bids for erection will be asked at an early date.

LYNCHBURG—The Lynchburg Glass Co. is arranging for the rebuilding of the portion of its plant recently destroyed by fire with loss estimated at about \$12,000. N. D. Eller is president.

PORTSMOUTH—The Texas Co., Houston, Tex., and 17 Battery Pl., New York, N. Y., is considering the erection of a new local oil manufacturing plant.

West Virginia

BELLE—The Belle Alkali Co. will take bids at once for the erection of a new 1-story plant on local site to cost about \$50,000. A list of equipment for installation has been arranged.

Wisconsin

SHEBOYGAN—The Falls Roller Mills have had plans prepared for the erection of a new local 5-story and basement flour mill, 50 x 60 ft., estimated to cost about \$125,000. E. Gozenbach is manager.

MADISON—The Malvorine Oil Co., 815 East Main St., will make extensions and improvements in its local works on Main St., estimated to cost about \$15,000.

SHEBOYGAN—The Trelling Kiel Oil Co., Calumet Drive, has awarded a contract to Verhulst Bros., 1621 Eddle Ave., for the erection of a new 1-story and basement plant building, 50 x 150 ft., estimated to cost about \$50,000.

Mexico

TAMPICO—The Corona Oil Co. is planning for the immediate erection of the second unit of its new local refining plant, to have a daily output of about 15,000 bbl. of material per day. The company has completed the construction of the first unit of the new plant. The total cost of the plant, including pipe lines, pumping stations, etc., will be in excess of \$5,000,000.

New Companies

THE BINGOL CHEMICAL CO., 2816 South Michigan Ave., Chicago, Ill., has been incorporated with a capital of \$50,000, to manufacture chemicals and chemical by-products. The incorporators are J. P. Davidonis, M. Jurgelonis and Andrew J. Bloomberg.

NEWSTADT BROS., INC., Wilmington, Del., has been incorporated with a capital of \$99,000, to manufacture paints, varnishes, etc. The incorporators are Samuel, Louis and Albert Newstadt, Wilmington. Harry P. Joslyn, Ford Bldg., represents the company.

THE ANCHOR OIL CORP., New York, N. Y., has been incorporated with a capital of \$100,000, to manufacture refined oil products. The incorporators are M. Berman, E. Weil and M. M. Sherower. The company is represented by H. Schapiro, 261 Broadway.

THE ALLYNDALE LIME CO., 235 State St., Hartford, Conn., has been organized to manufacture lime and affiliated products. W. C. Brooks, 479 West Main St., Meriden, Conn., is president; J. W. MacDonald, vice-president; and T. H. Goodrich, secretary-treasurer, 273 Washington St., Hartford.

W. N. WRIGHT, INC., Boston, Mass., has been incorporated with a capital of \$25,000 to manufacture chemicals, dyes and affiliated products. Wallace N. Wright is president; and Robert F. Wright, 212 Columbus Ave., treasurer.

THE PORTEOUS PRODUCTS CORP., New York, N. Y., has been incorporated with a capital of \$25,000 to manufacture rubber goods. The incorporators are A. G. Porteous, F. L. Woodward and W. R. Chamberlain. The company is represented by H. C. Knoepfel, 5 Beekman St.

THE AETNA CHEMICAL CO., Newark, N. J., has been incorporated with a capital of \$10,000, to manufacture chemicals and chemical byproducts. The incorporators are Gustave B. Feldman, S. H. Barnett and Vincent Aregena. The company is represented by Aaron Levinston, 20 Clinton St.

THE MCCARTHY FOUNDRY CO., 3307 South Lawndale Ave., Chicago, Ill., has been incorporated with a capital of \$300,000, to manufacture iron, steel and other metal castings. The incorporators are John C. Haswell, John J. Carroll and John P. Wheeland.

THE ORLANDO POTTERIES, INC., Orlando, Fla., has been incorporated with a capital of \$25,000, to manufacture china and earthenware products. M. J. Daetwyler, Orlando, is president; and G. D. Krebs, secretary-treasurer.

THE GUARD-GOOD CHEMICAL CORP., Geneva, N. Y., has been incorporated with a capital of \$10,000, to manufacture chemicals and chemical byproducts. The incorporators are L. H. and C. F. Guard, and G. G. Goodelle. G. I. Teter, Geneva, represents the company.

THE LOS ANGELES BRASS FOUNDRY, 2052 East Vernon Ave., Vernon, Cal., has filed notice of organization to manufacture brass, bronze and other metal castings. T. J. Morgozewitz, 416 Vernon Ave., Los Angeles, Cal., heads the company.

THE VICTORY SOAP JELLY CO., Iliion, N. Y., has been incorporated with a capital of \$25,000, to manufacture soaps and affiliated products. The incorporators are A. E. H. and W. B. Loomis, Iliion. The company is represented by J. A. McFarren, Iliion.

THE GARFIELD PETROLEUM CO., Enid, Okla., has been incorporated with a capital of \$100,000, to manufacture petroleum products. J. E. Sharp, Enid, is president; and Burton E. Moore, treasurer.

THE WATERPROOF PRODUCTS CO., 56 North Eighteenth St., East Orange, N. J., has filed notice of organization to manufacture waterproofing products, chemical specialties, etc. Leon Flacker heads the company.

JOHN F. WALSH & CO., New York, N. Y., has been incorporated with a nominal capital of \$5,000, to manufacture composition products. The incorporators are J. F. and J. J. Walsh and J. J. Maier. The company is represented by C. N. Rogers, 347 Fifth Ave.

THE TRADE COMPOSITION METAL CO., 538 South Dearborn St., Chicago, Ill., has been incorporated with a capital of \$15,000, to manufacture composition metal goods and kindred products. The incorporators are Julius C. Greenbaum, William S. Newburger and Maurice C. Handelman.

THE PACIFIC COAST TIRE & RUBBER MFG. CO., Los Angeles, Cal., has been incorporated with a capital of \$2,000,000, to manu-

facture tires and other rubber products. The incorporators are William B. Wightman, W. O. Bruess and Owen C. Emery, 106-A East Broadway, Glendale, Cal.

THE NASSAU FERTILIZER & OIL CO., Fernandina, Fla., has been incorporated with a capital of \$500,000, to manufacture fertilizers, oil products, etc. J. B. Guess, Jr., is president, and W. H. Faust, secretary-treasurer, both of Denmark, S. C.

THE KEENTON CO., New York, N. Y., has been incorporated with a capital of \$10,000 to manufacture chemicals, chemical byproducts, etc. The incorporators are E. Gettlinger, L. Weisberg and S. B. Lillenstein, 280 Broadway.

THE BENJAMIN PRODUCTS CORP., Jersey City, N. J., has been incorporated with a capital of \$1,000,000, to manufacture rubber products, gutta percha specialties, etc. The incorporators are Robert A. Van Voohls, Arthur R. Oakley and William E. Schiels, Jr. The company is represented by the Registrar & Transfer, 900 Market St., Wilmington, Del.

WILLIS BROS., INC., Jersey City, N. J., has been incorporated with a capital of \$25,000, to manufacture refined oil products. The incorporators are Merwin Rosenberg, Harry W. and William C. Willis, 245 Custer Ave.

THE TRIANGLE PRODUCING & REFINING CO., Los Angeles, Cal., has been incorporated with a capital of \$500,000, to manufacture petroleum products. The incorporators are John G. Clark, G. J. Knight and S. J. Bowman. The company is represented by Carnahan & Clark, 501 Investment Bldg., Los Angeles.

PERCIVAL E. FALKINGHAM, INC., New York, N. Y., has been incorporated with a capital of \$100,000, to manufacture chemicals and chemical byproducts. The incorporators are P. E. and K. E. Falkingham, and M. D. Craig. The company is represented by L. S. Posner, 15 Broad St.

THE HYGRADE GOLD STAMPING CO., Newark, N. J., has been incorporated with a capital of \$50,000, to manufacture stamped gold and other metal stampings. The incorporators are Isadore Silberman, and Jacob Alperun, 83 Wickliffe St.

THE GENERAL ALUMINUM CO., Knoxville, Tenn., has been incorporated with a capital of \$60,000, to manufacture aluminum and other metal products. The incorporators are E. H. Hickman, F. G. Arnett and H. B. Lindsay.

THE EYERS DRUG & CHEMICAL CO., Gloucester, Mass., has been incorporated with a capital of \$25,000, to manufacture chemicals, chemical byproducts, etc. G. P. Eyers is president; and Herbert H. Eyers, 175 Western Ave., Gloucester, treasurer.

GEORGE V. GROSS & CO., INC., New York, N. Y., has been incorporated with a capital of \$20,000, to manufacture oils, extracts and affiliated products. The incorporators are G. V. and G. E. Gross, and A. Davis. The company is represented by Cohen Bros., 35 Wall St.

THE PEQUOT MFG. CORP., New York, N. Y., has been incorporated with a capital of \$100,000, to manufacture paper products, paper boxes, etc. The incorporators are E. J. London, N. Bogin and M. L. Arnstein, 320 Broadway.

THE TRENT RUBBER CO., Trenton, N. J., has been incorporated with 10,000 shares of stock, no par value, to manufacture rubber products. The incorporators are William V. Lee, I. M. Martino and George Gildea. The company is represented by Thomas H. Thropp, Enterprise Ave.

THE MILLS-PENFIELD CORP., New York, N. Y., has been incorporated with a capital of \$20,000, to manufacture paper products. The incorporators are I. Mills, C. H. Penfield and J. Cohen, 7 West Eighth St.

THE HOPWOOD RETINNING CO., 459 Main St., Charlestown, Mass., has filed notice of organization to manufacture metal products. John A. Hopwood heads the company.

THE FLYNN SPECIALTIES CO., New York, N. Y., has been incorporated with a capital of \$200,000, to manufacture spark plugs and kindred products. The incorporators are J. F. and A. L. Flynn, and S. M. Platt, 908 Brook Ave., Bronx.

THE VACUUM FLOTATION CORP., New York, N. Y., has been incorporated with a capital of \$50,000 to manufacture chemical products. The incorporators are C. M. Chapman, C. S. Clark and C. P. Northrup, 31 Nassau St.

THE INSULATION & SPECIALTY CORP., Wilmington, Del., has been incorporated with a capital of \$500,000, to manufacture insulation products, fiber specialties, etc. The incorporators are W. L. Broman, P. C. Henning and J. L. McIntire, all of Wilmington.

Capital Increases, Etc.

THE FEDERAL CHEMICAL CO., Woodstock, Ill., has filed notice of increase in capital from \$10,000 to \$50,000.

DUNLOP AMERICA, LTD., River Road, Buffalo, N. Y., manufacturer of tires and rubber goods, has filed notice of change of name to the Dunlop Tire & Rubber Corporation of America.

THE JUNE CHEMICAL WORKS, INC., Wilkes-Barre, Pa., has filed notice of increase in capital from \$100,000 to \$250,000.

THE FISK RUBBER CO., Chicopee Falls, Mass., has arranged for a bond issue of \$10,000,000, following a merger with the Federal Rubber Co., Cudahy, Wis., and the Ninigret Co., Westerly, R. I.

THE UNITED STATES ASBESTOS CO. OF ILLINOIS, Chicago, has filed notice of increase in capital from \$25,000 to \$75,000.

THE CORTLAND GRINDING WHEEL CORP., Cortland, N. Y., has filed notice of dissolution under state laws.

THE ROSEVILLE POTTERY CO., an Ohio corporation, has filed notice of organization to operate in New York. M. T. Scott, 621 Fifth Ave., is representative.

THE WATSON-FITZGERALD CO., Danville, Va., manufacturer of bricks and other burned clay products, is arranging for an increase in capital to \$150,000.

THE APEX CHEMICAL CO., a New York corporation, has filed notice to operate in New Jersey for the manufacture of chemical products. The company is represented by H. Nelson Craig, 200 South First St., Elizabeth, N. J.

THE RIVER RAISIN PAPER CO., Monroe, Mich., has arranged for a bond issue of \$2,200,000.

Manufacturers' Catalogs

THE JEFFREY MANUFACTURING CO., Columbus, O., calls attention to Catalog 350, on Jeffrey conveying machinery, which contains illustrations, price lists and dimensions of Jeffrey chains, sprockets, conveyor and elevator details, transmission and gears.

THE ALDRICH PUMP CO., Allentown, Pa., has issued a 16-page catalog on Aldrich pumps.

THE PARKS-CRAMER CO., Fitchburg, Mass., has issued an attractive booklet on "Fluid Heat Transmission by the Merrill Process."

THE PACIFIC FOUNDRY CO., San Francisco, Cal., calls attention to a new catalog on "Corrosiron." Products made from Corrosiron, which is a high-silicon alloy, such as pipe and fittings, valves, plug cocks, plunger pumps, centrifugal pumps, etc., are illustrated and described. Specifications are also given. The physical properties are given, as well as information about the machining of Corrosiron, designs and patterns, casting, together with general information on areas and circumferences of circles, density of liquids, metric equivalents of feet and inches, conversion factors, and weights and measures.

PAWLING & HARNISCHFEGGER CO., Milwaukee, Wis., has just issued Pamphlet TX which describes and illustrates the new Skimmer Boom designed for attachment to the standard P & H 205 or 206 Excavator-Crane. The point is made that by replacing the standard boom of either of these cranes, an efficient road-grading machine is provided. In fact, this is similar to the Shovel Attachment brought out earlier this year and which is designed for use with either of the two types of P & H cranes mentioned. Data and operating cost figures on a road grading job done by William Datka, contractor, are included, together with a profile for the road, prepared by the county highway department.

THE MALCOLMSON BRIQUET ENGINEERING CO. has consolidated with the St. Louis Briquette Machine Co. under the corporate name of the Malcolmson Engineering & Machine Corp. This company acts as engineer and contractor for the building of complete plants for fuel, fuel briquetting, peat harvesting, low-temperature distillation of fuels, preparation of phosphate rock and for the drying, crushing and screening of coal and rock products. The officers of the new company are C. T. Malcolmson, president; G. Komarek, vice-president; C. E. House, secretary, and W. J. Monahan, treasurer. Offices are in the Old Colony Bldg., Chicago, Ill.

THE CALCO CHEMICAL CO., Bound Brook, N. J., has prepared some interesting data and maps showing the condition of the coal-tar dye industry in the United States in 1914 as compared with that of 1920. In 1914 there were only seven small plants in three states, employing 528 men. In 1920 there were 82 dye plants located in eighteen states, the largest employing about 4,000 men. There were also 213 coal-tar chemical plants located in twenty-five states. These conditions are cited by the Calco Chemical Co. as evidence against the presumption of a monopoly of the American dye industry.

THE PETROLEUM TRUST REFINERY, with offices in Chicago, Ill., has begun operations at the former plant of the Seven States Oil Co., Hollywood Ave., Memphis, Tenn. The plant is now running at a capacity of 800 bbl. per day, which will be increased by the end of the summer to 6,000 bbl. per day. Crude oil is being shipped in from the fields at Eldorado. B. W. Franklin is general superintendent of the Memphis plant.

THE NIAGARA RADIATOR & BAR CO., Chicago, has purchased 10 acres at the southwest corner of 83d St. and Woodlawn Ave., and is laying plans for the erection of a new foundry 140 x 175 ft. Later a 4-story warehouse will be built, making the total expenditure involved about \$250,000.

New Publications

BOOKS

SILICA AND THE SILICATES. By James A. Audley. Pp. 374; 27 illustrations. New York: D. Van Nostrand Co., 1921. Price, \$4.50.

This volume of the series on Industrial Chemistry edited by Dr. Samuel Rideal describes the silicate industries and their raw materials in the following order: silica, the many forms in which it occurs in nature; silicates and other compounds containing silica; lime, mortar and cement; the ceramic industries; glass and enamels; miscellaneous applications of silicates—alum, slag fertilizers, soils, earthy and other silicate pigments.

TECHNICAL METHODS OF ANALYSIS. Edited by Roger Castle Griffin, director of analytical department, Arthur D. Little, Inc. Pp. 666; 29 illustrations. New York: McGraw-Hill Book Co., Inc., 1921. Price, \$6.

Analytical methods which have been adopted as standard procedures in the laboratories of Arthur D. Little, Inc., have been brought together in classified form. The book covers a wide range of technical products and is supplemented by an excellent bibliography. The methods are grouped under the headings: Reagents; general inorganic analyses; general organic analyses; analysis of metals; fuels; paints and paint materials; oils, fats, waxes and soaps; wood, paper and paper-making chemicals; textiles and textile fibers; food-stuffs; miscellaneous—leather, rubber, case-hardening and cutting compounds, water, boiler scale, fertilizers, pitches, tars, cement and concrete, etc.

FAMOUS CHEMISTS: THE MEN AND THEIR WORK. By Sir William A. Tilden, F.R.S., D.Sc., LL.D., professor emeritus of chemistry in the Imperial College of Science and Technology. Pp. 296, illustrated. New York: E. P. Dutton & Co., 1921. Price, \$5.

"Among those who have supplied indispensable links in the chain of events which has culminated in the present state of knowledge in chemistry there are but few whose names are known even among well-educated people. And yet the story of their lives is full of interest and instruction for all who care about the progress of science.

"The present volume is an attempt to sketch, in a style suitable for general reading, the lives of some of the most prominent chemists of the past. As it is obviously impossible for one person to deal with them all, the first great difficulty in such a project is to make the selection. After much reflection the guiding principle adopted is the evolution of the atomic theory from the point of view of the chemist.

"The first question is, Who is to be included? A crowd of names comes at once into the mind and each man seems entitled to be called a 'great chemist'; but of those who have not been included it will be found, I believe, that however important their contribution to science their discoveries have not been indispensable along the line indicated. No disrespect is intended to any of them, but the necessity for limitation imposes a restraint which it would be easier to disregard than to comply with."

Thus the evolution of the atomic theory is traced in the lives of twenty-one chem-

ists: Boyle, Black, Priestley, Cavendish, Scheele, Lavoisier, Davy, Dalton, Gay-Lussac, Proust, Berzelius, Faraday, Avogadro, Cannizzaro, Liebig, Dumas, Frankland, Williamson, Mendeleeff, Crookes, Ramsay.

PHYSICAL CHEMISTRY FOR COLLEGES. By E. B. Millard, assistant professor of physical chemistry, Massachusetts Institute of Technology. Pp. 411; 61 illustrations. New York: McGraw-Hill Book Co., Inc., 1921. Price, \$3.50.

The more important topics of physical chemistry are treated at such length as the size of the volume allows and numerous references to recent periodical literature are included for those who would pursue any given topic further. The limitations of the orthodox laws of physical chemistry are emphasized more than is commonly done in beginning courses of physical chemistry, since it is felt that a wholesome appreciation of physical chemistry as an unfinished and growing science may stimulate thoughtfulness and research.

A TEXTBOOK OF INORGANIC CHEMISTRY FOR COLLEGES. By James F. Norris, professor of organic chemistry, Massachusetts Institute of Technology. Pp. 677; 45 illustrations. New York: McGraw-Hill Book Co., Inc., 1921. Price, \$3.50.

The subject matter is presented in a form which can be reasonably well followed by the student through private study and with the smallest amount of explanation on the part of the teacher. The subject is developed slowly and the consideration of the more abstruse material has been deferred until the student has gained some familiarity with chemical phenomena and with the language of the science.

AMERICA'S POWER RESOURCES. By Chester G. Gilbert and Joseph E. Pogue. Pp. 326; 37 illustrations. New York: The Century Co., 1921. Price, \$2.50.

This book is an attempt to interpret the special, though generally unrecognized, importance attaching to the energy resources—coal, oil, natural gas and water power; and to point to the shortcomings in the way they are handled, to which a considerable measure of our current economic difficulties is traceable. The attempt is also made to outline the changes in energy administration that are bound to come into play, if due social and industrial progress is to be attained, and to indicate the avenues of advance to which constructive efforts need to be applied. The material presented is largely the result of investigations carried on by the authors in the Smithsonian Institution, in the Fuel Administration, and in a somewhat diversified engineering practice, and brought out from time to time as special papers, emanating mostly from the Division of Mineral Technology, United States National Museum. These special contributions have attracted such notice that it seemed desirable to weld the results into this unified and less technical form for wider and more popular presentation.

AMERICAN CHEMISTRY. By Harrison Hale, Ph.D., head of department of chemistry, University of Arkansas. Pp. 215; 63 illustrations. New York: D. Van Nostrand Co., 1921. Price, \$2.

A popular treatment of the chemical industries which should be useful to the general reader and to the student as collateral reading with a course in general chemistry. The illustrations are excellent and should help the student in visualizing plant operations. References at the end of each chapter encourage further study of topics in which special interest has been aroused.

ORGANIC COMPOUNDS OF MERCURY. By Frank C. Whitmore, Ph.D., professor of organic chemistry, Northwestern University. Pp. 397. New York: The Chemical Catalog Co., Inc., 1921. Price, \$4.50.

The total amount of work which has been done on organic mercury compounds is probably greater than that done on the organic arsenicals, but it has received much less publicity. Although a number of monographs have been written in English and in German on the arsenic compounds, this is the first which has appeared in any language on the mercurials. It is number three in the American Chemical Society's series of scientific and technologic monographs.

THE WORKING OF STEEL. By Fred H. Corvin, editor, American Machinist, and K. A. Juthe, chief engineer, American Metallurgical Corporation. Pp. 245; 125 illustrations. New York: McGraw-Hill Book Co., Inc., 1921. Price, \$3.

A practical discussion of the annealing, heat-treating and hardening of carbon and alloy steel.

PHILOSOPHY AND THE NEW PHYSICS. By Louis Rougier, translated by Morton Masius, professor of physics, Worcester Polytechnic Institute. Pp. 159. Philadelphia: P. Blakiston's Son & Co., 1921. Price, \$1.75.

An essay on the relativity theory and the theory of quanta.

STATISTICAL ABSTRACT OF THE UNITED STATES, 1920. Pp. 874. Washington: Superintendent of Documents, Government Printing Office. Price, 50c., paper covers.

THE SILVER BROMIDE GRAIN OF PHOTOGRAPHIC EMULSIONS. By A. P. H. Trivelli and S. E. Sheppard. Pp. 143, illustrated. New York: D. Van Nostrand Co., 1921. Price, \$2.50.

This is the first of a series of monographs on the theory of photography from the research laboratory of the Eastman Kodak Co., edited by Dr. C. E. Kenneth Mees and Mrs. Mildred S. Schramm. It presents the results of a complete crystallographic study of the grains of high-speed emulsions which showed that all the grains belong to the same crystalline class and that consequently their formation in the emulsion could be studied in the light of von Weimarn's dispersion theory.

PAMPHLETS

THE ENGINEER AND THE UNIVERSITY. New York: Columbia University, 1921.

An interesting and attractive presentation of the engineer's status in industry, of the problems involved in his education and of what the School of Mines, Engineering and Chemistry of Columbia University has to offer toward the solution of these problems.

INTERFACIAL TENSION MEASUREMENTS AND SOME APPLICATIONS TO FLOTATION. By Robert B. Elder. Pamphlet No. 1, Bureau of Mines and Geology, State of Idaho, published in co-operation with the U. S. Bureau of Mines. Moscow: University of Idaho, 1921.

A mathematical consideration of the Du Nouy and Fahrenwald methods for measuring surface tensions and their application to flotation problems.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its seventy-fourth meeting at Toronto, Canada, Dec. 27 to 31, 1921.

AMERICAN CERAMIC SOCIETY will hold its twenty-first annual meeting at St. Louis, Feb. 27 to March 2, 1922.

AMERICAN GAS ASSOCIATION will hold its third annual convention in the Congress and Auditorium Hotels, Chicago, the week of Nov. 7. More than 100 manufacturers will exhibit their latest gas-burning appliances.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting at Lake Placid, N. Y., Sept. 29 and 30, and Oct. 1.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its annual winter meeting at Baltimore, Md., Dec. 6 to 9. Headquarters will be at the Southern Hotel and the sessions will be held in the Engineers' Club.

AMERICAN MINING CONGRESS AND NATIONAL EXPOSITION OF MINES AND MINING EQUIPMENT will hold its twenty-fourth annual convention in the Coliseum, Chicago, Oct. 17 to 22.

AMERICAN SOCIETY FOR STEEL TREATING is holding its third annual convention and exhibition Sept. 19 to 24 at Indianapolis.

NATIONAL SAFETY COUNCIL will hold its tenth annual conference at the State House, Boston, Mass., Sept. 26 to 30.

NEW JERSEY CHEMICAL SOCIETY has discontinued meetings for the summer and will resume them in October.

SOCIETY OF INDUSTRIAL ENGINEERS will hold its fall meeting at Springfield, Mass., Oct. 5 to 7.

The following meetings are scheduled to be held in Rumford Hall, the Chemists' Club, New York: Oct. 7—American Chemical Society, regular meeting; Oct. 14—Société de Chimie Industrielle, regular meeting; Oct. 21—Society of Chemical Industry, Grasselli Medal; Nov. 11—American Chemical Society (in charge), Society of Chemical Industry, American Electrochemical Society, Société de Chimie Industrielle, joint meeting; Nov. 18—American Electrochemical Society, regular meeting; Dec. 2—Society of Chemical Industry, regular meeting; Dec. 9—American Chemical Society, regular meeting.

CHEMICAL & METALLURGICAL ENGINEERING

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A consolidation of
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Assistant Editors
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Industrial Editor
J. S. NEGRU
Managing Editor

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The Chemical Exposition

THE Seventh National Exposition of Chemical Industries has gone into history, and when we consider the dullness of the times and the depression in all trade we can use the record to prove that chemical industry in the United States is alive. It is true that some of the exhibitors who usually make great displays reserved their space but showed no wares, merely equipping their booths as offices and reception rooms. Of these, however, there were but few, most exhibitors making their usual displays.

Although the trip to the armory at which the Exposition was held involved a long and weary journey—far beyond the Polo Grounds, which is “farthest north” for any but the most intrepid patrons of New York’s rapid transit system—there was an attendance only slightly smaller than was recorded at Grand Central Palace last year. The immense floor of the armory provided ideal exhibition conditions and exhibitors seemed to be well satisfied not only with the number of spectators but with the volume and character of the inquiries. It was a quality crowd. Far fewer “literature hounds” overran the premises. By the same token, fewer inquiries came from entire strangers. Most of the callers were old friends and visitors looking for valuable improvements or innovations.

It will be good news, however, that by a large majority the exhibitors voted to hold the 1922 Exposition in the old quarters at Grand Central Palace. This more convenient location, nevertheless, has the disadvantage of its merit in that the crowd of visitors becomes almost unmanageable and the vast number of curiosity seekers makes it difficult for interested persons to get information. Something will have to be done to regulate the attendance and restrict it to an appropriate class.

It will be news to many, as it was to us, that the plan to remodel Grand Central Palace into an office building was never consummated. Accordingly the building is still available for expositions, although a year ago its owners officially declined to consider the Chemical Exposition for 1921 on account of the proposed change. This forced the Chemical Exposition management to look for new quarters, resulting in the selection of the armory.

On the whole the Exposition was a great success. Some criticism could be recorded, but most of it pertains to the matter of location, which will not be a bothersome factor next year. All things considered, there was little complaint, although we have not yet heard from those who deftly purloined from the exhibit of the U. S. Industrial Alcohol Co. bottles of clear water-white liquid labeled “Ethyl Alcohol” but containing *aqua pura*. Doubtless when those individuals fondly began to mix their cocktails they concluded that the Exposition was a snare and delusion.

The Shoemaker And His Last

ANNUALLY for several years past there has been some mild talk on the part of a few exhibitors at the Chemical Exposition in favor of organizing for the purpose of holding and controlling an exposition of their own. Apparently the thought was inspired by a feeling that the Exposition Company was growing rich at the expense of the exhibitors and that the latter might as well run their own exposition on a mutual basis, and benefit accordingly. Perhaps this type of reaction and line of reasoning are natural enough, but we doubt if the reasoning is sound and logical.

We hold no brief for the Exposition Company. In fact we know nothing of it except through contact with its two managers. But we think it is possible by giving a little thought to the subject to see the futility of such a proposal as has recurred with the close of each exposition. The conduct of expositions is a business, just as the manufacture of chemical equipment or the publication of a chemical magazine is a business. It requires money, brains and organization. Expositions do not spring into full-fledged existence over night, nor do they manage themselves. Somebody works the year round on the Chemical Exposition.

There is no reason to believe that an association of manufacturers conducting their own exposition on a mutual basis could achieve the results of the last seven expositions without resorting to the same means that have made those expositions increasingly successful. If a mutual organization of manufacturers were to attempt to conduct their own organization they would find it necessary, first, to provide the money through subscription to capital stock; second, to employ skilled and experienced exposition managers to conduct their business for them, and third, to devote considerable time to the conduct of the association’s affairs. If there is anything attractive in this scheme it is not apparent on the surface. The net result would be additional burdens and inevitable disappointment and dissatisfaction due to attempting something entirely outside the training and experience of those who would undertake the task.

The whole conception is based on an industrial fallacy. Extended to its logical limit, it would involve each man doing everything for himself instead of allowing a specially qualified man to do one thing for a large number of us. That the promoters of the Chemical Exposition have made money is not to be doubted, otherwise they would not have continued in the business. Presumably the same is true of every exhibitor in his particular line of business. Business ventures succeed and make money because they render a service—real or imaginary. The Exposition Company has taken advantage of a great opportunity, but we believe it has also rendered a real service. If that service has not been all that it should be, there is no more cer-

tain way of improving it than by frank consultation and co-operation with the management or its advisory committee. No permanent good can be accomplished by holding aloof or indulging in carping criticism.

If we may judge from the way in which space has already been taken for next year's show, we may justly conclude that the proposal for exhibitors to hold their own exposition will make no substantial headway, and we hope it will not. Let the shoemaker stick to his last. If there is no satisfactory reason for the existence of the present Exposition, certainly none can be advanced for a substitute. We believe that the Chemical Exposition Company has a useful purpose to serve and that it has shown itself worthy of the support of the chemical industries. That the management has made mistakes there is no doubt; but it is equally certain it has been open to constructive criticism and has acquired experience that can only be increasingly useful as long as chemical expositions are held.

The Rubber Industry And the Planters

WHEN an American visualizes the word rubber he thinks of factories, tires, tubes, belts, hose, etc., for our end of the rubber industry is manufacturing. But in Europe, particularly in the British Isles and Holland, the reaction is entirely different. Your traveled Englishman will think of countless waving trees among which flits the inevitable coolie with his can of latex, for the British are the planters.

Taking the year 1919 rather than 1920 as a basis, a study of statistics shows that the United States consumed 68 per cent of the world's production of rubber, which amounted to 339,000 tons. The production for 1920 was 368,000 tons, practically 89 per cent of which was produced on the plantations of the Far East. Our British cousins own about 75 per cent of the plantation acreage, which in 1919 reached a total of 2,181,000 acres in bearing with 730,000 acres yet to come in. Their investment amounts to about \$300,000,000, of which by far the larger portion is held by small investors throughout the British Isles.

America therefore stands as best customer to the plantation industry. About 70 per cent of the rubber consumed in this country goes into tires and tubes. Consequently anything that affects the tire industry is soon the cause of no little concern in Great Britain. Unfortunately for the planters, their business has been built on a steadily rising American demand. When that demand is curtailed or cut off, there is no other market in which to dispose of the surplus. The situation from the Britisher's point of view has been rather well summarized by H. P. STEVENS in a recent issue of the *Journal of the Society of Chemical Industry*.

The chief difficulty is that our friends the planters have developed practically a one-market business. The depression of 1920-21, which played such havoc with our one-product tire factories, naturally raised Ned with the price of plantation rubber, which dropped from 40-50c. per lb., the normal price range of 1918-19, to 10-15c. This is considerably below the cost of production, which has been variously estimated at 18 to 25c. per lb. These are facts. The question is what to do about it.

The planters, through their association, are curtailing production. Their plan is evidently to produce only enough rubber to meet the demand. This will help, but will not furnish a complete remedy. The American

depression, coming as it did from real and not imagined causes, cannot be expected to have a short period of convalescence. The recovery will be slow and gradual, and has been estimated at from two to five years before normal conditions will be reached.

The remedy for our one-product tire factories is to diversify, play to more than one market. The advice applies to the planters as well. Tea, coffee and other tropical products should be made a regular business and not a side line. In fact there appears to be no reason why the planters cannot turn their attention to cultivating other trees and shrubs yielding valuable materials such as the alkaloids and even the tannins.

For several years past the Rubber Growers' Association has offered handsome prizes for new uses for rubber. To date we know of no awards having been made. There are plenty of new developments under way, but they are the outgrowth of a definite demand. Most of these schemes have still several years of research ahead of them. It is possible that new uses will be developed, but not soon enough to have a serious effect on the market for the next five years.

All credit is given the planters for the high quality of plantation rubbers, but it will be admitted by practically all American rubber technologists that there is still something lacking. Fine para (true up-river fine) is still the best rubber produced in point of (a) uniformity in period of vulcanization; (b) nerve; (c) elasticity and tack; (d) viscosity of cement, and (e) life. These properties could be elaborated to considerable extent. Suffice it to say that the ignorant *seringueiro* of the Amazon country, who prepares his hams by a method passed down to him from the ages, produces a rubber in many ways superior to the finest product of the scientifically controlled plantation.

Superior cleanliness, constancy of supply and reasonable constancy of product, coupled with price, have been in favor of the planter in his battle with the wild rubbers. Research has been practiced on the plantations, but many things of little importance have been magnified far beyond their deserts. Isn't it time that an effort be made to get at the fundamentals of rubber production and to produce a superior product?

The Psychology Of Business

SOME keen observers of business conditions and trends have lately been expressing the opinion that business has become ripe for a decided turn for the better. They base their opinion not so much upon the concrete underlying facts as upon their appraisal of how men's minds will act. The lapse of time since business got into the dumps is a prominent factor. In war time it is shown that it is not in the nature of the human mind for the owner to be scared continuously. It is a feeling which the normal individual cannot hold steadily. The average business man, according to the view of many observers, cannot remain indefinitely in a lethargic condition, or in a condition of waiting. When prices began to decline, some manufacturers decided to shut up shop, and some even declared that they would not reopen until they got their price. After a time the condition of a closed factory grew irksome to the owner and he became disposed to make some goods even if it was not certain he could make money.

It is supposed to be a distinctly feminine trait not to assign the real reason for an opinion or course of conduct. That may not be the case with business men,

yet an observer can see that business men do something not altogether dissimilar in making selection of different sets of facts from one time to another to find a reason or an excuse for a line of conduct. The facts selected may be hard, even statistical, the selection, however, being due to the mental state.

From the great mass of business facts available one can, as a matter of fact, make selections that will be decidedly encouraging or decidedly discouraging, and if the selection is dictated by the mental condition, psychology rules conduct, even though statistics are paraded as the basis. One may say that business is very bad, for there are 5,000,000 persons out of employment, but one may also say that business is not so very bad and there must be a considerable volume of buying power, since 35,000,000 or 40,000,000 people are in employment. One may say that money is tight and collections are poor, but it may also be observed that a great many payments must be made, since the Federal Reserve Board reports debits to individual accounts at banks running only 15 or 20 per cent below those of a year ago.

There really is little difficulty in selecting a collection of facts that will justify a line of conduct in business when psychological conditions have settled the question whether the individual desires support for a policy of "taking hold" again or of waiting still longer before doing anything.

Now it is an actual fact, which everyone has had opportunity for years past to observe, that when business improves the reasons for the improvement are cited, in facts that already existed, and then many exclaim, "Why didn't we think of that before?"

Already there is some improvement in many lines of trade, and we may now look forward with confidence to the reasons for the improvement being duly set forth, after the fact. A year ago practically everyone realized that business and prices would have to be cast in a new mold, a process that would take time. Now we are ready to wake up to the realization that a year has elapsed, a year of great readjustment.

The Oppau Explosion

OUT of the chaos of newspaper misinformation gradually comes what seems to be a rational interpretation of the disaster at Oppau, Germany, which resulted from an explosion at the Haber nitrogen fixation plant located there. We are finally informed through press dispatches that it was an "explosive" which caused the damage and that it was not a huge tank of nitrogen which by its "explosion" caused the disaster. Also the mysterious new gas which was being compressed but whose "properties were not known" is no longer the guilty party even in the most garbled guesses of the layman.

An explosion of such suddenness and violence as to do damage twenty, thirty or even forty miles away as reported could not conceivably have been essentially a gas explosion. In the first place, it is very doubtful whether sufficient quantities of combustible or explosive gas existed at the plant to account for even the damage within the city of Oppau itself. And the characteristics of the explosion, if properly described in the press, are not those which result from the rupture of high-pressure containers. It seems evident, therefore, that it must have been some form of solid material which could be detonated that was the cause of the principal

damage done. Of course in any such case the initial cause of trouble and to what extent the principal cause was a secondary explosion can be disclosed only by careful investigation, and perhaps not even then.

It is known that this plant has been for some time experimenting with mixtures of ammonium nitrate and sulphate for fertilizer use with the idea of developing a material of highest agricultural value that would also be free from the objection of deliquescence. Accumulations of this material or of ammonium nitrate may well have caused the major explosion and the extensive damage. Of course there are also possibilities of nitrated organic compounds of high explosibility that may have been under investigation as intermediates for dye manufacture. It is almost useless to speculate regarding these details, for even the best informed specialists in this country who have tried to keep in touch with the work at Oppau are unwilling to venture more definite opinion than that expressed above.

The Conference On Unemployment

SPECULATION is rife as to what may be accomplished by the President's conference on unemployment now in session in Washington. Granted that there is urgent reason for focusing the best thought of the country on the problem, what practical consequences can be expected? For the immediate relief of unemployment, which is the critical factor, it seems likely that little can be accomplished. But the conference will be worth the time and energy expended if it clearly formulates broad policies that will prove a remedy or at least a palliative for widespread unemployment in the future. The program of the conference has three phases: First, the presentation of recent reliable statistics of unemployment; second, the consideration of possible immediate remedies, and third, consideration of economic and industrial processes that will prove to be long-time remedies. As in the case of President WILSON'S First Industrial Conference, useful and practical results depend largely on guidance that will keep the conference from being sidetracked on non-essential issues such as controversies between employer and employee. Under Mr. HOOVER'S direction we may confidently expect the conference to avoid any such fiasco. The fundamental factors brought out will be recorded in the technical and business press of the country to the exclusion of more spectacular but less essential matters of controversy that may be featured by the newspapers.

Denying a Pernicious Rumor

UNFOUNDED rumor has been circulated during the last two weeks to the effect that cases of infantile paralysis exist in the vicinity of Lake Placid, New York, where the American Electrochemical Society will hold its regular fall meeting September 29 and 30 and October 1. We are glad to be able authoritatively and unqualifiedly to deny these rumors. Members of the Lake Placid Club who are also members of the American Electrochemical Society have the assurance of the club officials that there is no foundation for the rumor, and we have also made an investigation which satisfies us that conditions at the Lake Placid Club are normal and that there is no cause for alarm. Members of the Society and readers of CHEM. & MET. can confidently deny the rumor should it persist.

Readers' Views and Comments

The Slip Interference Theory

To the Editor of Chemical & Metallurgical Engineering

SIR:—I would like to congratulate the authors of the Slip Interference Theory on the excellent work they have done in examining the problem of hardening of metals, not only from the point of view of the usual hypo-eutectoid steel, but taking into consideration the other alloys as well. I especially appreciate the authors' reference to duralumin, one of the alloys of the future, and the marked tendency of the paper to find a general solution of the hardening problem.

Examination of the summary (clauses 1 to 8) as well as the text finds abundant proof as to the interest the authors have shown in the crystallography of alloys. One may follow also with great interest the authors' argument that "every known method of hardening metals can be referred to the principle of slip interferences" and to the action of small "key-particles."

Further, the writer would like to emphasize that some of the facts derived from the study of damascene steel may be interpreted as supporting the authors' general views. So, for instance, the heat-treatment of damascene blades¹ could be more easily explained by taking into consideration not only the hardening phenomena as they are usually interpreted in hypo-eutectoid steels but the "keying" action of the small cementite particles as well. Hypo-eutectoid steel usually served as a point of departure for the theories of hardening of steel. In view of the absence of free cementite in these steels the influence of cementite particles was never sufficiently appreciated. Even the "carbon" theories sought for a new modification of carbon or of carbide and not for the possible rôle of the particles of the existing carbide in the hardened metal.

When studying damascene steel the writer came across the fact that such theories as would explain sufficiently well the hardening of hypo-eutectoid steel seemed unable to account for the heat-treatment of damascene blades or for their certain "high-speed hardness." He therefore sought for explanation elsewhere, and naturally enough was attracted by the idea that the presence of a large number of highly spheroidized cementite globules might furnish the necessary explanation. He must confess, however, that up to now he admits the hardening effect of cementite particles only to a certain degree and is rather reluctant to overestimate such influence. So, for instance, the properties of martensite seem to me to be best explained by its structure, which, "crystallographically" speaking, is characterized by Widmanstätten figures.² These figures result from the octahedral crystallization of steel and show that the elemental octahedra were deformed parallel to the four surfaces of the octahedron.

In austenite we have the gamma iron, and the iron carbide, cementite, is evenly dissolved in that iron. By rapid cooling it is possible to prevent the segregation of the carbide, and in martensite, where iron has passed

from the non-magnetic gamma to the magnetic alpha state, cementite remains in a suspended form, as if in solution.³ The sudden change of volume from gamma to alpha iron causes severe internal stresses which manifest themselves by deforming every elemental octahedron parallel to its four faces. The hardness of martensite results very likely from these internal deformations. I am therefore quite in agreement with the authors that martensite is alpha iron; where we differ is, first, that I consider martensite as a pseudo solution not of carbon, but of cementite in alpha iron; and further that not only the fineness of grain but chiefly the "Widmanstätten structure" of the deformed elemental octahedra is responsible for the hardness.

I do not think that colloidal suspended particles of cementite may act as keys in martensite. On the other hand, I join the authors in their appreciation of Captain Grard's curves. I am quite in agreement, therefore, with the authors' idea that the first "increase" in hardness after tempering is due to the "key" action of the segregating cementite.

The only reservation which the writer would like to make is that in this instance, as in other instances, the "key" action is responsible for a comparatively small increase in hardness and that there is a difference in scale between the "key" hardness and the "quenching" hardness.

While still believing that carbon in solid iron is present not as such but as iron carbide (or cementite),⁴ nevertheless I do not think that if the authors were to consider austenite from that point of view it would in any way change the main deductions of their so brilliantly exposed theory.

COLONEL NICKOLAS T. BELAIEW.

London, England.

Athletics and Chemistry

To the Editor of Chemical & Metallurgical Engineering

SIR:—I was very much interested to read in the last issue of your journal the short article on page 310 entitled "Athletics and Chemistry." In reading the article I immediately thought of the captain of the track team at the University of Illinois, John Prescott.

Mr. Prescott was graduated from the university in June, 1921, in the course in chemistry given here. You probably know the standing of the school of chemistry at the institution. He was a member of one of the largest and best-known college fraternities and was interested in a number of activities outside of his scholastic work. He was a member of "Pierrots," a campus opera organization, on the student council of the Illinois Union, elected to Ma-Wan-Da, the highest senior honorary society for activities, and the Tribe of Illini, an organization of athletes who have been awarded "I"s. In addition to these societies, he was elected to two honorary scholastic fraternities, Phi Lambda Upsilon, national honorary chemical fraternity, and Phi Beta Kappa for excellence in scholarship in the College of Liberal Arts and Sciences.

¹Belalew, "Crystallization and Structure of Steel," Thesis, Petrograd, 1909, p. 48. See also Belalew, "Damascene Steel," *J. Iron and Steel Inst.*, 1918, p. 417.

²Thesis, p. 25.

³Thesis, p. 29.

⁴Thesis, p. 48-56.

Prescott was a member of the varsity track team for three years, and was captain of the team his senior year. His best work was in the 220 low hurdles, but he does the "hundred" in "ten flat" and has done some distance work, being on the conference champion mile relay team in 1920. He captained the University of Illinois track team this past spring to the championship of the "Big Ten" conference, and then took his team to the national meet in Chicago on June 18, winning this meet and the championship of the United States.

He is a rare combination of quiet, likable personality, consistent athlete, par excellence student and chemist.

FRED H. TURNER,

University of Illinois.

Chief Clerk.

Italian Chemical Industries

FROM OUR SPECIAL CORRESPONDENT

GENOA, Italy, Sept. 6, 1921.

THE last five weeks has seen some activity in the Italian chemical and metallurgical market, although from the 7th to the 21st many operatives and employees were absent from the works on account of the summer holidays and the lire suffered a reduction in value, bringing down considerably the price in dollars or pounds of the chemicals manufactured. The lire prices of Italian and other chemicals did not, however, increase in all instances; some remained unchanged and others fell, in response to the volume of offers received from abroad, the heavier or lighter import duties, or the demand.

HYDRO-ELECTRIC DEVELOPMENTS

The construction of the hydro-electric plant that is destined to use the waters of the Lys is proceeding very satisfactorily, the principal difficulties having been overcome. The plants in the recently annexed Trento territory are fairly numerous. One of these is on the Sarco River and produces electric energy amounting to 15,000 hp., which is to be raised to 35,000 hp. in the next twelve months. Another, on the Ponale River, was destroyed during the war, but will soon be repaired and will produce 40,000 hp. There is a hydro-electric plant in the valley of the Flemme, on the River Avisio, which is used to work the mines of the Pedrazzo Works. Its 8,000 hp. will be brought later to 70,000, by the artificial creation of three new waterfalls. Besides these there is a hydro-electric plant of 40,000 hp. in the Venosta Valley (Etsch Werke) and several smaller ones.

ITALIAN FERTILIZERS

The Italian superphosphate industry, although supplying all national needs, is still greatly dependent on importations of the mineral phosphates, as can be gathered from the most recent statistics. During 1918 Italy imported 23,213 tons of such products, in 1919 44,932 tons and in 1920 40,000 tons. For the first four months of this year the importations reached 24,205 tons, against 12,605 tons for the corresponding months of 1920 and 14,050 in 1919. The largest quantities of mineral phosphates came from Tunis (22,077 tons) and from Egypt (517 tons). The demand for superphosphates is still low, owing to the fear of many that the prices will suddenly drop; for this reason very little was accomplished for the autumn and winter treatment of the ground. The same was the case with Italian cyanamide. This product, made either synthetically or from calcium cyanide, has been subjected

to a higher importation duty, to encourage its local production. The importations of superphosphates increased during the first four months of 1921, reaching 322 tons out of a total of 5,405 tons of fertilizers imported. The importation of Thomas slag also increased considerably in that period, being 5,117 tons. In the case of ammonium salts the importations reached 202 tons in the first four months of the year, against 392 tons in 1920 and 3,271 tons in 1919 during the corresponding months.

ITALIAN SULPHUR

The crisis in the Italian sulphur industry became more acute during August, culminating in the strike of some of the miners, who refused to accept a decrease in wages in view of the fact that the price of food had increased considerably. A few days from the time this is written a conference will be held at the Ministry of Industry at Rome between the principal representatives of the industry and the representatives of the workpeople. After this meeting the Italian Government will study the situation and endeavor to find a remedy to offset the increased cost of production.

CARBONATE OF SODA

The manufacture and exportation of carbonate of soda received but little attention in the past, as can be gathered from the fact that Italy imported 34,252 tons in 1920, against 27,234 tons in 1919 and 22,651 tons in 1918, and exported only 66 tons in 1920, 26 tons in 1919 and 25 tons in 1918. The importations made in 1920 were distributed as follows: From the United States, 6,972 tons; from France, 15,967 tons; from England, 4,916 tons; from Spain, 3,278 tons; from Switzerland, 2,253 tons, and from other countries, 865 tons. This year, however, the case has been different, for during the first four months the importations were reduced to 1,836 tons, as against 10,447 tons in 1920 and 6,943 tons in 1919 during the corresponding period.

ITALIAN SOAP INDUSTRY

The Italian soap industry has been greatly developed since the war. In 1920 6,140 tons of common soap was exported to Albany, Austria, Czechoslovakia, England, Greece, Jugoslavia, Poland, Rumania, Switzerland, European Turkey, Asiatic Turkey, Egypt, Tripoli and other countries, while the importations amounted to only 5,690 tons. The exportations of perfumed soaps reached 230 tons in 1920, against 401 tons in 1919 and 24 tons in 1918, and the importations amounted to 739 tons in 1920, against 808 tons in 1919 and 1,549 tons in 1918.

ITALIAN MATCH INDUSTRY

Several of the Italian match factories closed their works after announcing a reduction of wages, made necessary by the reduced demand on the part of the government and by the low profits made on exportations. This led to a meeting, at the Ministry of Industry at Rome, of representatives of the workpeople and of the industry, which is under the direct control of the government. Several discussions have also taken place in the Italian Parliament, but no solution of the difficulty has yet been reached. A new match factory has been started at Turin, which will manufacture exclusively for export. The exportations of matches from Italy in 1920 were 1,033 tons, in 1919 757 tons and in 1918 1,957 tons, but during the first four months of this year they were only 110 tons, against 458 tons for the corresponding months of 1920.



Photo, Underwood & Underwood.

The Seventh National Chemical Exposition

Report of the General Meetings and Technical Sessions of the Exposition, Which Included Symposia on Crushing, Grinding and Pulverizing, Evaporating and Drying, Paint and Varnish, Ceramics, Chemical Power Plants, and American Dyes and Colors

THE Seventh National Exposition of the Chemical Industries was formally opened Monday evening, Sept. 12, with a brief address by Dr. Charles H. Herty. He spoke of the new spirit which is unifying the chemical industries and welding them into a mighty organization, with the single purpose of serving our country in time of peace, or if need arise, in time of war. If the industries are to serve these vital needs, they must be conserved, not alone by the chemist, but by the people acting through their representatives in Congress.

CHEMICAL PROGRESS AND OUR NATIONAL DEFENSE

The importance of chemical progress to the national defense was discussed by Senator Irvine L. Lenroot, who is a prominent member of the Committee on Military Affairs of the United States Senate. The Senator has long been a friend and supporter of chemical warfare and has had occasion to observe its progress and development. He declared that the recent bombing tests had convinced him that the airplane, the airplane carrier, the submarine, poison gases and high explosives will be the implements of war of the future. In referring to the work of the coming conference on disarmament, Senator Lenroot said: "We may agree upon a limitation of battleships, a limitation of submarines, a limitation of airplanes, a limitation of armies, a limitation of the quantity of the war material that can be kept on hand, but we cannot agree upon a limitation of brains, and if we could the limitation would be worthless."

He concluded his address with an appeal for continued research and development in order to insure a reserve of chemists and of chemical plants that can be

converted to the manufacture of explosives and gases should the need arise.

PREPAREDNESS AND CHEMICAL DISARMAMENT

General Amos A. Fries, head of the Chemical Warfare Service of the U. S. Army, who followed Senator Lenroot, declared: "There can be no complete disarmament while any country is operating its chemical factories. Therefore each country must develop its resources along chemical lines.

"The world today demands and will have dyes, photographic chemicals, perfumes and medicines. If we do not produce these substances, other nations will, and by the possession of plants for their manufacture, the nations are equipped to produce the most deadly weapons of war." General Fries declared further that disarmament is only an economic measure, not an insurance against international conflagration. "No disarmament treaty could presume to forbid the manufacture of these necessities of civilized life. Therefore disarmament cannot disarm. It may limit the size of navies, the size and number of guns, but it cannot prevent any nation advanced in the chemical arts from swiftly utilizing its dye plants for the manufacture of destructive gases and explosives."

PROTECTION FOR THE CHEMICAL INDUSTRY

That there are Members of Congress who thoroughly realize the importance of the dye industry was clearly demonstrated Tuesday evening in the address of Congressman Fred S. Purnell, of Indiana. The speaker declared that "just as the World War was the means of bringing to the attention of the world the remarkable

achievements of American chemistry, so a calm deliberation will show us our immediate duty. America has taken the lead in the world's chemical industry. That position must be sustained not only as a potential element of preparedness but as a peace measure. The coal-tar industry and the science of chemical warfare are so closely allied that it becomes our paramount duty to protect the dye manufacturer. The military strength of a nation will in the future depend almost entirely upon its dye plants."

In explaining his personal attitude toward the Longworth bill, Mr. Purnell said: "If we are to save this industry we must act now. Being an old-fashioned protectionist, it is not hard for me to advocate a measure of protection which will amount to an embargo. If the industry is not saved now and encouraged as well as fully protected, American capital will never go into it again and world monopoly will be returned to Germany for all time."

THE CHEMICAL INDUSTRIES AND THE TARIFF

The unprecedented interest of the chemical industries in tariff matters was probably responsible for the large attendance at the general meeting, Wednesday evening, when Dr. Thomas Walker Page, chairman of the United States Tariff Commission, delivered an address on "The Chemical Industries and the Tariff." Commissioner Page prophesied that more time will probably elapse between the introduction of the present tariff bill and its final enactment than has been required for any other tariff in a generation. The chemical industry has been acutely disappointed because of this apparent failure of the bill, and perhaps has failed to realize all of the serious difficulties confronting the tariff maker. The first of these is that it has been practically impossible to estimate the competitive strength of many of the war-developed industries. The growth of new processes abroad, such as nitrogen fixation in Germany and synthetic acetic acid manufacture in Canada, has complicated the valuation of our domestic industries. Abnormal costs and prices and the futility of ascertaining foreign costs of production have contributed to the difficulty.

A second cause for delay has been the growing friction between the producers of finished products and raw materials.

For example, the highly finished product of the dye industry is regarded by the textile manufacturer as his "raw material." The old fight between farm and factory has changed materially. Agricultural interests, formerly low tariff advocates, are strong in their demands for protection, while many of the Eastern manufacturers who have developed foreign markets for their products are desirous of keeping the rates as low as possible in order not to jeopardize their export trade.

Two other difficulties which add to the tariff maker's problem are the need for accepting goods in payment for foreign debts, and confusion arising from the chaotic condition of foreign exchange.

Commissioner Page discussed the many new features of the tariff bill passed by the House and pointed out the use made by Congress of the information supplied by the United States Tariff Commission. He also took the opportunity to refute in public the statements of Congressman Frear that the Tariff Commission had released its 1920 census of dyes in order "to bolster up this dye provision," and that the release of the report

had been "timed exactly by the commission, which wants the power, which wants the \$100,000 and which is insisting that they are the ones to determine what shall be imported and what shall not." Dr. Page declared that the legislator was hopelessly mistaken in his accusations, for "the Tariff Commission has at no time sought the administrative powers of the various dye bills, but has consistently discouraged Congress from placing such duties upon it, since the Tariff Commission is essentially an informative body and not an executive one."

Crushing, Grinding and Pulverizing Symposium

The subject was introduced by Harry J. Wolf, chairman. The three words, crushing, grinding and pulverizing, he said, have been assigned special technical meanings, which in one sense refer to a general classification of the mineral fragments as to size, and in another sense to the manner in which they are reduced, or to the motion of the parts of the machine designed to accomplish the reduction. He then reviewed briefly the status of the art of crushing, and called attention to some of the more prominent recent advances.

Crushing, Storing and Pulverizing.—L. H. Sturtevant of the Sturtevant Mill Co. in a paper on "Crushing, Storing and Pulverizing" said that during the last decade crushing and pulverizing machinery has become highly specialized, and no longer is the "all-purpose" machine recognized in the modern plant. It has been found that machinery embodying certain principles is necessary to produce certain results, and by deviating from these principles inefficiency and a high-cost product, if not failure, are sure. He then discussed the nature of the materials to be handled, and the machinery and equipment used especially in connection with the phosphate rock industry.

Grinding and Pulverizing With Air Separation.—F. B. Kanowitz of the Raymond Bros. Impact Pulverizer Co. presented a paper on the subject "Grinding and Pulverizing With Air Separation." The author discussed the subject at length, and presented a most complete detailed and exhaustive review.

Dust Collection as Applied to Grinding and Pulverizing Problems.—M. I. Dorfman of the Allis-Chalmers Manufacturing Co. delivered an illustrated lecture on the subject of dust collection as applied to grinding and pulverizing problems. He said that for the solution of a dust-collecting problem there are important facts which must be known before the problem can be handled, and they are briefly as follows: 1. The number and kind of dust producing machines. 2. Their relative location. 3. The quality and character of dust to be handled. 4. The condition and quality of the air or gas carrying this dust. Particularly must be mentioned the amount of moisture present in the air, gas or dust. With the above and a layout of the plant in question, the dust-collecting engineer can determine what will be required in the way of dust-collecting machinery to overcome the problem that exists. He must then determine for himself what velocities will be required to convey the various dusts, what type and size of piping had best be employed, and what type and kind of collector would give the operator the results sought.

Development of Compound Grinding Mills.—H. Schiffin's paper on the subject "The Development of Compound Grinding Mills" was presented by Theodore Pilger. This paper was illustrated by numerous lantern slides indicating the development and design of the com-

pound grinding mill. Following this paper Mr. Abbe stated that the compound mill was introduced by the Abbe Engineering Co. sixteen years earlier than the date claimed for its introduction by the Allis-Chalmers Manufacturing Co., and that the latter company could not claim the credit for having introduced the mill. Mr. Abbe promised to write a letter setting forth the claim he made.

There followed a short talk by Dr. H. H. Dow on the subject of the tariff in its relations to the dye industry, in which he called attention to the desirability of protecting the American dye industry just long enough for it to demonstrate its ability to take care of itself, which, he assured the audience, could be done.

Of the papers which were to be presented on the subject of Industrial Problems only the paper of H. Austin (Ernest Scott & Co.), on "Solvent Extraction on Edible Fats and Oils," was read and as the clock registered 6:15 p.m. there was no time to proceed with the other papers on the program—namely, those by R. H. McLain of the General Electric Co. on "Material Handling in Industrial Plants," and by W. H. Dickerson, of Industrial Waste Product Co., on "Utilization of Industrial Waste; Its Economic Importance."

The chairman made the recommendation to the manager of the exposition, that in outlining all future programs of this character the speakers be positively limited to a fixed number of words or a fixed time available for the presentation of their subjects, so that a large proportion of the time available could not be monopolized by any one speaker. Naturally some of those in attendance come a considerable distance to hear a discussion on a certain subject or to listen to a certain paper, and they are disappointed when the program must be curtailed on account of insufficient time.

Evaporating and Drying Symposium

The symposium on evaporation and drying was held Wednesday, Sept. 14, under the chairmanship of Wallace Savage. In the opening address Mr. Savage said that there are about sixty machinery manufacturing companies producing around two hundred designs of evaporating and drying equipment in this country. One-half of these devote their attention exclusively to driers and one-third to evaporators. About twelve companies produce both. This afternoon we have the pleasure of hearing a number of 15-minute talks giving the basic ideas involved in the leading types of equipment for transforming liquids to vapors and in this form displacing them from solutions or solids, either by air currents or vapor pumps.

SELECTION OF DRYING EQUIPMENT

H. S. Landell, of Proctor & Schwartz, was to present a paper on Drying and Drying Problems, but instead spoke on the understanding and confidence that should exist between a prospective purchaser and the manufacturer of drying equipments. He said that it is always to the purchaser's interest, especially when a new plant is being built, to consult with a reputable drying concern before his plans are all made. Often he thinks of his drying as an incidental process which can be placed anywhere, not realizing that frequently his drying is one of the most important problems. The best way for the prospective purchaser is to give the drying salesman a generous, representative sample of the material to be dried, and at the same time give him all the information possible regarding the preliminary

and supplementary operations. Drying tests will be run on the material furnished, and the drier manufacturer will then be able to submit a proposition for a drying equipment that will be guaranteed both mechanically and as to capacity.

SPECIAL PROBLEMS FOR ENAMELED EVAPORATORS

Max Donauer, of the Elyria Enameled Products Co., in speaking about the special evaporation problems, described briefly the two common types of enameled evaporator—namely, jacketed evaporating dishes and single-effect vacuum pans—and enumerated a series of industries where enameled evaporators are the most appropriate. "The field of enameled evaporators," he said, "is for the most part a special one. It includes those operations in which the presence of an enameled surface plays an important part. Thus enameled evaporators are used for concentrating solutions which contain acids and for preparing products which must be kept free from contamination. The uniform heating conditions make enameled vacuum pans suitable for concentrating sensitive products which are apt to discolor or become caramelized. Enameled surfaces can be readily cleaned, and this makes the evaporators very suitable for food and drug work. Indeed, in the preparation of many of the highest grade food and chemical products, enameled evaporators play an important part."

DRYING WITH MOIST AIR

Arthur B. Stonex, of the Hunter Dry Kiln Co., in his address on Drying With Moist Air said in part:

"To those not intimately familiar with certain forms of present-day industrial drying the title of this paper, 'Drying With Moist Air,' may seem in the nature of a paradox, a contradiction of terms, for obviously moisture is the antithesis of dryness, and so to dry with moist air may at first blush seem as preposterous as to refrigerate with warm air. But drying with moist air will not seem quite so insane a procedure when it is remembered that in nature one never finds air that is not moist, and every one knows that a vast amount of drying, as of the soil and vegetation, is constantly going on. Indeed in many industries where the drying of materials or finished products is necessary so-called natural drying is regarded as the ideal kind of drying.

"Moist air is so desirable for drying at least some materials that it is artificially produced. The principle governing this practice is that the increased absorptive capacity of the air is only indirectly due to the increased temperature—that is, the increased capacity is rather the result of the decreased degree of saturation of the air. The solution of the problem, therefore, is to find for a given material not the maximum temperature, but the minimum degree of saturation or relative humidity at and above which too rapid surface drying will not take place at the highest temperature the character of the material and profit will otherwise permit, and to maintain that temperature and, as long as necessary, that relative humidity.

"By raising the temperature, the vaporization of the water in the material is hastened, but by keeping the relative humidity of the air sufficiently high, the air will not absorb the vapor coming from the surface of the material any more rapidly than at a lower temperature. Indeed, with certain materials it is desirable, and with proper humidity control it is possible, to prevent any surface drying until the stock has be-

come uniformly and sufficiently warm and vaporization has begun throughout the mass. In general it may be said that besides the prevention of destructive surface drying, the maintenance of such relative humidity results in more uniform drying of any material, and that the effects of any temperature above 100 deg. appear to be less severe in a comparatively moist air."

DRYING AS AN AIR CONDITIONING PROBLEM

A. W. Lissauer, of W. L. Fleischer & Co., Inc., in his address on Drying as an Air Conditioning Problem, brought out the fact that drying is still supposed by many to be the simplest branch of all heating and ventilating and that failures are accredited consistently to circumstances which probably have no bearing. He stated that the phenomenon of drying can be explained very easily by the application of the law governing air conditioning—in other words, drying is merely air conditioning—and concluded by saying that the solution of any drying problem which has for its object the obtaining of the highest quality of product with the maximum efficiency can be accomplished if guesswork is eliminated and painstaking study and experimentation be substituted.

CRISS-CROSS EVAPORATOR

A new type of tube evaporator deriving its novelty from a decidedly different tube arrangement was described in an interesting paper on the Criss-Cross Evaporator by Robert V. Cook, chemical engineer and sales manager for the Chemical Equipment Co. The new evaporator is known as the Criss-Cross because of the cross-arrangement of its tubes. This is clearly shown in the accompanying cross-section drawing. It will be seen that the rectangular liquid chamber carries the crossed tubes and the steam chests. The front steam chest is divided in the center by a horizontal partition, so that the steam must descend down the tubes inclined toward the bottom of the back steam chest. That part of the steam which has not been condensed then rises and descends in the opposite direction toward the bottom part of the front steam chest. The condensed steam is drained out of the bottom of both front and back chests. The top of the evaporator, or the vapor chamber, is a cylinder with a vertical axis and has several times the volume of the liquor chamber. This allows the vapor to slow down, to expand and to drop out the entrainment. A standard save-all is employed to make sure that no liquid will be drawn out along with the vapor. In this particular evaporator there are ninety-six $\frac{1}{2}$ -in. seamless drawn copper tubes, 32 in. long, giving 33.5 sq.ft. of heating surface. They are arranged in two groups, half being inclined downward toward the right and half inclined downward toward the left, the rows being staggered, as shown.

Mr. Cook explained a number of advantages claimed for the new evaporator and referred to the possibility of applying the same principle to preheaters, boilers, surface condensers and different forms of heat-exchange apparatus.

VACUUM AS APPLIED TO INDUSTRY

James S. C. Chen, of the J. P. Devine Co., spoke on Vacuum as Applied to Industries. He said that vacuum drying, which was used only in limited fields in the past,

has in recent years attained a position of such importance in the chemical and allied industries that it is worth while to make a thorough and comprehensive study of the subject. At present vacuum drying is extensively used in the chemical and allied industries not only because its use is in many instances imperative, but because its use is efficient, economical and insures superior and uniform quality of the finished product. Vacuum drying has found extensive application in the drug and dye industries and in drying fruits, vegetables and dairy products. His closing remark was that no modern industry can long prosper or even survive without giving constant attention to the improvement of its method of production and refining and to the quality of its products.

ATMOSPHERIC DRYING: COMPARTMENT, TUNNEL AND CONTINUOUS BELT CONVEYOR DRIERS

Jerome D. Stern, of Grinnell Co., Inc., Drier Division, summarized his address on Atmospheric Drying by Means of Compartment, Tunnel and Continuous Belt Conveyor Driers, With Some Practical Applications, by saying:

"The physical and chemical characteristics of the wet

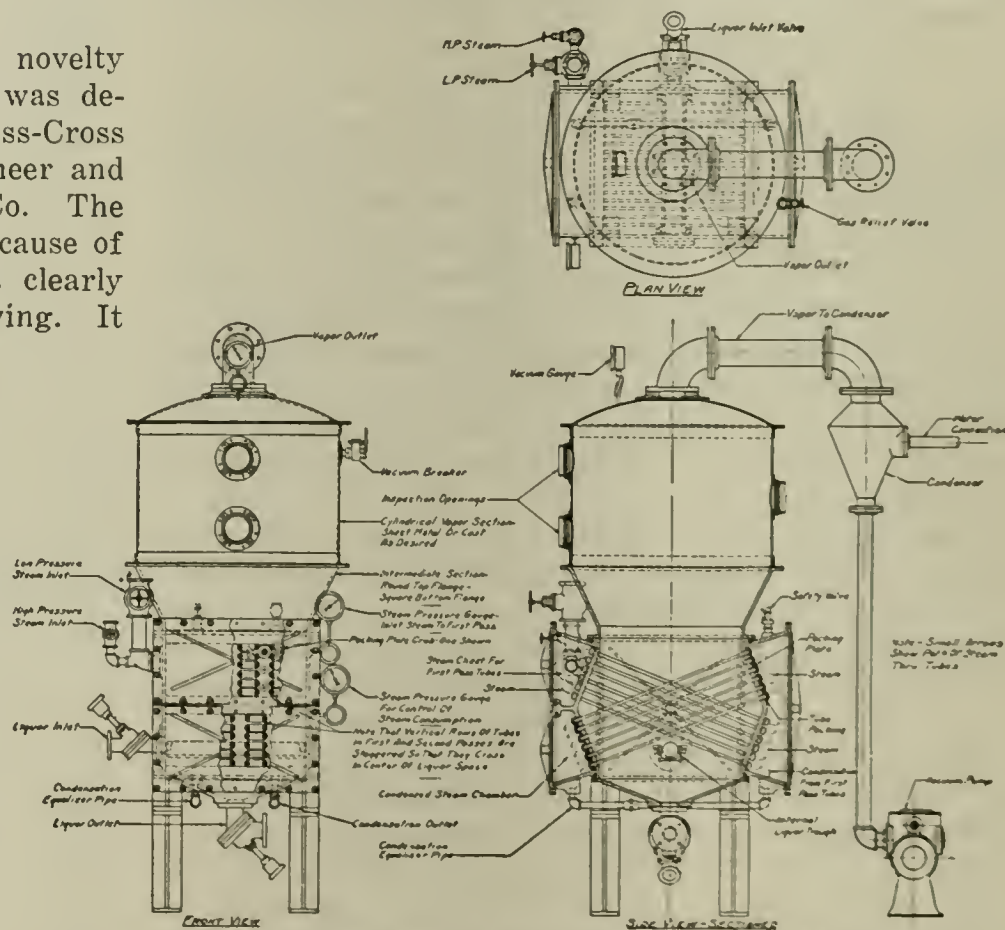


FIG. 1. SECTIONAL VIEWS OF THE CRISS-CROSS EVAPORATOR

and dried product are the primary factors in deciding on the proper type of drying equipment to install. The most efficient method of handling the material, the air temperatures, volumes, velocities and humidity are all dependent on this deciding factor, and unless one has wide experience with the nature and conditions of the product, or as a result of thorough and exhaustive laboratory tests, it is a waste of time to make any calculations or recommendations until these are absolutely determined."

EVAPORATION

H. Austin, of Ernest Scott & Co., presented a paper on Evaporation in which, after reviewing the various problems pertaining to evaporation and to the selection of an appropriate evaporator, he outlined some of the

characteristics of the Scott evaporators. He concluded by saying:

"'Evaporation' is in effect 'distillation,' and in the distillation of oils in which different fractions separate at a known fixed temperature and vacuum, evaporators using steam heat may, with advantage in cost of outfit and operating costs as well as more easy control, be used instead of ordinary type stills using fire heat. Benzine, gasoline, naphtha, etc., can, with advantage, be evaporated, distilled and fractionated in machines similar in design and construction to those more commonly associated with the evaporation of water."

Paint and Varnish Symposium

Thursday, Sept. 15, was Paint and Varnish Day and the well-arranged programs attracted large audiences. The afternoon technical session was followed by a popular meeting in the evening on the theme, "Save the Surface and You Save All." Ernest T. Trigg, chairman of the "save the surface" committee, Paint Manufacturers' Association of the United States, acted as chairman and delivered a most interesting address on the aims and accomplishments of this campaign.

At the paint and varnish symposium, which was presided over by R. S. Perry, the following papers were presented:

LABORATORY CONTROL

Scientific control of paint and varnish manufacture was discussed by Leo P. Nemzek, of E. I. du Pont de Nemours & Co. He spoke in part as follows:

While laboratory control has its most direct association with production, there are many points of contact with the sales department. Successful operation is measured largely by the contact with sales, and through them with the ultimate consumer. The paint technologist must know what the consumer requires from a point of service, and what he desires from a decorative point of view.

The handling of complaints offers one of the best avenues of sales department and laboratory co-operation. Nine out of ten complaints are due either to paint improperly applied as to time, surface condition, or workmanship, or else the proper paint was not selected for the job. Yet in the handling of a complaint, there is an excellent opportunity for displaying much tact and patience, besides bringing out all of the recorded facts and information available on the subject involved.

The major function of laboratory control is associated directly with production. The first requisite is a thorough knowledge of the products in which the different raw materials are used. A raw material record should be maintained, which immediately shows all products in which a particular material appears. This record is necessary in raw material development work, in advising the works where certain shipments of raw materials may be used to best advantage. The record is essential in the adoption of raw material substitutions which are occasionally necessary.

Laboratory control must exercise a close check on new formulations. This may be a part of control work, or merely come under the general supervision of the chief chemist. A properly kept products index will help to keep down the formulation of new paints. Such an index shows in a moment a list of products of the same character or similar nature to the material under consideration.

The greatest value of the index lies in the standard-

ization of formulas. All products of a certain type should be composed of the same ingredients. A thousand enamel formulas will vary only in the pigments necessary to give desired colors. The vehicle will consist of half a dozen standard varnishes, and not twenty or thirty, which might very easily be the case if standardization of formulas is not watched.

This holds true for ready mixed production, but the situation is reversed when it comes to pastes. Then the practice is not economy. There are cases where the use of two or three standard bases in producing a paste product means increasing the cost 10 to 15 per cent over what it would be if the formula ingredients were put together separately.

Laboratory control requires first of all a thorough knowledge of:

1. The user's requirements of the paint and varnish.
2. The chemical and physical properties of available raw materials. How they react one with another, and what different combinations develop on aging.
3. Possessing the first two requirements: control or supervision over the formulation of the most economical product that will give satisfaction.

Development work is essential both on raw materials and finished products. The field for research is large. The work that should be done is suggested by the conditions that arise in the usual routine functioning of technical control. The strictly routine functions of laboratory control are the checking of all raw material shipments and finished products so as to insure uniformity.

REFLECTION FACTORS OF INDUSTRIAL PAINTS

Dr. Henry A. Gardner presented a paper on reflection factors of industrial paints and pigments.

In computing the reflection factors of industrial paints, the factor 0.98 should be used for magnesium carbonate (the standard) rather than 0.88, and earlier measurements should be corrected accordingly. For instance, the reflection coefficient of a white paint which previously may have been reported as 76 should be corrected to read 85. The possibility of having walls in factories so painted that they yield by reflection 85 per cent of normal light is of great importance to the architect and owner. Figures for a few industrial flat and gloss paints now marketed are given in Table I. It will be noted that some of them run as high as 82 per cent, a figure extremely high in comparison with similar type paints marketed several years ago. This great advance in the production of interior industrial whites of high illuminating value has come as a result of many years of careful study and selection of the pigments and liquids available for the purpose.

TABLE I. REFLECTION FACTORS OF MODERN INDUSTRIAL WHITE PAINTS

	Coefficient of Reflection*		Coefficient of Reflection*
Exterior white oil paint	71	Gloss mill white XX...	76
Non-darkening exterior oil paint	78	Gloss mill white XXX.	82
Gloss mill white X	74	Flat mill white.....	78

* On basis of 98 for magnesium carbonate.

White paints may show a small loss of reflection value after remaining in a dark place for several years, due to yellowing of the oil content. This loss, however, is probably much less than would occur when paints become darkened due to dust adherence, even over a short period

of time. For the walls and ceilings of factories a paint is desired that will initially and permanently give the highest degree of reflection. Off-color products or those that show rapid yellowing of the oil content are considered unsatisfactory. Tinted and colored paints may or may not show a loss in reflection value upon aging. The result will vary with the type of tinting color used.

White opaque pigments vary in reflection value. It would appear that the greatest reflection is obtained from pigments with the greatest opacity.

For determining the reflection factors of industrial paints, it is suggested that two coats be applied under standard conditions to black iron surfaces previously coated with a continuous coat of flat black primer. For this purpose, the same amount of each paint should be applied, as determined by weight of paint applied.

An example of the results obtained by this method will be found in Table II. In this series of tests, the pigments were ground in a liquid consisting of one part of flattening varnish and two parts of turpentine. The paints contained 60 parts by weight of pigment and 40 parts of liquid, since it was impossible to make a

TABLE II. REFLECTION FACTORS OF CERTAIN WHITE PIGMENTS

Pigment	Coefficient of Reflection When Applied in Flat Liquid	Coefficient of Reflection, Compressed Dry Pigments
Lithopone (A grade)	81	91
Titanium pigment	78	91
Zinc oxide (French process)	78	91
Zinc oxide (5 per cent lead)	77	87
Lithopone (Grade B)	69	89
White lead, Type A	67	90
White lead, Type B	50	90
Calcium carbonate	38	90
Silica	19	88
Barium sulphate	13	88

workable paint with over 60 per cent of certain of the pigments employed. Two heavy brush coatings were applied to a series of sheet-iron panels, one hour being allowed between coats. The panels had previously been coated with a perfectly black, flat paint having a reflection coefficient of about 5. The great hiding power of the opaque white pigments was at once evident from the appearance of the finished panels. The inert pigments, on the other hand, had but little hiding power, in comparison.

For comparison, the reflection factors of the dry pigments are given in the second column of Table II. It should also be borne in mind that the hiding power of a paint depends largely upon the liquids chosen for the vehicle portion. The greater the difference between the refractive index of a liquid and that of the pigment the greater will be the hiding power of the paint.

This paper by Dr. Gardner has been published as Circular No. 133, Educational Bureau, Paint Manufacturers' Association of the U. S.

PHYSICAL TESTING OF PAINTS

Frank G. Breyer, of the New Jersey Zinc Co., called attention to the fact that the physical testing of paints and paint materials has not received attention commensurate with its importance. He made a plea for a rational development program for paint technology based on five fundamental factors—suspension (mixing or incorporation), life of suspension, application, conversion of applied material to adherent film and life of film.

PAINT AND VARNISH WASTE CONTROL

R. S. Perry's paper on "Paint and Varnish Waste Control" was read by his associate, Paul Webster. The

fume recovery process developed by this firm has been described in *CHEMICAL & METALLURGICAL ENGINEERING*, vol. 23, p. 771, Oct. 20, 1920, and many of the views shown by Mr. Webster were included in that article. Other installations described and illustrated by Mr. Webster were those of the Patton-Pitcairn Division, Pittsburgh Plate Glass Co., Milwaukee, Wis., and Breinig Bros., Inc., Hoboken, N. J.

THE IDEAL PAINT AND VARNISH SPECIFICATION

F. P. Ingalls' paper on "The Ideal Paint and Varnish Specification" will be found in full on page 595 in this issue.

LIMITATIONS OF STANDARDIZATION

The limitations of standardization of paint and varnish manufacture were considered at some length by D. A. Kohr, of Lowe Bros. Co. He said in part:

Very few of the products of the paint maker are made on absolute formulas; it has even been said that paint formulas serve merely as guides, and in a large measure this is true, because almost every batch of paint must be modified by the addition to it of small quantities of this, that or the other raw material before the batch is ready to pass final inspection. Accordingly most paint manufacturers have learned by experience to pay scant attention to the applicant for a position who shows as his chief recommendation a collection of someone's formulas. Almost anybody can mix together raw materials in accordance with a formula, but before the resulting mixture can pass muster as a paint of quality it must be given the careful attention of an experienced paint maker.

The same raw materials from the same sources of supply, as they are furnished to the paint maker, will not when made into a paint always produce a product that has the same properties—in fact, the resulting product is much more apt to vary than it is to be uniform. The consumer expects different lots of the same paint to be uniform and when the difficulties overcome are considered, different lots of the same paint from a reputable manufacturer are wonderfully uniform; but their chemical composition is not uniform within close limits and, if best results are to be obtained, it cannot be made uniform.

The paint and varnish industry differs from the automobile industry, for example, in an important respect. Whereas the automobile manufacturer turns out a product that is ready for the ultimate consumer to use, the products of the paint and varnish maker must first be applied by a painter or finisher to some surface owned by the consumer, and then be allowed to undergo the chemical and physical changes commonly known as drying and hardening before they can fulfill their real purpose. Hence what the paint and varnish manufacturer is actually furnishing the consumer is not paint and varnish, but beautification of his property, as when a piano is beautifully stained and varnished; or protection to his property, as when an expensive bridge is painted to prevent corrosion of the steel; or both, as when a man has house paint applied to his own residence.

A vast amount of work has been done by many manufacturers in designing a fairly large number of excellent products which when intelligently used will give fine results. Is it therefore not reasonable to suggest that consumers who certainly know less about paint making than paint manufacturers will more quickly

bring about the desired end of securing uniformly good results from painting, if they turn their energies from the question of standardizing the composition of paint and give more attention to the control of those factors that have an influence on the final result equal to that of the paint and which are entirely beyond the control of the manufacturer? When a consumer is sure that paint is applied only to clean, dry, warm surfaces under suitable weather conditions, and by mechanics who are fully competent and experienced, then, and only then, can he profitably consider whether he can specify a paint that will be better than the one offered by a reputable manufacturer as the result of his long experience and observation under many varying conditions.

American Ceramic Society Meeting

The American Ceramic Society meeting was held Friday, Sept. 16. Among the papers presented were the following:

Business Conditions Relating to the Clay-Working Industries.—John G. Jones spoke on the outlook for the clay products industry. The chief problem at the present time is to fix prices at a level which will appear attractive to customers. A clear statement is needed of the difficulties in the way of reducing prices. The cost of fuel is still 100 per cent above the pre-war level owing to the fact that the wages of the coal miners have not yet been reduced. Freight rates are still high. Materials used in manufacture have not declined in proportion to the rest of the commodity list. It is not difficult for steel mills to cut wages, because they are dealing with common labor, poorly unionized. Clay producers, on the other hand, must deal with skilled workers, highly unionized. For these reasons the present price of clay products is not unreasonable. There has been a reduction of 40 per cent from the peak prices. The approaching demand in many lines promises a revival of trade near the present price levels during 1922.

The Importance of Chemical Stoneware in the Chemical Industries.—Percy C. Kingsbury said that although chemical stoneware is a small branch of the ceramic industries, it is of great importance to chemical plants. No stoneware body can meet all the varied requirements of the chemical industry, and it is therefore necessary to furnish a wide range of stoneware products from the firebrick-like mass at one extreme to the porcelain-like mass at the other. Chemical stoneware is unaffected by any of the products met with in industrial chemical work, with one or two relatively unimportant exceptions. The glaze serves only to give the ware a smooth surface and does not add to its acid-resisting properties.

The Passing of King Methane.—S. R. Scholes, in speaking of the depletion of gas in the clay districts, said that forty years ago natural gas, which is chiefly methane, was regarded as a nuisance encountered in drilling for oil, but it became the most important glass-house fuel, and its abundance and excellence gave rise to the prosperous glass industry of the Ohio Valley. It has been wastefully used, and is now so scarce and expensive, especially in cold weather, that other fuels such as producer gas and fuel oil are replacing it. Even in the best glass-melting tank furnaces, less than 10 per cent of the heat of the fuel finds its way into the glass; 20 per cent goes up the stack and 70 per cent is lost by radiation. With the present refractories this high radiation loss cannot be stopped by heat insula-

tion, because of the consequent melting or failure of the refractories. These must be improved so as to bear insulating. Also there must be better engineering work done on designing furnaces for the best heat economy, so that the successors of "King Methane" need not be burned with the same prodigality that has wasted our resources of natural gas.

Porcelain for the Laboratory.—Charles F. Binns defined porcelain for the chemical laboratory, for it differs from china, even though both are white and translucent. He described its origin and method of manufacture. It was produced in common with most ancient wares by a reducing fire, involving a refractory glaze. Methods of production in America and Europe were compared. Mixture of porcelain glaze was contrasted with lime-soda glass and mixtures of chemical porcelains were compared with china and earthenware.

Heavy Clay Products Research.—Maurice B. Greenough of the National Paving Brick Manufacturers' Association and secretary-treasurer of the Joint Clay Products Research Committee spoke on heavy clay products research. The Federal Government through its bureaus, the scientists of the clay products industry through the American Ceramic Society and the manufacturers of facebrick, hollow building tile, common and vitrified paving brick through a joint committee of their respective national associations have all joined hands to seek by research to solve vital problems in heavy clay products production. The scope of work has been defined and assignments have been made to each group. The financial support is assured and the program is in operation. The program differs materially from the general run of such efforts. In the first place, the public is represented and has an interest exercised through the work that is being done in the Government bureaus. The buyer co-operates with producer in the improvement of processes and the bringing about of more economical industrial operations. The operations of the program are beginning with studies of existing equipment. Present kiln types must be employed with greater efficiency. Practical considerations are foremost in promoting the studies. The preliminary stages of the whole organization are passed and nothing but hard work lies between the present and the ultimate attainment.

The conference on the program of the American Ceramic Society activities held at the Hotel Commodore Sept. 15-17, will be reported in a later issue of CHEMICAL & METALLURGICAL ENGINEERING.

Symposium on the Power Plant in the Chemical Industries

The Symposium on the Power Plant in the Chemical Industries was held Friday afternoon under the chairmanship of R. C. Beadle, editor of *Combustion*.

Mr. Beadle in his opening address brought out the facts that about 10,000,000 tons of coal is used yearly by the chemical industries and that by the introduction of mechanical coal firing the fuel efficiency has increased to about 85 per cent from an efficiency of only about 50 per cent with hand firing. He predicted that before many years have passed the fuel used in the chemical boiler plants will be a byproduct of the raw coal.

Description of a Modern Boiler Plant and Equipment.—R. M. Gordon, manager of the steam supply and testing departments of the Solvay Process Co. at Syracuse, N. Y., gave a detailed illustrated description of the

water purification, coal preparation and boiler house at the Solvay Process plant, where all the principal operations are metered or recorded so that the efficiency of the plant can always be calculated and is figured and charted each month. Daily outputs are carefully watched. The efficiencies for the past six months are as follows:

	Per Cent
Boiler and furnace.....	77.5
Boiler, furnace and economizer.....	82.2
Plant efficiency	85

How Heat Losses in Chemical Plants May Be Reduced.

—John Primrose, vice-president of the Power Specialty Co., of New York, spoke on how heat losses in chemical plants may be reduced. He said in part: Modern engineering practice has recognized the importance of good combustion, and means are now available for more completely burning the fuel before attempting to recover any of the heat produced by combustion. After the fuel is properly burned, the next consideration is to absorb the heat produced.

Of all methods of supplying heat in process work probably the most economical is heating by saturated steam where the steam is condensed and the resulting hot water is returned to the boiler. This is limited to processes that do not require a temperature higher than is available with saturated steam, say, 300 deg. F. Above this temperature, up to 600 deg. F. or higher, superheated steam may be used, and if the steam can be used in turbines or pumps, etc., after it has served its purpose as a heating medium and the exhaust is used in heating feed water, the economy is almost as good as with saturated steam. Each individual problem is worthy of study by engineers, not necessarily chemists, but who by training and experience have obtained knowledge of heat engineering beyond that usual in the chemical industry itself. Such studies, it is reasonable to expect, would bring about that very much desired result—a reduction in manufacturing cost.

Compressed Air Installations in Industrial Plants.—

A. R. Stevenson, Jr., of the power and mining engineering department, General Electric Co., spoke on compressed air installations in industrial plants. He outlined the appropriate uses for single- and multi-stage centrifugal compressors, rotary displacement blowers and reciprocating compressors. In almost any chemical plant there are liquids to be moved. Compressed air is used extensively for such pumping. He touched on the three fundamental systems in use—namely: 1. Air lift, 2. Pneumatic displacement pump, 3. Return air system, and stated that these three systems are especially good for dye works, bleacheries, pulp mills, and for handling solutions, because there are no moving parts, lubrication or packing and they are therefore not affected by muddy or gritty water.

Application of Electric Power in the Chemical Industries.—The paper on the application of electric power in the chemical industries, by D. B. Rushmore, J. A. Seede and E. Pragst, of the General Electric Co., consisted of a lengthy discussion of the uses of electricity in electrothermics, electrolysis, for transformation into mechanical power and in the specialized applications such as magnetic and electrostatic treatment, ultra-violet rays, X-rays and others of small application but great possibility.

After passing in review the field of electrothermics, the sources of primary power and the problem of pur-

chased power versus isolated plants, they outlined at length the practice in steam-electric and hydro-electric generating stations and concluded as follows:

"The chemical industry is at present one of the most fruitful fields for electrical application in the future. It is fruitful not only from the point of view of those engaged in the manufacture and sale of electrical apparatus, but particularly from the standpoint of pure engineering, for it is forever presenting to the electrical engineer problems of a most diversified interest—problems ranging from heavy currents at low potentials to the opposite conditions of low current at high potentials, with alternating and continuous current; problems where the frequency ranges from 5 cycles to 10,000 cycles per second; problems involving X-rays, ultra-violet rays and other means of accelerating reactions; problems of insulating materials to withstand the effects of heat, corrosive gases and acids; problems involving the maintenance of continuity of service and the low cost conversion of energy; problems of processes and methods, etc. It is this diversity of interests of the industry, its problems and the rapidity with which it is expanding, that makes it appeal so strongly to the electrical engineer as an outlet for his productive efforts. Obviously the greatest advance will be made when the co-operation is most complete between the chemical and electrical engineer and, as the former has solved many difficult situations for the latter in the past, the electrical engineer will continue to reciprocate, especially along those lines that will materially assist in promoting our national well being."

The Limitations of Silent Chain Drive.—Some general and specific data on the design and use of silent chain drives were presented by F. G. Anderson, of the Morse Chain Co. He stated that the silent chain drive has gradually won on its merits until it is now generally considered by competent engineers a standard drive for practically all of the ordinary power transmissions between parallel shafts and gave as definite reasons: Reliability, positive speed ratio with flexibility of operation; possible short center distances, minimum attention required, high efficiency and quiet running.

Pulverized Coal in the Power Plant.—H. G. Barnhurst, of the Fuller Engineering Co., spoke on pulverized coal in the power plant. He said that the use of pulverized coal in preference to grate firing presents the following advantages: Higher efficiencies are obtainable. The reliability of the plant is increased by the much greater range of fuel which may be satisfactorily burned. Labor is greatly reduced and control of boiler operation simplified. Considerable economies are present in the elimination of standby losses and loss of carbon in the ash, and the boiler flexibility is increased very considerably. The use of pulverized coal in chemical and metallurgical furnaces is gradually becoming a standard method of fuel firing.

Other papers on the program were:

"Boiler Feed Water Treatment and Treatment Control," by E. C. Bashore of Rice & Bashore; "A New Method for Coking Coal as Required for Industrial Fuel," by D. S. Chamberlin, of the Distillation Industries, Inc.; "The Application of Pulverized Fuel," by H. D. Savage, of the Combustion Engineering Co.; "The Prevention of Internal Corrosion in Pipes, Tanks, and Other Iron and Steel Equipment," by Perry West, of the Anti-Corrosion Engineering Co., and a short talk on "The Master Key Industry," by Dr. Charles L. Parsons, secretary of the American Chemical Society.

Is There an American Dye Monopoly?*

BY FREDERICK E. BREITHUT

MANY good Americans are of the *opinion* that there is a monopoly in the dye-making industry. What are the *facts*?

The accompanying maps show:

1. In 1914 there was no real dye manufacturing in the United States—simply seven small plants in three states, assembling German intermediates into dyes.
2. In 1920 there were eighty-two American dye plants located in eighteen states.
3. In 1920 there were 213 coal-tar chemical plants located in twenty-five states.



1914—Total, 7



1920—Total, 82

LOCATION AND NUMBER OF PLANTS MAKING COAL-TAR DYES IN THE UNITED STATES

In this connection it may be interesting to submit two quotations from official Government reports.

The first is from "Artificial Dyestuffs Used in the United States," by Thomas H. Norton, Department of Commerce Special Agents Series 121, published in 1916:

"The manufacture of coal-tar colors in the United States has been in existence about thirty-seven years. Prior to 1915 it had never become a factor of importance in supplying the American market. The American manufacture was confined almost entirely to the 'assembling' into finished dyes of coal-tar intermediates imported from Europe, chiefly from Germany. In its entirety it represented less than one-tenth of the activity to be encountered in any one of the larger companies producing synthetic dyes in Germany and Switzerland."

Contrast this picture of national dependence with that presented by the following quotation from the United States Tariff Commission's Census of Dyes and Coal-Tar Chemicals, 1920:

"The total number of firms engaged in the production of coal-tar products in 1920 was 213, while those companies engaged in the manufacture of dyes alone numbered 82."

The Tariff Commission has made a study of the number of firms producing each dye, which reveals significant facts concerning the organization of the domestic industry. Three hundred and sixty separate dyes were manufactured in 1920. Of these, 108 dyes, the output of which represented more than 90 per cent of the total production, were *each* manufactured by three or more firms. Of greater importance, however, is the fact that those dyes, representing over one-half

of the total quantity produced (thirty-five in number), were *each* manufactured by seven or more firms.

Even a cursory glance at the figures in Table I reveals:

1. That the number of independent manufacturers of each of these large-tonnage dyes is sufficient to deny the existence of a monopoly.
2. In general, prices have shown a steady downward trend (of course there are a few specific instances in which other factors, such as rise in raw material costs and imperfections in process control, make this general tendency inoperative).

What about the intermediates from which dyes are made? Let us begin with a specific example. You are

all familiar with the substance known as naphthalene. It is commonly used in the form of moth balls. This commodity is one of the most valuable of coal-tar chemicals. According to the 1920 census there were forty-six important intermediates made from this coal-tar crude. The number of manufacturers producing each of these commodities is indicated in the following table:

Name	No. of Mfrs.
2-Naphthol-3:6-disulphonic acid	16
1-Amino-2-naphthol-4-sulphonic acid	13
1-naphthylamine-2-sulphonic acid	12
1-Amino-8-naphthol-3:6 disulphonic acid	12
2-Naphthol-6:8-disulphonic acid	9
Naphthalene, solidifying 79 deg. C., or above	9
1-Naphthol-4-sulphonic acid	8
2-Naphthol-6-sulphonic acid	7
2-Amino-8-naphthol-6-sulphonic acid	7
1-Naphthylamine-3:6:8-trisulphonic acid	7
2-Naphthylamine-6:8-disulphonic	6
β-Naphthol, tech.	6
1-Naphthylamine-5-sulphonic acid	5
2-Naphthylamine-1-sulphonic acid	5
α-Naphthylamine	4
1-Naphthylamine-8-sulphonic acid	4
1:8-dihydroxy naphthalene-3:6 disulphonic acid	4
1-l-diazo-2-naphthol-4-sulphonic acid	4
Phthalic anhydride	3
α-Naphthol	3
Phenylalphanaphthylamine	2
Nitronaphthalene	2
β-Naphthylamine	2
1-Naphthylamine-6-sulphonic acid	2
2-Naphthylamine-6-sulphonic acid	2
1-Naphthol-5-sulphonic acid	2
1-Naphthol-3:6:8-trisulphonic acid	2
β-Naphthol, U.S.P.	2
2-Naphthol-7-sulphonic acid	2
2-Naphthol-8-sulphonic acid	2
1-Amino-8-naphthol-2:4-disulphonic acid	2
8-Nitro-1-diazo-2-naphthol-4-sulphonic acid	2
Phthalanide	2
Chrononaphthalene	1
Ethylbetanaphthylamine	1
Naphthalene 2:7 disulphonic acid	1
1-Phenyl-naphthylamine-8-sulphonic acid	1
1-Tolynaphthylamine-8-sulphonic acid	1
1-Naphthylamine-3:8-disulphonic acid	1
1-Naphthylamine-4:8-disulphonic acid	1
2-Naphthylamine-4:8-disulphonic acid	1
2-Naphthylamine-5:7-disulphonic acid	1
1-Naphthol-3:6-disulphonic acid	1
2-Naphthol-5:7-disulphonic acid	1
Dioxynaphthalene	1
1-Chloro-8-naphthol-3:6-disulphonic acid	1

*A paper presented at the Seventh National Exposition of Chemical Industries, Eighth Coast Artillery Armory, New York, Sept. 12-17, 1921.

If you will glance through the pages of the Tariff Commission's report, you will find that the case of naphthalene is typical of the whole list of coal-tar chemicals produced in our country. This is made

TABLE I. DATA ON LARGE-TONNAGE DYES

Schultz No.	Name	Total Production, 1920	No. of Mfrs., 1920	Average Price per Lb.				
				1917	1918	1919	1920	Aug. 25, 1921
23	Tartrazine.....	701,722	5	.....	.....	.....	\$1 86	\$1 30
33	Chrysoidine Y.....	585,648	7	\$1.09	\$0.77	\$1.04	87	75
82	Ponceau 2R.....	1,286,002	8	1.15	.79	.80	80	60
134	Metanil yellow.....	629,437	6	.....	.....	1.65	1.64	1.10
145	Orange II.....	1,850,341	12	.98	.68	.63	.62	.45
181	Salicine black U.....	1,074,248	14	.....	1.62	1.25	1.10	.60
217	Algama black 10B.....	2,608,864	16	.....	1.26	1.47	1.29	.85
283	Bismarck brown.....	514,218	11	1.17	.81	1.01	.84	.70
307	Congo red.....	1,502,630	5	.....	2.01	1.12	.86	.60
333	Oxamine black BHN.....	803,501	6	.....	.....	2.72	2.97	1.40
337	Benzo blue 2B.....	1,789,774	14	2.00	1.37	1.00	.88	.50
363	Benzopurpurine 4B.....	617,629	11	.....	2.46	1.80	1.46	1.10
462	Direct deep black EW.....	7,736,994	14	.....	.....	1.04	1.03	.65
463	Erie direct black RX.....	2,050,741	4	.....	.....	.....	.99	.70
476	Benzamine brown 3GO.....	623,757	5	.....	.....	.....	1.60	1.10
495	Malachite green.....	654,237	6	6.28	5.60	3.26	3.32	2.00
515	Methyl violet.....	600,873	9	3.84	2.78	2.44	2.39	1.80
659	Methylene blue.....	577,264	12	3.09	2.80	3.03	2.94	1.50
698	Nigrosine (spirit soluble) ¹	919,242	8	1.11	.71	.71	.88	.65
700	Nigrosine (water soluble) ¹	2,743,021	6	.80	.63	.59	.72	.58
720	Sulphur black.....	16,305,037	12	.60	.37	.29	.25	.20
	Sulphur blue.....	1,514,811	9	1.63	1.45	1.11	.98	.70
	Sulphur brown.....	1,269,731	15	.....	.48	.47	.35	.30
874	Indigo (synthetic) ¹	18,178,231	3	1.42	.88	.59	.74	.45

obvious by the data contained in Table II. Again it is apparent that there is no monopoly and that prices have been coming down.

TABLE II. DATA ON LARGE TONNAGE INTERMEDIATES

Name	Total Production 1920	No. of Mfrs., 1920	Average Price per Lb.				
			1917	1918	1919	1920	Aug. 1921
Acetanilide.....	2,667,252	9	\$0.46	\$0.53	\$0.41	\$0.42	\$0.33
1-Amino-8-naphthol-3:6 disulphonic acid (H-acid)	5,180,993	12	.....	1.69	1.32	1.23	1.15
Aniline oil.....	39,234,186	14	0.23	0.27	0.24	0.28	0.18
Aniline salt (and sulphate)	2,024,956	5	0.33	0.34	0.38	0.37	0.25
Benzaldehyde.....	702,543	8	2.72	2.40	0.78	0.63	0.45
Benzidine base.....	2,071,858	9	1.65	1.01	1.26	1.15	1.00
Benzoate of soda.....	812,193	8	3.30	2.58	0.88	0.79	0.50
Benzylchloride.....	1,246,412	5	1.20	0.66	0.23	0.22	0.20
Chlorobenzene (mono).....	4,829,142	6	0.20	0.18	0.15	0.10	0.14
Dimethylaniline.....	5,447,107	7	0.59	0.57	0.55	0.71	0.42
Dinitrobenzene.....	2,492,178	6	.....	.....	0.24	0.27	0.21
m-Dinitrobenzene.....	887,934	5	.....	0.28	.....	0.29	0.27
Dinitrochlorobenzene.....	5,947,791	6	.....	.....	0.21	0.24	0.20
Dinitrotoluene.....	1,847,191	11	.....	.....	0.35	0.23	0.25
Naphthalene (refined).....	30,230,734	9	0.07	0.08	0.07	0.08	0.07
β-Naphthol (technical).....	11,920,714	6	0.67	0.59	0.49	0.47	0.35
1-Naphthol-4-sulphonic acid.....	561,929	8	.....	1.24	1.83	1.41	1.40
2-Naphthol-3:6 disulphonic acid (R salt).....	1,250,674	16	.....	0.80	0.72	0.66	0.65
2-Naphthol-6:8 disulphonic acid (G salt).....	1,446,605	9	.....	.....	0.82	0.68	0.60
α-Naphthylamine.....	5,177,547	4	0.44	0.50	0.41	0.34	0.35
1-Naphthylamine-4-sulphonic acid (naphthionic acid).....	3,773,191	12	.....	0.66	0.62	.....	0.60
p-Nitraniline.....	2,138,492	6	1.13	1.30	1.06	1.17	0.80
p-Nitro-acetanilide.....	569,728	4	.....	0.77	0.69	0.68	0.60
Nitrobenzene.....	53,244,008	9	0.14	0.15	0.14	0.14	0.12
p-Nitro-chlorobenzene.....	959,405	5	0.29	0.33	0.21	0.32	0.32
Nitrotoluene.....	6,100,618	6	.....	0.30	0.17	0.13	.....
o-Nitrotoluene.....	2,173,279	4	0.72	0.69	0.23	0.13	0.15
p-Nitrotoluene.....	2,004,089	7	1.24	1.11	0.56	0.61	0.85
m-Phenylenediamine.....	658,313	15	1.35	1.10	1.01	1.06	1.00
Salicylic acid (technical).....	3,914,163	8	0.66	0.57	0.29	0.29	0.20
Sulphanilic acid.....	1,796,838	13	0.30	0.29	0.24	0.36	0.25
Toluidine.....	1,145,361	6	0.76	0.81	0.58	0.37	0.40
o-Toluidine.....	1,302,097	8	.....	0.96	0.50	0.29	0.20
Xylidine and salt.....	1,054,476	8	0.65	0.54	0.53	0.47	0.40

No, there is no American dye monopoly! Our dyes are being made by many manufacturers, some very large, some very small. They are all selling against one another in open competition. As a matter of fact, every manufacturer who is actually in the business knows full well that the competition is not only in the open, but that it is really much fiercer than in most lines of business. Anyone is at liberty to go out with the salesmen of our dye companies, and we are convinced that a few days' experience will convince him

that there is absolutely no monopoly in existence. If there were such a monopoly, it would seem that it must be very inefficiently managed to permit ten, twenty and thirty different independent plants to produce the same product, and also to permit a consistent reduction of prices throughout the list of the products which it manufactures. Increasing the output, decreasing the price and permitting the existence of many plants producing the same article, thereby giving employment to a greater number of persons, are actions not usually ascribed to a monopoly.

If you will take the trouble to look through the capital investments of our eighty-two dye-makers, you will find that they vary from a few thousands to millions of dollars. An examination of the names on the boards of directors shows that there are no interlocking directorates nor other forms of commercial control.

The truths enumerated above are simply so, and it is very difficult to believe that those who persist in reiterating that there is an American dye monopoly can be doing so through sheer ignorance of the facts.

The Ideal Paint or Varnish Specification*

BY F. P. INGALLS

Chief Chemist, John W. Masury & Son

IN DISCUSSING the ideal paint or varnish specifications it is of course understood that the ideal or perfect specification cannot actually be written until the sum total of our chemical and physical knowledge shall reach the infinite, yet it is wholly rational to discuss such an ideal, and, by overcoming the obstacles one after another, try to approach continuously nearer to it in practice.

Although the larger part of the paint and varnish sold in this country is purchased ultimately by a large number of relatively small consumers, without any specification other than is implied by the brand or assurance of the manufacturer, there are many buyers who, by virtue of some obligation to purchase at the lowest rates or to avoid favoritism in awarding contracts, must accept the lowest obtainable quotations for satisfactory goods. Under such circumstances it is obviously necessary for the buyer to state in clear and unmistakable terms just what goods will be satisfactory or acceptable and at the same time exclude all other or inferior goods. Such a description is called a specification.

THE PERFECT SPECIFICATION

The most nearly perfect specification is that one which, in the fewest words, best describes the desired paint or varnish so clearly and completely that no inferior product can gain acceptance. The ability to write any such specification not only involves a general knowledge of the possibilities of production from such materials and by such methods as are known to be available, but it also implies the existence of ways and means of determining the probable economic value of the delivered goods before they are put into actual service. In other words, the specification must be based on a knowledge of what can be produced, and how to test the

*A paper presented at the Seventh National Exposition of Chemical Industries, Eighth Coast Artillery Armory, New York, Sept. 12-17, 1921.

delivered goods. This is fairly evident, because in any exchange of goods for money or other value the delivered goods must in general be accepted and paid for long before they shall have demonstrated their value in actual service.

It is scarcely to be expected that any one person can have at his command all the knowledge necessary for the best possible specification, nor that a specification which embodies only the knowledge of one person, however expert, will be universally acceptable. In this country, however, we are fortunate in having at our disposal the collective knowledge and co-operative work of Committee D-1 of the American Society for Testing Materials, a committee numbering about 115 members composed of the leading paint and varnish technical experts, producers and consumers, both having about equal representation. The A.S.T.M. is a permanent organization of about 3,000 engineers and technical experts, and its prime object is to prepare specifications and to define standards for engineering materials of all kinds. Any specification issuing from such a body may be regarded as highly authoritative. A number of other bodies are closely allied with it, especially the U. S. Government Inter-departmental Paint Specification Committee, the Paint Manufacturers Association of the U. S. and the National Varnish Manufacturers Association, all of which have direct representation on Committee D-1. With all this aggregation of talent, operative for a number of years past, it is pertinent to ask, Why are so few complete and satisfactory specifications for paint and varnish available at the present time? The answer to this question brings before us a realization of the really formidable array of obstacles encountered, and the large amount of slow, tedious and painstaking work required to overcome them.

Theoretically paint is a very simple thing. It is merely a solid-liquid two-phase physical system composed of any finely divided, essentially inert powder or pigment, suspended in a liquid vehicle which possesses the property of becoming solid upon extensive exposure to the air. In detail, however, it is no such simple thing, but is on the contrary a highly complicated affair with almost infinite possibilities.

GENERAL DIVISION OF PAINTS

The complete list of products of any of our larger manufacturers will show all the way from 300 to 600 or more items, each regularly carried in stock ready for delivery to the purchaser. In addition to these there may be several thousand formulas for special paints or varnishes of one kind or another especially adapted to some unusual or peculiar use. Fortunately these items, although distinct in themselves, may be divided or classified into about fifteen or twenty groups, or lines, of paints and half a dozen classes of varnish, the individuals of each class differing from one another merely in some minor detail, such for instance as color. In a system of classification the difference between the individuals would generally be determined by the pigment present, but the classes would be distinguished by the character and proportion of the vehicle. Paints are therefore usually divided into two grand divisions—namely, paste paints, which require thinning down for use, and liquid, or ready-mixed, paints, which are already thinned down and are practically ready for use; in the first division the proportion of vehicle is as small as is practicable for the grinding process, while in the

second division the proportion of vehicle is much larger and is adjusted so as to give the finished paint the required working properties under application. In both divisions the classification rests almost wholly on the quantity of vehicle present and not at all on the character of the pigment.

Although it is desirable that we should have good specifications for paste paints as well as for liquid paints, yet, inasmuch as the paste paints must in general be thinned down before use and in this process may be diverted into any one of several different subdivisions of the liquid paints, according to the character of the thinning liquid, it is only natural that the greater interest should center in the finished paints themselves, and it is these finished paints which not only command the greater interest but also present the greatest obstacles to standardization and specification.

EFFECT OF CHEMICAL REACTIVITY IN GRINDING

In theory the pigment of a paint is supposed to be essentially inert chemically, as regards the vehicle, the paint being a plain mechanical mixture of finely powdered pigment with a more or less viscous liquid. In the majority of paints, however, this condition is not immediately realized, because nearly all of the available vehicles contain organic acids in varying degree and kind, and many of the pigments are basic in character, some of them highly so. Under these circumstances a certain amount of chemical reactivity is to be expected, especially under the frictional heat of grinding. From the purely scientific standpoint this does not impair the validity of the theory, for if the new substances formed by the reaction are soluble in the remaining unaffected vehicle, then they become a part of the liquid phase, and if they are insoluble they become a part of the solid phase, so that finally we have a pigment and vehicle which can no longer react with each other. The important point to be considered here is that the resultant paint may, and generally does, have notably different properties from what it would have shown had there been no reaction; furthermore, sometimes these differences may be advantageous and at other times disadvantageous.

In most cases the pigment and vehicle are so chosen that the reactivity shall be relatively very small and fairly constant, but if not so chosen and if the reaction becomes extensive, either at once or during a considerable time, then the paint generally becomes useless, especially on storage. These, however, are not the only complications due to the pigment.

Aside from anything which may be traced directly to chemical reactivity the pigment may have a profound influence in other ways for which, up to the present, there is no tenable and comprehensive theory. Such influence may best be shown by citing illustrative cases.

A good raw linseed oil exposed in a thin film will dry in five or six days at ordinary room temperature. The same oil after the introduction of dryers may be made to dry in seven or eight hours under the same conditions; such an oil is readily obtainable commercially as "boiled" oil and in the trade is a fairly definite product. There are several hundred pigments in common use representing about forty or fifty different types or kinds which differ widely both chemically and physically. When these are ground into paste paints with either raw or boiled oil we notice that while the drying

time of the oil remains unchanged in some cases there are other cases in which it is accelerated and still others in which it is retarded. We shall quote only a few of the extreme cases.

MATERIALS WHICH ACCELERATE OR RETARD DRYING

Knowing, as we do, that small quantities of certain metals such as lead, manganese, cobalt, iron and a few others have a pronounced catalytic effect in accelerating the oxidation of oil, we are not particularly surprised to find that such pigments as white leads and umbers accelerate the drying speed, nor is it necessary to postulate anything further than a slight chemical reaction between pigment and vehicle to account for the acceleration. No such explanation, however, will account for the great retardation induced by such pigments as vandyke brown, various carbon blacks and certain coal-tar dye lakes made by precipitating basic dyes with tannin. It is difficult to imagine a pigment more inert chemically than the carbon black made by burning natural gas, and when ground in boiled oil it makes a good practicable paste with about 12 lb. of black to 88 lb. of oil. Good carbon black gives an ash of less than one-tenth of one per cent and contains occluded air sometimes to the extent of several per cent, but whether or not this occluded air is wholly displaced by oil in the ground paste, it is quite certain that any effect which either the air or the trace of mineral matter might have would be accelerative rather than retardant. Whatever might be expected as to the drying speed of such a paste paint, the fact is that twelve to fifteen days are required instead of the seven or eight *hours* required for the oil alone. If the drying time were retarded to only five or six days, it might be explained on the assumption that the metallic dryers are adsorbed by the finely divided carbon and their catalytic effect suppressed, but when the paint requires six or eight days more than raw oil itself, no such assumption is tenable. The different blacks owing their color to carbon do not all show the same degree of retardation, but no sort of chemical analysis reveals any sufficient reason for the observed differences. The most extreme case of retardation coming under the writer's notice was a "tannin-methyl violet" lake ground in raw oil; it did not dry in five months, and even when it could finally be touched was a gummy mess wholly unlike a good paint film. Fortunately lakes of this kind are unimportant, because better ones can be made, and at best they are too fugitive in color for general use, but the case is of considerable academic interest.

DURABILITY AND HIDING POWER OF PAINTS

Pigments also differ widely in their influence on the durability of paints made from them. This is especially important in exterior paints, or common outside house-paints well known and familiar to almost everybody. Whether this influence is a direct result of the same fundamental principle that affects the drying speed or not is open to question, but there is apparently some close connection, because long experience shows that some of those pigments which exhibit the greatest retardation also have the greatest influence in delaying the decay of the vehicle in service. Other factors probably enter, for it has long been known empirically that if small quantities of colored pigment be added to any given base white paint, the tinted paints so made will outwear the original white, and the hiding power is

also increased to a much greater extent than would be expected from such a small quantity of color.

A small instrument devised by Dr. Pfund of Johns Hopkins University allows us to measure this hiding power, and in a research bulletin issued from the laboratory of the New Jersey Zinc Co. on Aug. 1 of this year some results obtained by Dr. Pfund are set forth in detail. Among these results he shows that in a certain paint made from zinc oxide the addition of a very small quantity of lampblack raised the hiding power of the paint from 145 for the straight white to 486 for the light pearl gray tint, these figures expressing the hiding power in terms of square feet of black surface completely hidden by one gallon of paint. The proportion of lampblack required for such a tint is not more, and generally less, than one-tenth of one per cent on the zinc present—a quantity apparently out of all proportion to such a result. If any such demonstrable resistance to the passage of the visual rays of light follows the introduction of such small amounts of color, it is highly probable that the actinic rays are also obstructed and their influence in hastening the decay of the vehicle considerably diminished. This seems to be the most reasonable hypothesis, for it is fairly certain that actinism and water are the most potent causes of decay in exterior paints.

Whether paints be regarded as merely decorative or protective, or both, their durability as an economic factor is of paramount importance. No extended argument is necessary to carry conviction on this point for, on the average, it is fair to say that three dollars' worth of labor will be required to apply one dollar's worth of paint. The initial cost of the paint is to be considered, of course, but the real measure of value is the consumer's ultimate cost for continued upkeep, including the labor charges, and ultimate economy is clearly dependent upon the durability of the paint.

EFFECT DUE TO SIZE AND SHAPE OF PARTICLES

One other important influence of the pigment must be noted, and that is the effect due to the mere size and shape of the particles. Mixtures of pigments with any paint vehicle do not take on the physical properties characteristic of good paint until the particles present a relatively large specific surface to the liquid vehicle. Roughly speaking, the particle diameter may range from 0.2 micron to 50 microns with a mean average of 5 to 20 microns. When pigments are reduced by any process of mechanical grinding, the particles are far from uniform in size and if the material is subject to cleavage, the diameter in one direction may be much larger than in another, so that in stating average size we do not give a full idea of the physical state. It makes a great deal of difference whether there is a wide range between the maximum and minimum size, or whether the particles are more nearly uniform. The important point to us now is that as the particles become finer the tendency to flocculation increases, and, unless counteracted by the dispersive power of the vehicle, all sorts of changes in the consistency and applicability of the paint may ensue. However interesting the further discussion of this phase of the subject might be, we are concerned here only with the relation of such effects to the preparation of specifications, and enough has been said to show that they alone would render difficult the full description of a paint by merely specifying the ingredients and their proportions.

Whatever the difficulties arising from the pigment,

those arising from the vehicle are quite as great. There is no practical vehicle composed of a single unitary substance of fixed properties, and rarely if ever is the vehicle of a finished paint composed wholly of any one of the drying oils in its original state; almost invariably metallic dryers must be added, and while our knowledge of some of them is satisfactory, we know much less about those which have been prepared by the various cooking processes in common practice. Even linseed oil itself comes to the paint manufacturer in no fewer than five types—viz., raw, refined, boiled, bodied and blown—all in daily use, and when we consider the cooked and uncooked mixtures of the various drying oils with other substances whose chemistry is even less definitely known, we are forced to realize the essential hopelessness of attempting to describe them in terms of composition.

If then such obstacles to full specification by composition are interposed by both pigment and vehicle, what are we to do? The answer to this question is easy, but the preparation of a good specification founded on this answer is more difficult. If we consider paint from the consumer's standpoint the composition is of no great moment except in so far as the presence or absence of some particular ingredient positively adds to, or detracts from, the economic value of the paint. The consumer buys paint for what it will *do* and if he can rely upon a definite performance in service his further interest is perfunctory. We may write a good specification therefore by stating what the paint shall do, knowing of course that such a paint can be made, and the only real obstacle to this procedure is that we have no trustworthy test that will indicate with reasonable certainty the probable durability of the paint in service.

DURABILITY TESTS

Experience shows that the value of paint rests chiefly on five main properties—namely, color, degree of gloss, hiding power, working properties and durability, all physical attributes. All these, except durability, are susceptible of quantitative measurement, and if we could measure durability, we could determine the economic value of such paints without knowing anything about their composition.

When Committee D-1 first began its systematic study of paints it quite naturally attacked the problem from the chemical side on the reasonable assumption that if the composition were fixed the physical properties must also be fixed. Some of the reasons why such a method could be only partly successful have been given above in considerable detail. The committee soon realized that the subject was complicated, and in order to simplify matters confined its attention for some years chiefly to one type of white paints. On the Arlington test fence alone about 240 white paints were tested out in which the differences were due chiefly to changes in the proportions of the more common white pigments while the vehicle was maintained as nearly constant as possible. Supplementary tests of a similar kind were carried out, literally in thousands, by individual interests, but in spite of every care and an enormous amount of work, the knowledge derived has not been considered enough to serve for a satisfactory specification. The more recent efforts therefore have been directed more toward a study of the important physical properties, and the present tendency is to demand cer-

tain physical properties in a quantitative degree, putting up to the manufacturer the problem of how to get them in.

Specifying varnishes by composition has met with the same obstacles that pertain to paint. Until very recent times the attack has been from the chemical side despite the fact that our chemical knowledge of even the raw materials involved is incomplete, meager, and sometimes even no more than speculative. Varnish is simpler than paint in that there are no complications due to pigment, but when two problems are both beyond our capacity to solve, it makes little difference which is the more complex.

THE KAURI REDUCTION TEST FOR DURABILITY

During the war large quantities of varnish of maximum durability were required and there was great need for some test which would give some indication of the durability of the many brands offered. Under the stimulus of this pressure a method of test was developed from an idea that has been regarded as axiomatic in the varnish industry for generations. No gum-and-oil varnish yet made has anything like the durability of a first-class linseed oil paint in which the vehicle is practically all linseed oil with only the minimum proportion of dryers, and as the proportion of gum in varnish increases, the elasticity and durability are diminished. It has always been held that finishing varnishes which are required to withstand exterior exposure should always be "long in oil" and that elasticity and durability were accompanying features more or less in direct proportion. After thorough drying, short-oil varnishes crack readily when sharply bent, and therefore if we add more gum to a long-oil varnish until it cracks when bent we have a measure of the "length" of oil, and consequently the probable durability. This test is the so-called "Kauri Reduction Test" and for the detailed method of carrying it out we must refer you to the latest Inter-departmental specification for spar varnish. Whatever the further development of this test may show, it is founded on many years of solid experience, and while its results may not run exactly parallel to the service tests in all cases, yet as a test it is less liable to error than the service tests themselves unless the latter are carried out with most unusual care.

For some time yet it may still be desirable to include in varnish specifications the composition desired so far as that composition can be determined by analysis with reasonable accuracy, but by specifying what the varnish shall *do* and expressing it in terms which our present knowledge can measure quantitatively we are taking a long step ahead.

MUCH PROGRESS IN RECENT YEARS AND FUTURE FULL OF OPTIMISTIC EXPECTATIONS

During the past five or six years in which the attack has been active from the physical side much more progress has been made than in any previous similar period. Work is now under way which we hope will result in an accelerated test for durability in paints, and if this hope is realized the future is rosy with the optimistic expectation that, while we may not indeed reach the ideal, yet, for the first time in the history of the industry, we shall be able to standardize with reasonable accuracy the more important types of both paint and varnish, and write specifications which will be rational, sound and useful.

Brooklyn, N. Y.

Sidelights on the Chemical Exposition

General Impressions of an Interested Spectator and a Brief Account of Some of the New Products.
Apparatus and Materials Exhibited at the Seventh National Exposition of
the Chemical Industries, New York, Sept. 12 to 17

THERE were many new things to be seen at the chemical exposition this year and many old things were dolled up in new clothes and made to look attractive. It would have required weeks to inspect everything and to talk with all who were in charge of the many interesting exhibits. The writer of these brief notes is frank to admit that he didn't see everything. In fact there were a lot of important developments which he missed entirely and he probably wasted a good share of his time gossiping about inconsequential matters. However, he did observe many unusual things, and these notes were jotted down with the idea of conveying some of his impressions to those who were unfortunate enough to have missed the chemical show or were too occupied to make a detailed study of the novel products, apparatus and equipment. No effort has been made to arrange these items according to importance, novelty or interest and they are presented with an apology for their many errors of commission and omission.

THE DYE MAKERS were very much in evidence. The most elaborate architectural effort was doubtless the exhibit of the National Aniline & Chemical Co., although the booths of the Calco company, Klipstein and Sherwin-Williams were quite notable. The National's exhibit was one of a central group of the related corporations—Barrett Co., Solvay Process Co., and General Chemical Co.—and represented an old Egyptian street. For background on either side were the blank walls of the dwellings, interrupted here and there by doorways. At the street corners were four high ornamental pillars. All these structures and the partitions outlining their exhibits were painted in very harmonious blues, reds and yellows—rather soft and subdued as one would expect of colors generations old. The dooryards were shaded by more brilliant yellow awnings. The rumor that Sherwin-Williams was gradually giving up its coal-tar departments was completely refuted by a prominent array of new products, which included dyes for lake and ink manufacture and a new rubber accelerator known as formaniline. Attractive samples of fur, cloth, carpet and paper which had been dyed with these products gave an idea of the scope of this company's activities.

AN AIR OF DIGNITY and seriousness of purpose characterized the display of the Calco Chemical Co. The many new pharmaceuticals being developed for household and professional uses were given positions of prominence. Among these were calusol, a household antiseptic, and salicaine, a new local anæsthetic to take the place of cocaine.

KLIPSTEIN'S EXHIBIT was housed in a dazzling white pergola, with royal blue hangings for background—a colorful exhibit, much simpler in design than the

Egyptian street, but nevertheless extremely impressive. But with these few notable exceptions, the dyemakers' exhibits seemed less attractive than last year; perhaps that was because we were continuously meeting a party of dusky-skinned strangers, probably native of some country in southern Asia. One woman was draped in a magnificent shawl, of Oriental red, with a border vaguely suggesting the Paisleys dear to our grandmothers. Were the writer a dyemaker, he would try to make that red.

TWO OTHER BRIGHT SPOTS ON THE HORIZON were the colorful exhibits of the Newport Chemical Works and the Chemical Co. of America. The former now claims the distinction of having a very complete line of the famous vat colors of the indanthrene series. A number of new dyes have recently been added to this important series and as a result the number of products "not obtainable in the United States on reasonable terms as to price, quality and delivery" has been lessened.

A FEW BOOTHS, here and there, were vacant. Others seemed to be packing up, ready to go—but when you came closer, it proved that they were exhibits of trucks or other package-handling equipment. And speaking of packages, were you not struck with the number of booths which exhibited barrels, boxes, paper cartons and such like containers?

REVERTING TO VACANT BOOTHS, some were vacant and some were almost vacant. They suggested that the stingy hand of economy had intervened between the time when the space had been paid for and the construction of the exhibit. But still that explanation does not altogether fit the du Pont company. Last year everyone was greatly impressed by its magnificent purple hangings, reaching clear from ceiling to floor. And where was the collection of notable machinery which has featured the Buffalo Foundry & Machine Co.'s space in every exhibition since the first, and has almost become an institution?

THERE IS AT LEAST ONE COMPANY which keeps its chemists at work when dull times come and sales fall off. As a result it has developed a new product which promises to revolutionize gas engine manufacture. We refer to Dowmetal and its use for the piston heads of internal-combustion motors. As a conductor of heat it is three times as effective as cast iron and because of its lighter weight, engines can be speeded up to give more power with less strain. They don't generally boast of the fact, but the winning cars in the Indianapolis races were equipped with Dowmetal pistons. While the writer was discussing these things with Mr. Dow a man walked into the booth and, approaching the learned president of the Dow company, asked him if there was anybody there who understood chemistry.





With a whimsical smile Mr. Dow pointed to one of his associates near by who, he thought, might be able to talk with him. To ask this former professor of chemistry and toxicology if anybody around there knew any chemistry seemed funny, but the question would not down, whether it would be funny or sad to ask the presidents of many of our chemical corporations whether they knew any chemistry or not.

ONE OF THE REALLY NEW THINGS that attracted genuine interest was a new gyroballistic crusher that simply eats up the rock. The Stimpson Equipment Co. introduced several years ago the Mitchell screen, whose vibrating motion is caused by the very rapid vibration of a slightly balanced electric motor. The same kind of prime mover has now been applied to the top end of a crusher shaft with astonishing results. An entirely new principle is applied to crushing, wherein a force formerly considered destructive (vibration) is used constructively to produce an action of a cracking rather than crushing nature. The power requirement of the new machine is a paradox in that it is less while the apparatus is crushing than when it is operating without a load.

A MORE ELEGANT-LOOKING APPLIANCE is the new gas governor, designed by the Koppers Co., and primarily intended to regulate the pressure in the byproduct coke oven, thus preventing wastage of rich distillate from the coking coal through the brickwork, or the in-breathing of waste gas from the flues. Each battery of ovens has one of these governors operating a butterfly valve in the suction main leading to the recovery apparatus. As the pressure in the retorts goes up, from any cause, a float is raised which is connected by suitable linkwork to a pilot valve. The latter controls the flow of a body of circulating oil, allowing some of it to enter certain cylinders, whose rising pistons open the butterfly valve sufficiently to bring the gas pressure back where it belongs.

TO CATCH THE FEMININE EYE—and it did effectively—not a few exhibitors showed how their products entered into household utensils and furnishings. Many observers probably never before realized that applied chemistry is vitally necessary for their comforts. Lacquered, enameled and plated ware of all kinds were attractively exhibited; glassware and porcelains, and cooking utensils of aluminum, copper and nickel competed to catch the eye.

IF THE PROMINENT METALLURGICAL COMPANIES would collectively exhibit, it would make a metallurgical exhibition of considerable proportions. New Jersey Zinc Co. had a beautiful booth in blue and white, a background most effective for the silvery brightness of most of its articles on show. Other observers might offer first prize to the Nichols Copper Co. Its booth appeared to be the facade of a Greek temple, severe in the extreme. Directly in front was a large pedestaled fruit bowl made of sparkling crystals of blue vitriol. It was heaped with luscious fruit; a veritable altar to Demeter.

ANACONDA COPPER MINING Co. is to be especially complimented for a well-designed and harmonious exhibit. Not only was there an adequate showing of the several metals the company produces in bulk and various

byproducts, but there were also many specimens of chemical apparatus made of copper or copper alloys. Several manufacturers of copper utensils co-operated in this effort, contributing excellent panels or cases. For instance Duparquet, Huot and Moneuse loaned a very interesting collection of copper kettles and jelly molds, while Manning-Bowman's case of polished trays and percolators was particularly striking.

A NEW FORM OF DUCTILE NICKEL about which we have published several papers was exhibited by the British-America Nickel Corporation. A mammoth cathode, 20 ft. long, 5 ft. wide and $\frac{1}{8}$ in. thick and weighing 400 lb. was of especial interest, as was the company's statement that it is equipped to produce fifty such cathodes at one time. The new product was the result of five years' work in the laboratory of Mr. Madsen, for whom the metal has been named.

AS WAS SAID BEFORE, the du Pont company did not bring any of its many products to the exposition. The man at the desk labeled "Dyestuff Department," however, informed the writer that the company is now ready to announce the arrival of the Naphthol series of fast reds, scarlets, oranges, blues and pinks. These are the famous Naphthol AS colors introduced by the Griesheim works shortly before the war and their production in this country fills one of the last remaining gaps in fast colors for cotton.

"CANADIAN PACIFIC RAILWAY Co.—Exhibiting a colored map showing the industrial resources of Canada." This bare statement contained in the program certainly raised no great expectations. But the map was no ordinary colored map. It was a huge white thing; perhaps 20 ft. long and half as high, with a few sketchy outlines in black. In front was a switchboard. If you wished to see the route of one of the great railroad systems, merely press an appropriate button, and immediately flashed up a continuous line of miniature light bulbs; the names of the principal cities en route were also illuminated. Or if you wanted to know where Canada's precious metals were mined, push another one of the score of buttons and tiny red lights glittered here and there—Yukon, Rossland, Porcupine and dozens of others sprang forth. A regular Aladdin's map!

THAT PROMISING YOUNG OFFSHOOT of the Davison company, the Silica Gel Corporation, exhibited apparatus showing some important industrial uses for silica gel. For instance, in the Gayley process the gel is used to reduce the moisture in the blast for iron furnaces without refrigeration. The moisture content is brought down to $\frac{1}{2}$ grain per cu.ft. Adsorption from the gas phase is the basis for important uses of silica gel in refrigeration and in the manufacture of sulphuric acid by the lead chamber process. Removal of sulphur compounds from Mexican petroleum and the refining of various petroleum distillates by means of this gel depend upon its properties of adsorption from the liquid phase. Silica gel will adsorb 18 to 20 per cent of its weight of these offensive smelling compounds, and furthermore the gel can easily be repurified.

A NEW ROLLER PUMP which is as simple as rollin' off a log is the description given to the latest novelty of the Dorr Co. The pump is for any fluid or mud that can be passed through rubber tubing. The lower end



of the rubber tube is placed into the material to be pumped, and adjoining the pipe is a hard plane surface. A wheel (or spider) with three or more rollers attached at the periphery is also immersed on the other side of the pipe opposite the plane surface. Then, when the spider revolves, the first roller squeezes the pipe and pushes up some of the fluid, while before the first roller has been withdrawn the second has begun to squeeze upward, and so with the third, until a continuous stream is on its way—a sort of peristaltic motion applied to pumping.

NOW THAT p_{H} HAS COME SO VERY MUCH IN VOGUE, considerable attention has been attracted by the Elliot ionometer, which appears to be a rough and ready instrument adapted for rapid work and factory control. The Will Corporation declared that it is of especial service where dark solutions prevent the use of ordinary indicators.

A NEW SODA FOUNTAIN DRINK called "Cheerio" was dispensed to all comers at the booth of Heyden Chemical Co. Whether the great "heart" of the American public will take to it as it has taken to "Coca-Cola" or whether it will adopt the new synthetic grape juice of the Florasynth Laboratories, remains to be seen.

AN IMPORTANT INNOVATION in chemical engineering construction may follow the development of 3-in. Pyrex glass pipe-lines with T and L connections to be used as a substitute for brass pipes. The installation in tanneries for handling tanning liquors suggests important uses in other chemical industries.

SAMPLES OF A METAL which has some of the characteristics of bronze, but contains neither lead nor tin, were distributed in the form of little chisels by the American Metal Products Co. The alloy is made of copper, steel, aluminum and one other metal in varying proportions to serve different purposes, with copper preponderating. We suggest that this be called hardened copper, so that when gifted inventors come around with the secret of the lost art of hardening copper for sale for a million dollars, they may be told that it is done already.

ONE OF THE REASONS FOR THE CROWD which constantly surrounded the exhibits of the Bureau of Standards was the fact that many features were being carefully explained by the men who were responsible for the inventions and discoveries. For example, C. O. Fairchild showed the results of his process for the fusion of optical glass cells and similar articles which cannot be molded because of interference with optical properties. Formerly these were cemented and the cement was often a source of trouble. A small sample of the platinum developed by Dr. Edward Wichers was shown. The fact that it is spectroscopically free from any impurities suggests the possibility of greatly increasing the utility of rare-earth and resistance thermocouples. Priest's spectrophotometer is of such convenient operation that it may prove of great service in the much-needed work on the standardization of coal-tar dyes.

AFTER A VISIT to the booth of the Lake Erie Chemical Works of the General Electric Co., it is not difficult to predict that hydrofluoric acid will soon be displaced

in the production of frosted effects on glass. With Permelsol, a colloidal suspension of a mixture of inorganic compounds, similar results can be obtained more easily and at less expense. The mixture is simply sprayed on with an air brush and then fixed by development in a chemical bath. The finish may be colored if desired by the use of inorganic pigments. Another advantage claimed for this method is that it eliminates the breakage which occurs when it is attempted to fix frosting enamels on glass surfaces by baking.

IT MUST BE ALMOST LIKE SPLITTING HAIRS to manufacture an 840-mesh wire cloth, and it is no wonder that A. A. Campbell of the Newark Wire Cloth Co. felt himself called upon to design a special microscope for accurately measuring such fine mesh. By the use of a special micrometer stage this unique instrument measures accurately to one one-hundred-thousandth of an inch and it is claimed that with a vernier scale the accuracy was extended to one millionth of an inch. Although Mr. Campbell's device was built to serve a special purpose, it would appear that it might find important application in many other industries.

DOWN SOUTH THE LUMBER AND NAVAL STORES INDUSTRIES have for years been destroying yellow pine trees with such reckless abandon that less than one-third of the tree ever reaches the market in the form of lumber, lath or shingles. The stumps are left in the ground, for the enormous cost of removing them has in the past made it impracticable to reclaim the land. Chemical engineering has now appeared on the scene and pulp and wrapping paper and many byproducts, such as turpentine, pine oil and rosin, are being recovered. One of the pioneers in this field is Joseph Wallace & Co., which company demonstrated some of its accomplishments at the exposition.

A NUMBER OF THE SCIENTIFIC SOCIETIES AND TRADE ASSOCIATIONS took advantage of the educational opportunities offered by the exposition and used their booths to disseminate information to the general public regarding the scope of their activities and the possibilities for progress in their particular fields. These booths also proved convenient meeting places for members and were the scenes of many interesting reunions. Prominent among the society booths were those of the American Chemical Society, American Ceramic Society, American Electrochemical Society, Society of the Chemical Industry and the New Jersey Chemical Society.

IS THERE A CHEMIST who could spend fifteen minutes in the booth of the National Lime Association and not come away with an overwhelming realization of his ignorance on the subject of lime and its uses? On a pyramid in the center of the booth were arranged samples of 120 products which require the use of lime at some stage in their manufacture. A large chart detailed the uses of lime according to industry and according to function. Lime manufacture was visualized by a clever mechanical model of a lime plant, a flow sheet of the process, a chart giving the chemical engineering data involved, and photographs of typical plants. A feature of popular interest was a flashing red light which indicated the rate of consumption of lime in the United States—one ton every $2\frac{1}{2}$ seconds.

Meeting of the Fertilizer Division, American Chemical Society

THE fall meeting in New York of the Division of Fertilizer Chemistry was held Wednesday and Thursday, Sept. 7 and 8, 1921, under the chairmanship of F. B. Carpenter. H. C. Moore was secretary.

The only discussion of phosphate supplies on the program was a report by Waggaman on the briquetting and use of Florida and Tennessee phosphate rock for manufacture of phosphoric acid. Full details have been given by him in *CHEMICAL & METALLURGICAL ENGINEERING* (Dec. 1, 1920, p. 1057, and Sept. 14, 1921, p. 517).

CYANAMIDE IN SOME FERTILIZER MIXERS

Cyanamide as a fertilizer material was defended by W. S. Landis, who presented an elaborate reply to the article by Harger, which was given at the Chicago meeting of the division last fall. Both ton-lot and laboratory-scale tests were reported to show that in the quantities recommended the cyanamide does not form dicyanodiamide, a plant poison, in objectionable amounts "when it has been properly incorporated in the mixture." By analysis of the mixtures thus prepared it was attempted to identify the condition of all the added nitrogen, but from 15 to 50 per cent could not be found by the methods used. It was believed that only negligible percentages remained as dicyandiamide, the major part being as amino acids, guano-urea and urea.

J. E. Breckenridge reported also on cyanamide fertilizer experiments with the output of the American Agricultural Chemical Co., in which the Bureau of Soils co-operated. Tests of mixtures containing 40 lb. per ton of cyanamide show these to be safe from toxic plant materials.

Discussion by Harger and Schreiner of the Bureau of Plant Industry made clear their desire not to criticize the use of small amounts of cyanamide as is now trade practice, but their objection to the conclusions drawn by Landis according to the analytical methods which he used. It was also stated that Harger's work was the first presentation of the facts regarding the important influence of acid phosphate on the reaction by which the polymerization of cyanamide takes place.

WOOL SCOURING WASTES FOR FERTILIZER PURPOSES

Wool scouring wastes for fertilizer use offer promise if the U. S. Department of Agriculture results presented by F. P. Veitch can be realized in practice through co-operation of wool and fertilizer interests. The 300,000 tons of unscoured wool used annually in the United States averages 4 per cent K_2O , 0.5 per cent N and 15 per cent grease, with the first two named in useful water-soluble forms. The "concentrates" mix well with other materials and appear otherwise good.

GREENSAND AS A SOURCE OF FERTILIZER POTASH

Potash from greensand as a commercial proposition was discussed at length by R. N. Shreve, who presented figures as to the plant to use this method on 1,000 tons per day of greensand. This plant will make KNO_3 and caustic soda by treating the sand with lime at 470 deg. F. in the presence of $NaNO_3$. The byproduct caustic made will be 40 tons $NaOH$ per 100 tons KNO_3 , thus justifying use of $NaNO_3$ instead of $NaCl$ in the reaction, for most if not all of the expected output of 20,000 tons K_2O equivalent per year. The solid residue

from the process will be used for brick manufacture and special potash salts.

OTHER PAPERS PRESENTED

The use of triangular co-ordinates was cleverly described by Oswald Schreiner in explaining methods and interpretation of results in field use of three component fertilizers. The failure of many experiments to indicate the action of commonly used fertilizers—e.g., high potash for potatoes—was shown.

L. S. Bushnell emphasized a similar problem and use of similar methods in discussing the limiting constituents in fertilizer effects.

The soil and plant problems were covered also by J. J. Skinner's and H. A. Noyes' reports.

Analytical methods for nitrogen determination were on the program in papers by Charles S. Cathcart, J. E. Breckenridge, R. N. Brackett, H. C. Moore. Other analytical problems were covered by R. McG. Shuey, C. G. Atwater, Paul Rudnick and C. S. Robinson.

Meeting of the Rubber Division, American Chemical Society

THE fall meeting in New York of the Rubber Division, American Chemical Society, was held Wednesday and Thursday, Sept. 7 and 8, 1921.

In the beginning the Rubber Division was more or less of an experiment. Even its strongest supporters were dubious as to the outcome. Two years have now passed since its inception. Five meetings with steadily increasing interest have been held. There are over two hundred members, and finances are in excellent condition. In the beginning it was difficult to get the members to express their opinions, but at the meeting this year it was difficult to keep to schedule, so many had ideas which they wished to present. Without the least exaggeration it can be said that America's rubber technologists got together on a common basis for a full and free discussion of fundamental problems.

It was this spirit that prompted the division to pass unanimously a resolution calling the attention of the Rubber Association of America to the need of co-operative research for further investigation of the fundamentals of the industry.

With but one important exception, every American company interested in rubber has contributed something during these two years. One company, however, which is exceedingly well equipped, has so far declined to take anything but a selfish aspect of the situation. Thus far its organization has contributed nothing, and is apparently proud of it.

Election of officers took place at the close of the Thursday morning session. In recognition of his excellent contributions on the subject of acceleration, the division chose C. W. Bedford, of the Goodyear Research Laboratories, for chairman, to succeed W. W. Evans, of Goodrich, retiring. Arnold H. Smith, of the Thermoid Rubber Co., of Trenton, was re-elected secretary.

MECHANISM OF THE ACTION OF ZINC COMPOUNDS

C. W. Bedford and L. B. Sebrell presented the fourth part of their study on the Reactions of Accelerators During Vulcanization. This paper was by far the most important contribution to the chemistry of rubber presented in the two years the Rubber Division has been in existence. An abstract cannot do it justice.

Zinc oxide enters into chemical combination with the accelerators it activates and produces zinc salts which are much more powerful.

Zinc higher sulphides were described, which produce vulcanization in a manner similar to antimony sulphide.

The authors found that if H_2S and SO_2 are passed into cooled benzene and then one of the gases is run in for a time after the other is shut off, a form of sulphur thiozone, is produced, which when stirred into a rubber cement brings about vulcanization with setting of the cement in about 40 minutes at room temperature. This is evidently the key to vulcanization by the Dubosc-Peachey process.

MINERAL RUBBER

C. Olin North presented a paper on mineral rubber. This paper contained the most thorough inquiry into the effect of a compounding ingredient on rubber that has appeared to date. Mineral rubber is prepared by blending gilsonite and natural or blown asphaltic still residue. Various tests, such as stress-strain relations, hysteresis, permanent set, abrasion and elongation under constant load, were made with stocks containing an increasing volume ratio of mineral rubber. From 7 to 10 volumes of mineral rubber per 100 volumes of rubber were found most advantageous.

THE TETRA-HYDROPHENYL DERIVATIVE OF RUBBER AND ITS TETRA-METHYL ETHER

Harry L. Fisher and Harold Gray presented a paper on tetra-hydrophenyl derivative of rubber and its tetra-methyl ether. Some old work of Weber's was repeated and a previous error corrected. When rubber tetrabromide is treated with phenol, hydrobromic acid is split off and a product having the following formula is produced:



This is soluble in caustic soda solution with the formation of the sodium salt. When this solution is treated with dimethyl sulphate the tetramethyl ether



is produced. These compounds may serve to determine the molecular weight of rubber.

CORRECTED STRAIN CURVES FOR RUBBER

J. W. Shields presented a paper on corrected strain curves for rubber. The author corrects the stress-strain curve for decrease in cross-section area. In other words, he draws the true curve based on the actual area of each increase of load and a curve without the familiar S hook is obtained. It is similar to that obtained for other materials. Hooke's law holds for such curves which have the equation:

$$S = CE + \left(\frac{e}{B}\right) \times \frac{1}{K}$$

S = stress corrected for decrease in cross-section area.

e = elongation in per cent divided by 100.

E = Young's modulus.

C , B and K are constants.

The equation is said to apply to a wide variety of curves.

THE DETERMINATION OF PARTICLE SIZE OF PIGMENTS

W. W. Vogt presented a paper on the determination of the particle size of pigments. A rapid method for testing the average size of particle of various pig-

ments was described. The author prepares a suspension of pigment in liquid. Castor oil and carbon tetrachloride or glycerine and water may be used, depending on the nature of the pigment. The suspension is placed in a Nessler tube and the height of column adjusted so that the wires of a tungsten lamp placed underneath cannot be seen. The volume of filler necessary to obscure the area of the bottom of the Nessler is calculated to sq.cm. per c.c. of material and is known as the obscuring power. The method is said to be excellent in checking relative size of the same pigment.

RUBBER RESEARCH AND RUBBER TESTING

O. de Vries presented a paper on the preparation and testing of crude rubber.

Dr. de Vries is the director of the Dutch Experiment Station of Java. His visit to this country is for the purpose of ascertaining the direction research on rubber should take. He pointed out that much of their work on regulating the uniformity of rubber in cure and other properties is apparently without value to the American consumer. He wants to produce a better rubber and has compiled a set of questions which will be mailed the members of the division by the secretary within a short time.

Appearance of crude rubber is no guarantee of its inner properties, such as its rate of cure, tensile, etc. Resting trees slows down the rate of cure. Smoked sheets mill better than pale crêpe.

In the discussion, W. B. Weigand presented a method for arriving at relative plasticity. A square sheet is cut off the mill, and the crawl or contraction noted.

OTHER PAPERS PRESENTED

The Microscopy of Rubber Fillers: By Irene C. Diner.—This paper is preliminary to work on analysis of rubber compounds by use of petrographic methods. Optical constants and the effects of single and double polarized light for several of the more common fillers were described.

The Use of the Microscope and Photomicrographs in the Study of Inorganic Materials Used in Rubber: By Benton Dales and W. W. Evans.—Various fillers were dispersed in a 5 per cent rubber cement. Slides were prepared by floating them on the cement, after which the films were vulcanized by sulphur chloride. By loosening one end from the glass the thin film could be placed under any desired strain and its effects noted.

Recent Developments in the Art of Rubber Microsectioning: By Henry Green.—Previous methods described by the author required the use of liquid air and liquid CO_2 for freezing the sections before using the microtome. Liquid air is not accessible to all. Mr. Green has worked out a method whereby the sample is badly overvulcanized in sulphur chloride, after which it can be sliced as easily as if it were frozen.

Rapid and Low-Temperature Vulcanization: By G. S. Whitby and A. H. Smith.—Experiments with piperidine-piperidyl-di-thio-carbamate were described. Previous work by Whitby without an activator was repeated but in the presence of zinc oxide. The rate of cure was greatly increased. This is a very powerful accelerator.

An Improved Oven for Accelerated Aging of Rubber: By C. W. Sanderson.—A small oven mounted in an oil bath for accurately maintaining temperatures while dry preheated air is passed through was described.

An Apparatus and Method for Abrasion Tests on

Rubber Compounds: By J. C. Sproull and W. W. Evans. Test-pieces are mounted on a shaft which is revolved in carborundum dust. Abrasion values which are comparable to road tests were said to be obtained by the use of this apparatus.

The Determination of True Free Sulphur and True Coefficient of Vulcanization in Vulcanized Rubber, II: By W. J. Kelly.—An extension of work already published. The author eliminates sulphur combined with pigments, resins and proteins. This work had to do with stocks containing zinc oxide, hexamethylene tetramine, etc.

The Solubility of Sulphur in Rubber: By C. S. Venable and C. D. Green.—Solubility of sulphur at 55, 75 and 95 deg. C. investigated. The solubility increases with temperature, and with increase in coefficient of vulcanization.

Determining Temperatures in Tires.—A simple method for determining temperatures in tires was described by Frank G. Breyer. An awl with a hole bored through the head is used as a needle. The hot junction of the thermocouple is inserted in the hole in the awl. The couple is put in place by merely sticking the awl into the tire and withdrawing it. Mr. Breyer offered to supply the rubber trade with these awls and tested thermocouples at a very reasonable figure. He also mentioned that his company (New Jersey Zinc Co.) would supply those who are studying mechanism of vulcanization, acceleration, etc., with chemically pure zinc oxide.

GENERAL DISCUSSIONS

General discussions were held on: Accelerated Aging Tests, Mechanism of the Vulcanization of Rubber, Methods of Plotting Physical Testing Data.

Accelerated Aging Tests: Led by W. W. Evans.—The recently published article by W. C. Geer and W. W. Evans on "Ten Years' Experience With Accelerated Aging Tests" was discussed. There was a wide divergence of opinion as to temperature and other conditions of test, and also as to the actual value of such tests. The majority favored 70 deg. C. and circulation of air. An interesting test was described by A. A. Somerville. Test pieces are placed in a Mason jar and immersed in boiling water. During the first stages of the test oxidation is a factor. Later the oxygen disappears and the effect of heat alone is noted.

The Mechanism of Vulcanization of Rubber: Remarks by C. W. Bedford, G. D. Kratz, P. I. Murrill and others may be summarized in the statement that vulcanization is brought about by the action of sulphur carriers which are usually polysulphides. The carrier adds on sulphur, reacts with rubber, is split off, leaving the sulphur attached to the rubber. The process is repeated until there is no more sulphur or the temperature drops below the point where the reaction is possible.

Methods of Plotting Physical Testing Data: Led by W. W. Vogt.—An extremely simple and convenient method of visualizing and comparing the data contained in several stress-strain curves was presented. Load is plotted on the Y axis and time of cure or volume of filler on the X axis. The loads necessary to produce 100, 200, 300, etc., per cent elongation for the various stocks are plotted, and smooth curves are drawn. The method has the advantage that there is no overlapping of curves on the chart, and yet all points of interest are unobscured.

Capacity of Electrolytic Zinc Plants

At the present time the potential aggregate production of electrolytic zinc for the world amounts to approximately 125,000 tons, or 250,000,000 lb., per year. This is divided about as follows:

	Tons
Anaconda Copper Mining Co., Great Falls..	55,000 to 60,000
Consolidated Mining & Smelting Co., Trail..	20,000 to 25,000
Electrolytic Zinc Co. of Australasia.....	30,000 to 40,000
Judge Mining & Smelting Co., Park City....	2,500
Brunner, Mond & Co., England.....	1,700

The record production for Anaconda's plant was made in July, 1920, when a total of 11,801,662 lb. of cathodes was drawn. For Great Falls conditions this does not all represent marketable zinc, inasmuch as about 8 per cent of the cathode production must be blown into zinc dust for removal of copper and cadmium from the solutions. It should be borne in mind, however, that if the Great Falls plant had a copper-free concentrate to treat this would have very nearly represented net production, as on such concentrates probably not over 15 per cent as much zinc dust would have been required for purification. While, therefore, the Great Falls Plant is rated at only about 110,000,000 lb. per annum, this means production from the relatively impure and cupreous concentrates on which it operates. The maximum output of the tank house has been demonstrated to be at the rate of 140,000,000 lb. per year, or 193 tons per day, and it is probable that under favorable conditions, operating on concentrates such as are produced in the Joplin districts, the equipment at Great Falls could roast, leach and electrolyze sufficient concentrate for a production of 200 tons of zinc per day.

Casein Glues Exceptionally Durable in Damp Places*

Casein glues are as a class more water-resistant than animal and vegetable glues, but they are not, strictly speaking, waterproof. There is no glue that is waterproof in the sense that it is absolutely unaffected by water after a long immersion. Nevertheless there are casein glues that are so water-resistant that plywood glued with them will withstand soaking for many weeks in water or exposure for many months to a warm, damp atmosphere. Under similar conditions animal and vegetable glues would soon lose their strength.

When casein glue joints are kept fairly dry, they can be expected to retain their strength and remain unchanged for an indefinite period, as is the case with animal and vegetable glues. Water-resistant casein glue in a joint, kept constantly wet, will after a long time weaken, but it will ordinarily regain a great deal of its strength if the joint is dried. In a study aimed to discover the reason why casein glues ultimately decompose when kept moist, it was found that under certain conditions the decomposition seemed to be due to a hydrolysis of the casein, undoubtedly brought about by the sodium hydroxide always present in casein glues.

This explanation has been misunderstood to some extent. It should not be taken to mean that casein glues are unreliable and not durable enough for use in manufacturing plywood and other glued products. On the contrary, casein glues are considered as permanent as any under dry conditions, and the water-resistant casein glues are more permanent than animal or vegetable glues under wet or damp conditions.

*From U. S. Forest Products Laboratory Technical Notes.

Calculation of Equilibrium in Metallurgical Reactions

Thermochemical Computations Much Used by Physical Chemists, but Relatively Unknown to Metallurgists, Are Applied to Important Furnace Reactions — Relative Stability, Danger of Oxidation, Ease of Reduction, and Equilibrium Conditions Can Be Inferred From Thermal Data

By PAUL D. MERICA

METALLURGISTS are not infrequently called upon to answer questions concerning the nature of chemical reactions occurring in the various processes of smelting or refining in which they are interested and the extent to which and direction in which these reactions are influenced by change of temperature or by the addition of other materials either in the solid, liquid or gaseous form. In answering such questions recourse may often be had to the results of experience in plant operation or of direct experimentation with the reactions in question, and upon these concrete facts may of course be built the soundest and most satisfactory answer. Often, however, our experience may not be in such form as to be exactly applicable to the particular problem and we must resort to other more general and theoretical considerations for a solution of it.

WHAT REACTION WILL OCCUR

Will a certain chemical reaction proceed readily at a temperature of 1,500 deg. F.? A well-known rough and ready aid to the chemist or metallurgist in answering such a question is the consideration of the heat of reaction, it being assumed that if the reaction is accompanied by evolution of heat it will proceed, but that if accompanied by absorption of heat it will not. The heat of reaction may be readily calculated from the heats of formation of the compounds entering into it, data which are available in Richards' "Metallurgical Calculations" and Liddell's "Metallurgists' and Chemists' Handbook." It is perhaps also well known that considerations of this sort will lead often to entirely incorrect conclusions, particularly in the case of reactions involving gases and proceeding at high temperatures—reactions in which the metallurgist is peculiarly interested. The use of this simple criterion for deciding whether a reaction will or will not proceed must be restricted to the case of reactions involving only pure solids and liquids other than solutions—i.e., the so-called condensed systems, but in such cases gives conclusions not far from the truth in the majority of cases.

Modern developments of theoretical chemistry have shown the existence of further relations which we may utilize to extend somewhat our powers of theoretical prediction, and it is the purpose of this paper to describe and illustrate the use of methods based upon these relations and to show what are their scope and limitations and upon what fundamental laws and hypotheses they are based. For although the utilization of these methods has become somewhat familiar to the physical chemist, it does not appear that their value has become apparent to metallurgists in general or that any description of them has been given in metallurgical literature. It is therefore with the excuse of making these methods available to metallur-

gists that the author ventures to set down the discussion which follows, much of which, including the fundamental theory, is not new or original with him. He has himself found them of definite, practical value and does not doubt that they can be as valuable to others.

One fact must be emphasized at the very outset—namely, that the discussion to follow deals entirely with the equilibrium of chemical reactions and is based upon simple thermodynamic laws modified by a few assumptions. Results of such calculations of chemical reactions as are described will enable one to make definite predictions whether a chemical reaction should proceed in a certain direction or in which direction it will proceed if any chemical change takes place, but it will not enable one necessarily to predict whether a reaction which *should* proceed *will* proceed. It is a familiar fact that many reactions which should go on in a certain way according to their affinities will not do so owing to lack of mobility or velocity of the molecules or to other as yet little understood reasons. For example, hydrogen and oxygen will not unite at ordinary temperatures to form water with measurable velocity, although water is more stable than a mixture of its two component gases. Generally speaking, an increase of temperature relieves this frictional effect or resistance to reaction, probably by increasing the vibrational or translational velocity of the molecules, so that metallurgical reactions at high temperatures usually proceed to the chemical or thermodynamic equilibrium with which this discussion is concerned.

THE AFFINITY OF CHEMICAL REACTIONS

The amount of free energy—available as mechanical or electrical energy—which may be obtained from isothermal, reversible execution of a chemical reaction between molar amounts of the reacting substances is the exact measure of the affinity of that reaction and may be considered identical with it. It may be measured in calories, watts or foot-pounds; if it is positive—i.e., corresponding to evolution of free energy—the reaction should proceed; if negative, the reverse reaction should proceed; if it is zero, the reacting substances are in equilibrium and no chemical change will take place. The affinity of a reaction is not equal, generally speaking, to its heat of reaction; these two quantities are connected by the following relation based alone upon the two laws of thermodynamics:

$$A - Q = T \frac{dA}{dT} \quad 1$$

where

- A = the affinity or free energy of the reaction.
- Q = the heat of the reaction.
- T = the absolute temperature.

$\frac{dA}{dT_r}$ = the derivative of A to T at constant volume.

It is evident that unless $\frac{dA}{dT_r}$ is zero the free energy cannot be equal to the heat of reaction, but may be either greater or less than it.

Now our handbooks do not contain experimentally determined values of the free energy or affinity of reactions and only to a limited extent are such values to be found in our chemical literature. The principal reason is that they are difficult to determine directly. Handbooks do, however, contain extensive data on the heats of formation of chemical compounds from which heats of reaction Q may easily be computed. If we were able to calculate the value of the right-hand term of equation 1 we could always compute from the known heats of reaction the free energies or affinities of chemical reactions and our task of attempting to predict the course of these reactions would be completed.

The most promising method of making this calculation appears to be that based upon an assumption first made and discussed by Nernst,¹ of which the direct statement here would mean little and is omitted. It is sufficient to say that although the assumption has only a limited theoretical basis, it has been quite thoroughly tested out in comparison with the direct results of experience and observation in various and widely different fields and appears to have established itself as a reasonably accurate hypothesis.

Upon the basis of equation 1 and this assumption A and Q may be shown to have the following relation:

$$Q = Q_0 + \Sigma bT^2 + \Sigma cT^3 + \dots \quad (2)$$

$$A = Q_0 - \Sigma bT^2 - \Sigma cT^3 - \dots \quad (3)$$

where

Q = the molar heat of reaction at constant volume at the absolute temperature T , considered positive if heat is evolved in the reaction. Q_0 , the same at absolute zero.

A = the molar free energy or affinity of the reaction at the same temperature considered in the same sense.

Σ = summation of reacting mols (considered positive) and resultant mols (considered negative).

b and c = coefficients depending upon the change of the specific heats of the reacting compounds with temperature.

From Kirchoff's law and equation 2

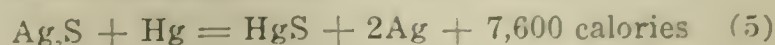
$$\Sigma S_T = \frac{dQ}{dT} = 2\Sigma bT + 3\Sigma cT^2 + \dots \quad (4)$$

where S_T = the true molar heat of each compound at the absolute temperature T and constant volume.

These liquids hold only for the case that pure solids and liquids (no solutions) alone take part in the reaction. It is seen that to compute values of A , the affinity, it requires only a knowledge of the heat of reaction at any temperature together with the values of the specific or molar heats of the reacting and resulting compounds at the same or several temperatures. The latter data are also available in reference and handbooks, although not as extensive as those on heats of formation.

Metallurgical reactions involving only pure solids and liquids are rare, but the following examples may serve to illustrate the application of the above equations.

Reduction of silver sulphide by mercury is supposed to proceed in amalgamation by the Washoe process.



molar heat of $\text{Ag}_2\text{S} = 248 \times 0.0746 = 18.5$

$$\text{Hg} = 200 \times 0.033 = \frac{6.6}{25.1}$$

$$\text{HgS} = 232 \times 0.0512 = 11.9$$

$$2\text{Ag} = 2 \times 108 \times 0.056 = \frac{12.1}{24.0}$$

If terms in T^2 , T^3 . . . be neglected, equation 4 becomes

$$\Sigma S_T = 2\Sigma bT$$

$$\text{whence} \quad \Sigma b = \frac{\Sigma S_T}{2T}$$

and for the reaction 5 at ordinary temperature

$$\Sigma b = \frac{25.1 - 24.0}{2 \times 300} = + \frac{1.1}{600} = + 0.0018$$

Substituting in 2

$$7,600 = Q_0 + 0.0018 \times 300 \times 300$$

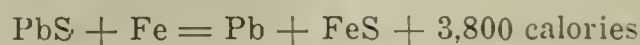
$$Q_0 = 7,438$$

Hence, from 3

$$A = 7,438 - 0.0018 T^2$$

The affinity of this reaction is positive, but its value decreases with increasing temperature.

Again, consider the reaction



$$\Sigma b = \frac{12.16 + 6.67 - 6.4 - 11.9}{2 \times 300} = + 0.001$$

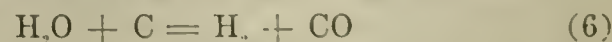
$$3,800 = Q_0 + 0.001 \times 300^2 \quad Q_0 = 3,710$$

therefore $A = 3,710 - 0.001T^2$

It is seen that the values of A for these reactions differ but little from those of Q , which is generally the case in reactions involving no gases or solutions. For this reason it is generally sufficient in such cases to consider only the heat of reaction as indicating sufficiently accurately the affinity of the reaction.

GAS REACTIONS

Most metallurgical reactions involve gases and it is to such reactions that the following methods of calculation are particularly applicable. Equilibrium in chemical reactions in which gases take part may be described completely, as is well known, by a statement of the equilibrium pressures of the several gases which are required to maintain the reacting system without chemical change. "The intensity of an action varies as the concentration of the reacting molecular species." Thus in the reaction by which water gas produced



the tendency of the reaction to proceed to the right equals some constant times the partial pressure of the water vapor—that is, equals $K \times P_{\text{H}_2\text{O}}$. On the other hand, the tendency to reverse and proceed to the left equals $K_1 \times P_{\text{H}_2} \times P_{\text{CO}}$. At equilibrium these tendencies are equal; hence

$$K_p = \frac{P_{\text{H}_2} \times P_{\text{CO}}}{P_{\text{H}_2\text{O}}} \quad (7)$$

in which K_p is known as the equilibrium constant of the reaction and depends only on the temperature. If it is known for any temperatures, the equilibrium pressures of these gases may be calculated for those temperatures.

¹Sitzungs-Berichte d. Kgl. Preuss. Akad. d. Wissenschaft, 1906, p. 933.

Quite generally a reaction may involve pure solids or liquids (not solutions) as participants as well as gases and may be schematically represented as follows:

$$lL + mM + \dots + qQ + rR + \dots$$

$$= uU + vV + \dots + xX + yY + \dots \quad (8)$$

where the lower case letters are integers representing the number of molecules taking place in the reaction, and

$L, M, \dots, U, V, \dots$ are solid or liquid compounds
 $Q, R, \dots, X, Y, \dots$ are gaseous molecules.

For this reaction at any given temperature the following relation similar to 7 will apply:

$$K_p = \frac{p_X^x p_Y^y \dots}{p_Q^q p_R^r \dots} \quad (9)$$

If the value of K_p for any temperature is known, the equilibrium gas pressures for the reaction can be calculated for this temperature. These pressures are conveniently expressed in atmospheres or fractions thereof, and assuming that the gases obey the simple gas laws and the partial pressure in a mixture existing at atmospheric pressure is one atmosphere times the percentage composition. Thus the pressure for CO_2 in combustion gases under atmospheric pressure containing 12 per cent of CO_2 is 0.12 atmosphere.

On the basis of the Nernst theorem and one or two other minor assumptions—namely, that the gases obey the simple gas laws and that the molecular heat of compounds at absolute zero is exactly additive—the relations shown in equations 10 and 11 may be derived. In these the equilibrium constant, K_p , is expressed in terms of the absolute temperature, the heat of reaction, coefficients depending on the rate of change of the specific heat of the compounds with temperature, and the so-called chemical constants (C). The values of these constants (C) have been computed by Nernst and are dependent on the vaporization characteristics of the gases taking part in the reaction; they are given in Table I. Other data required for the computation of K_p from these equations are found in handbooks. It will not be attempted here to derive these equations; those interested in this derivation may consult such references as Sackur-Gibson, "A Textbook of Thermo-Chemistry and Thermodynamics," McMillan & Co., 1917, or Lewis, "A System of Physical Chemistry," Longmans, Green & Co., 1918.

$$\log K_p = \frac{Q_0}{4.57T} - \Sigma g 1.75 \log T - \left(\frac{\Sigma b + \Sigma \beta}{4.57} \right) T - \left(\frac{\Sigma c + \Sigma \gamma}{9.14} \right) T^2 \dots - \Sigma C \quad (10)$$

$$\text{where } \Sigma S + \Sigma G = 3.5 \Sigma g + 2T(\Sigma b + \Sigma \beta) + 3T^2(\Sigma c + \Sigma \gamma) \quad (10a)$$

$$\text{and } Q_0 = Q_p - \Sigma g 3.5T - T^2(\Sigma b + \Sigma \beta) - T^3 \frac{(\Sigma c + \Sigma \gamma)}{2} \quad (10b)$$

where

Q_0 = the molar heat of the reaction at absolute zero;

Q_p = the molar heat of reaction at constant pressure at the absolute temperature, T , considered positive if heat is evolved in the reaction. This is the value which is computed from values of heats of formation found in handbooks;

S = molar heat of each solid or liquid substance;

G = molar heat (at constant pressure) of each gas;

$b, c, \dots$ = coefficient relating to solid or liquid substances;

$\beta, \gamma, \dots$ = coefficients relating to gaseous substances;

and ΣS = the summation of true molar heats of all solid and liquid participants; reacting mols are considered positive, resulting ones negative. The molar heat equals the specific heat multiplied by the molecular weight;

ΣG = summation in the same sense of the true molar heats at constant pressure of all gases taking part in the reaction;

Σg = summation in the same sense of all gaseous molecules;

ΣC = summation in the same sense of the chemical constants of all gases taking part in the reaction; values are given in Table I.

TABLE I. VALUES OF THE CHEMICAL CONSTANT, C , COMPUTED BY NERNST*

Hydrogen (H_2)	1.6	Nitrous oxide (N_2O)	3.3
Methane (CH_4)	2.5	Hydrogen sulphide (H_2S)	3.0
Nitrogen (N_2)	2.6	Sulphur dioxide (SO_2)	3.3
Oxygen (O_2)	2.8	Carbon dioxide (CO_2)	3.2
Carbon monoxide (CO)	3.5	Carbon bisulphide (CS_2)	3.1
Chlorine (Cl_2)	3.1	Ammonia (NH_3)	3.3
Iodine (I_2)	3.9	Water vapor (H_2O)	3.6
Hydrochloric acid (HCl)	5.0	Carbon tetrachloride (CCl_4)	3.1
Hydriodic acid (HI)	3.4	Chloroform (CHCl_3)	3.2
Nitric oxide (NO)	3.5	Benzene (C_6H_6)	4.0

*Zcit. *Electrochemie*, vol. 15, p. 687; 1909.

Our information concerning specific heats is generally not sufficient for us to evaluate the coefficients c and γ ; if we neglect this term in the equations 10 they take the following form:

$$\log K_p = \frac{Q_0}{4.57T} - \Sigma g 1.75 \log T - \frac{\Sigma b + \Sigma \beta}{4.57} T - \Sigma C \quad (11)$$

with corresponding omission of the last terms in 10a and 10b. Equations 10a and 10b also become

$$\Sigma b + \Sigma \beta = \frac{\Sigma S + \Sigma G - 3.5 \Sigma g}{2T} \quad (11a)$$

$$\text{and } Q_0 = Q_p - 3.5T \Sigma g - T^2(\Sigma b + \Sigma \beta) \quad (11b)$$

For still more approximate calculations, which are nevertheless of value in many cases, we may neglect also the coefficients b and β , and either assume that the heat of reaction at absolute zero, Q_0 , is equal to the value (Q_p) obtained from heats of formation, or consider that

$$Q_0 = Q_p - \Sigma g 3.5T \quad (12)$$

In the latter case equation 11 takes the form:

$$\log K_p = \frac{Q_0}{4.57T} - \Sigma g 1.75 \log T - \Sigma vC \quad (12a)$$

These equations, which may seem at first sight rather formidable, are in reality not difficult to evaluate with a little practice. A few illustrations may be given of their practical application.

EQUILIBRIUM IN BLAST-FURNACE GAS

What is the equilibrium composition of blast-furnace gases, CO and CO_2 , assuming that there is a slight excess of coke in the furnace?



$$\text{for which } K_p = \frac{p_{CO}^2}{p_{CO_2}} = \frac{p_{CO}^2}{1 - p_{CO}} \quad (13a)$$

(if $p_{CO} + p_{CO_2} = 100$ per cent; i.e., neglecting nitrogen).

We might judge from the negative heat of reaction that no CO could be formed in it, which is of course not true; this is a good illustration of the false conclusions to which one may be led by the application of this criterion.

Specific heat of carbon at about 25° C. = 0.16

Molar heat of carbon at about 25° C. = $0.16 \times 12 = 1.92$

Specific heat of CO₂, constant pressure, about 25° C. = 0.201

Molar heat of CO₂, constant pressure, about 25° C. = $0.201 \times 44 = 8.85$

Specific heat of CO, constant pressure, about 25° C. = 0.243

Molar heat of CO, constant pressure, about 25° C. = $0.243 \times 28 = 6.82$

ΣC (from Table I) = $3.2 - 2 \times 3.5 = -3.8$

From 10a and 10b omitting term in T^2

$$\begin{aligned} \Sigma b + \Sigma \beta &= \frac{\Sigma S + \Sigma G - 3.5 \Sigma g}{2T} \\ &= \frac{(1.92) + (8.85 - 2 \times 6.82) - 3.5(+1 - 2)}{2 \times 300} = +0.001 \\ Q_o &= Q_p - \Sigma 3.5T - T^2 (\Sigma b + \Sigma \beta) \\ &= -38880 - (-1) 3.5 \times 300 - 300 \times 300 \times 0.001 \\ &= -37920 \\ \text{And } \log K_p &= -\frac{37920}{4.57T} + 1.75 \log T - \frac{0.001}{4.57} T + 3.8 \quad (13) \end{aligned}$$

Table II shows the values computed from this equation for three temperatures in comparison with the values of the per cent CO and CO₂ actually observed by direct experiment.²

²G. Schraube, Diss. Berl. Tech. Hochschule, 1911.

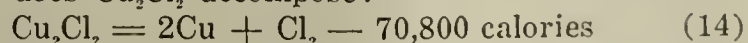
TABLE II. COMPARISON OF EQUILIBRIUM PERCENTAGE COMPOSITION OF CO:CO₂C AS CALCULATED FROM EQUATION 12 AND OBSERVED

Temperature		Log K_p		Per Cent of CO in Equilibrium CO + CO ₂ = 100 per cent	
Deg. C.	Deg. Abs.		K_p	Calculated	Observed
700	973	+0.27	1.85	72	63.4
800	1,073	1.14	13.73	93	88.6
900	1,173	1.88	75.8	99	97.0

The agreement is good between observed and calculated values and would be better if better data on specific heats and heats of formation were available.

CHLORIDIZING ROAST

A knowledge of the temperature range of stability of chlorides and of sulphates is essential to the proper conduct of chloridizing or sulphatizing roasting. For instance, At what temperatures and under what conditions does Cu₂Cl₂ decompose?



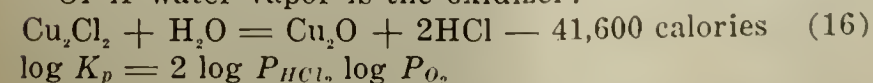
Using the above equation in the short form (12a) and assuming $Q_o = Q_p$

$$\log K_p = -\frac{15,400}{T} + 1.75 \log T + 3.0 \quad (14a)$$

If decomposition occurs according to
 $2Cu_2Cl_2 + O_2 = 2Cu_2O + 2Cl_2 - 54,000 \text{ calories} \quad (15)$
 $\log K_p = 2 \log PH_{Cl_2} \log PO_2$

$$= -\frac{11,800}{T} + 1.75 \log T + 3.2 \quad (15a)$$

Or if water vapor is the oxidizer:

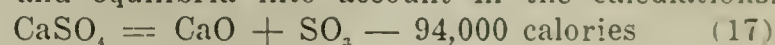


$$= -\frac{9,100}{T} + 1.75 \log T + 2.4 \quad (16a)$$

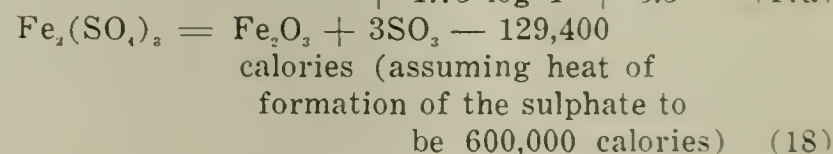
There is evidently little direct decomposition of Cu₂Cl₂ below about 2,000 deg. F. at which the equilibrium pressure of Cl₂ for the reaction 14a is about 1,000 parts per million. However, in the presence of air or of water vapor the decomposition according to the equations 15a and 16a will proceed at lower temperatures. If we assume 10 per cent of O₂ in the combustion gases (for purposes of calculation), it is found from these equations that at 1,600 deg. F. the equilibrium pressure of Cl₂ from reaction 15 will be 4,200 parts per million, or 0.42 per cent. When 10 per cent of water vapor is present, that of HCl will be 2.5 per cent. At these pressures the cuprous chloride would rapidly decompose in a stream of combustion gases. It is evident from the equations that the higher the temperature the less stable is the chloride, particularly in the presence of water or oxygen. It is of course well known that this chloride does decompose within this approximate range of temperatures.

STABILITY OF SULPHATES

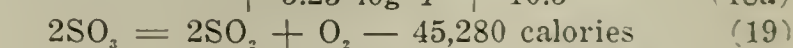
What is the comparative temperature stability of calcium and of ferric sulphate? They both decompose into oxide and sulphur trioxide, which in turn is decomposed into SO₂ + O₂. We may take both decompositions and equilibria into account in the calculations.



$$\log K_p = \log P_{SO_3} = -\frac{20,500}{T} + 1.75 \log T + 3.5 \quad (17a)$$



$$\log K_p = 3 \log P_{SO_3} = -\frac{28,300}{T} + 5.25 \log T + 10.5 \quad (18a)$$



$$\log K_p = 2 \log P_{SO_2} + \log PO_2 - 2 \log P_{SO_3} = -\frac{9,910}{T} + 1.75 \log T + 2.4 \quad (19a)$$

We wish to calculate the temperature at which these two sulphates are in equilibrium with a combustion gas carrying 1 per cent each of SO₂ and O₂. Equation 19a becomes:

$$-2 \log P_{SO_3} = +4 + 2 - \frac{9910}{T} + 1.75 \log T + 2.4 \quad (20)$$

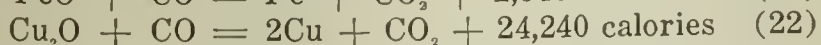
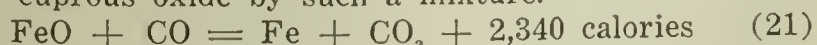
Equating the value of $\log P_{SO_3}$ of equation 20 first to that obtained from equation 17a and then to that from equation 18a and solving in each case for T , it is found that calcium sulphate is in stable equilibrium with 1 per cent each of SO₂ and O₂ at 1,307 deg. C. Ferric sulphate is stable under the same conditions at 649 deg. C. There is thus a marked difference in the stability of these two sulphates, which is of course well known.

OXIDATION AND REDUCTION

It is well known that there is a marked difference in the ease with which different metallic oxides are reduced to the corresponding metal. If we accomplish this reduction with a mixture of carbon monoxide and dioxide, which is generally the case, the ratio per cent CO to per cent CO₂ necessary to effect reduction may

be taken as a numerical index of the ease or difficulty of this reduction. If this ratio is high, the reduction is difficult; if low, easy.

Let us compare the ease of reduction of ferrous and of cuprous oxide by such a mixture.



Assume molar heats taken from handbook data as follows: Cu_2O , 15.87; FeO , 10.5; Cu , 5.91; Fe , 5.9; CO , 6.74; CO_2 , 8.38. We then find the following equilibrium equations:

$$\log K_p = \log P_{\text{CO}_2} - \log P_{\text{CO}} = 630/T - 0.0011T - 0.3 \quad (21a)$$

$$\log K_p = \log P_{\text{CO}_2} - \log P_{\text{CO}} = 5220/T - 0.00088T - 0.3 \quad (22a)$$

(Note that Σg becomes zero when there are as many gas molecules on one side of the equation as on the other.)

We see that a mixture of 96 per cent CO and 4 per cent CO_2 is necessary to reduce FeO at 1,400 deg. abs. (2,060 deg. F.), whereas at the same temperature a mixture of 0.6 per cent of CO and 99.4 per cent CO_2 will reduce Cu_2O .

These illustrations have shown the possibility of predicting the equilibrium conditions in any reaction entirely from thermal data (heats of formation and specific heats) together with the values of the chemical constants.

If we are fortunate enough to have determined the actual equilibrium at any temperature by independent experiment, we may use the same equations to determine it at any other temperature and of course with a considerable increase of accuracy over the previous method, for which no direct data are used. Use preferably formula 11 for this purpose. The determined value of K_p for temperature T_1 is K_1 . Substitute values of T_1 and T_2 , K_1 and K_2 in formula 11 and subtract one from the other.

$$\begin{aligned} \log K_2 - \log K_1 &= \frac{Q_o}{4.57 \left(\frac{1}{T_2} - \frac{1}{T_1} \right)} \\ &- \Sigma g 1.75 (\log T_2 - \log T_1) \\ &- \left(\frac{\Sigma b + \Sigma \beta}{4.57} \right) (T_2 - T_1) \end{aligned} \quad (23)$$

The method of application of this equation is obvious and is a most useful one whenever any direct information is available concerning equilibrium of any reaction.

From Table II it is noted that at 700 deg. C. there was equilibrium in reaction 13 when there was 63.4 per cent CO + 36.6 per cent CO_2 . Substituting these values, we may determine equilibrium at 900 deg. C. thus:

$$K_p \text{ for 700 deg. C.} = \frac{63.4^2}{36.6} = 3.0;$$

$$\log K_p = 0.477;$$

$$\begin{aligned} 0.477 - \log K_1 &= -8,310 \left(\frac{1}{973} - \frac{1}{1173} \right) \\ &+ 1.75 (2.988 - 3.069) \\ &- 0.00022 (-200) \end{aligned}$$

$$\log K_1 = 2.037;$$

$$K_1 = 109.$$

Whence

$$p_{\text{CO}} = 99 \text{ per cent};$$

$$p_{\text{CO}_2} = 1 \text{ per cent.}$$

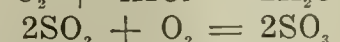
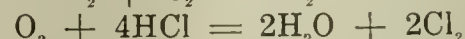
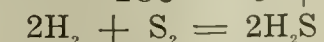
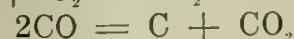
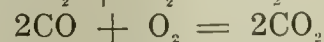
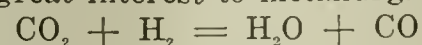
Thus at 900 deg. C. we calculate that there must be 99 per cent of CO and 1 per cent of CO_2 for equilibrium;

these values agree closely with the observed ones given in Table II.

USEFULNESS OF MATHEMATICAL METHODS

The more values of the equilibrium constant, K_p , we have as the result of direct determination the more accurately we can write equation 10 and consequently know the value of K_p for other temperatures. If, for example, two values of the constant are determined directly, they may be used to determine the coefficients in equation 11.

It may be pointed out here that the equilibria of many reactions of great interest to metallurgists such as



have been studied experimentally; the results of these investigations are for the most part scattered throughout current periodical literature for the last fifteen years. It would be well if they could be assembled for ready reference in the reference and hand books with which metallurgists are familiar, as they are of great practical value. Many of these results may be found in the book by Lewis mentioned above as well as in Jellinek, "Physikalische Chemie der Gasreaktionen," and Haber, "Thermodynamik der Technischen Gasreaktionen."

In conclusion, it must be pointed out that the calculation of equilibrium as described above is subject to restrictive limitations. It has already been stated that the equations 10, 11 and 12 are not applicable without alteration to chemical reactions involving solid or liquid solutions, except in a very approximate manner. Furthermore, the results of such calculations from purely thermal data are necessarily not more accurate than the data on which they are based and our present knowledge of the specific heats of chemical compounds leaves much to be desired; in particular our knowledge of these specific heats at higher and lower temperatures is very meager. The author must confess that it was not the least important purpose he had in mind in writing this article to emphasize the need of the metallurgical and chemical industries for new and more accurate data on specific heats of chemical compounds, covering the widest possible temperature ranges and to make an appeal to those institutions having the equipment of these determinations to undertake some systematic work along these lines. The results of such work would have a wide usefulness and would constitute a most valuable service to our metallurgical and chemical industries.

Foreign Portland Cement Specifications

The Bureau of Standards has recently completed a summary of the portland cement specifications of various countries. This includes not only the principal requirements but also many of the details of methods of tests, details which are frequently of great importance when considering the specifications of some of the countries. However, for ready reference, the principal physical and chemical requirements have been assembled in a single chart, 16 x 22 in., copies of which may be obtained by addressing the bureau.

The Constitution of Martensite and Troostite

Hardness of Martensite Mainly Due to Fine-Grained Alpha Iron—Martensite Also Contains Carbide in Same Condition as It Existed in Austenite—Such Carbide Contracts Into True Cementite Particles to Form Troostite

BY D. J. MCADAM, JR.

Metallurgist, U. S. Naval Engineering Experiment Station

IN THE paper on "The Slip Interference Theory of the Hardening of Metals," by Jeffries and Archer,¹ these authors have made a valuable contribution to the science of metallography. Their theory of slip interference as a general cause of the strengthening and hardening of metals has made it possible to classify and explain many facts hitherto not understood.

The effect of small, hard, disconnected particles in increasing the strength of metals has thus been explained. For example, the mechanism of the hardening of duralumin by means of the submicroscopic particles of CuAl_2 is now clear.

ARE TRANSFORMATIONS IN CARBON STEELS DIFFERENT THAN IN ALLOY STEELS?

The authors' explanation of the constitution of martensite, however, would seem to require some application and possibly modification in order that all the phenomena of the hardening of steel may be properly classified. The section headings, for example, "Martensite Is Alpha Iron" and "No Cementite in Martensite," on pages 1065 and 1066 of the authors' article, at once raise the question, Do these assertions apply to

heated or cold-worked, the first transformation products have a typical, "martensitic," structure² which is usually called "martensite." In such steels, when the carbon percentage is sufficiently high, the deposition of carbides on tempering precedes and accompanies the transformation of iron from the gamma to the alpha condition. The first transformation products, therefore, contain cementite. In austenitic manganese steel, for example, according to the authors' own description of the transformation process, the first change on reheating consists in the deposition of carbides. The order of transformation in such steels is thus entirely different from that described by the authors under the heading "No Cementite in Martensite."

Evidently, therefore, the "martensites" produced by tempering austenitic steels may contain cementite. Are all the martensites produced during the cooling of steels different in constitution from the martensites produced by tempering? This subject deserves careful consideration in relation to the probable space lattice arrangements and various physical properties of quenched steels.

INFLUENCE OF GRAIN REFINEMENT IN ALPHA IRON

In discussing the subject of the constitution of martensite, consideration will first be given to Jeffries and Archer's theory that the hardness of quenched steel is due chiefly to the presence of exceedingly fine-grained alpha iron. In this discussion, for the sake of brevity, all non-gamma iron will be called alpha iron. Careful study of the authors' theory has led the writer to the conclusion that it is valid, at least as applied to hypoeutectoid steels. To account for the hardness of these quenched steels, it is not necessary to assume the presence of cementite in martensite.

I was at the first inclined to doubt the authors' conclusion that in quenched carbon steel the ferrite can be of submicroscopic grain size while the carbon is in solid solution. In quenched "Armco" ingot iron, the ferrite grains are always visible under the microscope and are often of rather large size. How is it possible, then, that quenched steel of higher carbon percentage may be composed of submicroscopic ferrite grains with carbon in solid solution? How could carbon in solid solution obstruct grain growth of ferrite?

An investigation at the U. S. Naval Engineering Experiment Station on the influence of temperature on the grain growth of iron and published in the *Proceedings of the American Society for Testing Materials*³ throws considerable light on this subject.

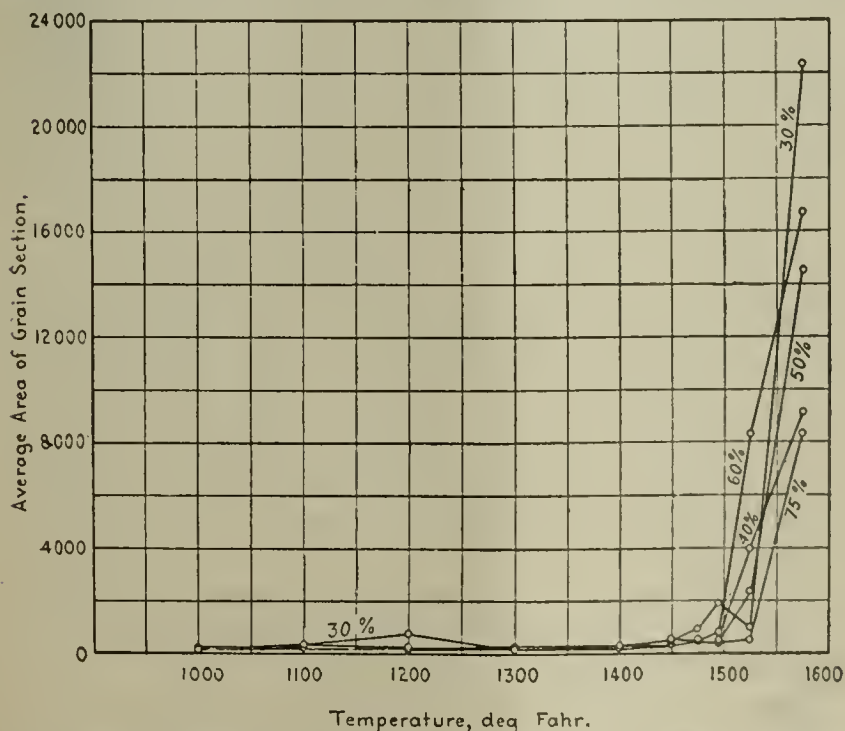


FIG. 1. GRAIN SIZE VERSUS ANNEALING TEMPERATURE OF INGOT, COLD-WORKED VARIOUS AMOUNTS

all microstructures that are now generally known as martensite? The authors seem to assert that "martensites" of all chemical compositions, whether produced during cooling or tempering of steel, consist of alpha iron with carbon in solid solution. Such a statement, it seems to the writer, does not correctly describe the constitution of every so-called martensite.

When austenitic alloy steels, for example, are re-

¹CHEM. & MET. ENG., June 15, 1921, vol. 24, p. 1057.

²Howe, "Metallography of Steel and Cast Iron," p. 642.
³"Annealing Temperatures and Grain Growth," by D. J. McAdam, Jr., *Proc. A.S.T.M.*, vol. 17, Part II, 1917. "Grain Size of Iron as Affected by Temperature," by D. J. McAdam, Jr., *Proc. A.S.T.M.*, vol. 18, Part II, 1918.

Fig. 1, taken from the second of the articles describing this work, shows the effect of temperature on grain coalescence⁴ of cold-worked ingot iron. As illustrated by the graphs in Fig. 1, these experiments showed that below about 1,450 deg. F. (790 deg. C.) the grain coalescence tendency is slight and is only slightly affected by temperature. From this temperature to the A_c point, however, the grain coalescence tendency increases very rapidly with rise of temperature.

Though the experiments summarized in Fig. 1 were made primarily to show the influence of temperature on grain coalescence tendency of recrystallized ferrite after various percentages of reduction by cold-working, the results throw considerable light on the influence of temperature on the grain coalescence tendency of the alpha iron formed from austenite in the quenching of hypo-eutectoid steel. Assuming that, when hypo-eutectoid steel is quenched, there is time for the formation of alpha iron but not for the formation of cementite, the infinitesimal grains thus formed would consist of but one phase. The grain growth of this phase, being unobstructed by the presence of a second phase, would depend on the time available for growth and on the grain coalescence tendency of the phase at its temperature of formation. For any quenched hypo-eutectoid steel, therefore, the grain coalescence tendency, and hence the grain size of the phase formed from the austenite, should depend chiefly on the temperature at which the austenite is decomposed. The grain coalescence tendency, and hence the grain size, of this phase would probably not differ greatly from that of pure alpha iron, if it could be formed from pure gamma iron at the same temperature. The graphs in Fig. 1, therefore, can be used in order to draw some conclusions in regard to the probable effect of carbon content on the grain size of quenched steel. In order to study this subject, the graphs in Fig. 1 must be considered in relation to the effect of carbon on the transformation temperature of austenite and in relation to the effect of carbon on the hardness of steel.

RELATION BETWEEN BRINELL HARDNESS AND A_r TRANSFORMATION

Further consideration of this subject has shown a surprising correspondence between graphs of hardness and the inverted graph of transition temperatures, both drawn with carbon percentages as abscissas. These graphs are shown in Fig. 2. Graphs A and B are plotted from hardness values for quenched carbon steels listed in Table 34 of Dr. Howe's book, "The Metallography of Steel and Cast Iron." Graph C is an inverted representation of the effect of carbon content on the decomposition temperatures of austenite as obtained by cooling curves. The data are taken from page 168 of Sauveur's book, "The Metallography and Heat-Treatment of Iron and Steel." In this graph, line Km represents the A_{cm} transitions and Kl represents the A_r temperatures. Curve D shows the maximum Brinell hardness, for any carbon content, obtained by quenching

steels at various temperatures. This curve was plotted from data taken from an article by McCance.⁵

By reference to Fig. 2, it will be noticed that, up to a carbon percentage of about 0.4, increase of hardness is most rapid and bears a nearly linear relation to the carbon percentage. Above about 0.4 per cent, however, the effect of further additions of carbon has a gradually diminishing effect on the hardness, until at about 0.7 per cent the hardness has apparently reached a maximum. Further increase of carbon percentage (at least up to 1.2) neither raises nor lowers the hardness. The similarity of the hardness graphs to graph C of Fig. 2 indicates that the hardening effect of carbon in steel

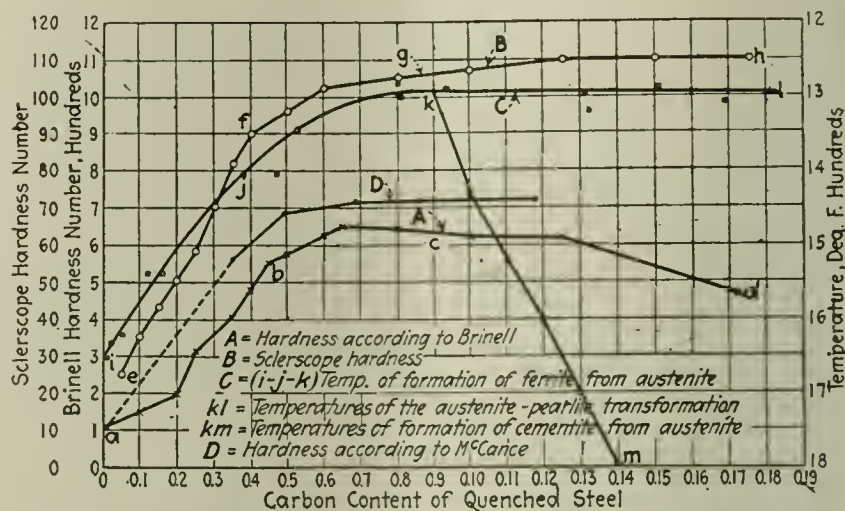


FIG. 2. COMPARISON OF HARDNESS AND TRANSITION TEMPERATURES OF PLAIN CARBON STEELS

is nearly proportional to the lowering of the transformation temperature of the austenite.

The rapid increase of hardness in proportion to the lowering of the A_r transition temperature as the carbon percentage is increased from zero to about 0.4 cannot be accounted for unless it can be shown that within this range of temperature the change of grain coalescence tendency with change of temperature is very great. Within this temperature range, however, as shown in Fig. 1, the change of coalescence tendency of iron with change of temperature is unusually great. If average diameter of grain-section after 7 hours annealing is taken as a measure of coalescence tendency, the ratio of the tendencies at 1,650 and 1,450 deg. F. (900 and 790 deg. C.) is about 10 to 1. This ratio, however, would be greater the shorter the time available for grain growth, and would probably be very great after the short period of growth available during the quenching of steel. It is, therefore, possible that the ratio between the average diameter of grain-section of pure iron and that of quenched 0.4 per cent carbon steel may be as great as 600 to 1, the ratio necessary to account for the ratio of Brinell hardness values according to Mathewson's formula.

Since the transition temperature is lower during rapid than during slow cooling, the transition temperature of 0.4 per cent carbon steel during quenching would be somewhat lower than 1,450 deg. F. (790 deg. C.). Though this secondary lowering would contribute somewhat to the grain refinement of such steel, it is believed that its influence would be small in comparison with the influence of the lowering of the temperature from 1,650 to 1,450 deg. F.

The fact that increase of carbon percentage above about 0.4 has a gradually diminishing effect on hardness

⁴If cold-worked iron is gently heated there results no change in crystallization up to a certain temperature, depending upon the amount of strain previously endured by the iron—that is, the metal is "inert." Higher anneals cause complete recrystallization, if the time is sufficiently long and the temperature sufficiently high. Metal at the point of recrystallization is known as "germinant." The grain size of ingot iron after recrystallization undergoes little if any increase until a higher temperature, about 1,450 deg. F., is reached. Above this temperature there is a rapid increase in grain size with rise of temperature until the A_c point is reached. This range of temperature I call the "coalescence range." The grain size reached at any temperature after a standard time of anneal may be taken as a measure of the "grain coalescence tendency."

⁵Andrew McCance, "A Contribution to the Theory of Hardening," *J. Iron & Steel Inst.*, 1914, No. 1, p. 192.

is evidently due to two factors. First, above a carbon percentage of about 0.35, the curve of austenite transformation temperatures does not fall so rapidly with increase of carbon percentage. Second, lowering of the austenite transformation temperature below about 1,450 deg. F. (790 deg. C.) has little effect on the grain coalescence tendency of the alpha iron formed from the austenite.

With a carbon percentage of about 0.7 the maximum hardness is reached. This would seem to indicate that

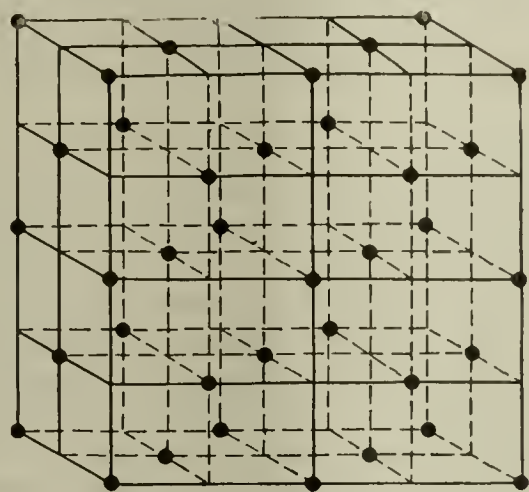


FIG. 3. FACE-CENTERED CUBIC ARRANGEMENT OF GAMMA IRON

with that carbon content grain refinement of the ferrite has reached its limit. A grain of this material, therefore, is probably the smallest possible crystal unit. Attempt at further refinement merely results in retention in the quenched steel of more or less austenite.

It seems probable, therefore, that the hardening effect of carbon, in hypo-eutectoid steel at least, is due to strengthening of the ferrite by grain refinement. The presence or absence of cementite in the martensite would probably have comparatively little effect on its hardness. Agreement with the authors' theory of hardening by grain refinement of the ferrite, therefore, does not necessarily involve agreement with their theory that

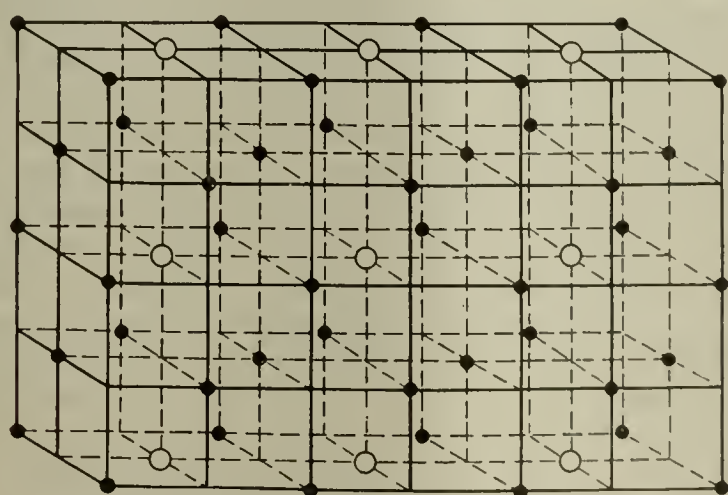


FIG. 4. FACE-CENTERED CUBIC ARRANGEMENT WHERE ONE-THIRD THE IRON ATOMS ARE REPLACED BY CARBON

"martensites" do not contain cementite. The probable condition of the carbon in martensite can be determined only by a study of the space lattice relations of austenite, alpha iron and cementite, and a study of volume, electric and magnetic relationships.

SPACE LATTICE RELATIONS OF AUSTENITE

The space lattice arrangement of gamma iron is illustrated by Fig. 3, in which the black dots represent iron atoms. The simplest assumption (that of the authors) for the space lattice arrangement of the solid solution

of carbon in gamma iron would picture every carbon atom as taking the place of an iron atom in the gamma iron space lattice. In the austenite space lattice every carbon atom would thus exert a strong influence over twelve neighboring iron atoms. The strength of this influence is shown by the fact that by the presence of carbon the temperature of the formation of alpha iron from austenite is considerably lowered.

If enough carbon could be dissolved in the gamma iron (austenite) to produce a composition equivalent to that of cementite, the space lattice arrangement of such a composition might be represented by Fig. 4, in which the carbon atoms are represented by small circles. Each of the cubes of Fig. 4 contains a carbon atom in the center of each of two opposite faces. For each carbon atom in a group of such cubes there are three iron atoms. Such a lattice structure may, therefore, be called *potential cementite*. If the carbon atoms are more widely scattered, so that there is not more than

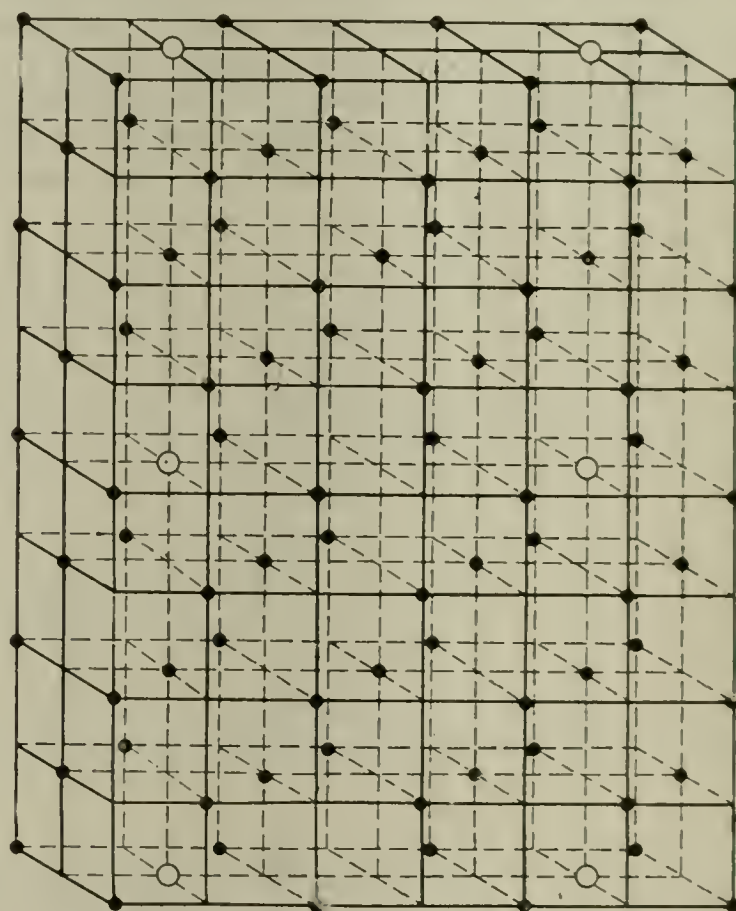


FIG. 5. FACE-CENTERED CUBIC ARRANGEMENT WHERE ONE OUT OF THIRTY-TWO IRON ATOMS IS REPLACED BY CARBON

one carbon atom in any unit cube, potential cementite could not be formed unless, by some rearrangement of atoms, two mono-carbon cubes are brought in contact.

In the lattice arrangement illustrated by Fig. 5 every pair of mono-carbon cubes is separated by a carbonless cube. Such a structure would have thirty-one iron atoms for every carbon atom and the carbon percentage would be 0.69. In a slightly closer condensation of the mono-carbon cubes, as illustrated in two dimensions in Fig. 6, there are twenty-six iron atoms to each carbon atom and the carbon percentage is 0.825, nearly that of a eutectoid steel. In the structures illustrated in Figs. 5 and 6, there is only one plane of iron atoms between any two mono-carbon cubes. A very slight movement of any carbon atom, therefore, will result in the formation of potential cementite.

In the slow cooling of hypo-eutectoid austenite, the separation of alpha iron results in bringing the carbon atoms of the austenite closer together until their concentration is about as represented in Fig. 6. In such

a structure it would seem impossible for any two carbonless cubes to pass through the rearrangement and increase in volume involved in the formation of alpha iron from austenite without thrusting two mono-carbon cubes together to form potential cementite, and finally actual cementite. With slow or moderate cooling, that is what happens; ferrite and cementite are formed simultaneously from eutectoid austenite. The influence of rapid rates of cooling will be discussed below in connection with a discussion of the volume changes involved.

With increase in carbon beyond the eutectoid percentage, mono-carbon cubes are brought in contact in increasing numbers to form potential cementite. It therefore requires higher and higher temperatures to prevent the separation of actual cementite crystals from austenite. In austenite of the maximum carbon content, containing only twelve iron atoms for every carbon atom, the steel is at the melting point.

When hyper-eutectoid steels are slowly cooled from above the Acm line, cementite forms, and this separation continues until the eutectoid composition is reached. Since on cooling hyper-eutectoid steels cementite is formed before alpha iron, and since on cooling hypo-eutectoid steels alpha iron is formed before cementite, it seems logical to conclude that in cooling eutectoid

on quenching such steels the formation of unit cubes of alpha iron might be prevented and the excess iron might remain in atomic dispersion throughout the cementite. It is, therefore, just as reasonable to conclude that the martensite of some hyper-eutectoid steels may consist of cementite with iron in solid solution as it is to conclude that the martensite of some hypo-eutectoid steels may consist of alpha iron with carbon in solid solution.

Whether such tentative assumptions reached from study of space lattice relations alone are confirmed or disproved by recent investigations of electrical, magnetic and volume relations will be discussed below.

VOLUME CHANGES DURING COOLING OF STEEL

Electrical, magnetic and volume relations of steels quenched from various temperatures were studied by McCance.⁵ DeNolly and Veyret⁶ made experiments on the change in length of various steels throughout a range of temperatures. Andrew, Rippon, Miller and Wragg⁷ made an extensive series of experiments on electrical, magnetic and dilatation relations of steels during slow cooling throughout a range of temperature, during tempering and after quenching. Since the data on volume relations thus obtained throw much light on the constitution of quenched steels, the writer has assembled and rearranged the essential parts of the data so as to bring out these relations most clearly. Since the dilatation experiments of DeNolly and Veyret, and of Andrew, Rippon and Miller, consisted of measurement of changes in length, the corresponding percentage changes of volume have been calculated from their results for comparison with McCance's results.

The results of these experiments show that the total volume change of any steel on slow cooling through the critical range is made up of two distinct and definite parts: an expansion due to the change from gamma to alpha iron; a contraction due to change in iron-carbide from the condition in which it occurs in austenite to cementite. The gamma-to-alpha expansion decreases and the carbide contraction increases with increase in carbon content. In steels having less than about 1 per cent, the allotropic expansion exceeds the carbide contraction, so that the net result is an expansion. In steels having more than about 1 per cent carbon, the carbide contraction exceeds the allotropic expansion, so that the net result is a contraction. The way in which these two factors vary with carbon content is shown in Fig. 7, in which graph A represents the effect of carbon percentage on the allotropic expansion, and graph B or C represents the effect of carbon percentage on the carbide contraction.

The work of the above-mentioned investigation has shown that, by rapidly cooling steels from above the critical range, it is possible to suppress entirely the carbide contraction, while permitting the gamma-to-alpha expansion to take place. This results in a "martensitic" structure. These experiments would indicate that the gamma-to-alpha expansion in the steels investigated is much more rapid than the carbide contraction. For this reason it is necessary to modify somewhat any conclusions that may be reached by study of space lattice relations alone. Even when the space lattice

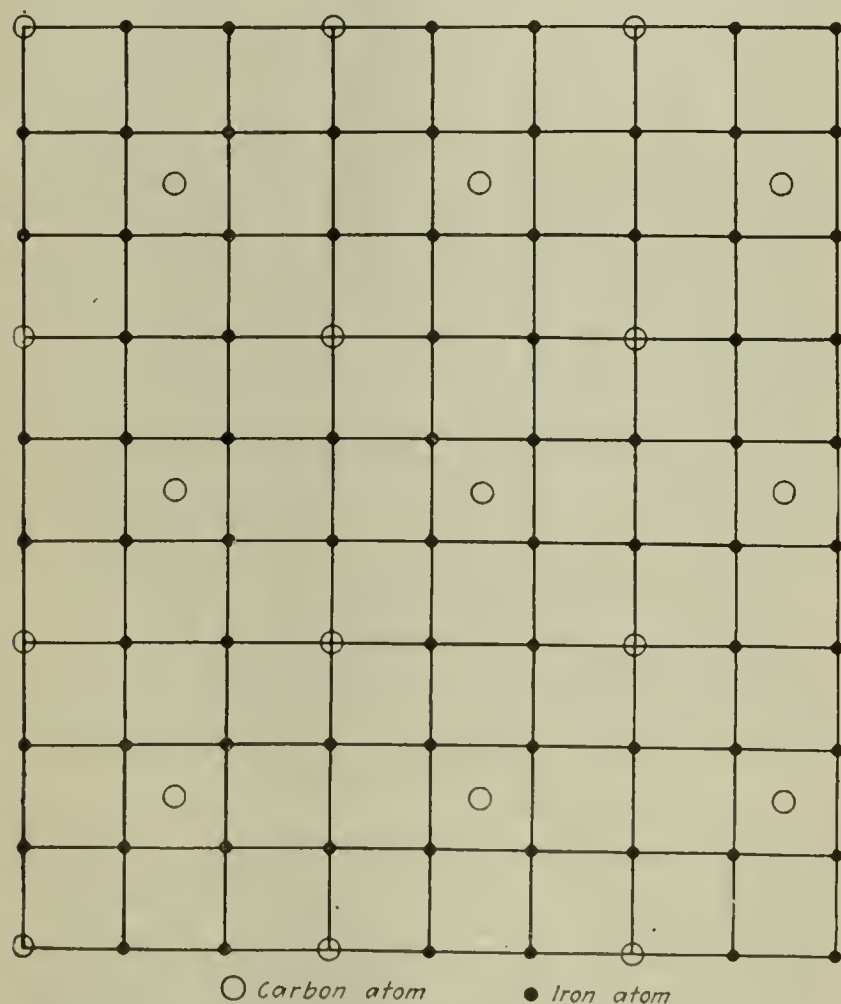


FIG. 6. PLAN OF ARRANGEMENT WHERE ONE OUT OF TWENTY-SEVEN IRON ATOMS IS REPLACED BY CARBON

steel the cementite and alpha iron are formed simultaneously. This reasoning, as well as the study of space lattice relations, therefore, leads to the conclusion that the authors are incorrect in their assertion that in eutectoid steels more migration of atoms is required for the formation of cementite than for the formation of alpha iron.

In the austenite of hyper-eutectoid steels of the higher carbon percentages the iron atoms not in the immediate sphere of influence of carbon atoms are so widely scattered that migration would be required for the formation of alpha iron. It is possible, therefore, that

⁵H. DeNolly and L. Veyret, "Note on the Transformation of Steels," *J. Iron & Steel Inst.*, 1914, No. 2, p. 165.

⁷Andrew, Rippon, Miller and Wragg, "The Effect of Initial Temperature Upon the Physical Properties of Steel," *J. Iron and Steel Inst.*, 1920, No. 1, p. 527.

grouping is such that no atomic migration is necessary for the formation of cementite on cooling, the change from potential to actual cementite is relatively so slow that it can be prevented without prevention of the change from gamma to alpha iron. With the possible exception of hyper-eutectoid steels of the higher carbon content, therefore, quenched steels may contain alpha iron and at the same time be free from actual cementite.

HYPER-EUTECTOID TROOSTITE

The above-described investigations of volume changes did not include carbon steels having more than about 1.2 per cent carbon. In the discussion of the space lattice relations of austenite it was shown that in the cooling of hyper-eutectoid austenites of the higher carbon percentages, unit cubes of alpha iron could probably not be formed without migration of iron atoms. The time required for this migration might, therefore, be expected to slow down the allotropic expansion so that it would be preceded and accompanied by the carbide contraction. The fact that in such steels the carbide contraction considerably exceeds in volume the allotropic expansion would probably make it more difficult to suppress this contraction while permitting the allotropic expansion to take place.

Even if by rapid cooling the carbide change in hyper-eutectoid steels can be prevented without preventing the allotropic change, there must be some intermediate rate of cooling such that the carbide contraction and allotropic expansion will take place simultaneously. The writer, by quenching hyper-eutectoid steels of the higher carbon content in oil at 300 to 400 deg. F. (150 to 200 deg. C.) has obtained structures, apparently "martensitic," in which the carbide and allotropic changes have occurred simultaneously. By quenching hyper-eutectoid steels at suitable rates, therefore, as well as by tempering hyper-eutectoid austenitic alloy steels, "martensitic" structures are obtained. According to the authors' definition of martensite, these so-called "dark etching martensites" should be renamed "hyper-eutectoid troostite."

PROBABLE CONDITION OF CARBON IN MARTENSITE

A study of the volume relations of cementite, alpha iron and gamma iron throws some light on the condition of the carbon in martensite. Though the space lattice arrangement of cementite is not known, the approximate relation between the volumes occupied by the same number of atoms of cementite, alpha iron and gamma iron can be calculated. The specific gravity of cementite, according to Benedicks, is 7.74 in steels having less than 1.26 per cent carbon. The specific gravity of pure iron, according to the same authority, is 7.87. If cementite had the same space lattice as alpha iron, its specific gravity would be about $\left(\frac{180}{224}\right)$ times that of alpha iron) 6.22. Since the specific gravity of cementite in steel having less than 1.26 per cent carbon is 7.74, the volume occupied by the same number of atoms in cementite is only 87.3 per cent that of alpha iron. The contraction of volume if iron carbide changed from the alpha iron space lattice to that of cementite would, therefore, be about 12.7 per cent.

In Fig. 7 the ordinates of the line *D* represent the percentage changes of volume that would occur if all the iron carbide in steel changed from the alpha iron

space lattice to that of cementite. The ordinates of the line *E* represent the volume changes that would occur if all the carbide in steel changed from the gamma iron space lattice to that of cementite. Lines *A* and *E* are both drawn on the assumption that the allotropic volume change in pure iron, if it could be measured at room temperature, would be practically the same (1.2 per cent) as the actual measurements that have been made at the transition temperature. Since the volume-temperature curves of gamma and alpha iron probably separate somewhat as the temperature falls, the allotropic change of volume if measured at room temperature may be somewhat greater than 1.2 per cent. Any change in the position of line *E* on this account, would, however, be relatively slight.

In graph *B*, plotted from data on carbon steels in the article by McCance⁹ previously referred to, the ordinates represent the maximum carbide contractions measured at room temperature. In graph *C*, plotted from

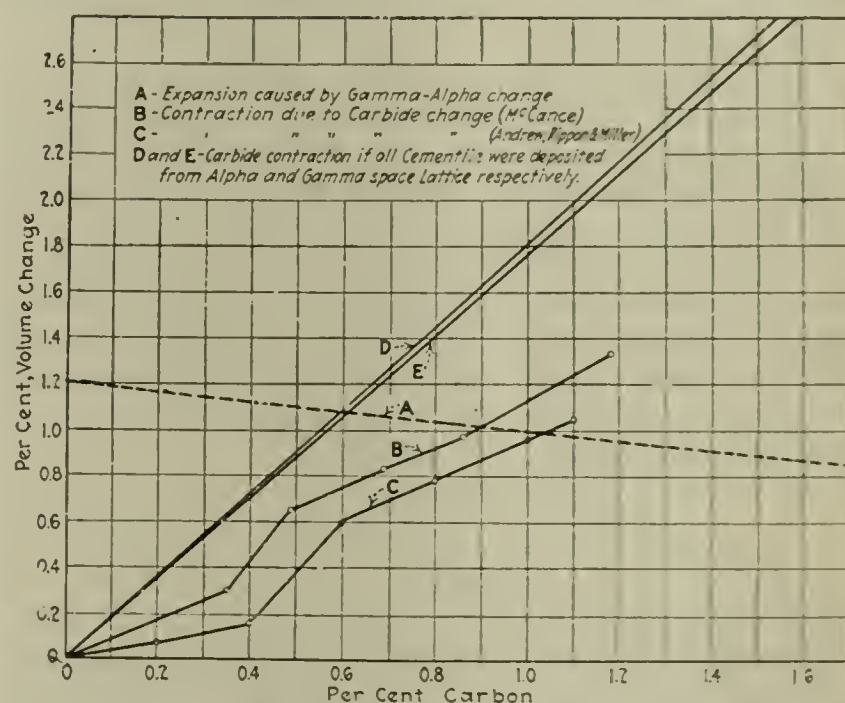


FIG. 7. VOLUME CHANGES IN STEEL DUE TO ALLOTROPIC TRANSFORMATION AND CEMENTITE FORMATION

data in the article by Andrew, Rippon and Miller⁹ previously referred to, the ordinates represent the maximum carbide contractions measured within the temperature range in which they occur. Allowing for experimental errors, the agreement between these two series of measurements is very good. A curve drawn half way between curves *B* and *C* would, therefore, probably represent correctly the carbide contraction as influenced by carbon percentage.

Comparison of graphs *B* and *C* with lines *D* and *E* of Fig. 7 shows that the carbide contraction is a little more than half what it would be if the carbide change were from either the gamma or alpha space lattice volume to that of cementite. It is evident, therefore, that neither in austenite nor in martensite does the space lattice of the carbides correspond to that of either gamma or alpha iron. The iron atoms surrounding every carbon atom in austenite must be more closely packed than the iron atoms that are not in the immediate sphere of influence of a carbon atom. When the steel is so quickly cooled that the carbide change but not the allotropic change is suppressed, the volume occupied by every carbide group remains practically unchanged. This would seem to indicate that in martensite every carbon atom with its surrounding iron atoms

preserves essentially the same space lattice arrangement that existed in austenite. These carbide groups, though they are in a denser space lattice than the average space lattice of austenite, will be designated "austenitic carbide" groups.

It seems probable that in austenite every carbon atom holds its twelve neighboring iron atoms at a radial distance that is smaller than it would be if the carbon atom were replaced by an iron atom. Such a shortening of the radial distance need be relatively slight to account for the difference between the ordinates of graph *E* and those of graph *B* or graph *C* of Fig. 7. In martensite the density, and probably the arrangement, of an austenitic carbide group is practically the same as in austenite.

When opportunity is given for two austenitic carbide groups to come in contact (forming potential cementite) and to undergo the necessary great contraction of volume, actual cementite is formed. In order of increasing coarseness of the cementite particles, the resulting microstructures are known as troostite, sorbite or pearlite respectively.

Martensite, therefore, probably consists of alpha iron with austenitic carbide in suspension. It is not quite correct to say that the carbon is in solution in the alpha iron, since that would imply that every carbon atom in martensite takes the place of an iron atom in the alpha iron space lattice (in which every atom is surrounded by only eight other equidistant atoms). Such a loose arrangement of the austenitic carbide groups would not be likely to exist, since it would be opposed by the tendency of the austenitic carbide groups to undergo "carbide contraction."

SUMMARY

(a) Jeffries and Archer's conclusions in regard to the causes of the hardness of martensite seem to be confirmed by results of experiments at the U. S. Naval Engineering Experiment Station on the effect of temperature on the grain coalescence tendency of ingot iron.

(b) If the term "martensite" is to be limited so as to apply only to the constituent of steels in which the allotropic expansion but not the carbide contraction has occurred, the constituents, usually designated "martensite," of some hyper-eutectoid steels should be known as "hyper-eutectoid troostite."

(c) Martensite consists of alpha iron with "austenitic carbide" in suspension. In troostite, the austenitic carbide has undergone the "carbide contraction" to form cementite particles of the smallest size that can exist independently.

Production Costs in Belgian Plate-Glass Industry

Acting Commercial Attaché Samuel H. Cross reports that in general wages in Belgian plate-glass plants approximate four times the pay received by employees in this industry in 1914. It is estimated that the production costs now have reached 600 per cent of those prevailing before the war. This advance is due not only to the increase in raw material costs and wages but also to the introduction of the 8-hr. day. This has necessitated the use of three shifts per day instead of two, which was the pre-war practice.

It is estimated that in the total production cost labor enters for 16 per cent, coal for 21 per cent, raw materials for 47 per cent and maintenance 10 per cent. The estimated cost of sales, agencies, warehousing and travel amounts to 4 f. per sq.m.

Spectroscopic Examination of Converter Flame*

BY W. J. CAMPBELL

The spectroscope is more extensively used on the Continent than in this country for the examination of converter flames. The usual practice here is to take the blow completely down, thus eliminating practically all the carbon, and thereafter to recarbonize with suitable fluid metal additions. In many Belgian and Swedish foundries engaged in the production of small steel castings the blow is brought down before the flame has completely dropped. Without any additions of recarbonizers the molten metal may contain 0.40 to 0.60 per cent carbon. The usual additions are added molten. The resultant steel is extremely hot and fluid, and is shanked from the converter in hot crucibles. The amount of short-run castings and skulls is considerably lower than with the usual procedure of completing the blow and either casting low-carbon steel or adding high-carbon metals.

The spectroscope is useful for indicating the point at which to bring down the blow in the second method of working. Many attempts have been made to obtain higher carbon steel by this method without the use of a spectroscope, but the great uncertainty and the erratic results secured condemned the practice. With the aid of the spectroscope better and more regular results may be obtained, but the process is still not so accurate as the practice of completely blowing and recarbonizing for obtaining a pre-arranged carbon content to within, say, a few points. The spectroscope is not so essential for judging the finish of the blow as for examining the carbon flame before the whole of the carbon has been completely burnt off.

At the beginning of the blow the spectrum is continuous and indefinite. With the faint appearance of the flame the characteristic yellow line of sodium is seen. For a short period this line is very faint and appears in flashes. As the flame gradually increases and becomes steady, the sodium line becomes stationary and brighter. As the flame and temperature rise the spectrum lines become more complex. The line spectrum of thallium and lithium and the banded spectrum of many other metals may be observed, but they are not of any particular value for the control of the blow. The principal lines to be noted are the carbon lines, which appear bright green. They are faint at first, but gradually, as the flame rises, they become brighter and more distinct, until, with the falling of the carbon flame, they diminish in number and fade completely away with the final drop of the flame.

The advantage for many classes of small foundry work of obtaining very hot and fluid steel may well repay the cost of installing a spectroscope.

The following table gives a brief outline of an average blow and its spectroscopic examination.

Duration of Blow	Eye Observation	Spectroscope Observation
3 min.....	Sparks, but no flame...	Faint flashes of sodium line in continuous spectrum.
3 to 10 min. ...	Flame gradually appearing at mouth of vessel and increasing	Yellow sodium line becoming stationary and bright. Also lines of thallium and lithium and bright green carbon lines.
10 to 12 min...	Flame brighter and longer and temperature rising	All the above lines fixed and brighter, the carbon lines being especially clear.
12 to 14 min...	Flame at maximum height and brightness.	Addition of green carbon lines in blue and green. All lines at their maximum brightness.
14 min. to completion of blow.....	Flame falling gradually.	Carbon lines not so luminous and gradually fading with dropping flame and eventually disappearing with the end of the blow.

*The Engineer, Aug. 5, 1921!

Glimpses of Ohio Ceramic Industries—II

Crooksville China Co., Located at Crooksville in Southern Ohio, Manufactures Tableware by Employment of Technical Methods—Preparing the Slip—Materials for Pottery Bodies—Scientific Study of Clay Body Composition—Alkali Treatment of Casting Slip—Constitution of Glazes*

By CHESTER H. JONES

LOCATED at Crooksville, in the same southern Ohio district, near the previously described plant, the Crooksville China Co. is engaged in the manufacture of medium grades of china- and dinner-ware, employing to a large extent the American clays as raw material, although some items are imported.

SAGGERS

Recent investigations of the American Ceramic Society have shown that the nature of the sagger, or burned clay box, holding the ware during burning is a most important consideration for any process where the pieces must be protected from mechanical action in the kiln. All saggars employed at this plant are hand-molded from raw materials, one-third of which is native Ohio clay, the remainder coming from other clay fields of America, excepting a small quantity which is imported. The stoneware clays mined in this district make excellent saggars. Hand-molding assures a more uniform consistency or temper to the finished sagger without the chance for laminations so common to machine-pressed saggars. Drying is accomplished by placing saggars on shelves located over a brick gas flue from the kilns. They are subsequently glazed and burned.

PREPARING THE SLIP

Materials used in the manufacture of the china are North Carolina china clay, Florida china clay, English ball clay, English china clay, feldspar and flint. These are delivered from the railroad cars to bins, from which they are drawn to an industrial hopper car on narrow-gage track running along the front of the row of bins. Definite quantities are weighed into the car by placing it over track scales. Each charge weighs about 1,400 lb. and fourteen charges are made each day. The car is emptied to the blungers, or vertical steel tanks equipped with agitating paddles, where, mixing with water, the creamy solution or slip is beaten to a uniform consistency. All the clay-working machinery in this factory is made by the Patterson Foundry & Machine Co.

MATERIALS FOR POTTERY BODIES

In general the preparation of white ware bodies or porcelains involves the use of clay, flint and fluxes. Either kaolin or china clay, or both, may be used, and ball clay may be employed, as in this instance. The kaolin may be either English or domestic, fineness of grain being the main distinction between the two. The English kaolin works up to a finer slip. Ball clays add to the strength and vitrification properties of the ware.

Neither the English nor German potteries use ball clay, but substitute a plastic kaolin.

The added flint is silica, and ground sand is substituted for flint in the United States. Rock quartz is sometimes used instead of flint, although it is costly to grind. Silica from southern Illinois has recently been considered a promising material for pottery bodies. True flint is a pebble gathered on the coast of France having an average egg size and a dark gray to white color. It is exported to the United States and calcined in rotary kilns. This operation burns out the organic material, causing the pebbles to soften and turn to a whiter color. These pebbles are subsequently crushed in a chaser mill and ground in ball mills using raw flint pebbles for a pulverizing medium.

There is less of this material on the market each year. It can be distinguished from ground sand only by the aid of the polarizing microscope, for there is chemically no difference between the flint and sand; possibly the sand is purer. Flint, being formed in the chalk cliffs of the English Channel, contains more lime. Sand is prepared by grinding in ball or tube mills.

FLUXES

Fluxes are often added to assist vitrification. Lime may be added as CaCO_3 in amounts up to 2 per cent to make the feldspar active. In Holland 30 per cent of lime is introduced and the ware is burned at a low heat. This gives a very porous body, which takes a high tin oxide glaze and is known on the market as Delft ware.

Other fluxes in use are magnesia, light and heavy, steatite or soapstone, and feldspar. Of all these feldspar is the most important and a good commercial grade will have the following analysis:

	Per Cent		Per Cent
Al_2O_3	16.76	K_2O	9.80
SiO_2	69.45	Na_2O	2.60

Potash feldspar contains about equal amounts of soda and potash. It is a white mineral occurring in dikes in Maine, Connecticut, New York, Pennsylvania, Virginia and the Southern States. It is quarried, hand-picked and ground in ball mills. Soda spar is about the same grade of material, but is a softer mineral. Lime spar is not used by the potter. Of the market grades, No. 1 spar is carefully selected hand-picked material, while No. 2 is the standard grade, having an Fe_2O_3 content less than 0.20 per cent.

FLUXING ACTION OF FELDSPAR

Below cone 0.05 feldspar acts as a grog, but at higher temperatures is a neutral flux behaving in a steady and uniform manner. It is frequently spoken of in burning operations as a solvent, since it performs on the other

*For Part I see CHEM. & MET. ENG., vol. 25, No. 12, p. 562, Sept. 21, 1921.

constituents like water on sugar. From 19 to 20 per cent is needed in a body mixture to get complete vitrification of the mass. It exerts a marked positive effect on the translucency of the ware. In the kiln it lowers the coefficient of expansion of the mixture to a small but important extent to prevent crazing or cracking of the glaze.

Cornish stone is similar to feldspar, but harder. It contains more silica, less alkali and less iron. It also has a fluorspar content. English potters use it mainly from tradition and habit, for it is without particular commercial value at the present time.

SCIENTIFIC STUDY OF BODY COMPOSITION

The clay-working business, particularly the pottery industry, has been a mystery to the layman mainly because he has been unable to see how the particles of a body form. Old-time potters have taken advantage of this, claiming to have special knowledge handed down on the death bed from father to son. They claim that new grinding methods do not give the same size and shape of particle as their own crude traditional processes of size reduction. As a matter of fact, the method is immaterial so long as uniformity of particle size is secured to give strength to the mass. Material which is too fine may cause dunting.

Ceramists and physical chemists have among other things found that the study of bodies by triaxial diagrams has done much to dispel the mystery surrounding body mixtures. The slow accumulation of such diagrams in scientific publications as worked out by the various investigators for all sorts of possible body materials is going far toward putting the pottery industry on a scientific basis. It is upon such industrial research that the future progress of the ceramic industries depends.

OBTAINING THE PLASTIC MATERIAL

After the proper constituents have been thoroughly blunged at the Crooksville plant the slip is drawn into the lawns, which are revolving cylindrical frames covered with bolting cloth, each lawn consisting of two concentric cylinders, so that the material is screened twice. This operation rejects all the coarse material in the slurry or slip. Double-piston pumps acting at 100-lb. pressure convey this slip from the agitated slip cistern below the lawns to the three plate-type filter presses. The water from these presses is stored and eventually returned to the blungers for the production of subsequent slip.

The smooth putty-like cake from the filter presses is thrown into a pug mill (English type, Windsor), whence it is extruded. Cake as it comes from the filter presses contains about 25 per cent water, which is not uniformly distributed. The pug mill, which consists essentially of a closed screw conveyor, extrudes an evenly tempered product.

ALKALI TREATMENT

Pugged clay is transferred to the first of a pair of casting slip mills operating in series. They are simply tanks of concrete and steel, equipped with agitating mechanisms like the blungers previously mentioned. The material enters the first and after a time is allowed to flow to the second one, located at a lower level. Each slip mill charge consists of 1,000 lb. of pugged clay, six buckets of water, 20 oz. of soda ash and 10 oz. silicate

of soda, the two latter being mixed with the water. After a thorough blunging in the slip mills the product is pumped to the upper floors.

The purpose of alkali treatment of clays for purification and use in the casting process is well outlined in Technologic Paper 51, U. S. Bureau of Standards, by A. V. Bleining. Alkalis tend to hold the clay in suspension in a fine-grained and jelly-like mass or state of deflocculation. The viscosity of the clay-water system is caused to change so that a constant degree of fluidity can be maintained by the use of the sodium salts added. Opposite effect or precipitation can be had by using acid electrolytes.

The casting process used in producing cup handles and irregular pieces such as vegetable dishes, pitchers, etc., consists of pouring this thick water suspension or slip from the mills into plaster of paris molds of the desired shape. The porous plaster begins at once to absorb the water from the slip and a coating of the clay body forms on the surface of the mold. When the desired thickness of ware is obtained, the remaining slip is poured off, leaving an article of the required shape.

With partial drying the body then stiffens and shrinks away from the mold, permitting the removal of the piece for complete drying. If the casting slip were made up with pure water, the resulting shrinkage would be very high, causing damage to the shape. The addition of the sodium carbonate and silicate reduces the amount of water required to form the solution, and consequently the drying shrinkage is lessened. Furthermore, a settling of the slip previous to the casting of the piece causes larger particles to precipitate from the solution.

The above-mentioned bulletin describes tests which show that the washing of kaolinitic clays may be decidedly improved as far as the quality of product is concerned by adding caustic soda or soda ash and sodium silicate in definite small amounts in the blunger. It makes possible more complete sedimentation of the undesirable granular impurities, improves the color of most clays where whiteness is desired, enriches the content in the clay substance, decreases drying shrinkage and tends to increase burning shrinkage. Clays containing iron as finely divided ferric oxide cannot be successfully treated by this process. Sodium hydroxide is absorbed to a far greater extent than the carbonate and probably combines chemically with the clay.

PREPARATION OF GLAZES

The large part of the product of this factory involves the use of a white glaze in which the ware is dipped and subsequently burned. Materials used include feldspar, zinc oxide, white lead, whiting, paris white (lime), and china clay. Frit, or artificial glassy ingredients, previously prepared is added to and ground with these materials. This frit is prepared by mixing boric acid, borax and flint, pouring the mixture into a sagger and burning to a glass in the kiln. On cooling it is broken up for mixing with other glaze substances.

The ingredients of the glaze are mixed wet and ground in three Patterson pebble mills, each containing 1,000 lb. of pebbles. After a thoroughly ground mixture is obtained it is drawn through lawns to remove grit and dirt and is then ready for the dipping room. Other equipment in the glaze room is a pebble mill and vertical cylinder mill for preparing sagger glazes. The

saggers are glazed to prevent pieces from chipping off and falling on the ware to its damage while in the bisque kiln.

CALCULATION OF GLAZES

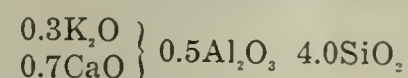
Potter's or trade recipes for glazes are usually expressed in the form of batch weights and have been evolved in the past from practical experiments after the manner of cooks rather than ceramists. These formulas have "just happened" after generations of rule-of-thumb ceramics, which is no guarantee that they are the best possible mixtures. Our leading ceramic schools, on the other hand, have attacked the glaze problem in a scientific manner and in the compounding of both glazes and bodies now employ methods of calculation which might be called ceramic stoichiometry. Empirical formulas are used to express the compositions of materials and mixtures. They show in a way the actual chemical composition, since they contain the relative molecular proportions of the various oxides. They do not, however, attempt to represent the actual chemical or mineralogical constitution. This is simply another step forward in the analysis for the chemical control of the ceramic industry.

Seger was the first to adapt this stoichiometric method of mineralogists to ceramic work, and ceramic chemists almost without exception now use it. In a lecture course at Illinois University, Cullen W. Parme-

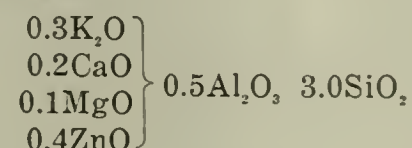
ular parts of each group present. In clays and many of the minerals used as ceramic materials the proportion of basic oxides is very small and it is found of advantage to make the coefficient of Al_2O_3 equal 1. This has been adopted as a custom and the mineral or body formula is expressed as $xRO \cdot Al_2O_3 \cdot ySiO_2$. Thus orthoclase has the formula $K_2O \cdot Al_2O_3 \cdot 6SiO_2$, and kaolinite is expressed as $Al_2O_3 \cdot 2SiO_2 \cdot 2H_2O$.

"In glasses, glazes and enamels the Al_2O_3 has a wide variation and frequently is absent. The RO oxides here play an important part, and the custom has been adopted of making RO equal 1 and giving to the Al_2O_3 and SiO_2 suitable coefficients to represent their relative molecular proportion. The general glaze formula is, then, $RO \cdot yAl_2O_3 \cdot zSiO_2$. It is to be remembered that RO represents the sum of the oxides and their individual molecular proportions are such that the sum equals 1.

"In glasses, glazes and enamels the Al_2O_3 may vary widely and is frequently absent, while the oxides of the mono- and bi-valent metals may be varied and substituted, but are always present. As a matter of convenience in comparison of formulas it has become the custom in the case of glasses, glazes, etc., to use such minor numerical coefficients to express the molecular proportion of the various oxides as to make the sums of the basic or RO members equal to unity. The general formula in this case becomes $RO \cdot yAl_2O_3 \cdot zSiO_2$. The composition of a porcelain glaze is expressed as



or a stoneware glaze as



These formulas must not be confused with the chemical formula of a compound. They merely express in a convenient way the proportions of various oxides present, although they are not introduced as such, nor do they exist in definitely known compounds in the glaze."

SHAPING THE BODIES

Plates, the bodies of cups and similar regular pieces are thrown on the jigger, while cup handles and irregular pieces as previously described are slip castings. Fig. 7 shows a group of workmen attaching handles to cup bodies, the plaster of paris slip-casting molds for handles appearing in a row on the bench in the background. The clay is slightly wetted at the points of contact between handle and cup, causing the two clay parts to weld to form one piece. This work is carried on very rapidly on piecework basis, as are most of the other operations in the plant.

The jigger or jolly is essentially a potter's wheel revolving in a horizontal plane with a plaster of paris mold conforming to the outside shape of the piece mounted thereon. The inside shape is obtained by throwing down a steel cutting tool to a set position after the machine starts to revolve. Ordinarily three operators work at each large jigger. The "batter out" throws a lump of plastic body clay of approximately the desired amount upon the adjacent table and flattens it out to approximate thickness and shape by striking with a flat paddle or iron block with a handle. The jiggerman seizes it, throws it into the jigger and pulls down the hinged cutting tool to position, trimming out the



FIG. 7. ATTACHING HANDLES TO CUP BODIES

lee explains the procedure of calculations as outlined in the following paragraphs:

"In the construction of the formula the oxides of the mono- and bi-valent metals, which form bases and act as such in silicate fusions, are grouped under a general heading, RO. These include the alkalis, alkaline earths and most of the coloring oxides, CuO , CoO , FeO , MnO , etc. The oxides of the trivalent metals are generally grouped with the Al_2O_3 , which is almost always present. Alumina plays a double rôle in that it may act as a base or as an acid, depending upon the conditions. The R_2O_3 group is often referred to as the intermediary group in glaze compositions. Silica (SiO_2) is the principal oxide of the acid group. In some cases it may be partly replaced by other acid oxides, but it is generally present in considerable amounts. Ceramic products may be generally considered as silicates, or silicate mixtures.

"The ceramic formula representing a mineral ingredient, a body, a glass or a glaze may be expressed in the general form $xRO \cdot yAl_2O_3 \cdot zSiO_2$, where x , y and z are numerical coefficients indicating the number of molec-

surplus clay. He then removes it to a table on the opposite side, where irregularities are wiped off with a wet cloth or brush by the third operator. Finally it is laid upon a movable rack or tray. All clay is transferred to the jiggers by elevators and overhead trams with traveling platforms.

DRYING

The racks containing the finished shapes are transferred by hand to the driers. The drying chambers consist of rooms divided off by wooden partitions with steam pipes passing around the sides. From five to six hours are consumed in drying the ware. This time is sufficient because of the thin walls common to china-ware objects.

BURNING

The dried pieces are conveyed to the kiln room, where they receive the bisque burn. The kiln room equipment consists of four bisque kilns, five gloss or glaze kilns and eight decorating kilns. Natural gas at 45c. per 1,000 cu.ft. is employed for fuel. Fig. 8 shows a corner



FIG. 8. VIEW OF KILN ROOM

of the kiln room with saggers stacked in the background and the entrance to one of the bisque kilns on the right. The bench in the right foreground with plates and saggers stacked on the shelves is employed in loading the ware in the saggers. To prevent sticking pieces are separated in the sagger by resting each on small triangular section clay supports imbedded in the sagger wall at an angle so that the contact where the piece rests is a sharp point of clay material. In this way the small protuberance of clay sticking to the piece after the burn may be broken off by a sharp blow in the chipping room.

GLAZING

The saggers are stacked in the kiln in such a manner that those containing large pieces are in the center and the smaller ware near the outside of the circular kiln. Firing time in the bisque kilns ranges from forty-eight to fifty hours and a temperature of cone 8 is attained. After this treatment the ware is removed to the dipping department, where the glaze is applied by simply dipping each piece in a tub of the glaze solution, the preparation of which has been described. It is then returned to the glaze kilns, where it is fired from twenty to twenty-six hours at a maximum temperature of cone 4. Cones are used in regulating the

bisque and gloss kilns, while the veritas disk is employed in the decorating kilns.

DECORATING

After chipping off the supports previously mentioned, the pieces are transported to the decorating department. Here either transfer method or hand-painting is employed in putting on decorative designs. In the transfer process the portion to be decorated is first treated



FIG. 9. INTERIOR OF A DECORATING KILN

with a coat of ordinary shellac brushed on as a binder for holding transfer paper in place. The designs are printed on the decalcomania paper with special inks. This paper is purchased from the manufacturer in strips and sheets of varying shapes to fit the piece and is covered with numberless different designs. Rubber stamps with special inks and stamp pads are also used in some cases. Hand painting is employed chiefly in decorating cup handles and edges. Fig. 9 shows the interior of a

decorating kiln with the dishes stacked on knock-down shelves. Eight hours is required to burn on the decorations and a temperature of about cone 0.015 is reached. This is sufficient thoroughly to penetrate the glaze with the colors. The shellac binder and paper are entirely volatilized and the finished pieces are finally removed from this last process. The wholesale price of china-ware is largely determined by the method and type of decoration.

The summation of impressions after a walk through this plant leaves with the observer the thought that the manufacture of tableware is a nice business. The factory is spotlessly clean, light and well ventilated, giving ideal conditions for the employees and reflecting good cheer in the personnel of the operating staff.

Zinc in the First Half of 1921

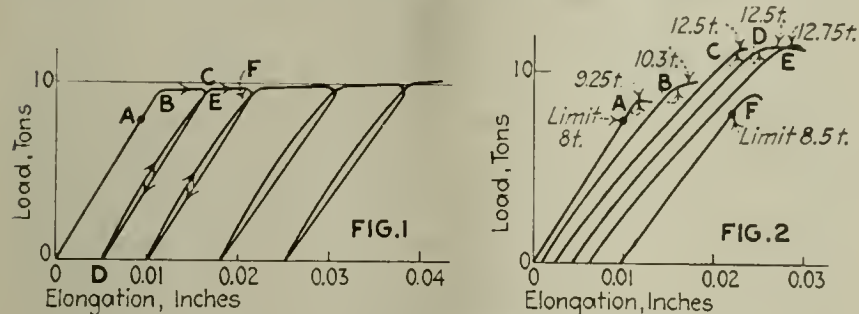
The Geological Survey reports that the smelter production of zinc from foreign and domestic ores for the first six months of 1921 totaled 102,525 tons, as compared with 258,108 tons in the same months of 1920 and 205,269 tons in the last half of 1920. The stock of zinc held at smelters and in warehouses June 30, 1921, was 94,747 tons, compared with 71,037 tons at the end of 1920 and 29,892 tons one year ago. The apparent domestic consumption of zinc, taking into account imports and exports, amounted to 83,965 tons in the first half of 1921.

The number of retorts in operation on June 30, 1921, was 36,000, compared with 56,000 at the end of 1920 and 75,000 on June 30, 1920.

Synopsis of Recent Chemical & Metallurgical Literature

Elastic Limit—Prof. William Dalby, in a paper read before the Engineering Conferences of the Institution of Civil Engineers, June, 1921, notes that the limit of proportionality between stress and strain during tension loading has often been called the elastic limit, but such a term conveys the idea that the elastic power of the material is exhausted, which is by no means true. Metal possesses elastic properties right up to the instant of fracture.

The author has devised an optical automatic recorder of great sensitivity and precision, and finds that if a bar strained beyond the limit of proportionality be unloaded, the piece will spring back and to all appearances acts like a perfect spring. Investigation shows, however, that no part of the stress-strain curve on unloading or reloading is a straight line. In fact such procedure always draws loops



like Fig. 1, the areas increase on subsequent reloadings at first rapidly in some materials, tending to a limiting value.¹

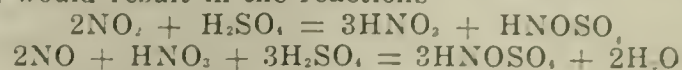
From a practical point of view, therefore, the term elastic limit should mean the limit where proportional elasticity ends and unproportional elasticity begins. Proportional elasticity is destroyed by overstrain; in alloy steels it remains so, as shown in the successive curves in Fig. 2. Iron and soft steels tend to recover their property of proportional elasticity by mere lapse of time—very short on moderate tempering, merely boiling in water. Alloy steels and high-carbon steels recover only after a high anneal (550 deg. C. for 1 hour for the last curve of Fig. 2).

Dr. Rosenhain observed that both the "limit of proportionality" and the "limit of restitution" depended upon the accuracy of measurement. It is impossible to determine the former by noting whether or not a loop was formed on successive loads, since there is always a certain thermal effect due to elastic stretching; in some cases a rise of temperature, in some a slight fall. If one allowed time for that temperature difference to vanish, the energy was changed, and when the load was taken off, a loop in the stress-strain diagram was bound to occur.

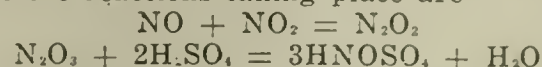
The heat generated in slow stretching of a piece of metal is always less than the mechanical work done, on account of the internal changes produced. The difference varied widely with different metals. In iron particularly, the amount of heat generated is very nearly the whole of the work done; therefore a very small loop (indicating internal work) would result. In copper the loop would be large; in aluminum larger still; the size varies inversely with the melting point and the latent heat of fusion.

Absorption of Nitrogen Oxide by Sulphuric Acid.—The analysis of higher nitrogen oxides requires that they shall first be absorbed by sulphuric acid. The transformations which they undergo during this absorption has led to many interpretations. Thus some authors, especially those who use physical methods, admit the direct passage from NO into NO₂, whereas those using chemical methods have noted in some cases the presence of N₂O₃. This contradiction has been solved by Wourtsel (*Comptes rendus*, vol. 170, 1920, p. 109) who has shown that there is no total decomposition of

N₂O₃ into NO + NO₂, and that NO can combine only partly with NO₂ to give N₂O₃, so that amounts of N₂O₃ up to 6 per cent can exist under atmospheric pressure. This small quantity, due to its great aptitude to react and to be regenerated rapidly at the expense of NO and NO₂, causes the formation of nitrous derivatives in the presence of absorbing reagents. This explanation is more satisfactory than that of Lunge, who stated that NO₂ and NO in the presence of H₂SO₄ would result in the reactions



A. Sanfourche has made a series of tests to determine whether the reactions as indicated by Lunge take place (*Comptes rendus*, vol. 172, June 20, 1921, p. 1573.) He has found that when nitrous gases whose total composition approaches N₂O₃ react with sulphuric acid they do not behave as would a simple mixture of NO and NO₂. He concluded that the reactions taking place are

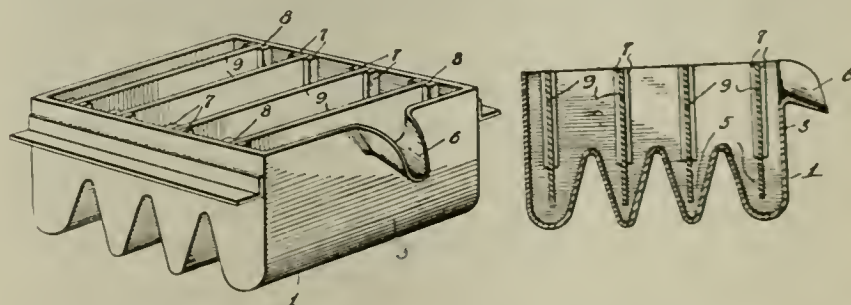


Recent Chemical & Metallurgical Patents

American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

New Type of Cascade Pan.—Ludwig A. Thiele, of Columbus, Ohio, has patented a new cascade pan of the type which is usually employed in the concentration of sulphuric acid. The pan has an open top, vertical side walls and a deeply corrugated bottom. As will be noted in the accompanying diagrams, there are a number of baffle plates in each pan which are so fixed that the acid flowing through the pan is compelled to follow a tortuous path, and since it is exposed to the extended heating surfaces of the pan, rapid evaporation is thus effected. The pans



are so adapted that they can be assembled end to end in the cascade commonly used in concentration plants. The construction of the pan can be noted from the figure. The side wall 3 to the pan 1 are suspended in an intermediate position in the pockets 5 by the vertical ribs 7, which form sockets 8 for the baffle plates 9. (1,380,689; June 7, 1921.)

Separation of Borax From Potassium Salts.—Crude salts such as those obtained from Searles Lake, California, by concentration and cooling of the brine, are heated and the water they contain is sufficient to cause the borax to be redissolved. If the hot mixture then is spun in a centrifuge, the liquor containing the borax is effectually separated from the potassium salts, which can be further purified by spraying with a small amount of hot water. It is claimed that a very pure product can be obtained in this manner. (1,382,825; Clinton E. Dolbear, assignor to Industrial Research Co., of San Francisco, Cal., June 28, 1921.)

Manufacture and Uses of Selenium Oxychloride.—Victor Lenher has been granted a number of patents relating to various methods of preparing selenium oxychloride and a number of important uses for this article. In patent 1,382,920 the preparation is carried out by combining selenium

¹"Researches on the Elastic Properties and the Plastic Extension of Metals," *Phil. Trans.*, Series A, vol. 221 (1920).

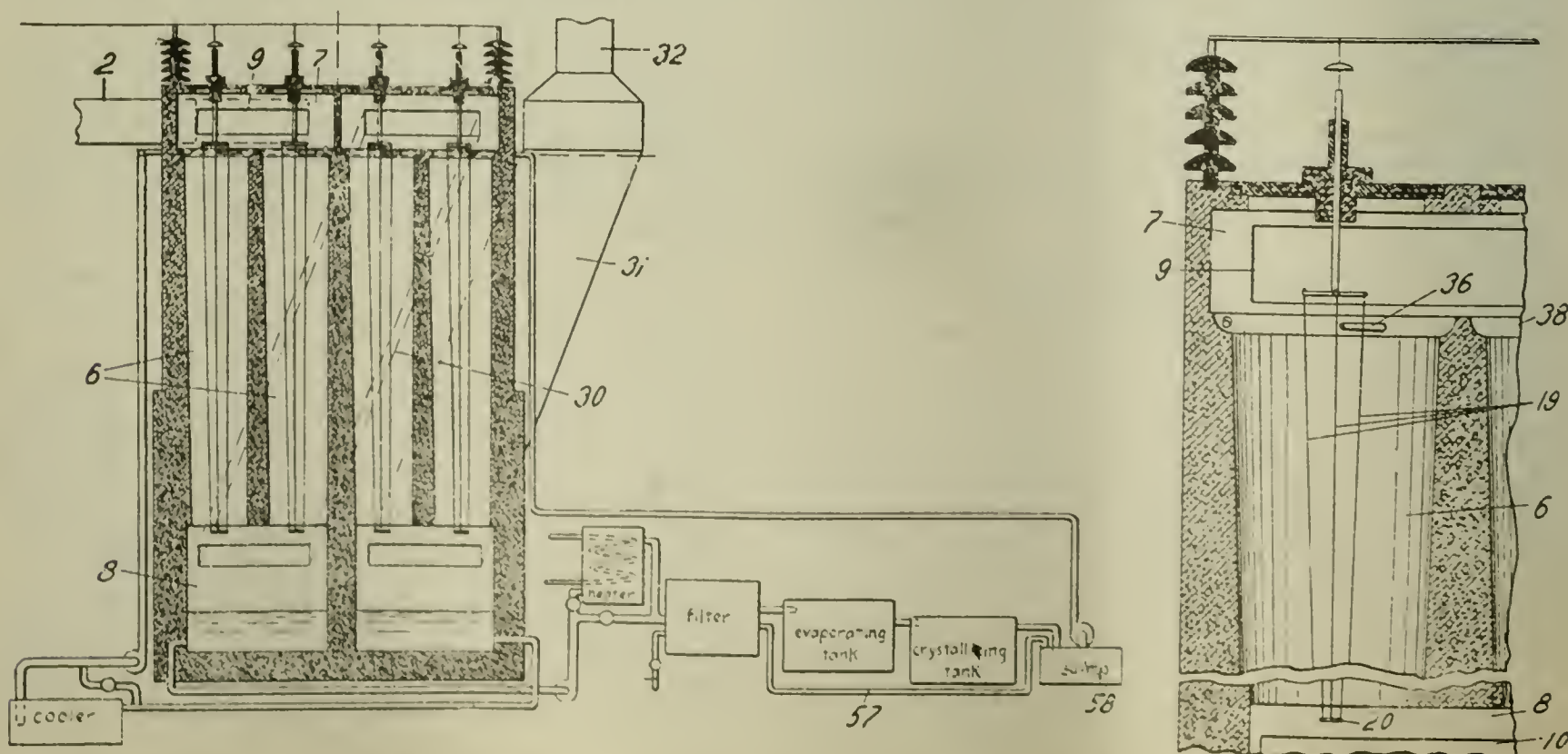
tetrachloride, which is a white crystalline solid, directly with selenium dioxide, also a white crystalline solid, to form the liquid selenium oxychloride. The product as it is formed acts as a solvent for the constituent materials and thereby facilitates the reaction. Carbon tetrachloride, chloroform or some similar solvent is also used. It is necessary that the process be carried out in a vessel which will not be attacked by the product, such, for example, as porcelain, terra cotta and glass or glass-lined equipment. Modified methods of preparation are outlined in patents 1,382,921 and 1,382,922. Selenium tetrachloride is formed by the action of chlorine and water on selenium. This compound, reacting in equi-molecular proportions with water, produces selenium oxychloride and hydrochloric acid; the latter is driven off by heat leaving the liquid selenium oxychloride. As in the previous patent, carbon tetrachloride is used as a solvent. Still another process of preparation is by means of a reaction between selenium dioxide and water, followed by dehydration with phosphorus pentoxide, calcium chloride or a similar dehydrating agent. Selenium oxychloride is claimed to possess remarkable solvent properties, being capable of dissolving many substances and compounds for which no known solvent has hitherto been discovered. Among the substances which it will dissolve are: Japans, paints, varnishes, rubber (pure or vulcanized), resins, pitch, glues, shellacs and lacquers, waxes, oils, fats, certain metals and oxides, salts and phenolic condensation products (including the infusible and so-called insoluble products). In patent 1,385,081 it is pointed out that selenium oxychloride is a solvent for the oxides of molybdenum, selenium, arsenic and vanadium, but that it will not dissolve the oxides of titanium, tungsten, zirconium, columbium and tantalum. Hence it is possible by this selective solvent action to separate various mixtures of the soluble and insoluble materials. Selenium oxychloride will react with various oils and greases to form waterproof, rubber-like compounds which may be used as rubber substitutes for certain purposes. (1,382,920, 1,382,921, 1,382,922, issued June 28, 1921, and 1,385,081, July 19, 1921.)

Recovery of Soluble Constituents From Furnace Fumes.—A process claimed to be an improvement on the usual methods for the electrical precipitation of fume or dust has been patented by Harry V. Welch, assignor to International Precipitation Co., of Los Angeles, Cal. It is proposed to supply water to the inside surfaces of the treater flues in order to carry away deposited material and to maintain smooth electrode surfaces. The water is used in a cyclic manner and is heated by waste heat from the furnaces. The operation of the process can perhaps be best understood by consulting the accompanying diagram.

The hot gases coming, for example, from a cement kiln or kilns, and carrying dust and fume containing potash as

a constituent, are conducted through flue 2 to the upper header 7 of the first set of treater flues and passed downwardly through said treater flues into the lower header 8 and then up through the connecting flue 30 and down through the treater flues of the second set, in which they are discharged through flue 31 to the outlet 32. In passing down through the flues 6, the gases are subjected to the action of an electrical field produced between the discharge electrodes 19 and the inside surfaces of the flues 6. These surfaces are kept wet or flushed by streams of water flowing from the nozzles 36 and the body or sheet of water flowing in this manner on the inside surfaces of the flues. High tension current, either direct or alternating, is supplied for maintaining a sufficiently high potential difference between the discharge electrodes and the flues 6 constituting the collecting electrodes. The effect of the electrical field is to cause precipitation of suspended matter, including dust or fumes in the gases, on the body or sheet of liquid flowing down the walls of the flues, this precipitating action being especially effective when the electrodes are charged by a substantially unidirectional current produced, for example, in the manner set forth in the patent of F. G. Cottrell (No. 895,729, dated Aug. 11, 1908). By maintaining a continuously flowing stream of water on the inside of each treater flue, accumulation of any solid material on the walls of such flue is prevented, and a substantially smooth surface free from projections tending to develop discharge from the collecting electrodes is maintained irrespective of the nature of the material being precipitated. This is of especial advantage in precipitating dust or fume, such as cement kiln fume, containing a comparatively high proportion of potassium salts, which would otherwise tend to form a poorly conducting deposit, interfering seriously with precipitation. By thus maintaining the collecting electrodes in condition of maximum effectiveness, it is possible to increase the velocity of the precipitating action and correspondingly increase the rate of flow of gas through the apparatus, with the result that the dust precipitating capacity of a plant of given size is increased to a considerable extent. (1,382,037; June 21, 1921.)

Acid-Resisting Aluminum Alloy.—An alloy particularly suited for resisting the corrosion of nitric acid and nitrate derivatives, such as picric acid, is prepared from purified aluminum and lead in the following proportion: Aluminum, 89 to 94 per cent; lead, 5 to 10 per cent, and 1 to 2 per cent of some oxidizing material such as metallic magnesium. The finished alloy is said to be characterized by increased density and ability to withstand high pressure and corrosion. (1,385,223; Foster Milliken, of Lawrence, N. Y., assignor to Foster Milliken, S. Fullerton Weaver and James M. Repplier, as trustees; July 19, 1921.)



APPARATUS FOR RECOVERY OF SOLUBLE CONSTITUENTS FROM FURNACE FUMES

Current Events

in the Chemical and Metallurgical Industries

Another Muscle Shoals Offer

Details of the offer of C. E. James, of Chattanooga, Tenn., to take over the Muscle Shoals water-power project and the nitrate plants have been given out by the War Department. The following constitutes the entire contents of two letters addressed by Mr. James to the Secretary of War:

First. I will pay for the general plants, land and material at Muscle Shoals, Sheffield, Ala., \$5,000,000.

Second. For rent on Wilson Dam and Dam No. 3 I would pay the following amounts for 97-year lease:

- \$1.00 per annum average horsepower first year
- 1.50 per annum average horsepower second year
- 2.00 per annum average horsepower third year
- 2.50 per annum average horsepower fourth year
- 3.00 per annum average horsepower fifth year
- 3.50 per annum average horsepower sixth year
- 4.50 per annum average horsepower seventh year
- 5.50 per annum average horsepower eighth year
- 6.50 per annum average horsepower ninth year and thereafter

All taxes on Government property and equipment to be paid by the Government.

I would not ask the Government to guarantee any specified amount of power; I would want them to put in the electric equipment capable of producing 400,000 hp.

If the Government put in additional dams above Muscle Shoals in the Tennessee River to aid navigation all the way to Chattanooga to a boating stage of 9 ft., and 6 ft. Chattanooga to Knoxville, the horsepower would run to 800,000 at Muscle Shoals. If so, the Government would receive rental on 800,000 hp., the Government to have the right to equip the plant to 800,000 hp., if it decided to do so, I to take the increased power as produced at above rates.

The concrete foundations in dams ought to be made capable of installing a total of 800,000 hp. machinery, but only install 400,000 hp. now, Government to have, free, 300 hp. current to operate lock gates.

I would operate nitrate plants for fertilizers on a basis of 8 per cent profit, and keep in good condition Plant No. 2, subject to be turned over to the Government in case of emergency.

I would like to have the option, if my proposition is accepted, but not to be embodied in contract, the right to build a high dam for power and storage in the Clinch River at some point near Kingston, Tenn., so as to increase the flow of water at Muscle Shoals, and also to take care of loss of current on wire line, and make the electric current more regular between Muscle Shoals and Kingston, Tenn.

FORD'S MUSCLE SHOALS PLAN DISCUSSED

During a conference with engineers representing Henry Ford the Secretary of War requested that the Ford engineers and the Army engineers harmonize their views as to the amount of money necessary to complete the dam. He also called upon the Ford engineers for the details of their plan for converting Nitrate Plant No. 2 into a fertilizer factory. W. B. Mayo, of Mr. Ford's engineering staff, told the Washington correspondent of CHEMICAL & METALLURGICAL ENGINEERING that the conference was informal and preliminary and that, at the proper time, Mr. Ford will be glad to accept the invitation of Secretary Weeks to come to Washington.

To Study Light Alloys

As a result of a co-operative agreement entered into by the Bureau of Mines with a large manufacturer of scientific instruments, the bureau has been enabled to undertake a much more comprehensive investigation of the alloys used particularly in the manufacture of instruments of precision. The study is to cover a considerable number of the light alloys which are being or may be used for that purpose. The experiments will be conducted by R. J. Anderson at the Pittsburgh experiment station.

Industrial Relations Association to Meet in New York

The annual convention of the Industrial Relations Association of America will be held at the Waldorf-Astoria, Fifth Ave. and Thirty-fourth St., New York City, Nov. 1, 2, 3, 4 and 5. The following preliminary program is announced:

TUESDAY, NOV. 1

- 1 p.m. Registration begins.
- 2 p.m. Round tables and sectional meetings.
- 5:45 p.m. Get-together dinner. Opening address, followed by five leading industrial representatives who will outline in ten-minute talks the most outstanding experiences in the industrial relations activities of their companies during the last year.

WEDNESDAY, NOV. 2

- 10 a.m. Business conditions.
- 2 p.m. Sound employment practice.
- 2:30 p.m. Essential labor statistics and their uses.
- 3 p.m. Industrial relations department costs.
- 3:45 p.m. Round tables.

THURSDAY, NOV. 3

- 10 a.m. Determination of wage rates.
- 12:45 p.m. Luncheon meeting. Business session, I.R.A.A.
- 2:30 p.m. Unemployment.
- 4 p.m. Fundamental principles of human relations in industry.

FRIDAY NOV. 4

Joint sessions with the Academy of Political Science in the City of New York, the general theme being "Constructive Experiment in Industrial Co-operation Between Employers and Employees."

Morning session at Town Hall. Personnel work and co-operation within industrial plants.

Afternoon session at Hotel Astor. Co-operation within separate industries.

Evening session and banquet at Hotel Astor.

SATURDAY, NOV. 5

Morning session at Hotel Astor. Industrial relations in governmental employment or departments and in financial institutions.

Afternoon session at Hotel Astor. Governmental and other organized counsel and information to promote better industrial relations.

American Mining Congress to Meet in Chicago

The twenty-fourth annual convention of the American Mining Congress will meet in Chicago, Oct. 17 to 22, with headquarters at the Congress Hotel. Special attention will be given to the following topics covering different phases of the mining industry: The railroads and the mining industry; co-operative effort and government regulation; standardization; the gold problem; increased use of metal products; taxation; the coal industry; national petroleum conference; educational conference; an American foreign mineral policy.

In conjunction with the convention, the National Exposition of Mines and Mining Equipment will be held at the Coliseum.

Superpower Report Almost Ready

The superpower report made under the direction of the U. S. Geological Survey now is in proof form and probably will be released for publication Oct. 1.

Portland Cement Output Increases in August

Production and shipments of portland cement in the United States continued to increase during August, 1921, and according to available statistics scored new high records for that month. The August production exceeded the average for August, 1917-1921, by about 15 per cent. Production for the first eight months of 1921 was about 99 per cent of the quantity produced during the corresponding period of 1920 and exceeded the average for the first eight months of 1917 to 1921 by about 8.5 per cent.

These statistics, prepared by Ernest F. Burchard, of the United States Geological Survey, and tabulated in the accompanying table, are based mainly on reports from producers of portland cement and in part on estimated data. They indicate that the present demand for cement is greater than might be expected in comparison with that for other mineral commodities, and that in the face of many handicaps to production supply is nearly keeping pace with demand at the height of the construction season.

CEMENT STATISTICS, 1921

Month	Production, Bbl.	Shipments, Bbl.	Stocks at End of Month Bbl.
January.....	4,098,000	2,539,000	10,300,000
February.....	4,379,000	3,331,000	11,400,000
March.....	6,763,000	6,221,000	12,000,000
April.....	8,651,000	7,919,000	12,600,000
May.....	9,281,000	9,488,000	12,450,000
June.....	9,296,000	10,577,000	11,150,000
July.....	9,568,000	10,301,000	10,414,000
August.....	10,244,000	12,340,000	8,280,000
	62,280,000	62,716,000	.....

To Use Chemical Agents in Alabama Tests

Tests with chemical agents will be made during the maneuvers that are expected to result in the sinking of the U.S.S. Alabama. Chemical bombs are to be tried out in the preliminary tests. Eight 50-lb. bombs charged with tear gas are to be dropped with the idea of gathering data as to the probable effectiveness of this type of bomb on a battleship. In similar manner, phosphorus and smoke bombs are to be dropped on the obsolete war vessel. One of the objects of the test is to determine the effect of smoke bombs in concealing the attack of aircraft and of the effect of white phosphorus clouds in neutralizing anti-aircraft elements.

The board of observers is to consist of three Air Service officers, two Chemical Warfare Service officers and two Ordnance officers.

In addition, there are to be night attacks, in which there will be demonstrated the tactical effectiveness of flares in illuminating a sea area under conditions simulating those of battle. The effect of white phosphorus in outlining sea-craft at night is to be studied to determine if they can be outlined with sufficient distinctness to permit accurate attacks.

T.A.P.P.I. Notes

As noted in our last issue, the executive committee of the Technical Association of the Pulp and Paper Industry has voted to cancel the scheduled joint fall meeting of T.A.P.P.I. and the American Pulp and Paper Mill Superintendents Association. However, the committee on service to members of T.A.P.P.I., of which Fred C. Clark is chairman, is hopeful of obtaining for early publication in the trade periodicals all reports of committees and papers that would ordinarily have been presented at the joint fall meeting. As one of the steps in giving improved service to members, Mr. Clark's committee has issued a questionnaire which members are asked to check according to instructions, and return to the secretary's office without delay.

REDUCTION IN DUES

The annual dues of active and associate members of T.A.P.P.I. will be reduced to \$15. After voting unanimously in favor of this, the executive committee of the association instructed the secretary-treasurer to bill active and associate members for next year's dues at \$15, instead of \$25. This action was taken pending its ratification by the association at the next annual meeting, which, it is believed, will be unanimous.

U. S. Urged to Concentrate on Lighter-Than-Air Development

Based partly on the fact that the United States possesses helium resources, the National Advisory Committee for Aeronautics in a letter to the Secretary of the Navy urges that the United States undertake a more intensive development of lighter-than-air craft. In the letter Joseph S. Ames, chairman of the executive committee of the organization, points out that Germany persisted in her early efforts to develop Zeppelins and refused to be discouraged by failures, with the result that such airships served that country with effect in time of war. It is pointed out that the use of hydrogen in the ZR-2 was a contributing cause to the great loss of life. The fact that the United States possesses large helium resources is given as one of the reasons why lighter-than-air craft probably could be developed more successfully in America than in any other country.

Foreign Markets for Scientific Apparatus

American manufacturers who are desirous of engaging in the export trade will find considerable information of value in a publication of the Department of Commerce on foreign markets for scientific apparatus. It comprises contributions from our Consuls and Vice-Consuls in Argentina, Australia, Belgium, China, India, France, Egypt, Spain and Switzerland. Statistics are given on the origin of imports of scientific instruments and apparatus into these countries. Considerable information of a trade and industrial nature is also given.

Association of Chemical Plant Equipment Manufacturers

At a meeting of representatives of manufacturers of chemical plant equipment at the Chemists' Club, New York, on Saturday, Sept. 17, it was decided to form an Association of Chemical Plant Equipment Manufacturers. The object of this association is to further various interests of these manufacturers, which, it is believed, can be promoted more satisfactorily by action as a group rather than as individuals.

The organization committee consists of J. George Lehman, chairman, Bethlehem Foundry & Machine Co.; Paul O. Abbé, Paul O. Abbé, Inc.; A. A. Holmes, E. B. Badger & Sons; Dr. C. H. Kimberly, Schutte & Koerting Co.; P. C. Kingsbury, General Ceramics Co.

Civil Service Examination

The United States Civil Service Commission announces an open competitive examination for associate metallurgist (qualified in foundry practice). Vacancies in the Bureau of Standards, Washington, D. C., at \$2,000 to \$3,000 a year, and in positions requiring similar qualifications, at these or higher or lower salaries, will be filled from this examination. Applicants should apply on Form 2118 before Oct. 11.

Book Reviews

A DICTIONARY OF APPLIED CHEMISTRY. By Sir Edward Thorpe, assisted by eminent contributors. Revised and Enlarged Edition. Vol. I, A-Calcium. 752 pp., illustrated. New York and London: Longmans, Green & Co. Price, \$20.

For over thirty years Thorpe's Dictionary has enjoyed the reputation of being the single standard reference book of chemical industry in all English-speaking countries. No other work has ever approached it for thorough, accurate and comprehensive information on industrial chemistry. Several times since the dictionary was first issued the editor and publisher have recognized the necessity for revising the work in order to keep pace with the growth and progressive advance of the science. Each new edition has improved and materially expanded its predecessor and has recorded the

increasing number of developments in the application of chemistry to industry.

During the nine years which have elapsed since the publication of the first volume of the previous edition, tremendous and unprecedented expansion has occurred in the chemical industry of all countries, and there is an evident need for a careful survey and critical summary of this progress. The late war stimulated the application of pure science. Many new products have been developed and many old products have been made by new or improved processes. It is too soon to judge of the permanency of some of these changes perhaps, but it is obvious that many of them represent real and substantial progress. In glancing over the present volume, in a cursory way, to be sure, it is interesting to note the number of these developments which have been recognized and accredited by the authors.

One of the first of the major subjects is the article on Acetic Acid, a section of which has rightfully been devoted to a discussion of the synthesis from acetylene. No mention is made, however, of the commercial developments such as those found in Canada, France and Switzerland. In what appears to be a rather inadequate treatment of Acetone, it is surprising to note that the more modern methods of preparation have not been recognized. The fermentation process and the production from acetylene, both processes which were used on a large scale during the war, are not discussed. Under the subject of Alcohol there is reference to the synthesis from acetylene in Germany and also to the preparation from wood by the Classen process which has been tried out in the United States. However, the development in Great Britain of a process of preparing alcohol from ethylene is apparently passed over without mention. An important contribution to the new edition is the article on Aldehyde. Here we find our references to the synthesis of acetic acid and acetone which we have previously looked for under the names of the respective products. This leads us to point out an objection, or rather an apparently inherent fault of the Dictionary or in fact to any other work of similar arrangement. A simple alphabetical presentation of the subject matter, without abundant (and bothersome) cross-references, often makes it extremely difficult to find the information one desires. A comprehensive index would certainly be a worth-while improvement to the new edition.

There has been notable revision and expansion in the reviews covering Alizarin Dyes and Ammonia. The new anæsthetics developed by the war are recorded. The section dealing with Analysis has been revised and slightly enlarged, and this brings to the reviewer's mind the question of whether such an extended treatise (104 pp.) is not out of place in a dictionary on applied chemistry. It would appear to the reviewer that this space could be better used in emphasizing chemical engineering applications and equipment, a subject in which is treated far too inadequately in most text books. A new article on Organic Arsenicals is a worthy addition to the volume. It is also to be noted that Azo Dyes have been given a somewhat extended treatment to very good advantage.

The reviewer was rather surprised to find that seven pages had been devoted to Bone Oil and the theoretical discussion of its constitution. Cutting the article on Brewing to half the size of the former contribution will probably be somewhat disappointing to the many American readers who have been conducting home experiments in this ancient art. Butyl Alcohol, however, has come to occupy a position of considerable industrial importance and there is no mention of its preparation by the fermentation process or its important application as a solvent.

With this final comment on the contents of the book, the reviewer is tempted to risk, as his opinion, one general fault of the work, past and present editions included. There is an evident failure to recognize American practice in chemical engineering. The emphasis is placed first on the British and then on the Continental methods, while there is seldom a reference to the processes used in the United States. It is natural, of course, that the English work should deal with England, but we believe that many American readers will join us in our rather selfish desire to find an occasional reference to our own way of doing things.

However, it is not our intention to be fault-finding and

we have previously referred to the work as "the greatest contribution in English to the literature of applied chemistry." The remaining volumes will be awaited with interest, and it is hoped that they too will record the same improvement that has characterized the first volume of this splendid work.

S. D. KIRKPATRICK.

Personal

Dr. E. M. A. CHANDLER has resigned his position with the Dicks-David Dye Co., Chicago Heights, Ill., to take employment with the Industrial Chemical Laboratory Co., at Hammond, Ind., manufacturer of dye intermediates.

Dr. V. H. GOTTSCHALK, formerly director of research for the American Cotton Oil Co., has accepted a position in the metallurgical engineering department of the Western Electric Co., Chicago, Ill.

WILLIAM MYERS has been engaged by the Bureau of Mines as a member of its non-metals investigation staff. He will be stationed in Washington.

TUDOR S. RODGERS has resigned from the Tecopa Consolidated Mining Co., Inyo County, California, where he was chief chemist and assistant mill superintendent, and is now engaged in the practice of law, with offices in Salt Lake City, Utah.

GEORGE OTIS SMITH, director of the U. S. Geological Survey, will address the annual meeting of the New York State Oil Producers' Association at Olean, N. Y., on Sept. 31. His subject will be "The Real Value of Oil." Dr. Smith has accepted an invitation to address the General Staff College of the Army on Oct. 5 on "Strategy of Minerals." Later in the course he will address the class on "Superpower."

L. J. WALDBAUER has resigned his instructorship at the University of Maine to accept a demonstratorship at McGill University, Montreal, Canada.

J. E. WALTERS, F. W. SCHROEDER and FRANK PORTER, chemists who have been on duty at the helium plant at Petrolia, Tex., have been transferred to Washington, where they have been added to the force at the cryogenic laboratory.

W. M. WEIGEL, of the chemical division of the Bureau of Mines, who has been studying deposits of filler materials in the Southwest, will now visit Eastern plants that are utilizing these materials. This work is being done in connection with the general study of filler problems being made by the bureau.

EDWIN D. WINKWORTH has been named executive vice-president for the Solvay Process Co., in full charge of management of the parent concern of all Solvay interests.

Obituary

Captain ANTHONY F. LUCAS, who was responsible for the famous Lucas gusher at Spindle Top, the pioneer of the Gulf Coast oil development, died in Washington on Sept. 2. Captain Lucas was born in Spalatro, Dalmatia, Austria, in 1855, and possessed all the kindness and sympathy for others characteristic of the Montenegrin race from which he was descended. He did important work on salt, petroleum and sulphur, it being the oil from Spindle Top, used as fuel, which made possible the development of the Frasch system of mining sulphur. His discoveries had an immense bearing on the development of modern technology, the raw mineral products discovered by him being the incentive for a great deal of engineering progress. He avoided publicity and ceremony and was content with doing for the sake of doing. His life work is catalogued in "Pioneering the Gulf Coast," by R. S. McBeth.

Review of the Industrial Chemical Market Since the Beginning of 1921

THE first eight months of the year have been a mighty disappointment to those who were of the opinion that January, 1921, would see the beginning of a marked revival in the general list. Everyone hoped for the best, but in reality looked for the worst and got the fulfillment of his expectations. The year so far has been filled with more business reverses than have ever before been experienced by the chemical industry, and it is only within the past few weeks that the rays of hope have been penetrating through the edges of passing dark clouds.

There has been some improvement in 1921 when conditions are compared with the acute slump in values during 1920. Conditions have improved steadily since the first of the year inasmuch as the rate of loss in values has been steadily diminishing. During the period of the war and immediately after the signing of the armistice spot quotations through speculation rose 300 to 500 per cent above the 1913-1914 normal values. At the beginning of the war the entire list was about 75 per cent above the 1914 average. The loss so far this year has been somewhat around 25 per cent of the inflated figure, bringing an average of industrial chemical values today to about 50 per cent above pre-war figures. Although there are quite a few items that are selling at figures which are actually lower than the pre-war price, the majority of chemicals still stand far above 1914 prices.

THE EXPORT SITUATION

The American chemical industry has suffered greatly during the current year, as far as export business is concerned. European rates of exchange have just about driven the American exporter out of the running. South America has welcomed German commercial representatives aided by a very cheap mark, and has returned to its former source of chemical products. Japan until recently has done only a small amount of chemical business. The Germans are attempting to win back this field and have dumped a large amount of products at much lower than American costs. It seems, however, that the Japanese are looking for American chemicals and have materialized this desire by placing numerous large orders in the market during the past few weeks.

THE IMPORT SITUATION

The chemical import business has progressed markedly in the face of the many adverse conditions. Here and there new houses are being organized to handle European imports. The depreciated mark and franc have given the foreign manufacturer an exceptional opportunity to ship goods into this market at prices with which American producers have been absolutely unable to compete. The biggest portion of the chemical business which has passed in the market since the beginning of the year has been in imported goods. American manufacturers have been looking on, awaiting some action from Congress which will give them a chance to do some business again. While the emergency tariff has kept out all synthetic and coal-tar chemicals, other products have been permitted to flood the market and have been the chief cause in bringing prices down. It is, therefore, quite evident that the export and import situations have been steadily depressing the American manufacturer, making it an impossibility to market his products at prices compatible with American costs of production.

THE TARIFF QUESTION

The apparent recovery of the German chemical export market, as evidenced by the heavy shipments of potash products to this market and the legislative situation in Washington, has held the center of the domestic chemical stage. Between the dye license clause and the Fordney tariff bill, the chemical industry as a whole has had little peace. The chemical market has been split in many ways by the legislative situation. Manufacturers have been strong in their desire for adequate protection in the form

of a high tariff, while opposed to this position stand the large consuming industries and the chemical importers. The frequent large shipments of German material at extremely low prices, especially potash salts, prussiates and bromides, combined with heavy imports of French and British soda ash, have been the big feature in the American producers' fight for protection. The consensus among leading manufacturers is that no definite action on these bills will be taken before some time in December. The chemical and dye industries, in the meantime, have been given protection to some degree by an extension of the emergency tariff to Nov. 27.

THE SODA SITUATION

Prices in the soda industry have not been affected so acutely by importations of foreign goods, because of the fact that imports have come from countries whose exchanges are not so depreciated as is that of Germany. Soda ash imports have come in large quantities chiefly from England and to some degree from France. Caustic soda has not gone below \$3.80 per 100 lb. in the resale market and imports have not been at all noticeable. The goods that have arrived in this country have been offered below those at which American makers have offered, but imports have been closely held, so that no excess above consumers' requirements have come into the market to force further decline in quotations. The practice of selling the goods before ordering their import has in no doubt saved the alkali industry from any serious injury. Scarcely an item in the heavy chemical list, with the exception of the heavy acids, has failed to feel the effect of the low exchange and low manufacturing costs abroad. Alums, fluorides, ammonium chloride and prussiates have been subject to the same influences and the result has been that producers of these products have been forced to close their plants or greatly reduce their output.

THE POTASH INDUSTRY

The sharp decline in the potash market was due to the Scandinavian countries, which reshipped large quantities of caustic potash that had been sent to them by American producers in 1919 and 1920. This material was shipped to them with the hope that the peace settlement would leave Germany without potash and that as soon as trade was resumed an open market would be found for it in countries which had previously depended principally on Germany as their source of supply. In spite of the fact that France assumed control of the greater portion of Alsatian deposits, German prices began to slump so rapidly that American manufacturers were forced to close their plants and center their hopes in Congress. Holders of American stocks of potash abroad became convinced that their plans had met utter failure and returned large portions of it to the New York market to be sold as quickly as possible. From that time until a few weeks ago prices slumped tremendously until this reshipped caustic had been absorbed. Prices worked themselves down to as low as 4½c. per lb. During this time crude muriate of potash, which was held at \$2.40 per unit during the summer of 1920, was forced down to the present price of 85c. per unit by the production of the Germans and French, who were endeavoring to place themselves on a better financial footing. The strong competition for the American market has put the domestic producers of crude potash salts under as heavy a handicap as the producers of other potash salts. The heavy freight charges from the western producing districts, together with the more expensive methods of obtaining potash from low-grade ores which it has been necessary to employ as compared with the ordinary procedure required by European salt deposits, have placed the crude potash producers in a very unhealthy position. It is highly questionable if the proposed duties will relieve the situation to any material degree. Manufacturers of potash compounds from this crude material have been forced to use imported raw material, and even then have found it impossible to compete with foreign goods. Their condition is considered more serious when it is to be remembered that the proposed duty on their products is equivalent only to the raw material duty urged to protect the crude potash producers.

Potash Production in Alsace

Reports from Strassburg state that the output of the Alsatian potash mines will be doubled in October, according to a Reuter cable from Paris. It is probable that the monthly production of potassium chloride in 1922 will average about 10,000 tons, a large proportion of which will be available for export.

Hydro-Electric Inspection Tour Planned by Engineering Society of Buffalo

The Engineering Society of Buffalo has planned a novel and interesting meeting for Saturday, Oct. 8. On that date the members of the society will meet at noon and travel by automobile to Niagara Falls, Ont., where they will be taken on an inspection tour of the Chippewa-Queens-town hydro-electric development which is now being completed.

This tour will be conducted by the men in charge of the electrical, hydraulic and construction branches of the work. After the tour the party will return to Buffalo for dinner at the University Club, where addresses will be given by the engineers in charge of the development.

The Rochester Engineering Society and the Niagara Peninsula branch of the Engineering Society of Canada have been invited to accompany the Buffalo Society on this trip.

Chemical Companies Organized

During the month of August, a total of thirty-seven new companies in the chemical industries was organized, with authorized capital of \$50,000 or greater. The combined authorized capital of the new concerns totaled \$15,495,000, representing the largest monthly total for new companies in this line of business since January last, and indicated a striking contrast with the aggregate for the preceding month of July, which stood at \$3,265,000. In August, 1920, the indicated capitalization of new chemical companies was \$36,715,000. During the first eight months of the present year, January-August, inclusive, chemical organizations with a combined capitalization of \$84,385,000 have been formed, as compared with \$167,922,000 for the corresponding period of 1920.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, Sept. 26, 1921.

Business is showing a decided improvement throughout the list as consumers become more confident of present price levels, and while the market is still somewhat irregular, the movement of stocks is rapidly increasing. The demand, while chiefly from domestic consumers, embraces a moderate amount of foreign requirements. South American countries and Mexico are inquiring for miscellaneous chemicals and sales have been noted in various quarters. Soapmakers have been among the largest purchasers, while glass factories, tanneries, paper and textile mills have all shown a marked improvement in covering their chemical necessities. Quite a number of firms report that business so far this month has been better than during the entire month of August, which was considered the best month since the beginning of the depression. There has been a tendency in several instances to increase the size of commitments and more carlot transactions have been noted in the heavy chemicals. The market, in general, is showing considerable resistance around prevailing levels and there were several instances of net advances at the close of the week.

Solid caustic soda was one of the large items which recorded a firmer tone in the final trading. Advancing prices on caustic potash also featured the week's market. This chemical is sharply higher on diminished spot stocks, and while the foreign markets are showing firmness, it is believed that arrivals will bring prices back to slightly

lower levels. Ammonium sulphate is higher both at the works and for export. Sodium nitrate is firmer. Bichromate of soda was another chemical that displayed a splendid tone on spot. The recent advance in prussiate of soda has been well maintained.

Importations of German chemicals have freely continued. Large arrivals of potash products are noted from Hamburg. These, however, did not have any marked depressing influence on values, as it is understood that a large portion of this material was sold to arrive. There have not been any recent importations of foreign caustic soda and soda ash. The price of domestic ash seems low enough to satisfy domestic consumers and they are not desirous of meddling with foreign goods at the present time.

Outside developments during the past week have been of a highly favorable character. The steel industry has shown a noteworthy improvement so far this month. Large steel companies have announced the reopening of their plants on full-time operation and have advanced prices, which have helped decidedly in stimulating new business. The textile industry is gradually forging ahead, while the paper mills are steadily recovering from their adverse conditions noted earlier in the year.

CHEMICALS

Spot *caustic potash* was advanced and the market closed in a firm condition with relatively little stock offered. Shipment prices from Germany have been advanced and it is doubtful if better than 5½c. per lb. would be accepted on the 88-92 per cent. Dealers quote the spot market at 5½c. per lb. Buyers have not been desirous of following the advance, but it looks as though they will soon be reconciled to the higher trading level. Imported *chlorate of potash* is quoted at 7c. per lb. on spot and 6½c. afloat. Shipments were quoted at 5½@5¾c. per lb., c.i.f. New York. Domestic material continued unchanged at 12c. per lb., f.o.b. works. Spot *bicarbonate of soda* is offered by dealers at \$2.40 per 100 lb. packed in barrels and at \$2.75 per 100 lb. in kegs. At the works producers quote 2c. per lb. for barrels and 2¼c. for kegs. A fair inquiry has featured the market for this material, but there has been no unusual change in trading. Closing prices for solid *caustic soda* record a net advance for the week. The demand for this chemical is gradually increasing, while supplies of standard brands are relatively light in second hands. Prices have ranged from \$3.90 to \$4.05 per 100 lb. during the past week and the final quotation for standard goods was 4c. per lb. Sales have included the wants of both foreign and domestic consumers and the movement is considered quite satisfactory by prominent dealers. Market prices on *nitrate of soda* have been a trifle easier, with sellers at 6¾@7c. per lb., depending upon the quantity. The inquiry continues rather light, with competition somewhat keener for the light passing business. Higher prices have been established for *prussiate of soda*, ex-store. The demand at intervals was active, and while small lots commanded the most attention, the aggregate business for the week was well up to the standard. Most of the business went through at 12¾@13c. per lb. Spot prices on *soda ash* have continued firm with an advancing tendency. Large dealers quoted the market for single bags at \$2.10@\$2.15 per 100 lb. and reported sales at these figures depending upon the quantity involved. Several transactions in barrels were reported at \$2.45@\$2.50 per 100 lb. Sales of *bleaching powder* in large drums are reported at 2¼c. per lb., f.o.b. works. Sales of imported material are noted at 2c. per lb., ex-dock New York, duty paid. Shipments of foreign material are quoted at \$1.90 per 100 lb., and this price was named for goods for arrival in about a week. Several carload lots have changed hands during the week and a good inquiry from the consuming trade was reported from leading makers.

Large sellers of *oxalic acid* quote the market firm at 16½c. per lb. Small lots could probably be purchased in some directions a shade under this figure. The call is mostly for small quantities. At the works 16c. per lb. was named. First-hand sales of *phosphate of soda* are reported on the basis of 4½c. per lb. for the commercial. The same price was named for *bisodium phosphate*. The U.S.P. variety is quoted by producers at 7½c. per lb. *Copperas* manufacturers quote \$18 per ton in bags and up to \$23 per ton in barrels

f.o.b. works in large lots. Domestic makers of *strontium nitrate* quote 18@20c. per lb., although it is possible to do 12@12½c. through importers.

COAL-TAR PRODUCTS

A decided improvement in the sales of intermediates has been made during the past week. The general air of uncertainty, caused by the tariff delay, which has hung over the trade for the past few months, is gradually being dispelled and is giving way to a firm conviction that adequate protection will be accorded to the industry. Consumers in many cases are abandoning hand-to-mouth operations and are placing contracts for good quantities. Resale lots of cheap material are cleaned out in most cases except where manufacturers are using resellers to cover their own unloading operations which have had to go on at sacrifices. For the first time in many months optimism is shown in producing quarters and even those formerly pessimistic are stating that the turn has come. Prices all around are holding steady, but some slight reductions in intermediates were made by makers during the week. Moderate selling of *naphthalene flakes* is going on at 6½@6¾c. per lb. for prime quality goods. Supplies are plentiful and competition for business is keen. First hands quote *aniline oil* at 20c. per lb., but actual sales have been made at 18@18½c. Some resale goods are still obtainable at 17½c. The demand shows considerable improvement and sellers generally are steadier in their views. Most *beta naphthol* sales have been put through at 34c. per lb. First hands continue to quote 40c. per lb., but resale lots are obtainable at 32c. Buying has been moderately active. Sales of *ortho-toluidine* were made at 21c. per lb. and some holders ask up to 25c. The demand is fair. Rumors of lower prices are heard on *alpha-naphthalamine* and there is little doubt that firm business in quantity would bring concessions from makers. Second hands quote from 33@35c. per lb.

WAXES

Importers of *African crude beeswax* report a good volume of business at steady prices. For spot material the market held around 15c. per lb., but on futures as low as 13½c. has been named. *Brazilian crude* was more or less nominal at 21c. per lb. and upward, depending upon seller and color. *White refined wax* was quoted at 36@42c. per lb. The situation on *carnauba wax* presented nothing new, prices holding in sympathy with primary markets. The lower grades were in the best demand and prices for the No. 3 chalky closed at 15@15½c. per lb., with the No. 3 North Country held at 25c. per lb. Holders' views on *Japan wax* were firm due to the recent rise in the cost of import, but the advance has checked buying and prices at the close were more or less nominal at 23@25c. per lb., depending upon the seller and quantity. A moderate improvement was reported in the export demand for *paraffine wax*, but with offerings liberal, prices failed to move upward. Scale wax closed nominally at 1½@2c. per lb., earload basis, f.o.b. works. Export of both crude and refined paraffine for the month of July amounted to 20,876,244 lb., as against 23,583,766 lb. for July a year ago. Exports for the seven months ended with July amounted to 112,101,773 lb., compared with 236,674,790 lb. for the same period a year ago and 128,051,891 lb. in 1919.

The Chicago Market

CHICAGO, Sept. 23, 1921.

All quarters report an increase in business on the general list of industrial chemicals during the past two weeks. Dealers are quite optimistic over the outlook and report conditions as very satisfactory. Prices are firm and holders show no disposition to shade their regular quotations. Stocks are getting low in some quarters, which is a factor to be considered in the firmness of the local market.

INDUSTRIAL CHEMICALS

There is a good demand for *caustic soda* in both the ground and solid forms and prices are very firm. The ground 76 per cent is bringing \$4.65@\$4.80 per 100 lb., according to quantity and holder, and the solid 76 per cent \$4.25@\$4.37½. *Soda ash* is moving in a very fair way and the price is firm and unchanged at \$2.60 per 100 lb. for material in coopeage. *Ammonium chloride* is rather quiet

with ample supplies of the white granular available at 7½c. per lb. *Sulphate of ammonia* has shown a decided firmer tendency during the last few days and it is doubtful if supplies could be had at less than 3¼c. per lb. *Potash alum* is reported to be moving in a fair way at 6c. per lb. for the granulated in barrels. *Aluminum sulphate* is rather scarce and small lots were bringing 2½c. per lb. for the ground iron-free. There is a good demand for *carbon bisulphide* at 7c. and *carbon tetrachloride* at 11c. per lb. Business in *formaldehyde* is rather dull, with dealers quoting 12@12½c. per lb. for single barrels. *Glycerine* is still quiet, with ample supplies of the c.p. material offered at 14c. per lb. Several small sales of *iron sulphate* were noted at 1¼c. per lb.

There is a very good demand for *litharge*, which is quoted by producers at 7½c. per lb. in kegs. *Lead acetate* is said to be selling at a rather brisk rate at 13@13½c. per lb. *Caustic potash* is showing a firmer tendency, with stocks diminishing, and 6½c. per lb. for the 88-92 per cent material was the best offer noted. *Bichromates* are firm as to price and are moving well. *Potash bichromate* is available at 13@13½c. per lb. *Sodium bichromate* on spot is difficult to locate and material to arrive is quoted at 9½c. per lb. There is a fair request for *bicarbonate of soda*, which is firm and unchanged at \$2.60 per 100 lb. *Sodium acetate* is moving in a fair way at 5½@6c. per lb. *Hyposulphite of soda* is in good demand and manufacturers are maintaining the price at \$4.05 per 100 lb. for the pea crystals in barrels. Several large sales were reported on *sodium fluoride* at 11c. per lb., smaller quantities bringing 12c. *Glauber salts* were available at \$1.90 per 100 lb., with a fair movement noted. *Zinc chloride* is in good demand, with prices ranging from 11½c. for the domestic to 9½c. per lb. for the imported.

The list of acids, generally speaking, was maintained as to price. Business in *acetic acid* has shown a decided improvement and prices are firm. The 28 per cent in barrels is quoted at \$2.65@\$2.75 per 100 lb., according to quantity, and the glacial at \$10.25@\$10.75 per 100 lb. *Citric acid* is rather slow, with manufacturers quoting 47½c. per lb. for barrels. It is possible to shade this price a few cents in second hands. *Tartaric acid* is in a similar position, first hands asking 35½c. per lb. for barrels. There is a better movement of *sulphuric acid* and the price is maintained at \$19@\$20 per ton for tank cars, f.o.b. works.

VEGETABLE OILS

A very good movement of *linseed oil* is reported by dealers. The raw oil is quoted at 76c. per gal. and the boiled at 78c.

NAVAL STORES

This branch of the trade has nothing to complain of and business is reported as very good. *Turpentine*, as with other paint materials, is moving very well. Today's quotation is 76c. per gal. for drums. There is also a fair demand for *rosins* with carlots of the WW grade quoted at \$7.50 per 280 lb. and corresponding prices for the other grades.

The Iron and Steel Market

PITTSBURGH, Sept. 23, 1921.

Last week's advance in prices of wire products, \$2 to \$3 a ton, has been followed by an advance of \$5 a ton in sheets. There are cross-currents, as pipe-mill products, including standard steel pipe, line pipe, oil country goods and boiler tubes, have been formally reduced \$8 to \$10 a ton, while to complete the divergence, bars, shapes and plates have been practically unchanged in price for a fortnight.

The steadiness in prices of bars, shapes and plates is a plain fact. These commodities are commonly called the "heavy rolled products" and easily comprise the most important part of the finished-steel market in general. The advances and declines referred to above are facts, but they are not so plain. The sheet and wire advances were preceded by heavy bookings at the old prices. It is no secret that the producers took pains to inform buyers that prices were going to be advanced. On the other hand, the formal reduction in pipe-mill products is not as great as appears by the changes from the published lists of July 7 to those of Sept. 16, for the reason that there had been some shading almost from the time the old lists had been put out.

In standard steel pipe the shading averaged about one-half of the formal reduction now made, while in oil country goods the shading was approximately equal to the formal reduction.

CONTINUOUS DECLINE IN STEEL PRICES ENDED

Declines in steel prices may not be wholly ended, but the continuous decline is over. For the future we shall have slight ups and downs, for while the general decline is over there is no plain indication that a general and continuous advance has succeeded it. One does not know that the advanced prices for sheets, for instance, will be maintained indefinitely, or be followed by other advances. This may or may not be the case.

Steel prices had declined far enough to represent a very decided liquidation. Taking wire and sheets at their former prices, since buyers are covered at those prices, finished steel products by a weighted average are at 33 per cent above their 1913 average, so frequently taken as a basis of comparison. Thus they would stand at 133 according to the system used by the Bureau of Labor, which reports for August 152 as the index number of wholesale commodity prices in general, made up of individual items ranging from farm products at 118 to house-furnishing goods at 230.

Bars, shapes and plates are generally quotable at 1.65c. In some cases mills may obtain a little more, for small or undesirable orders, while particularly desirable orders may go at slight concessions. There is no hint that as low as 1.50c. has been done in a solitary instance in the past fortnight. Weeks ago some buyers set 1.50c. as the price to which bars, shapes and plates should decline in order to be on a stable basis, but at this date, with wire products and sheets having already reacted upward, it seems safe to conclude that if bars, shapes and plates were going to go to 1.50c. they would already have done so. At some time, doubtless, they will sell below 1.50c., but probably not until fundamental items of cost have experienced reductions that are not in immediate prospect.

MILL OPERATIONS

The American Sheet & Tin Plate Co. operated its sheet mills at about 54 per cent last week and scheduled a 70 per cent operation for this week, but the average is likely to be higher. Independent sheet mills recently were operating at about 40 per cent, but are likely to go to an average of 75 per cent or better, disregarding a few plants that are entirely idle. Wire mills are doing better than 50 per cent and pipe mills nearly as well. Bar, shape and plate production is very light and rail production is almost nil, in percentage of actual capacity.

The rate of steel ingot production may be estimated at about 33 per cent, this comparing with an average of 30 per cent in August and a rate just under 20 per cent at the low point, about the middle of July. While demand for wire products, sheets and tubular goods has been improving decidedly, bars, shapes, plates and rails, being heavy products, prevent the production of ingots from showing any great response. The rate of steel production may reach 40 per cent within a short time, but it seems improbable that it will attain 50 per cent at any time this year. Rather strong hopes are entertained for early spring, these hopes being based on a resumption of railroad buying on a fair scale and a decided increase in general construction work.

PIG IRON

Pig iron prices have been well maintained in all districts in the past week and it looks as though prices would tend to advance rather than decline, not on the ground of there being heavy demand, but rather because prices are in most cases below cost of production and the cost of production is not going to experience a decline, by reductions in freight rates, as soon as was expected. The valley market remains quotable at \$20 for bessemer, \$19 to \$20 for basic and \$21 for foundry. Inquiry has been very light, since the recent little spurt in activity, but another movement is expected shortly. The Standard Sanitary Manufacturing Co. has just inquired for 4,000 to 5,000 tons of Northern and Southern iron for fourth quarter delivery to its plant in Pittsburgh, New Brighton and Louisville.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots	Less Carlots
Acetic anhydride.....lb.	10.12 - 10.12	\$0.40 - \$0.45
Acetone.....lb.	2.75 - 3.00	.13 - .13
Acid, acetic, 28 per cent.....100 lbs.	5.50 - 5.75	3.25 - 3.50
Acetic, 56 per cent.....100 lbs.		6.00 - 6.50
Acetic, glacial, 99 1/2 per cent, carboys, 100 lbs.	10.50 - 11.00	11.25 - 11.50
Boric, crystals.....lb.	.12 - .13	.13 - .14
Boric, powder.....lb.	.13 - .13 1/2	.14 - .14 1/2
Citric.....lb.		.45 - .47
Hydrochloric.....100 lb.	1.25 - 1.50	1.60 - 1.75
Hydrofluoric, 52 per cent.....lb.	.11 - .11 1/2	.12 - .12 1/2
Lactic, 44 per cent tech.....lb.	.10 - .11	.11 - .12
Lactic, 22 per cent tech.....lb.	.04 - .05 1/2	.06 - .07
Molybdic, C. P.....lb.	4.00 - 4.50	4.50 - 5.00
Muriatic, 20 deg. (see hydrochloric).....lb.		
Nitric, 40 deg.....lb.	.06 - .06 1/2	.07 - .07 1/2
Nitric, 42 deg.....lb.	.07 - .07 1/2	.07 - .07 1/2
Oxalic, crystals.....lb.	.16 - .16 1/2	.17 - .18
Phosphoric, 50 per cent solution.....lb.	.13 - .13 1/2	.14 - .18
Picric.....lb.	.20 - .25	.27 - .35
Perogallic, resublimed.....lb.		1.75 - 1.90
Sulphuric, 60 deg., tank cars.....ton		11.75 - 13.00
Sulphuric, 60 deg., drums.....ton		13.00 - 15.00
Sulphuric, 66 deg., tank cars.....ton	18.00 - 20.00	
Sulphuric, 66 deg., drums.....ton	21.00 - 22.00	22.50 - 23.00
Sulphuric, 66 deg., carboys.....ton		
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	21.00 - 22.00	
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	23.00 - 23.50	24.00 - 24.50
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	31.00 - 32.00	33.00 - 34.00
Tannic, U. S. P.....lb.		.75 - .85
Tannic (tech.).....lb.	.45 - .48	.50 - .55
Tartaric, imported crystals.....lb.		.25 - .26
Tartaric acid, imported, powdered.....lb.		.27 - .28
Tartaric acid, domestic.....lb.		.35
Tungstic, per lb. of WO.....lb.		1.30 - 1.40
Alcohol, Ethyl.....gal.		4.65 - 4.90
Alcohol, Methyl (see methanol).....gal.		
Alcohol, denatured, 188 proof.....gal.		.35 - .36
Alcohol, denatured, 190 proof.....gal.		.37 - .38
Alum, ammonia lump.....lb.	.03 - .03 1/2	.04 - .04 1/2
Alum, potash lump.....lb.	.03 - .04	.04 - .04 1/2
Alum, chrome lump.....lb.	.10 - .11	.11 - .12
Aluminum sulphate, commercial.....lb.	.02 - .02 1/2	.02 - .02 1/2
Aluminum sulphate, iron free.....lb.	.03 - .03 1/2	.03 - .04
Aqua ammonia, 26 deg., drums (750 lb.).....lb.	.07 - .07 1/2	.08 - .08 1/2
Ammonia, anhydrous, cyl. (100-150 lb.).....lb.	.30 - .32	.33 - .35
Ammonium carbonate, powder.....lb.	.07 - .07 1/2	.08 - .09
Ammonium chloride, granular (white salmuni ac).....lb.	.06 - .06 1/2	.06 1/2 - .07
Ammonium chloride, granular (gray salmuni ac).....lb.	.06 1/2 - .07	.07 1/2 - .08
Ammonium nitrate.....lb.	.07 - .07 1/2	.07 1/2 - .08 1/2
Ammonium sulphate.....100 lb.	2.20 - 2.25	2.30 - 2.40
Amylacetate.....gal.		3.25 - 3.50
Amylacetate tech.....gal.		2.50 - 3.00
Arsenic oxide, (white arsenic) powdered lb.	.05 - .06	.06 1/2 - .06 3/4
Arsenic sulphide, powdered (red arsenic) lb.	.11 - .11 1/2	.12 - .13
Barium chloride.....ton	43.00 - 45.00	46.00 - 49.00
Barium dioxide (peroxide).....lb.	.20 - .21	.22 - .23
Barium nitrate.....lb.	.07 - .08	.08 - .09
Barium sulphate (precip.) (blanc fixe).....lb.	.04 - .04 1/2	.04 1/2 - .05 1/2
Bleaching powder (see calc. hypochlorite).....		
Blue vitriol (see copper sulphate).....		
Borax (see sodium borate).....		
Brimstone (see sulphur, roll).....		
Bromine.....lb.	.27 - .28	.28 - .30
Calcium acetate.....100 lbs.	2.00 - 2.65	
Calcium carbide.....lb.	.04 - .04 1/2	.05 - .05 1/2
Calcium chloride, fused, lump.....ton	23.50 - 24.00	24.50 - 25.50
Calcium chloride, granulated.....lb.	.01 - .02	.02 - .02 1/2
Calcium hypochlorite (bleach powder) 100 lb.	2.75 - 2.80	2.90 - 3.50
Calcium peroxide.....lb.		1.40 - 1.50
Calcium phosphate, tribasic.....lb.		.15 - .16
Camphor.....lb.		.68 - .70
Carbon bisulphide.....lb.	.06 - .06 1/2	.06 1/2 - .07 1/2
Carbon tetrachloride, drums.....lb.	.10 - .10 1/2	.11 - .12
Carbonyl chloride (phosgene).....lb.		.60 - .75
Caustic potash (see potassium hydroxide).....		
Caustic soda (see sodium hydroxide).....		
Chlorine, gas, liquid-cylinders (100 lb.).....lb.	.08 - .09	.09 1/2 - .10
Chloroform.....lb.		.38 - .43
Cobalt oxide.....lb.		2.00 - 2.10
Copperas (see iron sulphate).....		
Copper carbonate, green precipitate.....lb.	.19 - .19 1/2	.20 - .21
Copper cyanide.....lb.		.50 - .62
Copper sulphate, crystals.....lb.	.05 - .05 1/2	.05 1/2 - .06
Cream of tartar (see potassium bitartrate).....		
Epsom salt (see magnesium sulphate).....		
Ethyl Acetate Com. 85%.....gal.		1.00 - 1.10
Ethyl Acetate pure (acetic ether 98% to 100%).....lb.		.40 - .42
Formaldehyde, 40 per cent.....lb.	.12 - .12 1/2	.12 1/2 - .13 1/2
Fusel oil, ref.....gal.		3.25 - 3.75
Fusel oil, crude.....gal.		1.50 - 1.75
Glauber's salt (see sodium sulphate).....		
Glycerine, C. P. drums extra.....lb.		.14 - .15
Iodine, resublimed.....lb.		3.50 - 3.60
Iron oxide, red.....lb.		.10 - .20
Iron sulphate (copperas).....ton	18.00 - 19.00	20.00 - 23.00
Lead acetate.....lb.		.10 - .12 1/2
Lead arsenate, paste.....lb.	.09 - .09 1/2	.10 - .11
Lead nitrate.....lb.		.15 - .20
Litharge.....lb.	.07 - .08	.08 1/2 - .09
Lithium carbonate.....lb.		1.30 - 1.40
Magnesium carbonate, technical.....lb.	.08 - .08 1/2	.09 - .10
Magnesium sulphate, U. S. P. 100 lb.	2.50 - 2.75	
Magnesium sulphate, technical.....100 lb.		1.10 - 1.75
Methanol, 95%.....gal.		.66 - .68
Methanol, 97%.....gal.		.70 - .72
Nickel salt, double.....lb.		.12 - .12 1/2
Nickel salt, single.....lb.		.14 - .14 1/2
Phosgene (see carbonyl chloride).....		
Phosphorus, red.....lb.	.40 - .41	.42 - .45
Phosphorus, yellow.....lb.		.30 - .35
Potassium bichromate.....lb.	.11 - .11 1/2	.12 - .12 1/2

	Carlots	Less Carlots
Potassium bitartrate (cream of tartar) . . . lb.	\$. . . \$. . .	\$0.26 - \$0.28
Potassium bromide, granular . . . lb.		.15 - .23
Potassium carbonate, U. S. P. . . . lb.	.35 - .40	.45 - .50
Potassium carbonate, 80-85% . . . lb.	.05 - .05½	.06 - .06½
Potassium chlorate, crystals . . . lb.	.07 - .07½	.07½ - .10
Potassium cyanide . . . lb.		.26 - .28
Potassium hydroxide (caustic potash) . . . lb.	.05½ - .05¾	.06 - .08
Potassium muriate, 80% K.C.L. . . . ton	40.00 - 42.50	
Potassium iodide . . . lb.		2.75 - 3.00
Potassium nitrate . . . lb.	.09¼ - .09½	.10 - .12½
Potassium permanganate . . . lb.	.20 - .21	.22 - .23
Potassium prussiate, red . . . lb.	.28 - .29	.29½ - .30
Potassium prussiate, yellow . . . lb.	.20 - .20½	.21 - .22
Potassium sulphate (powdered) . . . per unit		1.20 - 1.25
Rochelle salts (see sodium potas tartrate) . . .		
Salammoniac (see ammonium chloride) . . .		
Salt soda (see sodium carbonate) . . .		
Salt cake (bulk) . . . ton		20.00 - 25.00
Silver cyanide . . . oz.		1.35 - 1.38
Silver nitrate . . . oz.		.41½ - .42
Soda ash, light . . . 100 lb.	2.10 - 2.15	2.20 - 2.50
Soda ash, dense . . . 100 lb.	2.35 - 2.40	2.45 - 2.70
Sodium acetate . . . lb.	.04 - .04½	.04½ - .05
Sodium bicarbonate . . . 100 lb.	2.00 - 2.25	2.50 - 2.75
Sodium bichromate . . . lb.	.07½ - .08	.08½ - .08¾
Sodium bisulphate (nitre cake) . . . ton	5.00 - 5.25	5.50 - 6.50
Sodium bisulphite powdered, U.S.P. . . . lb.	.04¾ - .05	.05½ - .06
Sodium borate (borax) . . . lb.	.05½ - .06	.06½ - .07
Sodium carbonate (salt soda) . . . 100 lb.	1.90 - 2.00	2.10 - 2.40
Sodium chlorate . . . lb.	.07½ - .07¾	.08 - .08½
Sodium cyanide . . . lb.	.20 - .21	.22 - .30
Sodium fluoride . . . lb.	.10½ - .11	.11½ - .12
Sodium hydroxide (caustic soda) . . . 100 lb.	4.00 - 4.10	4.15 - 4.75
Sodium hyposulphite . . . lb.		.03½ - .03¾
Sodium nitrate . . . 100 lb.	2.20 -	2.35 -
Sodium nitrite . . . lb.	.06¾ - .07	.07½ - .07¾
Sodium peroxide, powdered . . . lb.	.25 - .26	.27 - .30
Sodium phosphate, dibasic . . . lb.	.04¼ - .04½	.04¾ - .05¼
Sodium potassium tartrate (Rochelle salts) lb.		.21 - .24
Sodium prussiate, yellow . . . lb.	.12¾ - .13	.13½ - .14
Sodium silicate, solution (40 deg.) . . . 100 lb.	1.00 - 1.15	1.25 - 1.40
Sodium silicate, solution (60 deg.) . . . lb.	.02¼ - .03	.03½ - .03¾
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	1.50 - 1.75	2.00 - 2.25
Sodium sulphide, fused, 60-62 per cent (conc.) lb.	.04½ - .04¾	.05 - .06
Sodium sulphite, crystals . . . lb.	.03 - .04	.04½ - .04¾
Strontium nitrate, powdered . . . lb.	.12 - .13	.13½ - .20
Sulphur chloride, red . . . lb.	.05 - .05½	.05¾ - .06½
Sulphur, crude . . . ton	18.00 - 20.00	
Sulphur dioxide, liquid, cylinders extra . . . lb.	.08 - .08½	.09 - .10
Sulphur (sublimed), flour . . . 100 lb.		2.25 - 3.10
Sulphur, roll (brimstone) . . . 100 lb.		2.00 - 2.75
Tin bichloride, 50 per cent . . . lb.	.18 - .19	
Tin oxide . . . lb.		.38 - .40
Zinc carbonate, precipitate . . . lb.	.16 - .16½	.17 - .17½
Zinc chloride, gran . . . lb.	.09¼ - .09½	.10 - .11
Zinc cyanide . . . lb.	.42 - .44	.45 - .47
Zinc dust . . . lb.	.11¼ - .11½	.11¾ - .12½
Zinc oxide, XX . . . lb.	.07½ - .07¾	.08 - .09
Zinc sulphate . . . 100 lb.	3.00 - 3.25	3.30 - 3.50

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude . . . lb.	\$1.15 - \$1.20
Alpha-naphthol, refined . . . lb.	1.35 - 1.40
Alpha-naphthylamine . . . lb.	.35 - .40
Aniline oil, drums extra . . . lb.	.17½ - .20
Aniline salts . . . lb.	.24 - .26
Anthracene, 80% in drums (100 lb.) . . . lb.	.75 - 1.00
Benzaldehyde U.S.P. . . . lb.	1.00 - 1.25
Benzidine, base . . . lb.	1.00 - 1.10
Benzidine sulphate . . . lb.	.75 - .85
Benzoic acid, U.S.P. . . . lb.	.70 - .72
Benzoate of soda, U.S.P. . . . lb.	.55 - .60
Benzene, pure, water-white, in drums (100 gal.) . . . gal.	.27 - .32
Benzene, 90%, in drums (100 gal.) . . . gal.	.25 - .28
Benzyl chloride, 95-97%, refined . . . lb.	.25 - .27
Benzyl chloride, tech . . . lb.	.20 - .23
Beta-naphthol benzoate . . . lb.	3.50 - 4.00
Beta-naphthol, sublimed . . . lb.	.70 - .75
Beta-naphthol, tech . . . lb.	.32 - .35
Beta-naphthylamine, sublimed . . . lb.	1.90 - 2.00
Cresol, U. S. P., in drums (100 lb.) . . . lb.	.17 - .19
Ortho-cresol, in drums (100 lb.) . . . lb.	.25 - .27
Cresylic acid, 97-99%, straw color, in drums . . . gal.	.70 - .75
Cresylic acid, 75-97%, dark, in drums . . . gal.	.60 - .65
Cresylic acid, 50%, first quality, drums . . . gal.	.45 - .50
Dichlorobenzene . . . lb.	.06 - .09
Diethylaniline . . . lb.	1.20 - 1.25
Dimethylaniline . . . lb.	.42 - .50
Dinitrobenzene . . . lb.	.25 - .28
Dinitrochlorobenzene . . . lb.	.25 - .30
Dinitronaphthalene . . . lb.	.32 - .40
Dinitrophenol . . . lb.	.37 - .40
Dinitrotoluene . . . lb.	.25 - .30
Dip oil, 25%, ear lots, in drums . . . gal.	.35 - .40
Diphenylamine . . . lb.	.60 - .70
H-acid . . . lb.	1.10 - 1.20
Meta-phenylenediamine . . . lb.	1.15 - 1.20
Monochlorobenzene . . . lb.	.12 - .14
Monoethylaniline . . . lb.	1.50 - 1.60
Naphthalene crushed, in bbls. . . . lb.	.06½ - .07½
Naphthalene, flake . . . lb.	.06½ - .08
Naphthalene, balls . . . lb.	.08 - .09½
Naphthionic acid, crude . . . lb.	.70 - .75
Nitrobenzene . . . lb.	.12 - .15
Nitro-naphthalene . . . lb.	.30 - .35
Nitro-toluene . . . lb.	.15 - .17
Ortho-amidophenol . . . lb.	3.00 - 3.10
Ortho-dichlor-benzene . . . lb.	.15 - .20
Ortho-nitro-phenol . . . lb.	.75 - .80
Ortho-nitro-toluene . . . lb.	.15 - .20
Ortho-toluidine . . . lb.	.21 - .25
Para-amidophenol, base . . . lb.	1.40 - 1.45
Para-amidophenol, HCl . . . lb.	1.70 - 1.80

Para-dichlorobenzene . . . lb.	.15 - .20
Paranitroaniline . . . lb.	.79 - .82
Para-nitrotoluene . . . lb.	.80 - .85
Para-phenylenediamine . . . lb.	1.70 - 1.75
Para-toluidine . . . lb.	1.25 - 1.40
Phthalic anhydride . . . lb.	.40 - .50
Phenol, U. S. P., drums . . . lb.	.08½ - .10
Pyridine . . . gal.	2.00 - 3.50
Resorcinol, technical . . . lb.	1.50 - 1.60
Resorcinol, pure . . . lb.	2.25 - 2.30
Salicylic acid, tech., in bbls. . . lb.	.18 - .20
Salicylic acid, U. S. P. . . lb.	.19 - .22
Salol . . . lb.	.60 - .70
Solvent naphtha, water-white, in drums, 100 gal. . . gal.	.25 - .28
Solvent naphtha, crude, heavy, in drums, 100 gal. . . gal.	.14 - .16
Sulphanilic acid, crude . . . lb.	.27 - .30
Tolidine . . . lb.	1.30 - 1.35
Toluidine, mixed . . . lb.	.43 - .45
Toluene, in tank cars . . . gal.	.25 - .28
Toluene, in drums . . . gal.	.28 - .31
Xylidines, drums, 100 gal. . . lb.	.40 - .45
Xylene, pure, in drums . . . gal.	.40 - .45
Xylene, pure, in tank cars . . . gal.	.45 - . . .
Xylene, commercial, in drums, 100 gal. . . gal.	.33 - .35
Xylene, commercial, in tank cars . . . gal.	.30 - . . .

Waxes

Prices based on original packages in large quantities.

Bayberry Wax . . . lb.	\$0.20 - \$0.21
Beeswax, refined, dark . . . lb.	.24 - .25
Beeswax, refined, light . . . lb.	.28 - .30
Beeswax, white pure . . . lb.	.36 - .42
Candelilla wax . . . lb.	.25 - .26
Carnauba, Florida . . . lb.	.48 - .50
Carnauba, No. 2, North Country . . . lb.	.25 - .26
Carnauba, No. 3, North Country . . . lb.	.15 - .15½
Japan . . . lb.	.23 - .24
Montan, crude . . . lb.	.05½ - .06
Paraffine waxes, crude match wax (white) 105-110 m.p. . . lb.	.03½ - .03¾
Paraffine waxes, crude, scale 124-126 m.p. . . lb.	.02 - . . .
Paraffine waxes, refined, 118-120 m.p. . . lb.	.03 - .03½
Paraffine waxes, refined, 125 m.p. . . lb.	.03½ - .03¾
Paraffine waxes, refined, 128-130 m.p. . . lb.	.03½ - .04½
Paraffine waxes, refined, 133-135 m.p. . . lb.	.04½ - .05
Paraffine waxes, refined, 135-137 m.p. . . lb.	.05½ - .06
Stearic acid, single pressed . . . lb.	.09½ - . . .
Stearic acid, double pressed . . . lb.	.10½ - . . .
Stearic acid, triple pressed . . . lb.	.11 - .11½

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on earload lots. The oils in 50-gal. bbl gross weight, 500 lb.

Rosin B-D, bbl.	280 lb.	\$5.80 - 5.90
Rosin E-I	280 lb.	6.00 - 6.50
Rosin K-N	280 lb.	6.60 - 7.00
Rosin W. G.-W. W.	280 lb.	7.15 - 7.65
Wood rosin, bbl.	280 lb.	6.25 - . . .
Spirits of turpentine	gal.	.79½ - . . .
Wood turpentine, steam dist.	gal.	.77 - . . .
Wood turpentine, dest. dist.	gal.	.76 - . . .
Pine tar pitch, bbl.	200 lb.	. . . - 6.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	. . . - 11.00
Retort tar, bbl.	500 lb.	. . . - 11.00
Rosin oil, first run	gal.	.35 - . . .
Rosin oil, second run	gal.	.37 - . . .
Rosin oil, third run	gal.	.44 - . . .
Pine oil, steam dist., sp.gr. 0.930-0.940	gal.	\$1.90 - . . .
Pine oil, pure, dest. dist.	gal.	1.50 - . . .
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.	.46 - . . .
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.35 - . . .
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.	.75 - . . .
Pine tar, ref., thin, sp.gr. 1.080-1.960	gal.	.35 - . . .
Turpentine, crude, sp. gr., 0.900-0.970	gal.	1.25 - . . .
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.	.35 - . . .
Pinewood creosote, ref.	gal.	.52 - . . .

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	\$0.37 - . . .
70-72 deg., steel bbls. (85 lb.)	gal.	.35 - . . .
68-70 deg., steel bbls. (85 lb.)	gal.	.34 - . . .
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.23 - . . .

Crude Rubber

Para-Upriver fine	lb.	\$0.16 - .17
Upriver coarse	lb.	.09 - .09½
Upriver caucho ball	lb.	.11½ - .12
Plantation—First latex crepe	lb.	.14 - . . .
Ribbed smoked sheets	lb.	.12 - .12½
Brown crepe, thin, clean	lb.	.15 - . . .
Amber crepe No. 1	lb.	.17 - . . .

Oils

VEGETABLE

The following prices are f.o.b. New York for earload lots.

Castor oil, No. 3, in bbls.	lb.	\$0.09½ - \$0.09¾
Castor oil, AA, in bbls.	lb.	.10½ - .11½
China wood oil, in bbls. (f.o.b. Pac. coast)	lb.	.11½ - .12
Cocoonut oil, Ceylon grade, in bbls.	lb.	.10 - .10½
Cocoonut oil, Cochin grade, in bbls.	lb.	.10½ - .11½
Corn oil, crude, in bbls.	lb.	.08½ - .09
Cottonseed oil, crude (f. o. b. mill)	lb.	.08½ - .08¾
Cottonseed oil, summer yellow	lb.	.10½ - .10¾
Cottonseed oil, winter yellow	lb.	.11 - .11½
Linseed oil, raw, ear lots (domestic)	gal.	.73 - .74
Linseed oil, raw, tank cars (domestic)	gal.	.67 - .68
Linseed oil, in 5-bbl lots (domestic)	gal.	.76 - .77

Olive oil, Denatured.....	gal.	\$1.10	—	\$1.20
Palm, Lagos.....	lb.	.08	—	.08½
Palm, Niger.....	lb.	.06½	—	.06½
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.08½	—	.08½
Peanut oil, refined, in bbls.....	lb.	.10½	—	.10½
Rapeseed oil, refined in bbls.....	gal.	.86	—	.88
Rapeseed oil, blown, in bbls.....	gal.	.90	—	.92
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.08½	—	.08½
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.07½	—	.....

FISH

Light pressed menhaden.....	gal.	\$0.40	—	.....
Yellow bleached menhaden.....	gal.	.42	—	.....
White bleached menhaden.....	gal.	.44	—	.....
Blown menhaden.....	gal.	.48	—	.....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$24.00	—	30.00
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	22.00	—	26.00
Barytes, crude, 88% @ 94% ba., Kings Creek.....	net ton	10.00	—	12.00
Barytes, floated, f.o.b. St. Louis.....	net ton	23.00	—	24.00
Barytes, crude, first grade, Missouri.....	net ton	7.00	—	.....
Blanc fixe, dry.....	lb.	.04	—	.04½
Blanc fixe, pulp.....	net ton	45.00	—	55.00
Casein.....	lb.	.06	—	.07
Chalk, Precipitated, domestic, extra light.....	lb.	.04½	—	.05
Chalk, Precipitated, domestic, light.....	lb.	.04	—	.04½
Chalk, Precipitated, domestic, heavy.....	lb.	.03½	—	.04
Chalk, Precipitated, English, extra light.....	lb.	.04½	—	.05
Chalk, Precipitated, English, light.....	lb.	.04½	—	.05
Chalk, Precipitated, English, dense.....	lb.	.04	—	.04½
China clay (kaolin) crude, f.o.b. mines, Georgia.....	net ton	6.50	—	8.50
China clay (kaolin) washed, f.o.b. Georgia.....	net ton	9.00	—	10.00
China clay (kaolin) powdered, f.o.b. Georgia.....	net ton	13.00	—	20.00
China clay (kaolin) crude f.o.b. Virginia points.....	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points.....	net ton	13.00	—	20.00
China clay (kaolin), imported, lump.....	net ton	12.00	—	20.00
China clay (kaolin), imported, powdered.....	net ton	25.00	—	30.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	net ton	5.00	—	7.50
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27.00	—	30.00
Fullers earth, f.o.b. Mines.....	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Pa.....	net ton	15.00	—	16.00
Fullers earth, powdered, f.o.b. Fla.....	net ton	18.00	—	.....
Fullers earth, imported, powdered.....	net ton	24.00	—	27.00
Graphite, Ceylon lump, first quality.....	lb.	.06	—	.07
Graphite, Ceylon chip.....	lb.	.04½	—	.05
Graphite, high grade amorphous crude.....	lb.	.00½	—	.02½
Kieselguhr, f.o.b. mines, Cal.....	per ton	40.00	—	.....
Kieselguhr, f.o.b. N. Y.....	per ton	61.00	—	.....
Magnesite, calcined.....	per ton	66.00	—	70.00
Pumice stone, imported, lump.....	lb.	.03	—	.40
Pumice stone, domestic lump.....	lb.	.05	—	.05½
Pumice stone, ground.....	lb.	.06	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore.....	net ton	.....	—	10.00
Quartz (acid tower) 1½ @ 2 in., f.o.b. Baltimore.....	net ton	.....	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	.....	—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange fine.....	lb.	.50	—	.51
Shellac, orange superfine.....	lb.	.51	—	.52
Shellac, A. C. garnet.....	lb.	.44	—	.45
Shellac, T. N.....	lb.	.44	—	.45
Soapstone.....	ton	12.00	—	15.00
Sodium chloride.....	long ton	12.50	—	13.00
Talc, paper-making grades, f.o.b. Vermont.....	ton	11.00	—	18.00
Talc, roofing grades, f.o.b. Vermont.....	ton	8.50	—	13.00
Talc, rubber grades, f.o.b. Vermont.....	ton	11.00	—	18.00
Talc, powdered, Southern, f.o.b. ears.....	ton	7.50	—	11.00
Talc, imported.....	ton	30.00	—	40.00
Talc, California talcum powder grade.....	ton	8.00	—	25.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	per ton	\$50.00		
Carborundum refractory brick, 9-in. { less than earlot	1,000	1250.00		
..... { earload lots	1,000	1100.00		
Chrome brick, f.o.b. Eastern shipping points.....	net ton	52- 55		
Chrome cement, 40-45% Cr ₂ O ₃	net ton	30- 32		
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in ear lots, f.o.b. Eastern shipping points.....	net ton	33- 35		
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	35- 40		
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	30- 35		
Magnesite brick, 9-in. straight.....	net ton	65- 70		
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	77		
Magnesite brick, soaps and splits.....	net ton	98		
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	40- 42		
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	42- 45		
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	35- 38		

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00	—	\$225.00
Ferrochrome per lb. of Cr. contained, 6-8% carbon, earlots.....	lb.	.11	—	.....
Ferrochrome, per lb. of Cr. contained, 4-6% carbon, earlots.....	lb.	.11	—	.12
Ferromanganese, 76-80% Mn, domestic.....	gross ton	60.00	—	63.00
Ferromanganese, 76-80% Mn, English.....	gross ton	63.00	—	65.00
Spiegeleisen, 18-22% Mn.....	gross ton	25.00	—	27.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.25	—	.....
Ferrosilicon, 10-15%.....	gross ton	38.00	—	40.00
Ferrosilicon, 50%.....	gross ton	60.00	—	65.00
Ferrosilicon, 75%.....	gross ton	130.00	—	135.00
Ferrotungsten, 70-80%, per lb. of contained W.....	lb.	.40	—	.45
Ferrouanium, 35-50% of U, per lb. of U content.....	lb.	6.00	—	.....
Ferrovanadium, 30-40% per lb. of contained V.....	lb.	4.25	—	4.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content.....	net ton	\$8.00	—	\$10.00
Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃	ton	25.00	—	27.00
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard.....	ton	25.00	—	27.00
Coke, foundry, f.o.b. ovens.....	net ton	4.25	—	4.50
Coke, furnace, f.o.b. ovens.....	net ton	3.25	—	3.50
Coke, petroleum, refinery, Atlantic seaboard.....	net ton	12.00	—	13.00
Fluorspar, lump, f.o.b. mines, New Mexico.....	net ton	12.50	—	.....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	20.00	—	22.00
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01½	—	.01½
Manganese ore, 50% Mn, e.i.f. Atlantic seaport.....	unit	.20	—	.21
Manganese ore, chemical (MnO ₂).....	net ton	50.00	—	55.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.55	—	.60
Monazite, per unit of ThO ₂ , e.i.f. Atlantic seaport.....	unit	30.00	—	.....
Pyrites, Spanish, fines, e.i.f. Atlantic seaport.....	unit	12	—	.12
Pyrites, Spanish, furnace size, e.i.f. Atlantic seaport.....	unit	13	—	.13
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	11	—	.12
Rutile, 95% TiO ₂ per lb. ore.....	lb.	.15	—	.....
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	2.75	—	3.00
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	3.00	—	3.25
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	1.50	—	2.50
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.25	—	2.50
Vanadium pentoxide, 99%.....	lb.	12.00	—	14.00
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1.00	—	.....
Zircon, washed, iron free.....	lb.	.03	—	.....

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic.....	12 125
Aluminum, 98 to 99 per cent.....	24 5/8 @ 25
Antimony, wholesale lots, Chinese and Japanese.....	4 45 @ 4 50
Nickel, ordinary (ingot).....	41 00
Nickel, electrolytic.....	44 00
Monel me al. shot and blocks.....	35 00
Monel me al ingots.....	38 00
Monel metal, sheet bars.....	40 00
Tin, 5-ton lots, S rails.....	26 625
Lead, New York, spot.....	4 65
Lead, E. St. Louis, spot.....	4 45
Zinc, spot, New York.....	4 50 @ 4 55
Zinc, spot, E. St. Louis.....	4 17.

OTHER METALS

Silver (commercial).....	oz.	\$0.68½
Cadmium.....	lb.	1.00-1.25
Bismuth (500 lb. lots).....	lb.	1.50 @ 1.55
Cobalt.....	lb.	3.00 @ 3.25
Magnesium (f.o.b. Philadelphia).....	lb.	1.25
Platinum.....	oz.	72.00 @ 78.00
Iridium.....	oz.	160.00 @ 170.00
Palladium.....	oz.	52.00-55.00
Mercury.....	.75 lb.	39.00-41.00

FINISHED METAL PRODUCTS

Warehouse Price
Cents per Lb.

Copper sheets, hot rolled.....	19 50
Copper bottoms.....	27 00
Copper rods.....	18 00 @ 18 75
High brass wire.....	15 75
High brass rods.....	13 25
Low brass wire.....	17 25
Low brass rods.....	17 25
Brazed brass tubing.....	25 00
Brazed bronze tubing.....	29 75
Seamless copper tubing.....	19 50
Seamless high brass tubing.....	18.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current	Cleveland	Chicago
Copper, heavy and crucible.....	9.50 @ 10.00	9.25	9.50
Copper, heavy and wire.....	9.00 @ 9.25	8.50	8.50
Copper, light and bottoms.....	7.50 @ 8.00	7.50	7.25
Lead, heavy.....	3.25 @ 3.50	3.25	3.25
Lead, tea.....	2.25 @ 2.35	2.25	2.25
Brass, heavy.....	4.25 @ 4.50	1.50	5.00
Brass, light.....	3.25 @ 3.50	3.25	3.50
No. 1 yellow brass turnings.....	4.00 @ 4.25	4.25	4.50
Zinc.....	2.00 @ 2.25	2.00	2.25

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ½ in. and larger, and plates ½ in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes.....	\$2.88	\$2.88	\$2.88
8 ft steel bars.....	2.78	2.78	2.78
Soft steel bar shapes.....	2.78	2.78	2.78
Soft steel bands.....	3.42	3.48	3.48
Plates, ½ to 1 in. thick.....	2.88	2.80	2.80

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

California

RICHMOND—The Republic Steel Package Co., 7930 Jones Road, Cleveland, O., has plans nearing completion for the construction of its proposed new plant on property recently acquired at Richmond. A railroad line is being constructed to the site. The initial plant unit will be 1-story, 60 x 300 ft., and will be equipped to give employment to about 100 operatives. S. B. Merry is treasurer.

SAN FRANCISCO—The Western Pipe & Steel Co., 444 Market St., is planning for the early operation of its new works at South San Francisco, comprising the former plant of the Shaw-Batcher Shipbuilding Co. Remodeling work is under way and a number of extensions and improvements will be made, with the installation of equipment for the manufacture of steel pipe, tanks, well casings and kindred products. Employment will be given to about 500 men.

Illinois

HAMILTON—The Champion Coated Paper Co. is completing plans for the construction of a 4-story and basement plant addition on North B St., 35 x 185 ft., estimated to cost about \$50,000. Peter S. Thompson is president.

Kentucky

BOWLING GREEN—The Hillman Syndicate is perfecting plans for the erection of a new local oil refinery, estimated to cost in excess of \$150,000, including equipment.

BOWLING GREEN—E. J. Riggs and associates are organizing a new company to construct and operate an oil-refining plant on local site. The refinery will have an initial daily capacity of about 300 bbl. and is estimated to cost approximately \$125,000.

Maryland

BALTIMORE—The United States Industrial Chemical Co., Fairfield Road, has filed plans for the erection of a 1-story addition to its plant, 42 x 112 ft.

BALTIMORE—The Fleischmann Co., North Ave., will commence operations at once at its new local yeast-manufacturing plant, occupying a large site at Central Ave. and Bank St. The structure with machinery represents an investment of close to \$3,000,000, and forms the third plant of the company in this city.

BALTIMORE—The Cooknut Corp., Lexington and Paca Sts., has awarded a contract to the Charles L. Stockhausen Co., Inc., 33 South Gay St., for the erection of its proposed new plant on Canton St. for the manufacture of lard substitutes and kindred products. The works will consist of a main 4-story and basement factory, 88 x 100 ft., with 1-story extension, 50 x 56 ft. A 1-story machine shop 35 x 50 ft., will also be constructed. The buildings will be of reinforced concrete and are estimated to cost close to \$125,000. W. R. Sprull is president.

Massachusetts

WALTHAM—The Elastoid Fibre Co. has awarded a contract to the H. P. Cummings Cons. Co., Ware, Mass., for the construction of a new 1-story plant on Lexington St., 70 x 180 ft., to be equipped for the manufacture of fiber products.

Minnesota

PAYNESVILLE—The Farmers Mill Co., J. Z. Jerabek, secretary, has awarded a contract to the T. E. Ibberson Co., Corn Exchange Bldg., Minneapolis, Minn., for the erection of its proposed new flour mill. The structure is estimated to cost in excess of \$80,000.

Montana

BUTTE—The Cascade Silver Mines & Mills Co. is planning for the rebuilding of its concentrating plant at Neihart, Mont., recently destroyed by fire. The company will also build a new zinc-smelting plant in the same district.

Nebraska

OMAHA—Fire, Sept. 11, destroyed the plant of the Eckman Chemical Co., 16th St., with loss estimated at about \$60,000. The works will be rebuilt.

New Jersey

HOBOKEN—The White Metal Mfg. Co., Grand St. near Eleventh St., has completed plans and will soon call for bids for the erection of its proposed new plant on Grand St. It will comprise a main 6-story building, with 1-story structure adjoining, 58 x 65 ft., and 136 x 136 ft., to be used for general production. Joseph C. Schaeffer, 11 East Fifty-sixth St., New York, is architect.

BAYONNE—The Standard Oil Co., Twenty-second St., has filed plans for extensions in the tankage department at its local oil refinery to cost about \$115,000.

NEWARK—The Wallington Leather Co., 46 Kent St., has filed plans for the erection of a new 2-story leather-manufacturing plant, estimated to cost about \$22,000.

NEWARK—The Butterworth-Judson Corp., Doremus Ave., manufacturer of chemicals, dyes, etc., is arranging plans for reorganization. It is proposed to form a new company to take over the property and assets of the present corporation, and continue plant operations. The new organization will issue bonds for \$2,600,000, for general financing, operations, extensions, etc.

FLORENCE—The Florence Pipe Foundry is considering the erection of a new 1-story foundry for the manufacture of iron and steel castings. It will be about 40 x 100 ft. C. L. Reeves is superintendent.

MILFORD—The Warren Mfg. Co., manufacturer of paper, has placed all units of its local plant in operation, including three paper-manufacturing machines and subsidiary equipment. Tentative plans are under way for enlargements at the local mill, due to the permanent closing of the company's plant at Riegelsville, Pa. Equipment now at the latter plant will be removed to Milford, as well as certain machinery to the branch mills at Hughesville and Warren Glen.

New York

ENDICOTT—Walter D. Johnson, operating a local leather-manufacturing plant, has had plans prepared for the erection of a 2-story addition, 40 x 100 ft. Construction will be commenced at an early date.

BROOKLYN—Fire recently destroyed a portion of the plant of the Manhattan Shoe Polish Co., 49 Dean St., with loss estimated at about \$40,000.

Ohio

EMPIRE—The Miner Firebrick Co. has resumed operations at its local plant, following a curtailment for many months. The plant will give employment to about 75 operatives for an indefinite period.

REDFORD—Officials of the Owen Tire & Rubber Co. are considering a plan for reorganization of the company. Manton M. Scott has been appointed receiver. The company has assets said to total \$800,000 and liabilities of about \$200,000. Operations at the plant will be continued pending the proposed reorganization.

Pennsylvania

NICHOLSON—Fire, Sept. 9, destroyed the celluloid department and other sections of the plant of the Lackawanna Cutlery Co., with loss estimated at about \$75,000.

PHILADELPHIA—Fire, Sept. 14, destroyed a portion of the Point Breeze oil refinery of the Atlantic Refining Co., with loss estimated at about \$100,000, including oil stills, etc.

South Carolina

LAURENS—The Laurens Brick Co. is planning for the construction of an addition to its plant on the Little River, to increase the daily output from about 30,000 to 40,000 bricks. H. C. Fleming is treasurer and manager.

KNOXVILLE—The Knoxville Fertilizer Co. has plans under way for the erection of a new plant at Vestal, near Knoxville, for the manufacture of commercial fertilizer products. The plant will consist of two main 1-story buildings, 160 x 350 ft. and 100 x 300 ft., respectively, and is estimated to cost about \$300,000, including machinery. The initial works will have a daily output of close to 150 tons. James W. Dean is secretary and treasurer.

Texas

WACO—The Southwestern Portland Cement Co., El Paso, has acquired an extensive tract of property at Waco, comprising about 250 acres of land, and has preliminary plans under way for the erection of a new cement-manufacturing plant on a portion of the site. The initial works will cost about \$1,500,000, including equipment. Carl Leonhardt is president.

THREE RIVERS—The Three Rivers Glass Co., 605 National Bank of Commerce Bldg., San Antonio, is perfecting plans for the erection of its proposed new glass-manufacturing plant at Three Rivers. The company has obtained a site with available high-grade glass sand. The new plant is said to be estimated to cost in excess of \$100,000.

CISCO—The Cisco Clay & Coal Co. has commenced the erection of its proposed new brick-manufacturing plant, to specialize in the production of vitrified paving brick and kindred burned clay products. The plant will have an initial minimum capacity of about 50,000 bricks per day, and is estimated to cost about \$200,000, including equipment. C. B. Bush is president.

DESDEMONA—The Magnolia Petroleum Co. has construction under way on a new casing-head gasoline plant, with initial capacity of about 3,000 gal.

West Virginia

MORGANTOWN—The Star Glass Co. is completing plans for the rebuilding of its local glass-manufacturing plant, recently destroyed by fire. The new works will consist of a main 1-story building, 145 x 500 ft., and two adjoining structures each 50 x 150 ft. A cooper shop and box factory will also be erected, as well as machine shop and other mechanical buildings for general operating and repair service. The new plant is estimated to cost about \$225,000, with machinery. Louis Kauffeld is general manager.

Wisconsin

PORT EDWARDS—The Nekeosa-Edwards Paper Co. is planning for the rebuilding of the portion of its plant, destroyed by fire, Sept. 2.

MILWAUKEE—The Red Star Yeast & Products Co., 79 Buffalo St., will soon commence the erection of a 1-story addition to its plant, 50 x 100 ft., on Twenty-seventh St., estimated to cost about \$15,000.

Wyoming

CASPER—Effective Oct. 1, the Standard Oil Co. of Indiana, Indianapolis, will take over and operate the oil-refining plants of the Midwest Refining Co. at Casper, Graybull and Laramie, Wyo. General expansion in operations is planned. The Midwest company will continue as a producer of crude oil and will operate in the different Wyoming fields.

Ontario

TORONTO—The National Potash Corp., Gravenhurst, Ont., has construction under way on a new plant for the manufacture of glass products. It is expected to have the works ready for service at an early date, with facilities to produce a general line of ware.

TORONTO—The Follansbee Bros. Co., Pittsborough, Pa., is planning for operations at its new local steel plant, now in course of construction, early in October. The plant is being rushed to completion, with double working crews.

Nova Scotia

HALIFAX—Fire, Sept. 12, destroyed a portion of the refining plant of the Imperial Oil Co., at Dartmouth, near Halifax. It will be rebuilt.

Capital Increases, Etc.

THE HIGH FALLS PULP & PAPER Co., High Falls, N. Y., has filed notice of increase in capital from \$150,000 to \$600,000.

THE CORNING FOUNDRY Co., Corning, N. Y., manufacturer of iron and steel castings, etc., has filed notice of dissolution under state laws.

THE INDEPENDENT STARCH Co., 204 Franklin St., New York, N. Y., has filed notice of increase in capital from \$30,000 to \$100,000.

CLARK M. WHITEMORE and EDMUND B. CLARY, Linden, N. J., have been appointed receivers for the Trans-Atlantic Chemical Co., operating a large local plant for the manufacture of chemicals, dyestuffs, etc. The application for receivership was made by William M. Stevenson, secretary of the company.

THE CONSUMERS' VEGETABLE GLUE Co., a Delaware corporation, has filed notice of organization to operate in Indiana for the manufacture of glues, pastes, etc. F. B. Shields, Indianapolis, represents the company.

THE LAKE CHAMPLAIN PULP & PAPER Co., Plattsburg, N. Y., has filed notice of dissolution under state laws.

THE MITCHELL LIME Co., Mitchell, Ind., has filed notice of change of name to the Lehigh Lime Co.

THE THOMPSON-CASE OIL & RUBBER Co., Chattanooga, Tenn., has filed notice of increase in capital from \$15,000 to \$50,000. The company formerly was known as the Thompson-Case Rubber Co.

THE UNITED STATES CHINA Co., Chester-ton, Ind., manufacturer of chinaware, has filed notice of increase in capital from \$200,000 to \$875,000, at the same time changing its name to the American China Products Co.

THE SOUTHERN GYPSUM Co., North Holston, Va., manufacturer of gypsum products, has filed notice of increase in capital from \$500,000 to \$750,000.

THE CORTLAND TIRE & RUBBER Co., Cortland St., Belleville, N. J., has filed notice of dissolution under state laws.

New Companies

THE AMERICAN OXYGEN CORP., Boston, Mass., has been incorporated with a capital of \$100,000, to manufacture commercial oxygen and affiliated products. Charles E. Donlan is president; Clinton B. Sherwood, Swampscott, Mass., is treasurer.

THE DRY PAINT CORP., Detroit, Mich., has been incorporated with a capital of \$10,000, to manufacture paints, varnishes, etc. The incorporators are George A. Smith, Lowry C. M. Conley and Andrew B. Couchman, 1529 Glendale St.

THE OIL REDUCTION Co., Hudson, N. Y., has been incorporated with a capital of \$300,000 under Delaware laws, to manufacture refined oil products. The incorporators are Riland S. Eagles, Hudson; Eugene F. Dumennil and Walter S. Griffin. The company is represented by the Delaware Registration Trust Co., 900 Market St., Wilmington, Del.

THE FERMANOS CHEMICAL Co., Brooklyn, N. Y., has been incorporated with a capital of \$10,000, to manufacture chemicals and chemical byproducts. The incorporators are B. Barbera and F. Maggio. The company is represented by Giaccone & Richard, 154 Wilson Ave., Brooklyn.

THE CHATTANOOGA MIRROR PLATE Co., Chattanooga, Tenn., has been incorporated with a capital of \$20,000, to manufacture mirrors and other glass products. The incorporators are F. R. Hymes and Spaulding Hoffman, Chattanooga.

THE ILLINOIS-ARKANSAS OIL Co., Havana, Ill., has been incorporated with a capital of \$45,000, to manufacture petroleum products. The incorporators are E. J. List, H. A. Starkweather and Carl H. Hillemeier, 121 South Orange St., Havana.

THE PEP GLAND Co., Jersey City, N. J., has been organized to manufacture chemicals and chemical byproducts. The company is headed by J. R. and B. F. Cortese, and P. G. Flint, 5 Montgomery St.

THE JOHN E. DANIELS LEATHER Co., Boston, Mass., has been incorporated with a capital of \$20,000, to manufacture leather products. John E. Daniels, 69 Kenwood St., Brookline, Mass., is president and treasurer.

THE ZOCH-BARNES PETROLEUM CORP., Wilmington, Del., has been incorporated with a capital of \$5,000,000, to manufacture refined oil products. The company is

represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington.

THE HOBOKEN RUBBER Co., 54 Fourteenth St., Hoboken, N. J., has filed notice of organization to manufacture rubber products. The company is headed by Frank J. Doran, 1221 Washington St.

THE ARNOLD CHEMICAL Co., Boston, Mass., has filed notice of organization to manufacture chemical products. The company is headed by A. S. Brodie, 120 Milk St.

THE ROCHELL PRODUCTS Co., Philadelphia, Pa., has been incorporated under Delaware laws with a capital of \$100,000, to manufacture chemicals and chemical byproducts. The incorporators are Harry Rochell, William J. Dougherty and Martin J. Lyons. The company is represented by Philip L. Garrett, Equitable Building, Wilmington, Del.

THE INTERSTATE PETROLEUM PRODUCTS Co., Fort Wayne, Ind., has been incorporated with a capital of \$100,000, to manufacture refined oil products. The incorporators are J. F. Blippus, Frank Martin and Milton Matter, Fort Wayne.

THE ROXBURY STEEL CASTING Co., Boston, Mass., has been incorporated with a capital of \$50,000, to manufacture steel and other metal castings. Isaac E. Sexton is president; Perley C. Rogers, Quincy, Mass., is treasurer.

THE PHOENIX BELTING & OIL Co., 198 Pacific St., Newark, N. J., has been incorporated with a capital of \$100,000, to manufacture oils, greases, leather belting, etc. The incorporators are Benjamin, Matthew M., and Leon Gallop, address noted.

THE SANITARY BOTTLE MFG. Co., West Pittston, Pa., has been incorporated with a capital of \$200,000 under Delaware laws, to manufacture bottles and other glass containers. The incorporators are L. O. Culver, West Pittston; George W. Culver, Forty-Fort, Pa.; and D. O. Coughlin, Luzerne, Pa. The company is represented by the Capital Trust Co., Dover, Del.

THE SETH LEE FIREBRICK Co., Boston, Mass., has been incorporated with a capital of \$300,000, to manufacture firebrick and other refractory products. Thomas W. Pelham is president; Martin J. Lee, vice-president; and Seth Lee, 100 Carver St., Newton Highlands, Mass., treasurer.

THE ABBOTT-CADE ENAMELING Co., Dallas, Tex., has been incorporated with a capital of \$10,000, to manufacture enameled products. The incorporators are N. F. Wertheimer, H. L. Bromberg and C. S. Reynolds, Dallas.

THE RIVERSIDE BRICK & TILE Co., Knoxville, Tenn., has been incorporated with a capital of \$40,000, to manufacture brick, tile and other burned clay products. The incorporators are R. P. Black, J. W. Dooley and B. C. Ogle, Knoxville.

THE WAUKEGAN FOUNDRY Co., Waukegan, Ill., has been incorporated with a capital of \$60,000, to manufacture iron, steel and other metal castings. The incorporators are Andrew K. Barr, Elmer T. Kidmore and Elmer Olavey. The company is represented by Benjamin Farmalee, Waukegan.

THE EL DORADO REFINING Co., New York, N. Y., has been incorporated with a capital of \$500,000 under Delaware laws, to manufacture refined oil products, with plant in the vicinity of Texarkana, Tex. The incorporators are G. W. and L. A. Merrill, Texarkana; and L. F. Severson, Tulsa, Okla. The company is represented by the United States Corporation Co., 65 Cedar St., New York.

THE KRANISH CHEMICAL Co., Brooklyn, N. Y., has been incorporated with a capital of \$20,000, to manufacture chemicals and chemical byproducts. The incorporators are A. and H. Kranish, and J. G. Turnbull, 27 Cedar St., New York.

THE TRAVERTINE PRODUCTS CORP., Livingston, Mont., has been incorporated with a capital of \$500,000, to manufacture cement, lime and kindred products. The incorporators are C. T. Sackett and L. R. Nye, Livingston.

THE INDUSTRIAL SUPPLY Co., New Haven, Conn., has been incorporated with a capital of \$10,000, to manufacture chemicals, polishing materials, etc. The incorporators are James F. and M. Toole, 144 Townsend St., New Haven.

THE KAOLIN PRODUCTS CORP., Los Angeles, Cal., has been incorporated with a capital of \$500,000, to produce kaolin, clays and kindred products. The incorporators are G. A. Elcheberger, M. L. Gilmore and H. P. Goodwin, 232 Title Insurance Bldg., Los Angeles.

THE VANO PRODUCTS Co., New York, N.

Y., has been incorporated with a capital of \$10,000, to manufacture chemical compounds and affiliated products. The incorporators are F. A. Nelson, I. Price and J. Weiner. The company is represented by Price Bros., 261 Broadway.

THE MOUNTAIN CITY CHEMICAL Co., Fairmont, W. Va., has been incorporated with a capital of \$100,000, to manufacture chemicals and chemical byproducts. The incorporators are R. P. and C. E. Hutchinson, and J. V. Abbott, Fairmont.

THE OLYMPIC OIL CORP., Tralee, W. Va., has been incorporated with a capital of \$100,000, to manufacture petroleum products. The incorporators are J. C. Sullivan and J. F. Korner, Tralee.

THE INDIANAPOLIS MOLDED RUBBER PRODUCTS Co., Indianapolis, Ind., has been incorporated with a capital of \$100,000, to manufacture rubber products and composition specialties. The incorporators are F. L. Tompkins and T. S. Stewart, Indianapolis.

THE OREGON CHARCOAL IRON Co., Portland, Ore., has been incorporated with a capital of \$500,000, to operate a smelting plant. The company is headed by J. H. Kelly, 1524 Yeon Bldg., Portland.

THE HAMMOND GREASE & OIL Co., Hammond, Ind., has been incorporated with a capital of \$15,000, to manufacture greases, lubricating oils, etc. The incorporators are M. M. Dermody, O. B. Loyd and W. H. Breckenridge, Hammond. The last two noted incorporators have also organized the Lloyd-Breckenridge Grease Co., Hammond, to manufacture greases, soaps, oils, etc.

THE MAXWELL PAINT Co., Philadelphia, Pa., is being organized by H. C. Middleton, Roy M. Boyd and William A. Stuetz, to manufacture paints, varnish, sizing and kindred products. J. Claude Bedford, Liberty Bldg., represents the company. Application for a state charter will be made on Oct. 3.

THE ALABAMA LIME Co., Chattanooga, Tenn., has been incorporated with a capital of \$10,000, to manufacture lime products. The incorporators are A. C. Noone, Horace Hamby and C. N. Miles, Chattanooga.

Industrial Notes

SIECK & DRUCKER, Inc., mechanical and chemical engineer, Chicago, Ill., announces it has associated with itself Herbert Sieck, formerly in charge of operations of the Chicago properties of the American Cocoa-nut Butter Co.

THOS. FIRTH & SONS, LTD., Sheffield, England, has terminated its agency arrangement for the sale of sheet steel heretofore existing between it and Wheelock Lovejoy & Co., of New York and Cambridge, and has appointed Horace G. Hides as general sales manager for the United States. This company and the Firth-Sterling Steel Co., an associate company of New York, have opened a joint office in Hartford, Conn., where Mr. Hides will have his headquarters for the former company and Henry I. Moore will represent the latter company. The stock of the Firth Sheffield sheets will be carried in the warehouse of the Firth-Sterling Steel Co., New York City.

GEORGE C. D. LENTH has been appointed secretary of the Clay Products Association, with offices in Chicago, to succeed the late George H. Tefft. Mr. Lenth is a graduate of the Massachusetts Institute of Technology and has for some time been chief engineer of sewers of the City of Chicago. He will follow out one of the chief lines of endeavor of this society at the present time—namely, the promotion of vitrified and salt glazed sanitary sewer pipe to resist chemical action of sewage.

STUART CROASDALE & Co. announce the removal of Pittsburgh offices from the Magee Bldg. to 946 Union Arcade Bldg.

THE LINK-BELT Co., Chicago, announces a practically uniform reduction of 10 per cent on malleable iron and steel (SS Class) chains, sprockets, buckets and other products, effective at once.

THE GENERAL ALLOYS Co., New York and Chicago, announces a new heat-resisting alloy, under the trade name of X-ite. It is the fourth standard material to be sold by this company under the Q alloy trade name.

THE TEXAS GULF SULPHUR Co. announces the removal of its offices to larger quarters in the Liggett Bldg., at 41 East 42nd St., New York.

E. I. DU PONT DE NEMOURS & Co., Wilmington, Del., announce that Cesare Protto has been appointed assistant director of the sales division of the dyestuffs department in place of E. V. Patterson, who has re-

signed. Robert S. Lunt has been appointed manager of the Boston office of the dye-stuffs sales division, with Charles H. Scott as assistant manager.

DWIGHT P. ROBINSON Co., INC., New York, has published a chart showing the range of index numbers of wholesale prices by groups of commodities by months, 1913-1921.

ROGERS, BROWN & Co., Cincinnati, Ohio, have been appointed sole agents in the United States for the sale of Virgin aluminum, of various grades, produced by the Norsk Aluminum Co. of Christiania, Norway. Stocks of aluminum will be carried at the New York City and Cleveland, Ohio, offices of the company.

THE CUTLER-HAMMER MFG. Co., Milwaukee, Wis., has moved its Cincinnati office from the Gwynne Bldg. to the Dixie Terminal Bldg. A. R. Maujer, formerly of the sales-engineering force of the Pittsburgh office, is now in charge of the Cincinnati office.

THE CHICAGO FLEXIBLE SHAFT Co. has placed Ralph C. Schwarz in charge of the northwestern New York territory for the distribution and sale of Stewart industrial furnaces and appliances. Mr. Schwarz's address will be 921 Granite Bldg., Rochester, N. Y.

FORD, BACON & DAVIS, New York, have opened an office in Philadelphia at 1421 Chestnut St. This engineering firm has the following departments, which are adapted to meet present economic conditions: Engineering, report, valuation, accounting, construction, management and financing.

THE SOCIÉTÉ ANONYME DES USINES GIULINI, Basel, Switzerland, manufacturer of Virgin aluminum ingots, notched bars, bars, plates and sheets, has appointed C. W. Leavitt & Co. sole selling agents for the United States and Canada.

THE M. H. DETRICK Co., Chicago, maker of Detrick arches and Detrick-Hagan steam jet ash conveyors, announces the appointment of H. W. Thompson, 503 Mining Exchange Bldg., Denver, Col., as sales representative in that territory.

THE W. A. JONES FOUNDRY & MACHINE Co., Chicago, has elected T. A. Jones president, to take the place of William A. Jones, deceased. Mr. Jones has been for many years associated with the company as secretary and treasurer and is largely responsible for its firm position. Other officers elected are: W. G. Jones, vice-president and treasurer; J. A. Sizer, secretary; G. W. Page, assistant secretary. The general policy of the company is in no way altered by these changes and W. G. Jones continues as general manager in addition to his new position as vice-president and treasurer. This company also announces the appointment of Robert B. Moir as manager of its New York branch.

THE RADIUM LUMINOUS MATERIAL CORP. at a recent meeting of the board of directors decided to change its name to the United States Radium Corp. The control and management of the corporation remain unchanged.

BANKS & CRAIG, engineers and chemists, have moved to new quarters at 51 East 42nd St., New York City.

THE TECHNICAL CREDIT ASSOCIATION, 2 Rector St., New York City, announces that it is organized to make investigations including: Geological, chemical, mining, metallurgical, electrical, with expert sampling and accounting, efficiency engineering and appraisal of raw material resources and supplies, equipment, processes and management of properties and operations, for the purpose of sustaining or establishing credit.

HUNGERFORD & TERRY, Philadelphia, Pa., have appointed the Hurricane Engineering Co., 53 State St., Boston, Mass., selling agents for its apparatus in the New England territory. The managing director of the Hurricane Engineering Co. is E. L. Smith, for years the New England representative of the Philadelphia Drying Machine Co. The entire line of water filters, water softeners, iron removal plants, hypochlorite feeds and other feeding devices manufactured by Hungerford & Terry, Inc., will be handled by the Hurricane Engineering Co.

F. J. RYAN & Co., Philadelphia, Pa., announce the establishment of three additional agencies. They are as follows: Detroit, under the direction of David P. Harr, 423 Depot St., Latrobe, Pa., who will also cover the Cleveland and Toledo districts; Chicago, under the direction of the Singer Kennedy Construction Co., 39 W. Adams St., Chicago, Ill., who will cover the Middle West; L. H. Chamberlain, 72 New Montgomery Ave., San Francisco, Cal., will cover the Pacific Coast. F. J. Ryan & Co. have

recently moved their general offices and sales from the Franklin Trust Bldg. to larger quarters in the Wesley Bldg., 17th St. and the Parkway, Philadelphia, Pa. The removal is also announced of the engineering departments to Lancaster, where they will be established in the headquarters of the Lancaster Iron Works, with which F. J. Ryan & Co. became associated in the early part of the present year.

J. SCHANZENBACH & Co. has been organized by former department heads of the old house of Laidlaw-Kelly & Co., and is organized to engage in handling chemicals, oils, waxes, dyestuffs, etc. The company's office is 74 Cortlandt St., New York City.

L. R. CHRISTIE Co., engineer, Pittsburgh, Pa., specializing in the design of drying machinery, has granted the Duff Patents Co. of Pittsburgh sole license and rights to manufacture driers of the Christie patents and design.

New Publications

BOOKS

THE MINERAL INDUSTRY OF THE BRITISH EMPIRE AND FOREIGN COUNTRIES. Statistical Summary (Production, Imports and Exports), 1913-1920. 104 pages. London: Printed by H. M. Stationary Office, 1921. Price 3s. 0d. net.

This title sufficiently describes the scope of the book which is planned to be the first of series of annual volumes. It consists of tabular matter exclusively, with no textual comment, but covers the war years fully, 1919 completely, and 1920 in part. Particularly valuable will be the figures for the mineral production of the enemy countries. Not only are minerals, such as chromite, asbestos and gypsum, included, but metals, such as copper, ferromanganese, silver, etc.

WATER POWERS OF GEORGIA, THIRD REPORT. By B. M. Hall and M. R. Hall. Pp. 316, illustrated. Atlanta, Ga.: Geological Survey of Georgia, 1921.

USEFUL INFORMATION FOR COTTON MANUFACTURERS, VOL. IV, AIR CONDITIONING, second edition. Compiled and issued by Stuart W. Cramer, Charlotte, N. C.

A study of air-conditioning problems as related to textile mills, with a description of the Cramer system of air conditioning.

CONCENTRATION BY FLOTATION. Compiled and edited by T. A. Rickard. Pp. 692, illustrated. New York: John Wiley & Sons, Inc., 1921. Price, \$7.

Forty articles dealing with all phases of the flotation process which appeared in the *Mining and Scientific Press* during the years 1915 to 1920 have been brought together in book form by the editor. This compilation will thus serve as a convenient compendium of the principal literature on the technology of flotation.

COLORIMETRIC ANALYSIS. By F. D. Snell. Pp. 150; illustrated. New York: D. Van Nostrand Co., 1921. Price, \$2.

This book is an attempt to combine in one volume for ready reference all the colorimetric tests which experience has shown to be at all practical. These have been grouped under the heads: Iron; copper; carbon in steel; lead, bismuth and arsenic; aluminum and chromium; nickel, cobalt, manganese and zinc; potassium and magnesium; gold; titanium, vanadium and tungsten; fluorine, chlorine and perchlorates; nitric and nitrous acids, ammonia; phosphorus, silica and boron; oxygen and hydrogen peroxide; sulphur, hydrogen sulphide and selenious acid; salicylic acid and cyanides; water, oils and dyes. Chapters on conditions of use of colorimetric methods, colorimetric apparatus and its use, and nephelometry are also included.

ELEMENTARY QUANTITATIVE ANALYSIS OF THE METALS AND ACID RADICALS. By Frederick G. Reeve, E.E., acting head of the department of physics and chemistry at the East Side High School, Newark, N. J. Pp. 143. New York: D. Van Nostrand, 1921. Price, \$1.50.

An elementary laboratory manual.

THE ENGINEERING INDEX, 1920. Pp. 586. New York: The American Society of Mechanical Engineers, 1921. Price, \$6.

Nearly 14,000 items referring to articles in 700 engineering and allied technical publications will be found in this index. The alphabetical arrangement which proved to be so convenient and satisfactory in the 1919 volume has been retained. Each item contains the exact title of the article indexed; the author's name, if given; the name of the publication; the volume, number and date; the page numbers and number of figures. It also includes a brief note summarizing the article indexed.

Manufacturers' Catalogs

ALLIS-CHALMERS MFG. Co., Milwaukee, Wis., calls attention to bulletin 1118, descriptive of its new line of continuous rated polyphase induction motors, covering the type "AR" squirrel cage line, and type "R" potential starter; Leaflet 1459 entitled "Fullers Earth," which relates to rotary kilns for reclaiming this product, and Bulletin 1106 A, on "Type 'E' Direct-Current Motors and Generators."

W. S. ROCKWELL Co., New York, has issued a very interesting and instructive pamphlet on Furnace Design. It contains 13 pages of outline drawings showing the essential parts of over 250 different styles of heating and heat-treating and melting furnaces and muffles, both manual and automatic, intermittent and continuous, regenerative and otherwise. The pamphlet closes with a drawing showing about three dozen arrangements of furnace chambers and working openings to which nearly all of the types illustrated could be adopted. This company also announces that a general misunderstanding of principles governing the selection of fuel and equipment for industrial heating operations has led it to issue a pamphlet which contains a series of papers relating to the selection and use of fuels and equipment for industrial heating operations.

THE PENNSYLVANIA TANK LINE, Sharon, Pa., calls attention to its attractive catalog entitled "The Tank Car." All of the latest special rulings, traffic regulations and repair charges as fixed by the American Railway Association have been included in this catalog. It also shows in detail the numerous accounting forms, technical engineering charts and half-tone reproductions of this company's construction.

THE ANTI-HYDRO WATERPROOFING Co., Newark, N. J., has issued a leaflet on "Anti-Hydro," which hardens and waterproofs concrete.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its seventy-fourth meeting at Toronto, Canada, Dec. 27 to 31, 1921.

AMERICAN CERAMIC SOCIETY will hold its twenty-first annual meeting at St. Louis, Feb. 27 to March 2, 1922.

AMERICAN GAS ASSOCIATION will hold its third annual convention in the Congress and Auditorium Hotels, Chicago, the week of Nov. 7. More than 100 manufacturers will exhibit their latest gas-burning appliances.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting at Lake Placid, N. Y., Sept. 29 and 30, and Oct. 1.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its annual winter meeting at Baltimore, Md., Dec. 6 to 9. Headquarters will be at the Southern Hotel and the sessions will be held in the Engineers' Club.

AMERICAN MINING CONGRESS AND NATIONAL EXPOSITION OF MINES AND MINING EQUIPMENT will hold its twenty-fourth annual convention in the Coliseum, Chicago, Oct. 17 to 22.

INDUSTRIAL COST ASSOCIATION will hold its second national conference at Pittsburgh, Pa., Nov. 2-4, with headquarters at the William Penn Hotel.

INDUSTRIAL RELATIONS ASSOCIATION OF AMERICA will hold its annual convention at the Waldorf-Astoria, New York, Nov. 1-5.

NATIONAL SAFETY COUNCIL is holding its tenth annual conference at the State House, Boston, Mass., Sept. 26 to 30.

NEW JERSEY CHEMICAL SOCIETY has discontinued meetings for the summer and will resume them in October.

SOCIETY OF INDUSTRIAL ENGINEERS will hold its fall meeting at Springfield, Mass., Oct. 5 to 7.

The following meetings are scheduled to be held in Rumford Hall, the Chemists' Club, New York: Oct. 7—American Chemical Society, regular meeting; Oct. 14—Société de Chimie Industrielle, regular meeting; Oct. 21—Society of Chemical Industry, Grasselli Medal; Nov. 11—American Chemical Society (In charge), Society of Chemical Industry, American Electrochemical Society, Société de Chimie Industrielle, joint meeting; Nov. 18—American Electrochemical Society, regular meeting; Dec. 2—Society of Chemical Industry, regular meeting; Dec. 9—American Chemical Society, regular meeting.

CHEMICAL & METALLURGICAL ENGINEERING

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Consulting Editor

ERNEST E. THUM
Associate Editor

SIDNEY D. KIRKPATRICK
Assistant Editor

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY and IRON & STEEL MAGAZINE

ALAN G. WIKOFF
R. S. McBRIDE
CHARLES N. HULBERT
Assistant Editors
CHESTER H. JONES
Industrial Editor
J. S. NEGRO
Managing Editor

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Conferences and Publicity On Unemployment

HOOPER'S bent for organization was in evidence when the unemployment conference gathered, setting a mark which the meeting on disarmament will find difficulty in hitting. The invited conferees found the mechanical details had been well arranged; adequate rooms, stenographic and clerical service were in waiting. Not only that, but a tentative plan of organization and procedure had been prepared, a plan which was under discussion by a special committee within an hour after President HARDING had delivered his opening address. By 3 o'clock the committee's report had been considered, the main body had resolved itself into smaller units and each was working on some phase of the unemployment situation, using as raw material a mass of facts, records and statistics gathered during the preceding weeks by qualified investigators.

With such a flying start, an emergency program was reported on October 1, five days ahead of the tentative schedule, and final meeting of the general conference will occur on October 10, when a permanent program will be considered.

New and brilliant ideas can scarcely be expected from this meeting—no panacea short of a millennium will cure the various ills afflicting the nations of this earth. But even the emergency program should result in vigorous and widespread propaganda, calling on every one to aid according to his circumstances and ability. Construction by governments and municipalities can be broadened by each establishment and even each property owner going ahead with needed repairs and renewals. A tremendous amount of unemployment will disappear when adequate steps to relieve the housing shortage are taken. Furthermore, if manufacturers, all manner of middlemen and retailers would think more on production and distribution with the greatest expedition and minimum waste rather than with the greatest profit, reasonable prices to the ultimate consumer would again obtain, and the buyers' strike vanish into thin air.

Exorcising profiteers with the fair name of patriotism is a waste of breath. Adequate publicity on unemployment, however, will stress the fact, and perhaps blast its way into consciousness, that "bare shelves" in Germany cannot be filled by us as long as marks are not worth a cent; that times will therefore be good in the United States only if domestic trade is thriving; that "unsatisfied consumer demand" in America has less and less chance of becoming satisfied as long as unemployment and low prices on raw materials, coupled with high retail prices, combine to prevent purchases by the men and women who must work for their living. If foreigners cannot buy, we must depend on our neighbors. But if the farmer gets next to nothing for his hides, and the longshoreman has no work, how can either of them buy \$10 shoes?

Anent Peace With Germany

ON THE DAY the treaty of peace was signed between the United States and Germany they had a great meeting in Berlin. Thirty thousand persons participated, and their leaders were Prince EITEL FRITZ and General LUDENDORFF. The old regiments paraded and fair daughters of the Empire strewed flowers before them. The bands played "Die Wacht am Rhein." "Undefeated in the Field" was the slogan that floated over the stadium. "With proud gratitude," wrote the old Kaiser from Holland, "I think today of my brave comrades, never vanquished in the field," etc. We suppose he referred to those that did not run away as he did. What he said about the beacon for victorious illumination in the dark future was not very important, because whatever he says is not important. But the threat of his presence as a symbol is not to be despised. Count VON WALDERSEE said, "There will come again a day when we will stand together for Kaiser and for Fatherland. Hatred will stand guard in Germany. We must train our children to use the rifle and the sword." And he urged them to prepare for revenge, revenge for their present impotence.

Well, what is to be done about it? It behooves us to keep our tempers and think before we act. Fulminations at a mass meeting are not final and binding. We might hear a lot of dicta that we should hate to publish as public opinion by listening to soap-box orators, almost any evening, on the streets of New York or, for that matter, published in current journals.

We have always felt that it was a great error not to lick the Germans a little harder than we did—until they knew that they were licked. With two weeks more of chasing they would have been Kamarading it all over Europe wherever they could make themselves heard. They might have brought influence to bear on these orators of the other day to be more modest in their expressions. If we are to trade with Germany as a friendly nation, we want to know it. If we are to trade with a race of people who are resolved to destroy us for their own infamous aims of the past, it is well that we should know that too.

It is not fair to indict a whole people for what their rulers do. But if they persevere in selecting rulers who lead them astray they must take the consequences of going astray. Our business is to wait and observe. If they cannot govern themselves and if they establish a war-lord king again, then the less we have to do with them in the way of commitments and obligations the better it will be for us. It would be a great mistake to tie ourselves up with German industries once more so that we cannot get along without them. The wise course will be to keep other markets open and reasonably active, no matter what they offer and to make ourselves as self-sufficient and independent as humanly possible.

When Is a Research A Mere Inquiry?

ARE we not, many of us, often guilty of loose talking when we talk about research?—guilty of calling researches things which are often nothing more than systematic tests? A real researcher is as jealous of his proud calling as an engineer, and, like the latter, must rebel at times against the lack of precision which associates several different branches of human endeavor with his calling.

These thoughts were called to mind at a session on Research at the recent meeting of the American Society for Steel Treating, addressed by no less personages than E. P. HYDE, Director of Research at Nela Park; COMFORT A. ADAMS and H. E. HOWE, of the National Research Council; A. E. WHITE, Director of Engineering Research, University of Michigan; and GEORGE K. BURGESS, of the Bureau of Standards. Dr. HYDE opened the way to a blanket discussion by presenting and elaborating the following interesting outline:

RESEARCH

(A) SCIENTIFIC

(a) *Pure Scientific Research*

- (1) Frontier research. (Best performed at universities and privately endowed laboratories.)
- (2) Intensive and co-operative research. (Best performed by governmental, endowed or corporation laboratories.)

(b) *Applied Scientific Research*

- (3) Industrial research. (Best performed in corporation and private laboratories.)

(B) ENGINEERING

- (4) Engineering research. (Best performed by the government, corporations, technical school and private laboratories.)
- (5) Engineering practice. (Best performed in corporation and private consulting laboratories.)

These five classes cover a wide range. Even though dictionary definitions may be discovered that show "research" to include them all, we protest that it is too much. Item No. 1 doubtless is RESEARCH, resulting in the discovery of a new and unknown fact. No. 2 takes this fact and proceeds to an EXAMINATION of it from all angles. No. 3 devises APPLICATION of the new truth to human comfort; No. 4 is often nothing more than TESTING of materials, and the last is usually mere EXPERIMENTATION.

Research is often, and with reason, likened to a *voyage of discovery*, out into the unknown country. Land once discovered, then comes the task of *map making*, followed by necessary *road building*. Next comes an era when the *fields are cultivated* or other natural resources exploited, and lastly, when the land has been well settled, comes the necessity for *crop rotation* and fertilization. These phases in the development of a new land roughly correspond to the five classes of "research" listed by Dr. HYDE; and we submit that it is a far cry from the trackless forest to the truck garden.

Or, drawing another rough parallel between the kind of men who do the investigative work and the men who develop a country, first we have the EXPLORERS who push out into the jungle; then come the PIONEERS entering the wilds. After them follow CAPITALISTS building up industries demanding the services of ARTISANS, and finally are acquired PRODUCTION ENGINEERS! Even allowing for a certain freedom in this characterization, surely there are profound differences in the mental and spiritual equipment of these five classes of men.

So, we repeat, let us be a little more careful in our use of terms. We instinctively place the title "sales

metallurgist" in the Index Expurgatorius. Let us be as circumspect in calling a research a few experiments yielding a few approximations of certain physical properties of something or other. The work may unquestionably be worth while; but it is not research, nor is it done by a researcher.

Student Chapters

For the A.I.C.E.

ONE of the questions awaiting final decision by the American Institute of Chemical Engineers at its coming meeting in Baltimore is the proposal to establish student chapters of the Institute. At Detroit, last June, the matter was reported favorably to the council, but the amendment to the constitution, in its final form, is yet to be approved. In taking this step the Institute is following the example set by several of the other engineering societies. The American Society of Mechanical Engineers now has fifty-eight student branches representing institutions located in thirty-one different states. The American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Institute of Electrical Engineers and the American Ceramic Society have provided for affiliated student societies, and it would appear that these branches have been mutually beneficial—both to the students themselves and to the members of the parent societies.

Probably the most obvious advantages are to the student. Contact with the professional organization stimulates the student's interest in his chosen field. The privilege of attending the society meetings brings with it the opportunity for social intercourse with the older members and the benefit of their advice and council. The meetings of the student chapters also develop the student's ability to present technical papers before an audience—and it is evident that many of the more seasoned engineers show the need for such practice. And finally, in the case of some of the societies, the student is given the expectation of some day becoming eligible to junior, associate or active membership.

The mother organization, too, is forwarding its own interests by this early introduction of the engineering student to the purposes and functions of the society. The men in the colleges today are the men in the industries tomorrow, and it is worth while for the societies to keep in touch with them and to follow their progress. Furthermore, by furnishing speakers and councilors to the student chapters the society is carrying on a great educational work for the profession which it represents. The colleges and universities, in turn, are benefited by the *esprit de corps* fostered among the students. The better realization of future responsibilities makes for a more serious purpose on the part of the student, and this should be reflected in the scholastic standing of the institution.

All of these worth-while purposes can be accomplished in the field of chemical engineering. The indefinite status of the chemical engineer in some institutions and the continual jostling back and forth between the chemists and the engineers, with recognition by neither, has resulted in an unhappy situation for the student in chemical engineering. If, however, he can become affiliated with a professional organization of the character and recognized standing of the Institute and if, for his guidance, he can look to its members and their accomplishments in the chemical industry, his status will have been improved materially.

The Dye Industry And Modern Warfare

THERE is a book lately published by Dutton & Co. which we propose to review at length some day when time is less pressing, called "The Manhood of Humanity, or Human Engineering," by Count ALFRED KORZYBSKI. It brings out the fact that we have passed the childhood of Humanity, and are now grown up. We may like our old toys and our childish ways, but we know better. For the first time in literature as we know it a definite answer is given to the question, "What is man?" The book is a work of amazing enlightenment.

The opening of the Chemical Exposition brought the idea to mind. We are grown up. Senator LENROOT and General FRIES both called attention to the immense significance of chemical warfare. "We have entered into a treaty of peace with Germany," said the Senator, "and her battleships are sunk and her army disbanded. But her greatest stronghold remains. Her great arsenals of chemical warfare are unimpaired." It is fair to say that Germany today is the strongest military power on earth because *warfare has changed*. We may not like it, but that does not alter the fact. We remember the flare and the dash and the grand appearance of cavalry troops, but of what value are they really? A battalion of well-trained chemical warfare troops can put a whole division of cavalry out of business. General FRIES spoke of the sinking of warships by bombs dropped from the air, and called attention to the fact that this was done without the aid of smoke. If the warship that was sunk had been manned by an enemy crew a dose of smoke would have put all their air defenses out of business, while explosive bombing would have sunk her. Warfare has changed, both on sea and on land; and warfare in the air has been added. General FRIES also declared that without an active and progressive chemical industry engaged in intensive organic synthesis over a broad field, of which the dye industry is but one branch, a nation is without military defense.

Senator LENROOT said we may agree on limitations of armament and war materials as much as we please, but we must not agree to any limitation of scientific activity. We must not agree to prevent our scientists from working for national defense, and he earnestly hoped that the country will recognize the need of this.

General FRIES reminded the audience that not one new chemical was used in the late war. Everything used was known before. Making mustard gas, for instance, was a slow process until Sir WILLIAM POPE invented the new and rapid one which was eventually put to use. But even by the slow process the Germans *had the facilities* in their dye-works, and it is reported now that a new indigo technique lends itself by a slight transformation to the production of mustard gas. He joined Senator LENROOT in the willingness to enter into any agreement as to limitation of defenses and armament, but said that the last thing on earth to do is to agree not to use chemical warfare on an attacking enemy.

There is a powerful lot of thinking to be done these days. And in the face of the fact that the old order is not only changing but has changed already, we lose all safety in conservatism. We must seek our welfare in understanding and in wisdom. And we must not forget that chemistry can do.

"Normalcy" and Extrapolation

WE HAVE HEARD so much lately about "returning to normalcy" that the word has become somewhat nauseous to quite a few. Sometimes we have to deal with unpleasant expressions just as we must deal frequently with unpleasant things. Undoubtedly the idea is all right, and if the thing still has to be talked about, it is because the operation has not been completed.

Now the word "normal" may be used in connection with various things, such as a state of mind, a rate of doing work and a volume of business. If we think of "normal" in connection with a state of mind, we mean simply a sensible, reasonable, rational state of mind. There is no room for argument there. All of us should be that way. Usually or frequently we are not, so "normal" in that case scarcely means "natural" and it is not even interchangeable with "average."

Dismissing the concept of "normalcy" in connection with a state of mind as being something we cannot disagree upon, one observes the desire to judge business affairs by reference to "normal," and it is plain that very often this requires extrapolation. When a period of time has passed it is not difficult to decide what was normal during that period, but we are always at the center of time. The past is behind us, the future before us. Hence we must extrapolate.

The problem is really to determine when to extrapolate and when not to extrapolate. We see many references to "pre-war prices." That is far from extrapolation, since such statements refer to a period ended seven years ago. When we consider quantities of business, on the other hand, nearly everyone is disposed to extrapolate. We expect expansion and increase. Normal today is not the average of past years, but the average of past years plus future years.

Now in extrapolation we can easily make serious mistakes. For instance, the production of coal was 219,976,267 tons in 1898 and 357,356,416 tons in 1903. That represented an annual rate of increase of 10.2 per cent, equal to a doubling in a trifle over seven years. If at the end of 1903 one had extrapolated to 1922 he would have found 2,259,000,000 tons as the proper production for next year. This year's production is expected to be about 425,000,000 tons. To follow the rule, next year's production should be five times as much, not to speak of making up for lost time. This is fanciful, and no one tries it, but substantially that sort of thing really has been argued as to pig iron. Men have taken the previous rate of increase, carried it forward, and computed the number of tons by which the world was deficient, insisting that the world would probably try to make it up, if not to regain the former pace.

Between returning to pre-war conditions and conditions indicated by extrapolation there is a very wide gap, and yet the proper applications of "normalcy" hit points all the way from the one extreme to the other. We want to be normally useful. We should think not of quantities of coal, but of useful results. The total quantity of coal produced has been increasing, but the quantity per unit of work, electric light thrown on the machine tool, or locomotive drawbar pull, has been decreasing. We should think less of the quantities that go into the statistics and more of the useful results attained, measuring success not by quantities of money or materials or hours employed but by useful work accomplished.

Readers' Views and Comments

Boiler Feed Water Purification

To the Editor of Chemical & Metallurgical Engineering

SIR:—In the article on "Boiler Feed Water Purification," which appeared in your issue of July 6, the author makes a number of interesting points whose correctness will be conceded by all specialists in industrial water purification. In his zeal, however, he makes several statements which probably would never have seen the light of publication had he been writing from a strictly impartial standpoint.

In a former capacity as chemist for one of the larger manufacturers of zeolite water softeners I have analyzed at various times the effluent from many zeolite water softeners; Permutit, Refinite, Borromite and De-Calco were all included. These analyses without exception have shown that Mr. Applebaum overstates his case very, very badly when he writes as follows: "Slight amounts of hardness in the effluent of some zeolite softeners have been noticed in some cases; but this can mean only that the particular zeolite softeners examined were improperly designed and that the volume of a proper grade of zeolite used was not in sufficient excess so that the softener was seriously overloaded."

... If the size of the zeolite softener is correctly selected to take care of the required volume of water containing a known hardness, the effluent of the softener is always of zero hardness."

It is obviously impossible that these statements could be correct, except by taking the meaning given by the zeolite manufacturers themselves to the term "water of zero hardness." As I understand it that meaning is: Any water which, titrated against standard soap solution, produces a permanent lather with an amount of soap solution representing 1.4 grains per gal. or less of hardness, expressed in terms of CaCO_3 . The very law which makes zeolite water softening a commercial possibility—the law of mass action (which is but a phase of the law of ion concentration)—renders it impossible to remove entirely all Ca and Mg from natural supplies of water. On account of this law, whereby the excess of the sodium in the zeolite forces an exchange for the Ca and Mg in the water, waters having a high sodium content cannot be successfully treated, for the exchange ceases where the point of equilibrium is reached between the sodium in the zeolite and that in the water. In waters of low sodium content, the exchange can progress much nearer completion, but the point of equilibrium is nevertheless reached before the Ca and Mg have been entirely eliminated from the water. When this point of equilibrium is reached, were we to add a slight—a *very* slight—amount of some sodium salt to the water, the equilibrium being disturbed, a reverse reaction would take place, until the equilibrium was restored.

In an article which appeared several months ago¹ the writer quoted an analysis of a representative zeolite-treated water, the hardness of which expressed in terms of CaCO_3 was 0.50 grain per gal. (This, incidentally, is as nearly free from Ca and Mg as has

been any sample of zeolite-treated water which I have analyzed.) This is the analysis to which Mr. Applebaum refers in the paragraph quoted above. It is possible that he may have been misled by a typographical error, corrected in a later issue, whereby the CaCO_3 equivalent hardness of this zeolite-treated water was given as 6.50 grains per gal., but an examination of either the context or of the analysis itself should have corrected any such false impression, for the analysis showed CaCO_3 0.25 grain per gal. and MgCO_3 0.21 grain per gal.

He also makes the following assertion: "It is falsely claimed that zeolite-softened water increases the tendency of boilers to foam, on the consideration that the sodium salts have a heavier molecular weight by about 5 per cent than the corresponding calcium or magnesium salts."

This appears to be a misinterpretation of point 1 in the discussion of the disadvantages of the zeolite system of water purification in the article mentioned above.² The unquestioned tendency of zeolite-treated waters to foam should not be attributed to a difference in molecular weight. The cause for this increased tendency is the increased amount of sodium salts in the water, the Ca and Mg being replaced by sodium, and sodium salts being notorious offenders in causing foaming, a property almost entirely absent from Ca and Mg salts.

Furthermore, his chemical arithmetic is not accurate. In the average natural water, on account of the fact that the CaCO_3 is held in solution by half-bound CO_2 , a quasi-bicarbonate, 1.00 grain per gal. of CaCO_3 is not replaced by 1.06 grains per gal. of Na_2CO_3 , but rather by 1.68 grains per gal. of NaHCO_3 ; and 0.84 grain per gal. of MgCO_3 is replaced by 1.68 grains per gal. NaHCO_3 ; exactly double the amount. Take, for example, a water whose analysis showed 10.00 grains per gal. CaCO_3 , 8.40 grains per gal. MgCO_3 and 2.60 grains per gal. of sodium salts—total, 20.00 grains per gal. Ignoring the small amount of Ca and Mg salts which would remain unchanged, the zeolite-treated water would show 33.60 grains per gal. NaHCO_3 , 2.60 grains per gal. of other sodium salts, a total of 36.20 grains per gal. of sodium salts where there originally was only 2.60 grains per gal. This is the basis of the claim which Mr. Applebaum brands as false.

And, as is well known, the carbonates are the most notorious of all sodium salts in causing foaming, not to mention that when introduced into the modern high-pressure boiler they have been known to break up, forming volatile organic acids which have caused destructive corrosion in pipe lines and in steam-consuming equipment.³

There are a number of other points in the article which are not compatible with the writer's experience in the purification of water for boiler feed, notably those concerning the baking of sludge in the boiler, where his contention is impossible without criminal negligence in blowing down, on account of the levigating

²*Loc. cit.*, p. 126.

¹"A Comparison of Various Methods of Water Purification," CHEM. & MET. ENG., vol. 24, No. 3, Jan. 19, 1921, p. 123.

³"Boiler Chemistry and Feed Water Supplies," J. H. Paul, published by Longmans, Green & Co., Chapter X.

effect of the racing circulation of the water in the boiler; the fact that he exaggerates the disadvantages of boiler compounds, thereby attaching to these disadvantages greater weight than they possess; and he denies the existence of certain advantages which an impartial steam expert will concede to them; and the fact that he minimizes the importance of the disadvantages which practical experience has taught are impossible of elimination in the use of the zeolite system in treating water for boiler feed.

It is really regrettable that an article of so much unquestioned merit should have contained these few glaring discrepancies; and after attempting to correct them, I wish to congratulate Mr. Applebaum upon an article which was highly interesting and genuinely instructive.

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Chief Chemist.

The Slip Interference Theory of the Hardening of Metals

To the Editor of Chemical & Metallurgical Engineering

SIR:—The complete solution of the difficult problem of the hardening of metals cannot be very far off now. In the recently published paper¹ by Jeffries and Archer mentioned above the authors in a very meritorious way drew up the principal lines that undoubtedly must be followed to a clear conception of the phenomena of hardening.

The question is very important and has been dealt with in a scientific manner as long as there has been theoretical metallurgy. Jeffries and Archer do not give any account of previous investigations on the matter. Surely it would have been a difficult enterprise to give a lucid review of the many developments in this field of research, considering the great number of rather obscure speculations and theories put forth in the course of time on this matter. However, by reviewing former researches the authors should certainly have found that ideas similar to their own have been suggested before, even if the hypotheses have not been nearly as fully comprehended and ably presented as in this new paper.

F. C. Thompson² in 1916 drew the attention to the disturbing effect that atoms of a substance in solution certainly have on the space-lattice of a metal. He was also well aware of the influence of this distortion on the hardness of the solid solution, even if he ascribes the hardness to those rather problematic and unproved internal stresses in the metal—stresses about which there has been so much written.

Another very clear conception of the great importance of the influence of foreign atoms in a space-lattice has been put forth by C. Benedicks³ in 1916. Possibly Jeffries and Archer are not familiar with this contribution, as it is part of a paper concerning metallic conduction of electricity. To show how very similar the ideas of the American authors are to those of Benedicks a paragraph may be quoted from page 390, on the hardness of martensite:

"This enormous influence on hardening can evidently be accounted for, even if the phenomena of allotropy are taken into consideration, if we might suppose that one single foreign atom has the power to lower the possibility of sliding displacements and

to act like a 'key' for whole planes (like a grain of sand on a rubbing surface in a machine)."

A few weeks ago a very interesting article on the hardness of solid solutions has also been published by W. Rosenhain,⁴ who on the whole has the same views on this matter as Jeffries and Archer.

The reason why former attempts to solve the hardening problem have not been successful may probably be attributed to the fact that the phase rule hitherto has been such a dazzling loadstar to metallography. Investigators on this research field have been so accustomed to the habit of thinking in diagrams that they have not paid sufficient attention to the fact that the various phases are built up of a manifold number of crystals, every one with a certain architecture of atoms.

In the first decade of this century the real existence of atoms has been proved. In the following years it was shown by Laue and Braggs that the atoms in crystals are arranged in regular space-lattices. Problems covering the internal structure of crystals have come into the focus of scientific interest, thinking in terms of diagrams by metallographers begins to give place and will yield still more to thinking in terms of atoms.

Jeffries and Archer have certainly been led to their conception of hardening by their dealing with X-ray analysis of metallic phases. I have also made some X-ray spectrographic investigations of metals⁵ and have come to the same conclusions regarding the hardness of solid solutions as they. In principle I completely agree with them. In a few points, however, my opinion differs from their views.

I do not think the reasons presented for saying that carbon in martensite is dispersed in the form of atoms are quite convincing. I am more inclined to believe that martensite really contains cementite in the form of Fe_3C molecules, and even as very small Fe_3C crystalline grains. The chief reason that Jeffries and Archer put forth for their assumption is that it is impossible for carbon atoms to migrate freely in the metal if they are in contact with particular iron atoms. The authors have evidently overlooked the fact that each carbon atom can very well be connected with three iron atoms and yet easily travel in the metal, since during the displacement it merely changes its companions. If one supposes that there is Fe_3C present in martensite, the very great hardness of martensite as compared with austenite follows in a very natural way. Molecules or grains of Fe_3C certainly act as more efficacious keys, producing slip interference in the ferrite crystals, than could free carbon atoms. I do not wish to go deeper into this matter now; the question can be further elucidated experimentally.

Indeed there are still other points that I would like to discuss with the American authors, such as the influence of amorphous metal, which I think has been very much exaggerated, but it would be better to wait for experiments to decide whether my opinion is right.

Last, I wish to congratulate Dr. Jeffries and Mr. Archer most heartily upon their excellent paper and to record my very firm conviction that a final solution of the hardening problem certainly will diverge very little from the assumption given therein.

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Dr. ARNE WESTGREN.

¹CHEM. & MET. ENG., vol. 24, p. 1057 (June 15, 1921).

²Trans. Faraday Soc., vol. 12, June, 1917, p. 23.

³Jahrbuch der Radioaktivität und Elektronik, XIII, 4, 1916, p. 351.

⁴Proc. Roy. Soc., A, vol. 99, 1921, p. 796. Reprinted in CHEM. & MET. ENG., vol. 25, p. 243 (Aug. 10, 1921).

⁵Jernkonteret Annealer, 1920, Iron and Steel Institute, 1921, I.

Meeting of the American Society for Steel Treating

Varied Social and Technical Activities at the Indianapolis Convention — Some Important Papers on Carbonizing, Heat-Treatment of Ordnance, Manufacture and Properties of Tool Steel, and Theory of Hardening, Abstracted From a Great Wealth of Material

INDIANAPOLIS royally entertained the third annual convention of the American Society for Steel Treating during the week of Sept. 19. In fact, if any criticism should be leveled against the local members of the society it was that they entertained somewhat too lavishly. Mr. and Mrs. George Desautels, acting as chairmen of the members' and ladies' entertainment committees, certainly spared no effort and scarcely left breathing time for their guests. In addition to the usual smoker and banquet, auto trips, teas and such familiar events, the Steel Treatingers and their friends—numbering in all some thousands—beheld a special race on the Indianapolis Speedway, certainly something which only Indianapolis could produce. Ten or a dozen "speed kings," whose names doubtless would be very familiar to racing fans, donned their goggles and helmets and thundered around the track at 100 miles an hour. It was a real Roman holiday and furnished even the exquisite thrill of a car running wild over the top of the embankment, crashing double fences into kindling wood and furnishing the surgical ward with two more patients.

MEMBERSHIP AND FINANCIAL STATUS—NEW OFFICERS

Prof. A. E. White, of the University of Michigan, the retiring president, called attention to the fact that the present membership is 3,237, an increase of approximately 500, or 18 per cent, in the past year. Local chapters also increased by four, the present number being thirty-one. Financially the society is in excellent shape, having no unpaid obligations whatever, while the cash on hand was increased about \$6,000.

F. P. Gilligan, of the Henry Souther Engineering Co., Hartford, Conn., was elected president of the American Society for Steel Treating for the year 1921-22. F. C. Lau and R. J. Allen are the new vice-presidents, J. V. Emmons the treasurer, while W. H. Eisenman retains the post of secretary.

One of the features of the Steel Treatingers' conventions is the daily conferences between national officers and the representatives from each of the local organizations, or "chapters" so called. Many phases of the society's affairs are discussed, with the view of making a determined effort to shape this organization's activities in the correct way. It has made great progress already, and it is not too old to learn.

The exhibits of steel-treating equipment were held in the Manufactures Building at the State Fair Grounds and the technical meetings in the Women's Building, just alongside. In view of the business depression the displays on the whole were not very elaborate, but sixty different concerns manufacturing furnaces, pyrometers, tool steels, carbonizing equipment and heat-treating accessories were represented. Transportation between downtown hotels and somewhat distant Fair Grounds was adequately handled. The attendance was good, especially at the technical sessions. These

were twelve in number, at which no less than eighty-two papers on various phases of metallurgy and metallurgical equipment were presented, either in whole or by title. Printed abstracts of all of them were available, however. A very unusual amount of interest was displayed at these meetings, but the crowded program prevented much discussion. A number of papers are abstracted in these columns. Unfortunately, however, manuscripts of some very important contributions were not available, but they will be printed at length in the society's monthly *Transactions*.

Session on Case-Hardening

The convention opened its technical sessions on Tuesday with a number of interesting and valuable papers on carburizing.

S. C. Spaulding, metallurgist for the Halcomb Steel Co., Syracuse, N. Y., first presented the voluminous results of a research on the comparative rate of carbon penetration in various commercial steels whose chemical analyses are listed:

Group	Alloy	Alloy Content	Carbon
1	{ Cold-rolled	.....	0.15
	{ Hot-rolled	.....	0.20
2	{ Cr:Si:Mn	0.83 : 0.31 : 0.78	0.16
	{ Cr:V	0.92 : 0.17	0.17
3	{ 3½ per cent Ni	3.5	0.16
	{ 5 per cent Ni	5.29	0.14
4	{ Cr:Ni	0.98 : 3.14	0.18
	{ Cr:Ni	1.31 : 3.79	0.11
5	Cr:Mo	0.96 : 0.48	0.13

Three-fourths-in. rods were turned, and one specimen of each was packed in a single box, using a commercial carbonizer. A dozen or more such boxes were put into a large furnace, brought to 1,600 deg. F., and a pair of them removed after 5 hours, 10 hours, and so on up to 60 hours. A second run was made at 1,700 deg. F. After cooling in the pots a wafer was cut from one end, split, polished, and the depth of case measured by microscope, estimating distances to the place where carbon was 0.50 per cent. Typical results follow:

Time, Hr.	Penetration			
	0.15 C		3½ per Cent Ni	
	1,600 Deg. F.	1,700 Deg. F.	1,600 Deg. F.	1,700 Deg. F.
5	0.019	0.029	0.022	0.037
15	0.039	0.052	0.052	0.070
30	0.053	0.075	0.077	0.096
50	0.060	0.095	0.092	0.111
	First Cr:Ni		Cr:V	
	1,600 Deg. F.	1,700 Deg. F.	1,600 Deg. F.	1,700 Deg. F.
5	0.023	0.040	0.023	0.041
15	0.058	0.089	0.051	0.072
30	0.090	0.131	0.075	0.100
50	0.111	0.150	0.086	0.107

Results on penetration and microstructure can be grouped as shown in the first table.

Group 1. Both carbon steels gave time:penetration curves of exactly the same shape, the cases in the hot-rolled being somewhat deeper probably owing to its much lower phosphorus. A cementite network appeared at the edge, inclosing very large grains of pearlite; then a zone of pearlite, then carbon decreasing to the original stock.

Group 2. These curves were about the same up to 40 hours. It seems that 0.17 per cent V, which is the only material difference, had no effect on carbonization. Cementite appeared as rounded masses—there was no network or large grain growth.

Group 3. Nickel retards cementation; this is especially noticeable in the 5 per cent Ni sample. The 3½ per cent Ni sample showed a fine lacy network at the edge, the cementite accumulating into small spots after being carburized a long time at 1,700 deg. F. No network was observable in the 5 per cent Ni sample. The original material possessed a very pronounced banded structure characteristic of many rolled products, and the carbon penetration favored certain of these bands very markedly.

Group 4. This combination, chromium:nickel, seems to be of unique benefit to carbonizing, and these samples gave the deepest cases. They are air-hardening, and the outer edge was austenitic, containing excess carbide as large patches at the border. As the carbon decreased, the ground mass became martensitic, troostitic, and on down. The case preserved the banded structure very clearly; high-carbon bands appeared to replace the original low-carbon streaks.

Group 5. This steel was run at a different time, using the Cr:V of group 2 as a check. Cr:Mo gives slightly deeper penetration than Cr:V, but is associated with a wide cementite network containing many sizable accumulations of carbide. No banded structure remained of this very pronounced condition in the original metal.

Each of these steels was given the appropriate single and double treatment recommended by the S.A.E. specifications, furnishing a mass of data not easily compressed. In general, however, the alloy steels are more easily refined than carbon steels in a single treatment, and give better microstructures after the double treatments.

WOOD CHARCOAL AS CARBONIZER

Although wood charcoal is not looked upon with favor as an agent for case-hardening, H. Schagrin, chief chemist of the U. S. N. Ordnance Plant, Charleston, W. Va., described a commercial operation where it had proved very satisfactory. The parts hardened were forgings about 12 in. long made from acid bessemer steel analyzing C 0.15, Mn 0.70, S 0.05, P 0.06, forgings cheaply made and requiring cheap treatment. Unscreened charcoal up to 30 mesh was used, attempting to place 1 in. of the material between pieces, the cover pressed down and luted, exactly as in ordinary practice. Three of the boxes in each furnace load contained thermocouples, and one of them a "spy" which the furnace tender could withdraw and judge the heat visually.

On being drawn it was often found that one-quarter of the charcoal had burned, due to infiltration of air, but very seldom did this spoil the bright silvery color on the metal. An hour and a half at 1,900 deg. F. gives good carbon penetration to a depth of $\frac{1}{8}$ in.; each 50 degrees above this point makes a great difference in the

depth and character of the case. Experimentally it was found that a carbonization in wood charcoal must be performed at above 1,750 deg. F. or no appreciable result will occur in a few hours' time. The charcoal was forked and re-used, although its consumption was heavy.

For conditions as existing at that plant—i.e., a mass of cheap parts to be given a thin case, with carbon no higher than 1 per cent—the author would recommend wood charcoal as a cement, allowing 1½ to 2 hours at 1,900 or 1,925 deg. F. Two runs can easily be made per shift.

HARDENING WITH CYANAMIDE

Prof. Richards read a paper on the Shimer Case-Hardening Process before the 1919 winter meeting of the Mining and Metallurgical Engineers. The inventors now give some further data on its operation, as perfected by five years' experience. It may be remembered that a bath of CaCl₂ and NaCl (known as "Meltite") is first prepared, and first-class, hard cyanamide (known as "Cyrok") immersed by a weighted basket. Soon a rapid evolution of gases occurs, bursting into small yellow candle flames at the surface of the pot, this continuing for some hours—as long as the bath is active, when, of course, new cyanamide must be added. The gases analyze 70 to 80 per cent N₂ and the remainder CO plus a little CO₂. No CN has been found by analysis, nor is there any cyanide odor noticeable.

Cyanamide air-slakes, and the fine material must be carefully removed in order to prevent frothing in the bath. It should also be handled with gloves. "Meltite" is also hygroscopic, and must be stored in tight cans. It melts at 1,150 deg. F., and while the usual operating temperature is 1,425 to 1,450, it can be heated to 1,700 deg. F. without unusual volatilization. At the latter temperature it produces a $\frac{1}{2}$ -in. case in 2 hours.

It is necessary to dip the finished metal in hot soda ash solution, since any speck of CaCl₂ remaining will facilitate corrosion.

Comparative carburizations in cyanamide and cyanide have been made, and it is found that the former consistently puts higher carbon and lower nitrogen into the metal. For instance, a steel containing C 0.09, Si 0.18, S 0.04, P 0.01, Mn 0.40 was case-hardened 1 hour at 1,526 deg. F. (830 deg. C.) and analyzed with the following result:

	—Cyanamide—		—Cyanide—	
	C	N	C	N
1st cut 1/200 in.....	0.75	0.30	0.62	0.35
2nd cut 1/100 in.....	0.24	0.04	0.27	0.08
3rd cut 1/100 in.....	0.16	0.04	0.11	0.03

CYANIDE HARDENING

Observations on the time of penetration in three different cyanide baths were made by V. E. Hillman, metallurgist of the Crompton & Knowles Loom Works, Worcester, Mass. The process is ordinarily used to give a very hard thin case on pieces made on screw machines. Ordinarily a mixture of about 27 per cent NaCN, 18 per cent NaCl and 55 per cent Na₂CO₃ is used, the latter two raising the melting point of the mixture, and thus counteracting the loss in speed of work due to low concentration of the active cyanogen. The more concentrated cyanide baths must be run at a considerably lower temperature.

A quenched case is composed of two distinct rings; the outer one of martensite and a narrow inner one of

troostite; the center of the latter was taken as the depth of penetration. Results follow:

Time, Minutes at	Penetration in Inches		
	27 per Cent NaCN at 1,475 Deg. F.	76 per Cent NaCN at 1,425 Deg. F.	98 per Cent NaCN at 1,375 Deg. F.
5	0.010	0.010	0.015
10	0.015	0.016	0.020
20	0.025	0.026	0.030
35	0.044	0.039	0.044
50	0.060	0.054	0.056
75	0.077	0.071	0.065
100	0.087	0.084	0.071
125	0.095	0.093	0.077
150	0.104	0.104	0.083
180	0.113	0.123	0.098

Heat-Treatment of Ordnance

Commander W. F. Leary, U. S. N., presented an interesting paper on the heat-treatment of steel for ordnance purposes, in which he ascribed a great part of the improvement in guns, armor and projectiles to the development of proper heat-treatment. Whereas it was formerly necessary to rely on the skill of the workmen, it is now recognized that sound ingots, preliminary annealing, prevention of grain growth after forging and preliminary machinery before forging are essential to prevent failures during heat-treatment. Recording pyrometers and all the ordinary precautions of heat-treating are now liberally used, and a definite and minute program of operation is studied and laid down in advance. Without this practice the 16-in., 50-caliber gun would have been impossible.

Ordinarily, specifications list the physical and chemical requirements in detail and only general notes on heat-treating designed to prevent gross mishandling. Shock tests should also be added, since the finished material before acceptance is tested severely, often by methods developing severe impact.

Castings of plain carbon and nickel steel are much used. Close inspection during manufacture prevents acceptance of pieces with blow-holes and other flaws and also insures correct melting practice for material which will heat-treat properly. Test coupons must be cut from the body of the casting itself to be of real value.

Specifications for gun forgings fill a small book. Numerous paragraphs cover raw materials, melting and ingot practice, so that it would be relatively easy to heat-treat to pass the physical tests. While the process is not specified, the acid open hearth and electric furnaces seem to give the surest results. Sulphur, phosphorus and copper maximums are the only chemical requirements. Physical requirements are between the following limits:

Tensile strength	86,000 lb. per sq.in.	95,000 lb. per sq.in.
Elastic limit (by extensometer)	46,000 lb. per sq.in.	65,000 lb. per sq.in.
Elongation	18 per cent	18 per cent
Reduction in area	30 per cent	30 per cent

These limits are very easy to meet in small pieces, but very difficult in forgings weighing tons. Four transverse test specimens are slotted out of each end, to cover outer, middle and inner portions; in case of failure a check test-piece is taken from that vicinity. Repeated failures cause rejection of the forging. Ghost lines and other segregations are usually associated with irregularity in test results, although it is improper to say that static tension or bend indicates that a ghost-line structure is itself detrimental.

Streaks or ghost lines are generally surrounded by good metal, and the factor of safety in the design is so large that in the case of large forgings their specific effect is greatly masked and difficult of appraisal. Many rejections, however, have resulted from this cause, because such flaws are considered evidence of the doubtful value of a forging. Ghosts are of two classes, one with fine sorbitic grains and much ferrite, the other with large sorbitic grains and absence of ferrite. Inclusions (probably manganese sulphide and silicate) may often be seen with the naked eye in these streaks—close microscopic examination always show them. If they are segregated, the metal is highly suspicious. It is now thought that minute specks of iron oxide are most detrimental to the steel; these, settling in the ferrite boundaries, weaken the adhesion.

Reduction in forging is at least half. The reduced bars are then usually given a preliminary anneal above A_c , (cooled in the furnace to 600 deg. F.) and an examination to insure a normal uniform structure. Rough machining removes that metal which shows no ferrite at grain boundaries, and the desired properties may generally be obtained by a simple quench and draw. A second and higher draw may be necessary if the test specimens show a uniformly great hardness. Structure is generally sorbitic, with grain boundaries plainly marked with uniformly distributed ferrite, considerably increased in amount toward the center. Sometimes needles of ferrite penetrate the grains along a geometric pattern; while this is not considered desirable, it is not reason for rejection. Successful metal can be bent 180 deg. flat without fracture.

Armor piercing projectiles of alloy steel are subjected to very extensive treatments, the details of which are held secret. Forging is done at a low temperature to prevent grain growth and a preliminary normalizing anneal given. After rough machining, the shell is given a series of oil quenchings and drawings for utmost grain refinement and production of "fiber." Hardening the point is done by a graduated heating by dipping the point in molten lead, and quenching in agitated cold water. The base is then reheated to a lower temperature, and suspended, nose down, in agitated cold water, thus tempering the rear only. The projectile point is covered with an alloy steel cap whose heat-treatment is similarly complex.

FORGING AND HEAT-TREATING AT WATERTOWN

F. C. Langenberg, director of laboratory and superintendent of foundry, Watertown Arsenal, explained the methods in use at that place. This work is of great variety, and includes much investigative work on new gun mounts and new high-strength forgings. Since these are all different, it is necessary that closest control be exercised, so that there may not be rejections of some important forging with consequent long delay, or doubt as to its exact history.

After the order for a certain job is received the engineering division makes the design, which of course involves selection of the strength and ductility figures. Then, after consultation with the foundry, metallurgical department, forge shop and machine shop, a forging sketch is prepared, showing the dimensions of the finished specimens, the dimensions after rough machining ready for heat-treatment, location of test specimens, and specifications for strength.

The planning division then routes the work, calling

upon the metallurgical division for information as to the size, weights and composition of the ingots required. If new ingots have to be made, they are ordered from the foundry, after a consultation with the foundry and metallurgical departments has determined the best chemical composition and melting and pouring practice. All of these steel-making operations, as well as the finished ingots, are inspected and carefully recorded by the metallurgical department. Inspection after forging is done by the inspection division; if defects are noted, they are reported to the metallurgist.

The accepted forging is then sent to the annealing department, and heat-treated exactly as specified by a chart of instructions. Then after machining to the heat-treating dimensions, and a second inspection, the forging is sent to the heat-treating shop, which has previously received all instructions as to the treatment desired on a drawing. This shows a complete time-temperature curve covering the entire treatment, and also the nature and temperature of the quenching medium.

The metallurgical division now makes the tests specified (these now include impact tests), and decides whether the piece is acceptable or whether a re-treatment is necessary. Then the inspection division makes its examination, and the accepted forging is shipped to its destination.

If trouble occurs anywhere between steel making and final loading, this close and continuous planning and inspection locates the blame quickly and precisely. Since each department foreman has been consulted regarding all features affecting his work, he is less apt to attempt shifting blame for poor results.

CARBURIZING ARMOR PLATE

W. I. McNerney, of the Armor Plate Department, U. S. N. Ordnance Plant, Charleston, W. Va., presented a paper on the carbonizing of heavy forgings. The plate is forged somewhat thick, and replaced while hot to cool in an annealing furnace. All scale is removed from the plate, and any seams or surface imperfections are chipped out.

If only a thin case is required, say $\frac{3}{16}$ in., a plate is preheated to 1,500 deg. F., removed from the furnace, a 2-in. blanket of carburizer spread over, and the whole covered with a 3-in. layer of dry yellow clay (through $\frac{1}{4}$ -in. mesh). The plate is then slid back into the furnace and heated for time and temperature known to give the desired results. Carburizers used for all this work are purchased (not home made) and must not burn off while being applied, flux with the clay or stick to the metal.

Heavy cases are made by heating plates in pairs, sandwich fashion, with 3 or 4 in. of carburizer between. The bottom plate will have an angle-iron frame attached around its edges, supporting a two-course brick wall to confine the granular material. Four pairs of such plates weighing up to 600 tons have been treated at one time in car-bottom furnaces 15 ft. wide and 52 ft. long. Such practice builds up the following cases in 0.28 C alloy plates:

Time, Hr.	Carbon at Depth			
	$\frac{1}{16}$ In.	$\frac{1}{2}$ In.	1 In.	$1\frac{1}{2}$ In.
24	0.90	.....	0.28	.....
120	0.96	0.59	.....	0.30
240	1.00	0.69	.....	0.35

Lighter sections (up to 5 in.) are often carburized while preheating for final forging. After having been

raised to 1,500 deg. F. (requiring 12 hours), the piece is covered with carburizer, raised to the forging temperature (requiring 10 hours) allowed to soak for 24 to 30 hours. Carbon analyses resulting are at $\frac{1}{2}$ in. depth 0.90, $\frac{1}{4}$ in. 0.98, $\frac{1}{8}$ in. 0.80, $\frac{1}{16}$ in. 0.60, in a plate having C 0.50, Cr 2.10, Ni 3.50.

It is not usual to "fire back" the plate before stripping and after the completion of the carburizing treatment. Rather the furnace is stripped, and carburizer dumped. The heavy scale on the exposed surfaces falls off as the plate cools to about 1,500 deg. F. The whole plate is then covered with a protective layer of buckwheat coal, a layer of dry yellow clay, and heated for the final forging operation.

Tool Steel

M. H. Medwedeff, of Baltimore, Md., presented a short paper emphasizing correct hardening room practice—points which are well known, but often honored by their breach. It would be well to bear in mind at all times:

1. Anneal thoroughly before hardening, to remove any forging or machining strains. There is no short cut for this operation. Pack the tools in powdered charcoal, heat slowly to 1,500 deg. F., hold from 2 to 4 hours, depending upon the mass, and cool in the closed furnace.

2. Preheat the tool slowly, else exposed corners will be a long time at the high hardening temperature, with corresponding grain growth. In quantity work it is well to have three furnaces, one at 1,150 deg. F. kept filled and used as a stock furnace. Next is a furnace holding not more than three tools, kept at 1,525 deg. F. Next is the high temperature furnace (2,200 to 2,400 depending upon the steel) in which a single tool remains only a few minutes before being quenched.

3. Do not harden tools if you are color blind unless you use a first class optical pyrometer constantly. The thermocouple merely tells you the temperature of a particular spot in the furnace; color comparisons are the best way of judging whether the tool is as hot as the thermocouple.

AMERICAN VS. ENGLISH CRUCIBLE PRACTICE

An extended paper by T. Holland Nelson, steel works manager of Henry Disston & Sons, Philadelphia, Pa., gave a detailed discussion of the crucible melting practice in England and America. Whereas abroad a simple coke hole is still used for 90 per cent of their tool steel and produces three rounds (since the war but two) of metal per day, here regenerative gas furnaces operate continuously, furnishing six heats per 24 hours. There they use fragile clay crucibles, costing 60c. each and good for a day's run, while here we use tougher and larger plumbago crucibles costing \$5 each. Furnace output for a 12-hole furnace there amounts to 3,200 lb., while in America the production is 18,000 lb. Carbon variation in the clay crucible is quite small—it can be held as low as 0.06 per cent. Due to variable graphite consumption, steels from individual crucibles here vary as much as 0.30 per cent.

It is therefore necessary for Americans to teem all their pots into a mixing ladle, casting ingots from the latter. Thus a more uniform analysis is obtained. English steelmakers are as a rule still advocates of the advantage of hammering the ingot to a bar. This is done at a minimum temperature, and great care used to prevent surface decarbonization. Here we use rolling

mills almost exclusively, a practice which is not equal to the other, principally due to the fact that tonnage production seems to insist upon high rolling temperature and heavy drafts. Furthermore, English toolmakers still insist that the more Swedish iron they put in their crucibles the better the resulting steel—a contention the author unqualifiedly indorses, on the ground that no other known raw material is its equal.

TREATMENT OF TOOL STEEL IN THE MILL

A. M. F. Green, chief of laboratory, the John Illingworth Steel Co., agreed with Mr. Nelson that hammering was much better than rolling for reducing high-speed steel from ingot to bar. Hammering is usually done in two heats; first the cogging, then the finishing. Both these operations are started at moderate temperature, the working continued in the first case nearly to A_r , while in the second heat light work may be continued at will to a lower temperature, thus producing more exact sizes and a stronger bar. The correct temperature may be determined by the gain in magnetism, or the greater adherence of scale below the transformation. Cooling from both hammerings is done in lime or ashes, so that a certain annealing effect results.

Rolling, on the other hand, is done from a single high heat, and the finishing temperature is less under control. Hot finishing results in large grains; high heats mean decarburized surfaces.

Normalizing, annealing, or both are necessary if the steel is to be shipped in the best condition. The former is especially necessary to break up banded structure in chromium steels. The correct structure is that in which complete spheroidization of the carbides has taken place. This is an extremely difficult thing to produce if the steel has a structure of great crystals such as caused by high temperature annealing or finishing. Veins of cementite making sorbitic grains in a piece of high-speed steel are indications of especially bad mill practice.

TENSILE STRENGTH OF HIGH-SPEED STEEL AT HIGH TEMPERATURES

A. H. d'Arcambal, metallurgist for the Pratt & Whitney Co., Hartford, Conn., has continued his studies of high-speed steels at ordinary and high temperatures, and at this meeting presented results on two steels of accepted composition:

Steel	C	Cr	V	W
A	0.63	3.55	0.97	17.04
B	0.65	3.33	1.78	13.85

First, transverse tests were made to determine the best heat-treatment; $\frac{1}{2}$ -in. turned bars, 7 in. long, were treated and then ground to $\frac{3}{16}$ in. Hardness was tested with flat temper-testing Nicholson XF files. A series of bars showed that the greatest fiber stress on transverse rupture, together with requisite hardness, is had on either steel after quenching from 2,350 deg. F. in a lead bath at 1,100 deg. F., cooling to room temperature, and drawing back to 1,100 deg. F. If the final drawing was omitted, the test-bar developed many grinding cracks. Those which could be tested gave only half the strength of the tempered bars.

Grade B showed slight coarsening of grain on the fractured surfaces and probably should have been quenched at 2,300 deg. F. Under the microscope, quenched steel showed polyhedral austenite, with nearly all the original free carbides and tungstides dissolved.

Grade B requires a higher draw to remove this polyhedral structure, a little remaining at 450 deg. F., a condition associated with very low strength under transverse test. Both steels give a full martensitic structure after 1,100 deg. F. draw.

Steels of the same class were tested in tension at high temperatures, turning specimens 11 in. long from $1\frac{3}{8}$ in. bars, hot rolled and annealed. Two inches at the center was reduced to 0.505 in. in diameter, the test-piece quenched in oil from 2,350 deg. F. and drawn at 1,100 deg. F. A thermocouple was wired to the center of the piece and the specimen mounted in the testing machine so it extended through an electric tube furnace. After holding at temperature for 30 minutes the specimens were pulled.

Temp., Deg. F.	Strength of	
	Grade A	Grade B
100	243,500	215,000
400	256,500	.....
600	287,500	273,750
800	285,000	260,000
1,000	240,000	223,000
1,100	220,000	200,000
1,200	185,000	160,000

Fractures of Grade A were all of the usual velvety nature. Grade B gave coarse crystalline fractures, possibly due to undissolved carbides. All except those pulled at 1,200 deg. F. remained hard to the file.

Either steel A or B when tested without a high draw is soft to the file until the temperature at fracture attains 1,100 deg. F. In view of the tendency to omit the 1,100 deg. draw this fact is important. An undrawn tool put into use will often run at temperatures of several hundred degrees F., but will be handicapped by being softer than though it had originally been tempered sufficiently to develop the martensitic structure.

None of the samples showed any measurable elongation or contraction. It is worthy of note that properly hardened and annealed high-speed steel attains its greatest strength at about 600 to 700 deg. F., much like plain and other alloy steels.

Steel A quenched, but not drawn, is comparatively weak (175,000 lb. per sq.in.) a figure less than that for hardened carbon tool steel (183,000 lb.).

TUNGSTEN DETERMINATION BY SPECIFIC GRAVITY

A study of the specific gravity and chemical analysis of a large number of commercial high-speed steels was made by A. S. Townsend, chief chemist of the Cleveland Twist Drill Co., Cleveland, Ohio. He finds that if the specific gravity of a clean piece of annealed steel is determined—a very simple, quick operation—the tungsten content can be obtained to within ± 0.30 per cent by the formula

$$\frac{Sp.gr. - 7.82}{0.049} = \text{Per cent tungsten}$$

About half of the error is due to ordinary variation in chemical content other than iron and tungsten, and the remainder is due to variation in structure—slag content and amount of free carbides.

HEAT-TREATMENT OF 1 PER CENT C STEEL

H. J. French and W. G. Johnson, of the Bureau of Standards, presented an excellent investigation of 1 per cent carbon steel, one largely used in tools, dies, bearings and springs, to determine the best combination for strength and ductility. If the steel is to be drawn relatively high, it should be quenched just above A_{c1} . If it

is to be drawn at 1,000 deg. F. (538 deg. C.), maximum hardness and tensile strength are had by previously quenching from 1,550 deg. F. (843 deg. C.), which is nearly up to A_{cm} . Increased time at the quenching heat acts like an increased quenching temperature—i.e., increases hardness, strength and proportional limit, but decreases ductility.

If a strength of 120,000 lb. is desired, a water-quench before drawing is preferred if the piece will stand it, on account of the higher elastic ratio resulting. If higher strength and ductility are desired at the expense of the elastic ratio, oil-quench from just above A_c . In general it is found that a certain draw (especially if low) will give a higher strength if the piece is water-quenched rather than oil-quenched. If the oil-quenched specimens are tempered higher, to give the same strength, they will have a lower hardness.

Good combinations of tensile strength and ductility may be had by high draws, especially if the steel is ground to size after heat-treatment, but the steel has low resistance to impact. Long heatings just under A_c (704 deg. C. or 1,300 deg. F.) result in a decrease of 40 per cent in Brinell hardness, even though there is little or no change in the appearance of the excess carbide.

Steels at High Temperature

An investigation was undertaken by H. J. French at the Bureau of Standards to find a good steel for use in the Haber ammonia process, requiring pressure vessels at 550 deg. C. He now reports on four normalized steels containing about 0.40 carbon, as shown below, and concludes that the chromium:vanadium alloys are the best, because they possess a high limit of proportionality at elevated temperatures, and consequently will not flow like pitch when under load. Test-machine data were recorded with a cinema, as described in CHEMICAL & METALLURGICAL ENGINEERING, vol. 24, p. 131, Jan. 19, 1921.

Steel	C	Mn	P	S	Si	Ni	Cr	V
A	0.38	0.56	0.014	0.013	0.14	.....	.....	.....
B	0.37	0.67	0.021	0.010	0.20	3.43	.....	.....
C	0.39	0.59	0.019	0.005	0.23	3.05	0.93	.....
D	0.37	0.74	0.020	0.023	0.21	.....	1.04	0.17

Breaking strengths (load at rupture divided by reduced area) are given in Fig. 1.

According to Jeffries' theory of equicohesive temperature, the fractures in the steels broken at more than about 550 deg. C. should be intercrystalline, while lower-temperature breaks should be transgranular. Microscopic examination of these breaks failed to reveal any great difference—on account of the fine-grained distorted structure it is impossible to state what is the ruling type.

Theory of Hardening

Prof. O. E. Harder, of the University of Minnesota, presented a clearly written paper emphasizing one aspect of the theory of hardening—i.e., the importance of solution and precipitation as a cause of hardness in steel and other alloys.

A great many alloys can be usefully hardened: carbon steel, many alloy steels, duralumin, and certain Al:Mg alloys. Experiments with them yield many points in common. For instance, well-made annealed pieces, when cooled at a correct rate after an appropriate heating, possess an increased hardness and exhibit a structure consisting of an assemblage of polyhedral crystals,

all alike—in other words, a solid solution. These pieces can be further hardened, sometimes by mechanical work, sometimes by further cooling, sometimes by aging at room temperature, and always at a rapid rate of tempering. This last-mentioned increase in hardness may result in no change in the microscopic appearance. Hardening steel by mild tempering causes distinct change in appearance; further and higher tempering causes a loss in hardness and the final appearance of recognizable crystals of iron carbide.

These facts all conform to the supposition that a substance which existed in the original piece is much more soluble at a high temperature than at lower, particularly at ordinary atmospheric temperature. Further facts confirm this. When a steel is originally heated, there is an absorption of heat and a contraction in volume when the separate crystals merge into one another and form the solid solution. This is exactly what happens when salt and water, etc., form liquid solutions. Carbon steels on slow cooling expand and liberate this heat of solution when the carbide is reprecipitated, as would be expected in a reversible process of solution and precipitation.

However, quenching locks the solute and solvent in a metastable condition. The tendency for the now insoluble solute to precipitate exists, but there is not the necessary internal mobility or plasticity to allow of the atomic rearrangements. Prof. Harder believes that maximum hardness ensues after this condition of false stability has changed into one of actual instability and complete precipitation of the insoluble constituent has

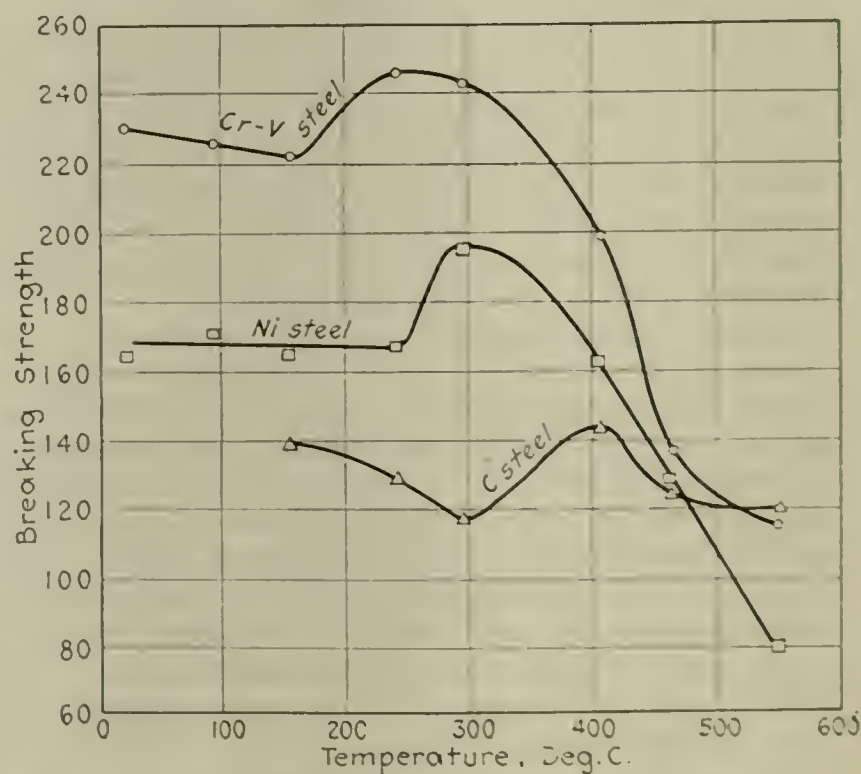


FIG. 1. BREAKING STRENGTHS OF STEELS AT HIGH TEMPERATURES

occurred in the form of the finest possible particles which can exist as separate crystalline entities. It requires several molecules to form these particles: how many is not known, but they are doubtless far too small for microscopic observation. As an instance, quenched nickel steel is austenitic; it is in the metastable state. Further cooling decreases the solubility of the carbide more and more until finally the tendency to precipitate overcomes the hindering forces, and actual precipitation of cementite occurs with the evolution of heat. The microscopic appearance now suggests martensite, and there is a notable increase in hardness. It

should be noted that the metal as a whole is too rigid to permit an appropriate increase in volume required by the combined volumes of solute and solvent; no expansion is observed and the metal is therefore under high internal stress. Prof. Harder considers that the effect of such stresses has not been given the attention its importance warrants as a principal cause of hardness.

The laws of physics indicate that these tiny particles will accumulate into larger ones if given an opportunity. Tempering allows this. Steels change in microscopic appearance and decrease in hardness (decrease in internal strain) as the particles grow. But not all of the insoluble material may have come out at one time. Jeffries and Archer's *critical dispersion*¹ is therefore thought to be that point where the softening effect of crystalline growth becomes of greater magnitude than the hardening effect of continuing precipitation of tardy particles.

Rosenhain² notes that the hardness of solid solutions is greater than that of either constituent and that it is greatest at saturation of the constituents each in the other. On the basis of this general rule, austenite may be regarded as a highly saturated solid solution, and the change into martensite (with further hardening) is an increase in the saturation, due either to a change in the solvent (gamma to alpha iron), a new solute (carbon changing into carbide), or merely a great change in mutual solubility of two unchanged substances with decreasing temperature. This only applies when martensite is regarded as a solid solution; Rosenhain's theory does not cover heterogeneous systems after precipitation has commenced.

The action of alloys in steel or other metals is thought to be principally one of retarding or catalyzing (as the case may be) the processes of solution or precipitation. Thus, in the Al:Cu alloys a compound CuAl_2 forms which is not of use in hardening until magnesium and perhaps some other metals are added which cause a greater difference in the solubility of the compound at high and low temperatures respectively.

These conceptions—that unusual hardness is associated with the presence of an intermetallic compound of variable solubility, and of the effect of additional metals in "catalyzing" the solution and precipitation processes—should be of great assistance in the search for new useful alloys. Binary systems having intermetallic compounds are the most likely ones. If the solubility of a compound does not show great variations with temperature, try whether additional metals in small quantity will not catalyze this phenomenon. Al:Fe alloys are a case in point; at present worthless, they may become of greatest value.

The Pulp Industry of Pennsylvania

The Bureau of Research of the State Department of Forestry, Pennsylvania, has just completed an initial survey of the pulp industry of the state. The capital investment is stated as \$50,000,000, with average annual value of production placed at \$60,000,000. The industry is giving employment to 7,144 persons, with total annual wages of \$12,500,000, or an average yearly wage of \$1,750. In connection with the survey, it is shown that a large amount of wood is imported annually from other states. Very little of Pennsylvania pulp, it is set forth, is utilized for newsprint manufacture.

Consumption of Coal by Principal Uses

The uses of coal are classified in the following summary issued by the U. S. Geological Survey as a portion of its weekly coal report dated July 23. Although the actual tonnages do not apply strictly to other years than 1917, the proportion probably is much the same for any typical year. In commenting on the table, the Survey issues the following comment and warning:

It must be remembered that consumption is not the same as production. Not only must exports and imports of coal be taken into consideration but the flow of coal in and out of storage must be reckoned with. Further, there is great variation in the quantity of coal actually consumed from year to year, depending to some extent on the weather and to much greater degree on the activity of the industries which are the chief consumers of coal.

The proportion of the total coal consumed, taken by different industries, does not vary so greatly, and the percentages shown in the table below are roughly constant from year to year. The table represents in a general way the conditions during 1917, a year of large consumption. The principal changes since 1917 have been an increase in the proportion exported and a transfer of some millions of tons from beehive to byproduct coke. The proportion consumed by the two types of coke ovens combined has undergone little change.

COAL CONSUMED IN THE UNITED STATES AND EXPORTED

(The figures for bituminous coal in this table represent in somewhat generalized form the calendar year 1917; those for anthracite, the coal year ended March 31, 1917)

	Quantity (Net Tons)	Per Cent
Bituminous coal:		
Industrial plants.....	174,600,000	31.7
Public utilities:		
Electric.....	31,700,000	5.8
Gas.....	4,960,000	0.9
Railroads.....	153,700,000	27.9
Domestic consumers.....	57,100,000	10.3
Power and heat at mines.....	12,100,000	2.2
Exports.....	22,900,000	4.1
Bunkers:		
Foreign trade.....	6,700,000	1.2
Coastwise and Lake trade.....	3,600,000	0.7
Beehive coke.....	52,240,000	9.5
Byproduct coke.....	31,500,000	5.7
	551,100,000	100.0
Anthracite:		
Domestic consumers (domestic sizes).....	49,400,000	55.1
Artificial gas plants.....	1,650,000	1.8
Steam trade (industries, power plants, and heating large buildings).....	18,450,000	20.5
Railroad fuel.....	6,400,000	7.1
Power and heat at mines.....	9,350,000	10.4
Exports.....	4,600,000	5.1
	89,850,000	100.0
Grand total.....	640,950,000	

Lumber Value of Pine Trees Not Affected by Turpentine*

The operation of turpentine pine trees does not lower the strength or resin content of the wood. The crude turpentine, or oleoresin, is not drained from a store in the tree, but is manufactured under the stimulus of the wound by living cells in the sapwood immediately adjacent to the cut on the trunk. No turpentine is produced by the heartwood, because all of its cells are dead. The heartwood may be saturated in places with pitch, but this does not readily flow out as does the resin freshly formed in the sapwood. The major part of the tree is not appreciably affected, and the loss due to death of trees or to a reduction or degrading of lumber is very small when the proper method of turpentine is followed; this loss is more than offset by the additional revenue obtained through turpentine.

¹CHEM. & MET., vol. 24, No. 24, p. 1057, June 15, 1921.

²CHEM. & MET., vol. 25, No. 6, p. 243, Aug. 10, 1921.

*From U. S. Forest Products Laboratory Technical Notes.

American Ceramic Society—Executive Meeting

Report of Conference of Board of Trustees, Officers of Divisions and Sections, Members of Committees and Ex-Presidents—Held to Formulate General Program of Activities for Increasing Technical Service to the Clay-Working Industries

PRESIDENT PENCE called a conference of the leaders in the American Ceramic Society at the Commodore Hotel, New York City, Sept. 15-17, for the purpose of counseling together with the new organizing secretary on methods, policies and plans of activities to be entered into for the future growth and service of the organization. The meeting opened as per schedule on the morning of Sept. 15 and Ross Purdy was elected temporary or informal chairman with the privilege of entering into the discussion. Full stenographic notes were taken at this and all subsequent sessions and are available at the secretary's office in Columbus, Ohio.

DEFINITION OF OBJECTS OF SOCIETY

Considerable discussion ensued on the definition of the objects of the society, and it was thought by some members that the aims and methods of accomplishment of them should be set forth in detail. Motion was made by Mr. Barringer and subsequently carried that the definition of the objects of the society be approved as set forth in the constitution—namely, "to advance and promote ceramic arts and sciences by meetings, publications, literature, journals and other activities."

Chart for research organization was then taken up. The term "research" was here used in the broadest sense. Eventually it was agreed that the chart should be considered a grouping of service committees, so organized under the co-ordinating council of committee chairmen that service and activities with outside agencies and associations might be greatly facilitated. This chart does not include any of the committees functioning on the strictly internal affairs of the society. It is thought these will continue to serve as in the past directly under the board of trustees. The chart as finally approved and recommended to the board of trustees of the society by motion carried in this conference was as follows:

The feature of honorary membership for those who by inventions, investigations, organization or artistic developments have merited recognition as having materially advanced ceramic art and science has been neglected for many years. The promotion from associate to active membership has been carried out at times in a careless way. The membership committee is to look up the question of honorary memberships.

The motion was carried that it was the sense of the conference that the board of trustees should scrutinize more closely the status of those to be elevated to active membership. It was further carried that the question of perpetual membership in the society wherein one fee is paid to keep the member's name forever on the roster of the society be referred to the membership committee for consideration and recommendation.

LOCAL SECTIONS

Discussion of redistricting local sections merged into talk of having the society allot dues to sections; the elimination of sections and strengthening of divisions; having permanent headquarters for divisions; types of programs for local section meetings, and development of new membership by meeting with other local bodies like the sections of the American Chemical Society and engineering societies. The motion was carried that the entire question of local section organization be referred jointly to the committee on membership and that on sections and divisions, because the interests of each are involved, with the request that they return a report.

CERAMIC SCHOOLS

The questions of ceramic trade schools, courses in high schools and art schools and clubs were considered together. A successful trade school is now operating at Trenton, N. J. Others are recommended at Zanesville, and East Liverpool, Ohio. Many high schools have art pottery courses, the total number having some sort of equipment exceeding 300. Over 2,000 teachers

CO-ORDINATING SERVICE COUNCIL

Organizing Secretary as Chairman, and Consisting of Four Other Members Appointed by the Board to Serve as Committee Chairmen 1-4

		Committee Members Appointed by	Co-operation With Other Organizations
1. Com. on Research.....	Pure Science.....	3 members appointed by board	N.R.C. div. chem. and chem. tech.; federal bureaus; semi-public, commercial and industrial labs.; universities
	Applied and Industrial.....	1 from each division	N.R.C. div. research extension; N.R.C. div. engineering; federal bureaus, etc.; industrial associations; universities
2. Com. on Standards.....	Definition.....	3 members by board	A.S.T.M. Committees C-I to C-II inclusive and D-I, D-9 and E-I; ceramic societies abroad, industrial associations, federal bureaus, etc.
	Raw Materials Specifications	3 members by board	
	Standardization of Tests.....	1 member from each division	
3. Com. on Geol. Surveys	Specification of Products.....	1 member from each division	N.R.C. div. geol. and geography; U.S. Geol. Survey and state surveys
4. C m. on Sympos'uns, Monographs, Bibliographies, Statistics.....		4 members by board	N.R.C. div. geol. and geography; U.S. Geol. Survey and state surveys
		1 member from each division	National Research Council; industrial associations; federal bureaus; commercial laboratories; universities

This council of committees will have power of recommendation to the board of trustees and will absorb several service committees which are now covering the same work. The purpose of this form of organization is wholly to aid in outside contacts and obtain co-operation between committees.

in the United States are engaged in this sort of work. Motion was carried to recommend that the board of trustees consider seriously the advisability of establishing trade schools and promoting courses in other schools. Frederick H. Rhead is to work up a brief of opinions from authoritative sources on the possibilities

for such action and bring it with above recommendation before the board of trustees.

COMMITTEE ON CERAMIC EDUCATION

The matter of ceramic education is now left to the direction of the instructional force in each university. It may be that the instructors would like to have some means of contact for advice and information as could be provided by a committee of the society. It would be very queer if the instructional force in any university would not welcome the support of a committee whose interest is general and representative of the territory outside the immediate territory being served. This committee could really study the courses, the equipment and the kind of work being done and give sound advice. The motion was carried to recommend to the board that it consider establishing a committee on ceramic education to function independently of other existing committees.

DIVISION OF ORGANIZATION

Opinion was expressed that the white ware division should be devoted to the pottery industry and electrical porcelains and others formed into a separate division. The terra cotta division is co-operating successfully with the National Terra Cotta Society. The new art division is getting under way with a program for the next meeting.

Divisions should each outline their research problems and take them up with others to try to discover the best method of attacking them. As to how they would be undertaken, whether by individual industrial laboratories, fellowships or federal bureaus, would depend largely on the type of problem. The Bureau of Mines, for instance, wants all the help it can get, whether through committees of the American Ceramic Society or other sources. Everyone interested is approached on each problem undertaken. It was decided that society committees could be of valuable assistance in promoting research for the industries in the various agencies.

The motion was carried that recommendation be made to the board of trustees that the matter of issuance of a bimonthly bulletin from the secretary's office be taken under consideration in order to determine if such a bulletin can be issued without great financial burden to the society.

ENDOWMENTS

The society should have some fixed policy regarding endowments. Plans are being formulated for the Ernest Mayer fund, and those who have it in charge desired some general expression from the conference. The consensus was that the board of trustees continue to handle endowment funds and that further ideas may be developed by the secretary's office.

A motion was carried that the secretary proceed through the present committee on European excursion to make arrangements for an excursion to England or Europe that will include all the clay-working industries in addition to the glass works.

ANNUAL CONVENTION

Arrangements of divisional meetings at the annual meeting are unsatisfactory, because a great many members would like to attend the different divisions and hear the papers. They are unable to do so because of simultaneous readings. Papers of general interest

might be given both before general assembly and divisional meetings. Abstracts should be required in order properly to place papers in divisional meetings or the general meeting, or reject them entirely. Reprints would save considerable time at the meetings as worked out by the American Electrochemical Society.

Motion was carried that it be recommended to the board to place a stenographer in each divisional meeting and in the general session to take record of discussions.

After some debate the motion was carried that an exhibition be organized for the annual convention and the society rent space to exhibitors. The exhibits can replace some advertising papers that are now given on the programs. Such papers cannot be eliminated, however, where they deal with engineering data or new developments.

The motion was carried that the society should neither establish a testing laboratory nor act as a clearing house for existing laboratories. Such institutions should advertise in the *Journal*.

CHEMICAL EXPOSITION

The motion was carried that if the board of trustees decides to have a booth at the next Chemical Exposition the matter of having exhibits be seriously considered.

PUBLICITY

Even a technical organization that is as formal as it can be, as dignified as it wishes to be, if it is to be effective, must publish the fact that it exists and the work it is doing. This applies to both internal and external publicity. It was agreed that the best type of publicity was to get news items into other journals. This is a duty of the organizing secretary.

The motion was carried to approve a publicity program involving uses of reprints and inclosures for general distribution; addresses before conventions or other associations, clubs, schools, etc.; and articles for publication in newspapers and magazines.

CENTRALIZATION OF BUSINESS ACTIVITIES

It was carried by unanimous vote to recommend to the board of trustees that the office of secretary and editor of the *Journal* be combined and that for the following year the general secretary shall act as editor.

The consensus seemed to be that the general office of the society should remain at Ohio State University, Columbus, Ohio, for the present, but that when finances permitted it might better be located in a larger business center.

The Brass and Copper Industry in Canada

An official report on the brass and copper industry of Canada in 1919 (the latest statistics to be had) gives the number of individual plants as fifty-nine—thirty-nine in Ontario, twelve in Quebec, three in British Columbia, three in Manitoba and two in New Brunswick. The total capital investment in that year was \$15,054,981, consisting of land, buildings and fixtures, \$3,099,676; machinery, tools, etc., \$3,285,942; materials on hand, stocks in process, etc., \$3,362,238; and cash, trading and operating accounts, etc., \$5,307,125.

Employees numbered 2,778 males and 343 females, to whom salaries and wages aggregating \$3,642,663 were paid in 1919. Employees earning \$30 per week and over numbered 600.

Operation of Fatty Acid Distillation Plants

Equipment of Modern Fatty Acid Distillation Plant—Preliminary Tests on a New Installation—Operating Technique for the Production of Single-Distilled and Double-Distilled Fatty Acids—Yields and Operating Costs

BY OSCAR H. WURSTER

Chemical Engineer, Chicago, Ill.

ECONOMIC conditions during the post-war period brought about a greater expansion in the fatty acid distillation industry than the country has experienced in any previous similar length of time.

In discussing the design, construction and operation of distillation plants with owners and operators many questions have from time to time been asked, the answer to which the writer has thought might be incorporated into one article.

The operation of a "going" fatty acid distillation plant with experienced operators becomes a reasonably simple matter. But to start up a new plant appears less simple to operators only partly familiar with the process. Furthermore, some of the conditions necessary for the smooth and successful operation of the plant are not always easily maintained. For the best results the system must be continuously in equilibrium—proper temperature balances must be obtained.

An inexperienced or partly experienced operator will find it useful to be able to recognize indications that the plant is not running properly, and will be further benefited by a knowledge of how to restore normal operating conditions.

We trust, therefore, that these directions and comments will be useful as simple operating instructions to the beginner, and that they will be found at the same time to be sufficiently complete and comprehensive to guide him in the best and most efficient operation of the plant as he becomes more experienced.

The writer takes this opportunity of thanking several of his friends among distillation plant operators, to whom the first draft of this paper was submitted for criticism, for useful suggestions and further questions.

CONSTRUCTION OF FATTY ACID DISTILLATION EQUIPMENT

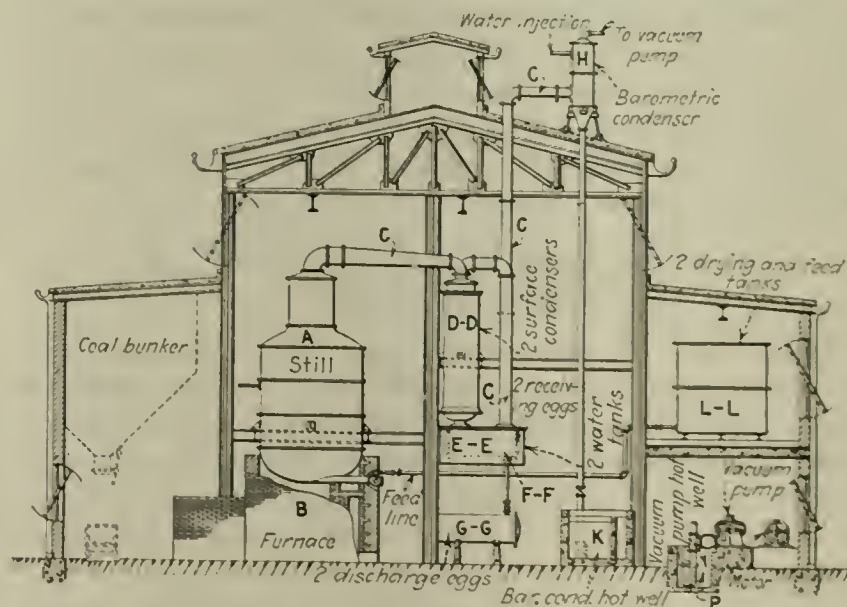
Referring to the accompanying figure, the still *A* is constructed of cast iron of sufficient thickness to give it proper strength and to insure its satisfactory wearing qualities. Being built in sections with separate bottom, cover and dome, the bottom, which receives the hardest wear, can be replaced. To facilitate this the still is carried on lugs bolted to the side of the still, leaving the bottom to hang free into the furnace. Present experience indicates the average life of a bottom to be about five years, the still lasting very much longer.

A brick furnace *B* to fire the still externally and to superheat the injected steam is built under the still. This furnace is of such design that the heat is distributed as uniformly as possible over the bottom of the still. The still bottom is designed to give a maximum heating surface. Local overheating of fatty acids tends to burn the stock, increasing the tar yield by decreasing

the yield of good distilled fatty acids and affecting the color and odor of the distillate. The superheated steam is introduced through a manifold, or "spider," with legs provided with openings placed to give a thorough distribution of steam and to circulate the contents of the still to further avoid local overheating.

Coal is at present most generally used for firing. Oil and gas are used in some plants. The latter can be applied more effectively and efficiently, thus the fuel cost is not as much greater as the difference in cost of these fuels would indicate. The greater ease with which the still temperature can be controlled and maintained uniformly is also conducive to higher yields of good distilled product.

The pitch produced in the stills has also been used mixed with crude oil as liquid fuel to fire the still and superheater furnaces. Some of the indirect methods of heating have also been used. There is, however, not sufficient difference in thermal head between the required still temperature and the temperature of the



FATTY ACID DISTILLATION PLANT

fluid heating medium in a system operating under moderate pressure to make this method a success, and when water is used as the heating medium the pressure required on the heating system is so high that further engineering problems are introduced.

A satisfactory indirect heating method—that is, one in which a fluid at high temperature would be heated at some distant point, as in the boiler room, and circulated through a coil within the still—would be very desirable. The temperature control of the still would be improved, there would be less wear on the still bottom, the furnaces and heat would be removed from the still room and fewer and more efficient furnaces could be used.

The surface condensers *D, D* are of the vertical type

and are usually constructed with copper dome, tubes and bottom chamber. The water jacket is steel. Under the condensers are placed copper expansion chambers or receiving eggs *E, E*, in which the condensed fatty acids separate from the vapor. The steam and uncondensed fatty acids pass on, while the liquid flows down to the copper discharge eggs *G, G*. When two discharge eggs are used, they can be shut off from the system alternately, the vacuum broken and the collected fatty acids pumped to storage. When but one discharge egg is used, the fatty acids are allowed to accumulate in the receiving eggs *E, E* until the discharge egg *G* is emptied.

The vapor piping *C* connecting the still, surface condensers, receivers and barometric condenser is copper. All these various pieces of equipment have been built of aluminum also, but under practical operating conditions copper has generally been found to be most satisfactory.

The steam and non-condensable gases passing the surface condensers *D, D* pass on to the barometric condenser *H*. This is usually steel or cast iron and of the counter-flow type, the vapor entering near the bottom and the condensing water near the top. The non-condensable gases and air introduced with the steam and through leaks are taken off the top of the barometric condenser *H* by the vacuum pump *S*, thus maintaining the vacuum on the entire system. A simple rotary type of vacuum pump has in recent years been found to be exceptionally satisfactory, maintaining a uniformly high vacuum, having a very large working capacity and being economical both in first cost and in operation and maintenance.

The hot-wells *K, P* and catch-basins are usually built of concrete. Cast-iron feed tanks *L, L* built in two or three sections and of large capacity are very satisfactory. The tar tank is a steel tank.

Buildings of various types are used, the most satisfactory being those of modern fireproof construction designed to fit the plant.

TESTING EQUIPMENT PRELIMINARY TO STARTING PLANT

In the case of a new installation, the usual precautions should be taken to warm up gradually the furnace brick work. Since the brick furnace can be completed some time before the still will be ready to operate, there is usually ample time to allow the brick work to dry out naturally and then to build a wood fire in the furnace for several days to dry it out thoroughly.

The equipment should be filled with water, tested for leaks under 15-lb. pressure and tightened up wherever such leaks are found. After drawing off the water, vacuum of 26 to 27 in. should be pulled and held on the entire equipment. With the entire installation in good shape, as shown by these tests, the still is ready to be put in operation.

Single-Distilled Fatty Acids

PREPARATION OF FATTY ACIDS FOR THE STILL

The "split" or saponification of fatty acids for distilling purposes should be as high as can be practically obtained—that is, 94 to 96 per cent. The fatty acids, by whatever process produced, should be thoroughly freed, by washing if necessary, of sulphuric acid, calcium sulphate (lime salts) or sodium carbonate and sodium sulphate (alkaline salts). After washing and

settling, the crude fatty acids are ready to pump to the drying and feed tanks. To dry the fatty acids thoroughly, they are heated in the drying and feed tanks to a temperature of 220 deg. F., being agitated at the same time with air. By drying under these conditions, there is positive assurance that no moisture is left in the stock. Feeding water into the hot still (425 to 550 deg. F.) causes the sudden formation of a large volume of steam, in the expansion of which stock is carried over to the condensers, causing discoloration. In other words, the still "primes over." Feeding a large quantity of relatively cold water into the still is also very likely to result in damage to the still bottom. In some of the older plants the fatty acids are not preheated in this manner, but the water is settled out by allowing the fatty acids to stand hot for longer periods of time in large wooden tanks. This requires somewhat more storage capacity and also a greater lapse of time in the preparation of fatty acids for the still. There is at the same time always a possibility of feeding some water into the still with the fatty acids, whereas if all fatty acids in the feed tank have been heated to 220 deg. F. with air agitation, it is impossible to feed water to the still from the feed tank.

CHARGING AND STARTING STILL

Vacuum is pulled on the still, and at the same time about 15,000 lb.¹ of hot fatty acids from the feed tank are fed to the still. This quantity of fatty acids will come to an inch or two of the center of the gage glass, and the level of the fatty acids should show in the gage glass throughout the entire run until running down to tar. Fire is now built under the still. (Never have fire under empty still.) Steam is turned in through the superheater. If the still is cold so that stock fed in on start is cooled below 200 deg. F., the still may be warmed up until the stock shows a temperature of 200 deg. F. or slightly above before turning in the superheated steam. At the same time fire is built in the superheater furnace. The reducing valve on the steam line is set so that the steam goes to the superheater at from 15 to 20 lb. pressure. All of the valves on the superheater sections are set wide open. The regulating is now done on the main valve next to the still. If, to provide for emergency, two valves are placed on this line, the first valve is set wide open and the regulating is done on the main valve next to the still. The same valve should always be considered as the "emergency valve," and therefore, always being wide open or closed, the seat and disk will be free from wire-drawing. The regulating valve is now so set that the steam goes to the still at about zero pounds pressure. (Whether the steam should go to the still under slight vacuum or slight pressure depends upon how the superheater sections are connected. If connected in series so that all of the steam passes through each section, then the steam may go to the still under several inches vacuum. If, however, the superheater sections are connected in parallel so that the steam is divided and a fraction of it passes through each section, then the steam should go to the still either under zero pounds pressure, or preferably 1-lb. pressure, so that the presence of steam in each section is assured, otherwise it is possible to burn out a superheater section.) A small amount of water is turned on to the

¹All figures given which are dependent upon the size and capacity of the still refer to a still 9 ft. in diameter by 17 ft. deep, with 1,000 sq.ft. of copper-condensing surface in two condensers.

barometric condenser. The surface condensers and the steel tanks containing the receiving eggs are filled with warm water.

The still temperature is brought up to about 450 deg. F. and the superheater temperature to about 550 deg. F., as rapidly as possible. As the temperature rises, some steam will condense in the surface condensers and collect in the discharge eggs, and this is blown or pumped out as necessary. Fatty acids will start to distill over at 410 to 425 deg. F. As the system heats up and rapid distillation takes place, it becomes necessary to turn on sufficient water to both surface condensers and the barometric condenser to control the temperatures properly. The water going to all condensers should have a temperature of 100 to 110 deg. F.—that is, the temperature of the cooling water going to the condensers should be slightly above the melting point of the fatty acids being condensed. (If the temperature of the water is taken at the pump on the ground floor or at some other point at a distance from the condensers, allowance must be made for further cooling.) The hot water coming from the surface condensers should be about 140 deg. F. and the water in the down-leg of the barometric condenser should be 115 to 120 deg. F. It is usually found that the cooling water temperatures of the two surface condensers can be so regulated to advantage that the water coming from the first surface condenser will be about 160 deg. F. and that coming from the second surface condenser about 130 deg. F. As the fatty acids distill over, crude fatty acids should be fed to the still to keep the level in the gage glass constant. If it becomes necessary to discontinue feeding at any time because the fatty acid level in the still is too high, then the feed line should be blown out with steam to prevent the freezing of fatty acids in the lines. If the feed tanks are located sufficiently high to get a gravity feed to the still and there are no "pockets" in the feed line, then the vacuum on still will generally draw all fatty acids from feed line if only the valve at the feed tank is closed. Care, however, should be taken that no air is drawn into still through leaks in feed line.

CONTROL OF CONDENSERS

The above condenser water temperatures are given having in mind the distillation of cottonseed oil, garbage grease and similar low titered fatty acids. The practice is to run the cooling water to all condensers at a temperature just slightly above the melting point of the fatty acids being distilled so as to prevent same from solidifying on the condenser tubes. The cooling water should be taken from the surface condensers as cold as possible to obtain maximum condensation of fatty acids, but not so cold that an excessive amount of steam will be condensed with the fatty acids—that is, 130 to 140 deg. F. (The fatty acids as blown from the eggs will contain from 10 to 20 per cent water.) The temperature of the condensing water in the down-leg of the barometric condenser should be as low as is consistent with economy in the use of cooling water, as thereby the efficiency of the vacuum pump is increased.

With higher titered fatty acids, the condenser water temperatures are increased accordingly. With stearine fatty acids, the cooling water is run to the condensers at 120 to 130 deg. F., the overflow from the surface condensers will be 140 to 160 deg. F., and the barometric down-leg will be 130 to 140 deg. F.

It is not necessary to circulate water through the steel tanks holding the receiving eggs. On the other hand, should the water in these tanks become cold, as in between runs, then it should be heated with steam, or the cold water should be run out and replaced with hot water. These tanks should preferably be equipped with a small ($\frac{1}{2}$ -in.) steam line so that the water in them can be at all times maintained at a temperature somewhat above the melting point of the fatty acids being distilled.

STEAM CONSUMPTION AND RATE OF DISTILLATION

One pound of steam, approximately, is required to distill 2 lb. of fatty acids. Instructions were given above how to set the steam valves to start operations. During the first few runs it can be determined if the proper amount of steam will be supplied in any particular installation and under local conditions with the valves set as directed. With still temperatures and steam pressure as directed and other conditions normal, if the still does not deliver its rated output, it is probably due to insufficient steam supply. In starting up a still on crude fatty acids and in redistilling single-distilled fatty acids, 1,500 to 2,000 lb. per hour should be distilled. If, on the other hand, the rate of distillation is high, condenser temperatures maintained by adequate water flow as directed and other conditions normal and an excessive quantity of fatty acid is going to the barometric condenser (as indicated by the accumulation in the barometric condenser hot-well), then it is very probable that too much steam is being turned into the still, with the result that fatty acids are distilling over at a rate exceeding the capacity of the surface condensers to condense same and some of the fatty acids pass on to the barometric condenser. In either case, proper regulation of the steam supply should be made.

COOLING WATER REQUIRED FOR CONDENSERS

Approximately 150 gal. of water per minute per still will be required when distilling at the rate of 1,000 lb. per hour. Since the rate of distillation will at times be much greater than this, correspondingly more condensing water will be required. From one-half to two-thirds of this condensing water is required for the barometric condensers, the balance for the surface condensers, the proportion, of course, depending somewhat upon the temperatures maintained in the surface condensers.

When the still is operating at a maximum capacity, the necessity for a larger quantity of cooling water can be partly offset by running the cooling water to the condensers at a somewhat lower temperature, say 90 to 100 deg. F. This, however, must be done carefully and by an experienced operator, since there is always the danger of freezing fatty acids locally in portions of the condensing system, and such local freezing occasionally results in choking up the entire system by closing the passageway for the gases and vapors.

The freezing of fatty acids in the condensers and serious choking up of the system is usually indicated first by the dropping of the vacuum on the still. Partly solidified fatty acids will show in the sight glasses over the eggs, and the flow to the eggs will gradually cease, the white solid fatty acids showing in the glass. Then, if the condensing system is examined, the vapor

pipe leading to the barometric condenser will probably be found cold and the second condenser may be cold, as well as the vapor line from first to second condenser. It will also be noted that the condensing water will leave a frozen surface condenser at about the same temperature at which it enters. The operator no doubt will note the trouble long before the first condenser closes up. To open the system, the cold water should be drained from the steel water jackets and these be filled with hot water. If an open steam line was connected into the steel jackets in the erection of the plant, it is a simple matter to turn off the water supply and turn on steam until the water boils. The water in the steel tanks surrounding the receiving eggs should be brought to boiling with open steam. The trouble, once discovered, is quickly eliminated. Should the whole system become solidly frozen through inattention, it would probably be advisable or necessary to draw the fires, but such an extreme case has never come to the writer's attention.

The discharge eggs are blown out or pumped out alternately as they fill up. We recommend pumping out the fatty acids from the discharge eggs. Blowing out with air is common practice and is also satisfactory. Blowing out with steam is not satisfactory. A 2-oz. or 4-oz. sample of the fatty acids from each egg should be taken and held for reference. This sample can either be taken at the discharge into the storage tank, or, more conveniently, from a petcock in the discharge line near the eggs.

UNIFORM FIRING INCREASES YIELD

The still and superheater furnaces should be fired uniformly and the feeding to the still should be uniform, as it is only in this way that uniform temperatures and even distillation can be maintained. With careful and sensible firing, about 100 lb. of coal per hour per still will be required for still and superheater furnaces combined. The quality of the distilled product is improved and the yield of good colored fatty acids increased by maintaining a uniform still temperature and even distillation. When operating in this manner, it will be necessary to make only slight and gradual changes in the cooling water supply. Large variations in temperature resulting from poor firing or from suddenly feeding large quantities of relatively cold fatty acids to the still interfere with the smooth and uniform distillation of fatty acids and also interfere seriously with the smooth and proper operation of the still in that it requires frequent changes in the condensing water supply.

During the first run of a new still the several valves controlling the water supply to various points in each surface condenser can be, by careful regulation, so set that they will thereafter require practically no attention, the future regulating of the water supply to each surface condenser being done entirely by the single-control valve in the line feeding the separate supply lines.

LENGTH OF RUNS VARIES WITH PITCH YIELD OF STOCK

When feeding black fatty acids to the still, from 50,000 to 125,000 lb. of stock can be fed to the still before running down to tar, this depending upon the amount of pitch obtained from the material being fed. In the case of fatty acids obtained from cottonseed oil foots, 50,000 to 60,000 lb. will constitute a run, whereas

with fatty acids from garbage grease or low-grade animal fat from which the pitch yield is relatively low from 60,000 to 125,000 lb. stock may be run. The character of the distillate—that is, its color and odor—will indicate when it is time to run down to tar. When the distillate becomes so dark that it can no longer be classed or used as once-distilled stock, there is no object in continuing the run. Feeding to the still is then discontinued. To some extent the amount of stock fed is also controlled by the preference of the operator. Some operators prefer short runs of about 60,000 lb. yielding about 3,000 lb. pitch, with less time consumed in running down to tar.

RUNNING DOWN TO TAR

After the feeding of fresh stock to the still is discontinued, the still temperature gradually rises. The temperature of the superheated steam should be forced up accordingly. After the fatty acids can no longer be seen in the gage glass, samples should be drawn from the tar sampler regularly to determine the consistency of the residue in the still. As the still temperature approaches 550 deg. F. and the superheated steam has been forced up to about 650 deg. F. most of the fatty acids will have been distilled over and frequent samples should be taken from the tar sampler. The first samples taken will be thin and oily. As the temperature rises, the pitch will become thicker, more "rubbery," but on drawing out between the fingers will be "short" and greasy. The point at which the tar should be drawn from the still will be approached when the sample drawn will pull out in long threads and is fairly dry when worked in the fingers. So long as samples can be drawn out from the tar sampling tube, there will be no difficulty in drawing the tar from the still.

Tar from acidulated cottonseed oil foots hardens more quickly than that from garbage grease and animal greases. With the latter stocks, higher still temperatures, from 575 to 600 deg. F., must be reached before drawing pitch. Temperatures above 600 deg. F. are not required to give a hard pitch. If the still temperature rises too rapidly and shows signs of going above 600 deg. F., it should be checked by regulating the firing. When, however, a sample can no longer be drawn from the sampling tube or if the last sample drawn is fairly dry and hard when cold and draws out into long threads when pulled—in other words, is thick and viscid and rubber-like—then the pitch should be withdrawn immediately from the still. As the samples indicate that the pitch in the still is thickening and must soon be drawn from still, no fresh fuel, if coal is burned, is added to the furnaces and the temperature is maintained by breaking up and burning freely the fuel already on the grates. This will leave a relatively small amount of fire in the fire beds when it is time to draw the tar.

DRAWING TAR

The fires are drawn from the furnaces, or the burners turned off if gas or oil fuel is used, the valve on the vacuum line to the barometric condenser is closed and steam is turned on the ejector on the tar tank. The vacuum on the still starts dropping. When the still vacuum is down to zero, or at most 1 to 5 in. and a vacuum of about 20 in. has been pulled on the tar tank, the superheated steam into the still is shut off (and

the superheaters vented to the atmosphere) and the tar cock on the still opened. In making a first run, an inexperienced operator can, by hammering on the 4-in. tar line before drawing tar, familiarize himself with the clear ring of the empty pipe as distinguished from the deadened sound obtained when hammering on the tar line while the tar is running. (The flow of the tar in the tar line can also be felt by placing one end of a pencil on the tar line and pressing the teeth against the other end.)

After the vibration of the tar line ceases, showing that the flow of tar has discontinued, and the tar line rings clear and the vacuum on the still rises and equalizes with the vacuum on the tar tank, then the 4-in. cock next to the tar tank is turned so as to close off the tar tank and open the tar line discharge to the atmosphere. Steam through the superheater is again turned into the still and the still thoroughly steamed out for 10 or 15 minutes. The condensation and tar thus blown out are collected in a barrel placed under the open discharge next to the tar tank. It should be pointed out that whenever steam from the superheater to the still is shut off while there is fire in the superheater, or the superheater furnace is hot, the bleeder to the air between the superheater and the still should be opened so as to pass at least a small amount of steam through the superheater to prevent overheating or burning out.

In some plants it is not the practice to turn off entirely the superheated steam to the still while drawing tar. From 5 to 8 lb. pressure is left on the superheater. The temperatures are so high that the steam is not condensed in the tar, but passes out of the still to the condensers. The manipulation of the still at a time when the operator is extremely busy is thus materially simplified.

REGULATING CONDENSING WATER

No mention has been made of regulating condensing water while running down to and drawing tar. This is optional. Less water is, of course, required as less stock passes over, and the extent of the regulation will be determined by the source of the water supply and the possible economy which may be effected.

After the still has been steamed out, superheated steam to the still is shut off, the tar cock on the still is closed and the still is ready for another run. After the cock in the tar line next to the tar tank is turned so as to shut off the tar tank and vent the tar line to the atmosphere, then the valve on the suction line between the ejector and tar tank is closed and steam turned off of ejector. If the tar is drawn from the still very hot, say above 575 deg. F., the ejector should be left on the tar tank for an hour or so as a precaution to remove gases given off and avoid pressure developing in the tank.

Mention should be made here of the remedy in case it is found that the pitch has become too thick to flow, or has become spongy and cannot be drawn from the still. This is of infrequent occurrence and is apt to be so troublesome that after an operator has had the experience once he is quite likely to avoid a recurrence. The tar cock should be closed again or set for feeding in fresh stock, vacuum pulled on the still and several thousand pounds of fresh stock fed in. The still is fired and run for a short time, following the instructions given above for running down to tar. In

this way the heavy, thick pitch is dissolved and thinned down with the fresh stock, and most of the latter is recovered in the subsequent distillation. While running down to tar the second time and before drawing same, the tar line should be blown out with steam to make sure that the line to the tar tank is open.

If the still is allowed to stand with thick tar in it, several days must elapse before the still cools sufficiently to work in it and then it is an extremely slow and tedious job to dig out the tar and clean the still and steam distributing system.

FILLING OFF TAR FROM TAR TANK

The tar can be drawn from the tar tank any time after several (5 to 6) hours' cooling. If fairly hard, care should be taken not to leave it in the tar tank so long that it will not flow freely. At a temperature of 300 to 350 deg. F. the tar will flow and not froth in the barrels or drums. The tar tank is provided with a small furnace in which a fire can be built to take the chill out of the setting and tank. The fire built under this furnace should at no time be greater than that obtained by burning one or two barrel staves. Too hot a fire may injure the tar tank, since there is no circulation on the inside. In other words, the fire is used merely to warm the setting and tank, to keep cold tar from building up in the tank, and not to attempt to heat the tar after same has cooled. This can be done only by running in a fresh batch of hot tar on top of the cold tar in the tank. The tar is usually filled into caustic drums or tight tierces. Barrels should be dry to prevent frothing and are usually whitewashed by rinsing with limewater to make them strip easily.

The gases given off by the hot tar in the tank are flammable, and together with the air in the tar tank form an explosive mixture. Therefore, do not use a red hot bar to open the passageway through the tar cock, should it become plugged. Use a warm bar, or close the tar cock and build a slow fire under the outlet nipple and cock until same are warm. Remove the fire before opening the cock. If for any reason the manhole cover is removed from the tar tank, no open flame or lantern should be brought near. Do not use air pressure in tar tank to force out the tar.

Double-Distilled Fatty Acids

The general instructions applying to the operation of the still in making single-distilled fatty acids apply to the operation in making double-distilled. The length of the run is, of course, considerably increased, since there is very little pitch (from 1 to 1½ per cent) obtained in running from single-distilled to double-distilled.

PREPARATION OF FATTY ACIDS

In making double-distilled fatty acids, once-distilled fatty acids are fed to the still. As collected from the first distillation, the once-distilled fatty acids contain considerable moisture. This should be allowed to settle out in the storage tank and the clear fatty acids pumped to the feed tank, where they are heated and dried, as described for crude or "black" fatty acids.

The still is started up and operated in the same way as described above for single-distilled fatty acids. Eighty thousand to 200,000 lb. of good double-distilled fatty acids is collected before the distillate darkens to such an extent that it can no longer be classed or

used as double-distilled fatty acids. When this point is reached, the distillate is blown or pumped to the single-distilled fatty acid tanks, and at the same time the feed from the single-distilled feed tanks is shut off and crude or "black" fatty acids are fed to the still. The operation of the still is now continued as described above for single-distilled fatty acids until tar is drawn and the still steamed out.

When a battery of stills is operated, it is customary to reserve certain stills for making single-distilled fatty acids and other stills for making double-distilled fatty acids. In this case, when the distillate is no longer suitable for double-distilled fatty acids, the residue remaining in the still is drawn through the tar line into one of the stills running on crude fatty acids, and the still without any further steaming out is ready to be charged anew with single-distilled fatty acids.

The advantage of this procedure when a battery of stills is being operated is that the operator is assured that no hard pitch is at any time left in the stills which are used to make double-distilled fatty acids. It is to remove any such hard tar or pitch in the still that the steaming out of the still is done in accordance with the instructions given in making single-distilled fatty acids.

With proper control and operation, it is possible to run a still distilling double-distilled from single-distilled fatty acids continuously for a week before drawing the residue over to the "black" still. At times the distillate may show signs of darkening, and one or two eggs may have to be pumped to single-distilled storage, but by easing off on the firing temporarily or feeding in fresh stock, the distillate can be brought back to the proper color.

YIELD OF DISTILLED STOCK

The yield of double-distilled fatty acids varies with the nature of the stock, with the manner in which the stock is handled and with the design and operation of the still. With fatty acids from acidulated cottonseed foots, the yield of double-distilled stock is about 85 per cent. About 12 per cent of pitch is obtained. Garbage grease fatty acids yield about 90 per cent double-distilled stock and 6 per cent tar. Other low-grade naphtha extracted greases will run slightly better than garbage grease, and pressed animal stock will give higher yields. The higher the split or saponification—that is, the less neutral oil left in the fatty acids—the higher the yield of fatty acids. The elimination of impurities by washing improves the yield. Proper design of still furnace, still and steam-distributing system is necessary to give maximum yield obtainable from a given grade of stock. The still must be operated with judgment and with careful, thoughtful attention to details. Air leaks throughout the plant must be avoided. Thus a high yield of superior color without offensive odor will be assured.

GRADING DISTILLED FATTY ACIDS

For color reading the Lovibond Tintometer is most commonly used and the fatty acids are placed in a 1-in. glass cell. Fatty acids acceptable from the color standpoint as "single-distilled" will run 35 yellow, 7 red. Double-distilled fatty acids will run 35 yellow and 4 red. There are no universally accepted standards at the present time. In a plant operated in connection with a soap factory or a stearic acid plant the fatty acids produced are brought up to the requirements of

the kettle or press room, and fatty acids distilled for sale are commonly sold on sample. In the earlier stages of a run double-distilled fatty acids will give a color test of 35 yellow and 2.5 red, or even slightly better.

COST OF OPERATION

The following costs were determined by the writer the early part of the present year in a two-still plant which had been recently installed and put in operation:

COST OF OPERATING TWO FATTY ACID STILLs			
Material and Labor Cost:			
20-hp. water circulating pump motor	} at 2½c. per kw.	\$1.33	
50-hp. vacuum pump motor			
1,000 lb. steam per hour		.50	
300 lb. coal per hour at \$4 per ton*		.60	
1 fireman		.45	
1 still man		.60	
1 helper		.40	
Cost per hour		\$3.88	
Cost per 24-hour day			\$93.12
Overhead, etc.:			
Depreciation per day on stills and equipment, total \$55,000 at 10 per cent per year		\$18.00	
Depreciation per day on building, \$55,000 at 3 per cent per year		6.00	
Interest on investment—building, \$55,000; equipment, \$55,000; land, \$8,000; total, \$118,000 at 6 per cent		24.00	
Insurance at \$150 per year, per day		.50	
Interest per day on inventory of \$75,000 at 6 per cent		15.00	
Overhead per day			63.50
Operating and overhead per day, producing 24,000 lb.		\$156.62	
Operating and overhead costs per 100 lb. D.D.F.A.		.65	

* Note.—The coal consumption was reduced to about 200 lb per hour, or about one-third, after the stills were insulated and the fireman became more experienced.

It will be noted that in this plant the cost of producing double-distilled fatty acids from crude fatty acids is 65c. per 100 lb. The writer knows of no reason why this cost should be any higher in any modern, properly constructed and operated plant. In the plant referred to all equipment is of the most recent and best design and, together with the installation and building, is of the very highest class.

CONCLUSION

In closing, it may be said that from the experience gained by the writer in designing and operating the many recent fatty acid plant installations, it has been possible to make very decided improvements. These apply not so much to the relatively simple basic principle of design, but rather to the perfection of numerous details which facilitate the uniformly smooth operation and proper control of the plant, centralize this control, eliminate unfavorable working conditions, simplify the duties of the operator, prevent damage to the equipment and make all parts of the equipment easily accessible.

The equipment must be substantially constructed so as to eliminate costly repairs and the more serious loss of output incident to shut-downs while making such repairs.

It is the desire of the still operator to obtain the highest possible yield of best quality distilled fatty acids at minimum cost. The writer trusts this paper may assist him in attaining that end.

German Trade With Santiago de Cuba

Imports of merchandise into the port of Santiago de Cuba from Germany in 1920 were valued at \$275,231, and were principally hardware (tools, cutlery and aluminum ware), cement, beer pianos and toys, reports Consul Clum. Dutch vessels carried about 90 per cent, American vessels about 5 per cent and Norwegian vessels about 2 per cent of these imports.

Studies of Crystal Structure With X-Rays

Apparatus for Analyzing Atomic Spacing of Metals and Crystalline Powders, Brief Notes on Its Design, Operation and Interpretation of Results—Known and Potential Scope of the Method Is Discussed

By EDGAR C. BAIN

Cleveland Wire Division, National Lamp Works

IT SEEMS conservative to predict that some very important data will soon be disclosed in the realm of physical metallurgy as a result of crystal study. While in no way encroaching upon the microscope—which has served to clear away much of the mystery surrounding the production of useful alloys and their subsequent mechanical and thermal treatment to develop desirable physical properties—the knowledge of the spacing and character of atomic arrangements in metals may find a more fundamental application.

With large and perfect crystals, the crystallographer has been able to give with surprising accuracy the form and angles of many materials. But metals are opaque and prone to exist as aggregates of polyhedral crystal grains whose contours bear no relation to crystal structure. Less has been accomplished in studying their internal structure except by the uses of X-rays developed by Laue and the Braggs.¹ Largely as the result of further development of this method by Hull,² St. John and others, it is not difficult now to study the crystal structure of almost any material.

Usually the metallurgist has not been inclined to follow out the complexities of X-ray diffraction and interference phenomena, and hence the work has been performed by physicists. But if the prospective investigator does not wish to devote the time necessary to a complete familiarity with the physics of the process, he still may be able to obtain end-results which he can utilize. If possible, he should become acquainted with the development of the method from the first "reflection" of X-rays by planes of atoms to the evolution of the present practices. But even if this is not practicable, he may accept the barest facts of crystal patterns and still derive useful information from his results. The splendid descriptive papers of Jeffries and Archer³ in this journal should furnish him such understanding.

In the author's laboratory the method of Hull² is employed. Effort has been made at all times to simplify equipment to the utmost. Such simple devices as will enable the investigator to determine atomic arrangement will be described here.

SOURCE OF X-RAYS

A universal, broad-focus, molybdenum target Coolidge tube, operated from a high-tension transformer, supplies the radiation. Its connections are shown diagrammatically in Fig. 1. The X-rays may be regarded as a form of radiation differing only in frequency or wave length from Hertzian waves (wave length 10^6 cm. to 0.2 cm.), infra red (wave length 0.031 cm. to $7.7 \times$

10^{-5} cm.) visible light (wave length 7.7×10^{-5} cm. to 3.6×10^{-5} cm.), ultra violet (wave length 3.6×10^{-5} cm. to 5×10^{-6} cm.), or gamma rays (radium radiation, wave length 1.4×10^{-8} to 1.0×10^{-10} cm.). X-rays have been produced which overlap the range of the radium radiation.

On account of the general suitability of the dominant wave length, the lower voltage required and the absence of excessive penetration, the molybdenum target is chosen. For use with some specimens the characteristics of the rays produced by the tungsten target are very suitable, however. To permit use at high capacity the broad focustube is chosen. To shorten exposures, the tube is run at limiting capacity and the sharp focus target would be locally overheated by the desired energy input. The sharp focus tube is chosen by the radiographer to give less confusion in his shadows, approximating as it does a point source.

The Coolidge tube is essentially a vacuum in which an electrically heated spiral filament supplies the available electrons which bombard a heavy target, maintained at a positive potential of several thousands of volts to the filament. This target emits X-rays of various wave lengths as a result of the electronic bombardment. The distribution of intensity in the different wave lengths is controlled by the potential maintained between the filament and the target—the higher voltage giving the shorter wave lengths. The intensity of any particular

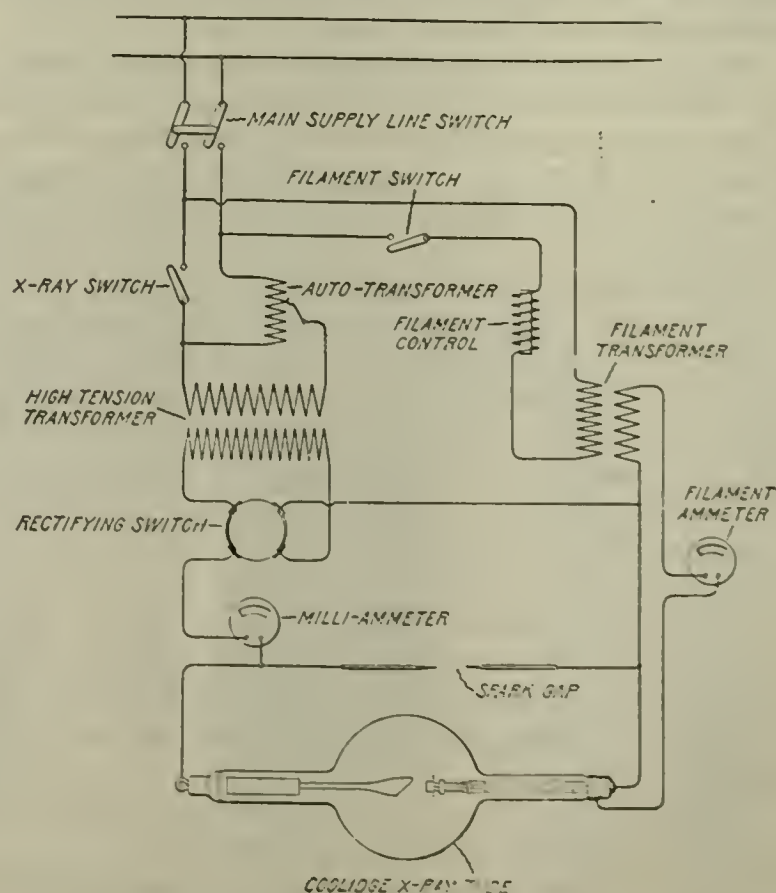


FIG. 1. WIRING DIAGRAM OF UNIVERSAL TYPE COOLIDGE X-RAY TUBE ON RECTIFIED CURRENT

¹Proc. Roy. Soc., 1913 and 1914; MET. & CHEM. ENG., vol. 15, p. 35 (July 1, 1916).

²Phys. Rev., vol. 10, No. 6, December, 1917.

³"Atoms and Metals," vol. 24, p. 507, March 23, 1921. "The Crystalline Structure of Metals," vol. 24, p. 771, May 4, 1921.

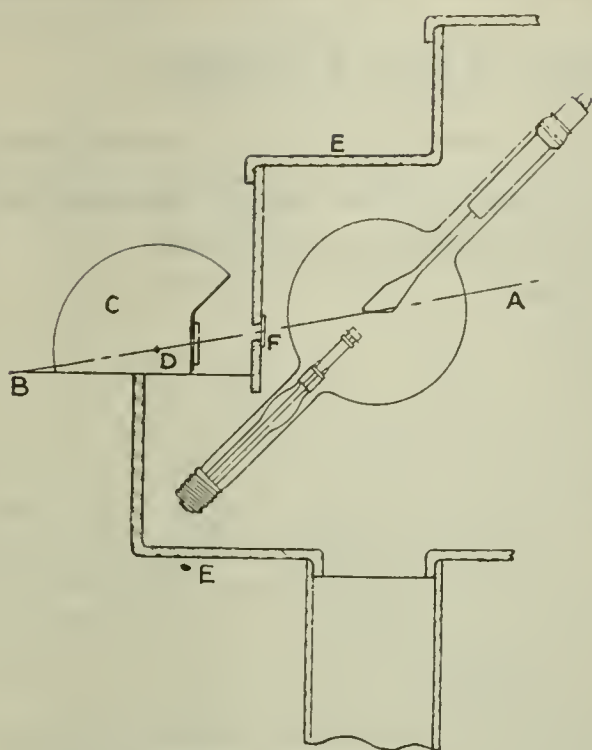


FIG. 2. DIAGRAM OF APPARATUS FOR CRYSTAL ANALYSIS

ray is controlled by the temperature of the spiral filament, and this in turn by the filament current.

The transformer should have a continuous capacity of at least 5 milliamperes at 40,000 to 45,000 volts. A small auto-transformer in the primary circuit controls the high-tension voltage. Rheostatic control is poorly suited to this type of work, but could be used with vigilant supervision. The filament may be heated by almost any steady source of 10 to 12 volts, current closely regulated by rheostat. The author finds a step-down transformer most convenient, employing a rheostat control on the primary.

The factor limiting the X-ray production is the heating of the glass comprising the tube. About 99.8 per cent of the energy of the applied wattage is transformed into heat, and in conducting this away the glass may give up traces of gas or even melt. A strong blast of air bathing the tube is very effective in raising its capacity. The author operates a tube continuously at 5 milliamperes and about 32,000 volts.

Meters are placed in the various circuits to indicate the filament current, the milliamperage of the high-tension circuit through the tube and the primary voltage across the transformer. From this primary voltage the potential backed up by the tube may be roughly estimated.

For moderate input the Coolidge tube is self-rectifying on alternating current. Very little inverse current is noticeable until the target reaches approximately the temperature of the filament, and this condition is not reached in continuous running without disastrous results to the tube. However, in the interest of accurate voltage control across the tube, a synchronous rectifier, though not essential, is conveniently placed as shown in Fig. 1.

Built-up mica preparations have been very useful as insulators in the author's equipment. Either tubes or plates may be obtained which can be adjusted to fit the contour of housing by bending under pressure while heated.

Complete installation and operating instructions invariably accompany X-ray equipment.

For crystal analysis a few thin flat beams are required and all other rays must necessarily be stopped. A complete housing of $\frac{1}{4}$ -in. lead sheet accomplishes this very

easily. It has been stated that even comparatively weak X-rays may be injurious to the human body after very prolonged exposure—so the safest scheme is to know where all the rays are emitted and arrange to absorb them positively.

Fig. 2 shows one of the author's outfits diagrammatically, and Fig. 3 is a photograph of the set-up. The target-face is horizontal, the axis of the tube at 45 deg. as shown in Fig. 2. The beams utilized (AB) lie on the surface of a flat cone springing from the target as apex, whose elements are at about 10 or 12 deg. to the plane of the target. Even the broad focus target under these conditions presents almost a "line-source" to the slits in the housing C. All slits for defining and screening the ray should be tapered—that is, smaller toward the source—to prevent the material of slit from scattering the rays, and thus interfering with the action of the beam on the specimen D.

To filter out and stop radiations of all but a narrow range—i.e., to secure monochromatism—Hull uses 0.35 mm. thickness of zirconia. The author uses a very pure sheet rubber as a filter into which the proper amount of zirconia has been compounded. The filter (F) must be placed on the inside of the screening slit, so that the latter will confine the scattered rays derived from the fluorescence induced in the filter. Zirconia is moderately transparent to the strongest molybdenum wave-length. Its fluorescence has furthermore dominant characteristic wave length (0.0690 Ang.) longer than the two shorter molybdenum lines, so that the latter are transformed into the characteristic zirconia wave-length and emitted in all directions. The screening slits prevent this general fluorescence from reaching the film. Fig. 4 shows the effect on a pattern of pure iron of filtering



FIG. 3. ASSEMBLY OF APPARATUS FOR MAKING SIMULTANEOUS EXPOSURE

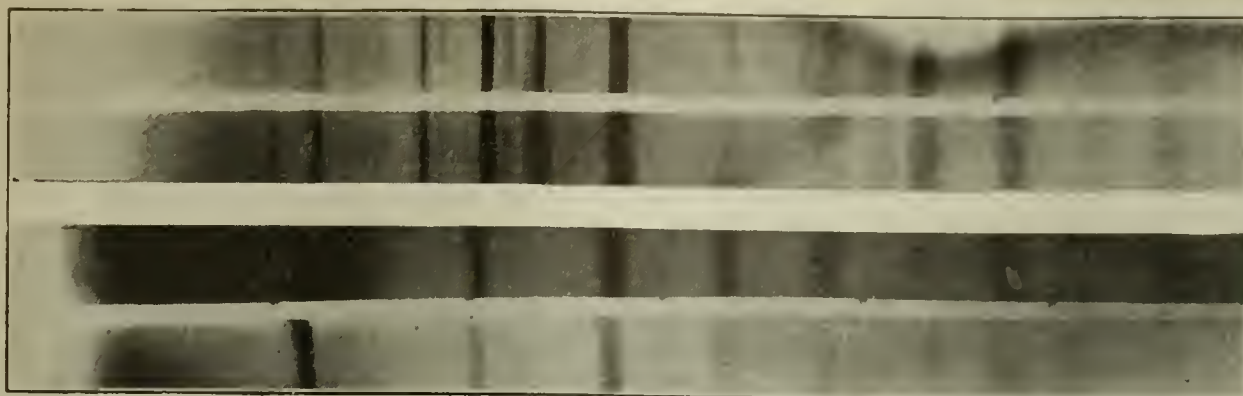


FIG. 4. SPECTROGRAM OF ALPHA IRON; WITHOUT FILTER ABOVE,
WITH ZIRCONIA FILTER BELOW

for monochromatism. As a matter of fact, the molybdenum alpha ray which is used, $0.712 \text{ \AA}$, is not strictly homogeneous, but is a mixture of two very nearly equal wave-lengths, and gives a double line with fine definition at a considerable diffraction angle. If recognized, this does not cause any ambiguity, however.

A form of screening slits is shown in Fig. 5. A wrought-iron pipe turned down and opened up supplied the material of construction. It is adjustable for width of beam, by means of the set screws shown.

An improved arrangement has been designed whereby the entire electrical equipment (tube and connections) is placed in a lead tank containing transformer oil, an arrangement which will more effectively protect the operator from accidental shock from contact with high-voltage conductors.

As will be shown, the specimen must lie at the center of a circular film. Therefore the author has built all film holders with a rigid specimen holder as an integral part. Rigid stops against which the specimen is pressed by springs keep the alignment very accurate at all times.

Two types of holders are shown in Fig. 6. The one at the left has the specimen well inside the film holder and permits use of a longer film. Also the holder is divided so that two patterns may be recorded simultaneously on one film for close comparison. The other type has an exposed and easily accessible specimen holder. Aluminum sheet 0.007 in. thick is fitted to the

¹The Angstrom unit of length (10^{-8} cm.) is a most convenient one for X-ray wave-lengths and atomic spacings.

holder in the arc of the circle; this provides a smooth resting place for the film and serves to filter out any soft rays (long wave-lengths) which may be produced by fluorescence of the sample or filter, and tends to give a more "contrasty" film. The film is conveniently placed in a black opaque paper envelope.

The author finds the duplitized film most sensitive.

A sheet of Patterson special intensifying screen is placed in the envelope on the side away from the specimen. This screen transforms much of the rays not absorbed in the film—which would otherwise be lost—into actinic light, which in turn acts upon the film to record the pattern and greatly shortens the time of exposure. Two strong rubber bands encircling the

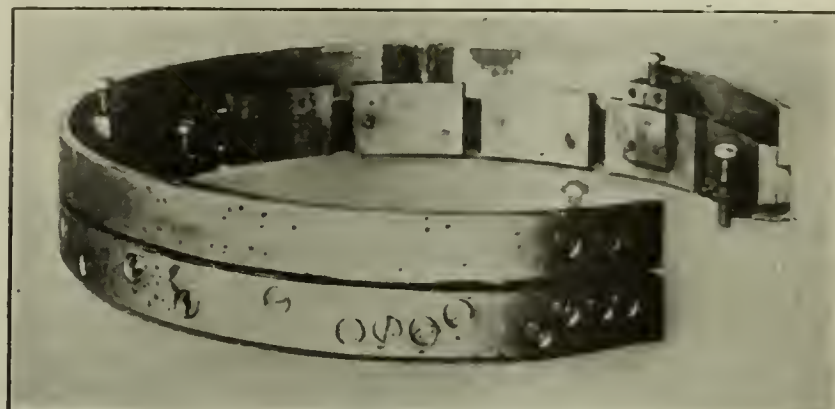


FIG. 5. SERIES OF SCREENING SLITS

whole film holder serve to maintain a very intimate contact between film and intensifying screen—a most necessary condition.

Before considering the details of apparatus further, let us see what happens to the beam as it strikes the specimen. Fig. 7 very crudely represents the diffraction of a pencil of X-rays directed upon a conglomerate of many tiny crystal units. As we desire only to measure the angles of the several diffracted beams from the main beam, we do not need to record the whole circles. If we place a narrow film in the arc of a circle about the

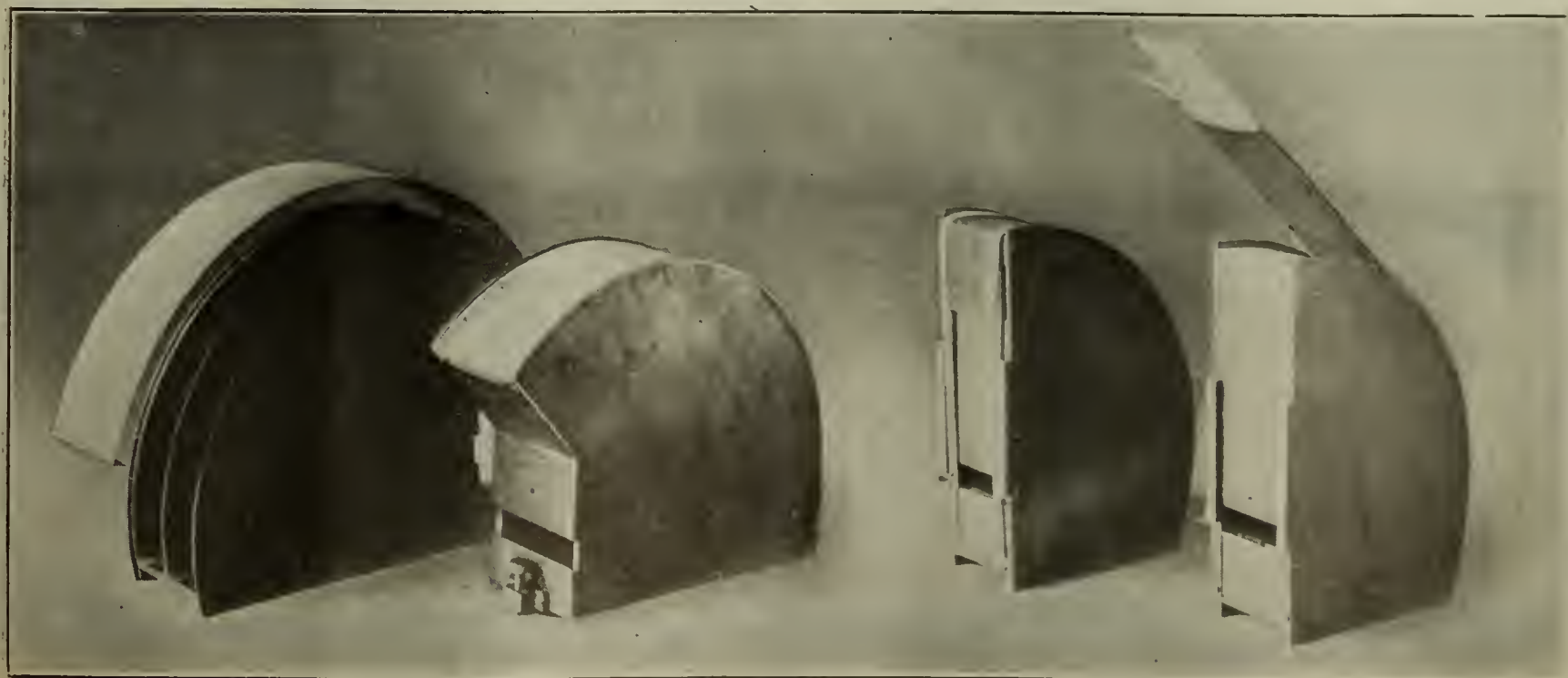


FIG. 6. TWO TYPES OF SPECIMEN HOLDERS

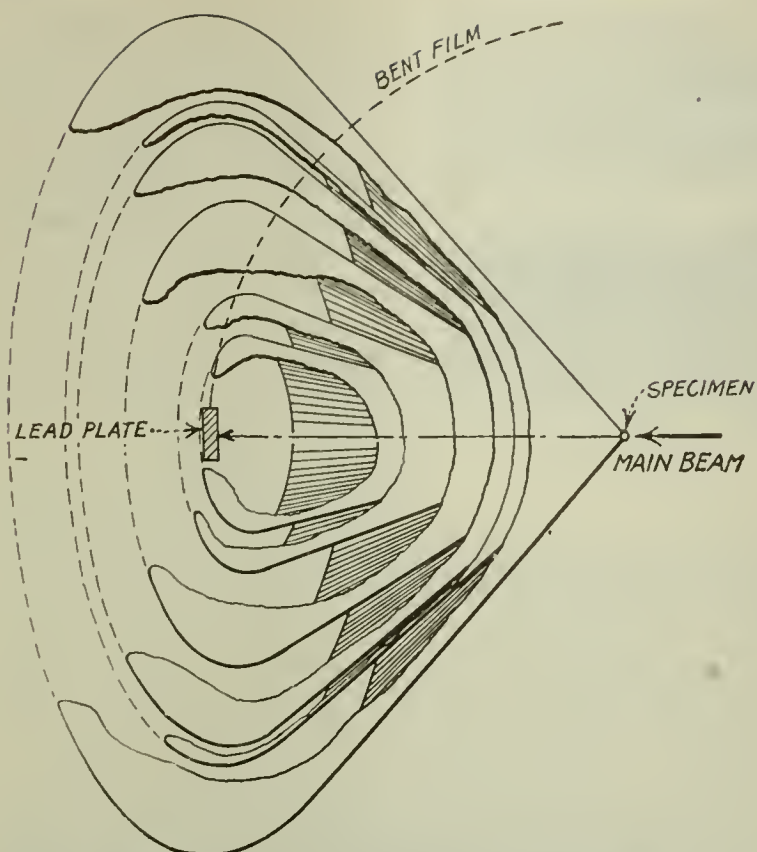


FIG. 7. CONES OF RAYS DIFFRACTED FROM A FINE GRAINED SPECIMEN (CUBIC FACE-CENTERED SYSTEM OF CRYSTALLIZATION)

specimen as center, it will give us conic intersections with a very slight curve, and angle estimation becomes only a linear measurement along the film. A convenient radius is 114.6 mm., or 4 $\frac{3}{4}$ in. In this case each degree is 2 mm. on the film. There is such disparity in intensity between the direct beam and any of the diffracted beams that enormous halation would result on the film if some means were not employed to cut down its intensity. This is accomplished by interposing about 0.025 in. of lead. It should not exceed about $\frac{1}{2}$ in. at the most in width, lest it obliterate some of the pattern. The main beam should then register with intensity comparable to the reflected lines.

With this set-up a 24- to 36-hr. exposure will yield a film which will show black lines—such as in Fig. 4.

The mechanism of the diffraction of X-rays has been described frequently and the reader is referred to Bragg's "X-Rays and Crystal Structure"; Chapter 13, "X-Rays," by G. W. C. Kaye; and A. W. Hull's paper in *Physical Review*, vol. 10, No. 6, December, 1917.

Crystallinity requires regularity in the spacing and grouping of the atoms of the material. As a corollary to this statement, we must then be able to pass systems of uniformly spaced parallel planes, through all the

atoms, or atomic groups, in a crystal, and indeed all the data we obtain are the distances between the various parallel imaginary planes. Bragg has always considered the X-rays as being reflected from these planes, and while diffraction creates the phenomenon it is vastly clearer to consider that reflection is what actually takes place. When a system of parallel planes is in a position to reflect the X-rays, it is done precisely like the specular reflection of light, in which the angle of incidence equals the angle of reflection.

Let us consider a crystal lattice with which we are very familiar, and termed the simple cubic arrangement. Rock salt, silver chloride and calcium oxide are examples of this structure. If imaginary elementary cubes be piled regularly, at each cube corner we have an atom. Three of the possible systems of parallel planes passing through all atoms of the crystal are shown in Fig. 8. The first is composed of the cube face planes—the distance between planes will be our unit. Evidently there are three planes of this sort which are indistinguishable, corresponding to the directions of the three axes of symmetry. In the second (middle) we have passed planes through one of the six possible directions containing the diagonal edges of cubes. The spacing is $\frac{1}{2}\sqrt{2}$ times the distance between planes shown to the left, and the planes are those described by Miller as the 110 plane. At the right we have passed the 111 planes, the distance apart is $\frac{1}{3}\sqrt{3}$. We could continue passing planes through the atoms until the spacing would be very thin indeed. These spacings—it is interesting to note—would continue in a series 1, $\frac{1}{2}\sqrt{2}$, $\frac{1}{3}\sqrt{3}$, $\frac{1}{4}\sqrt{4}$, $\frac{1}{5}\sqrt{5}$, $\frac{1}{6}\sqrt{6}$, $\frac{1}{8}\sqrt{8}$, $\frac{1}{9}\sqrt{9}$, etc., with only a few omissions, notably $\frac{1}{15}\sqrt{15}$.

The condition for obtaining reflection from the atomic planes is that the wave fronts originating from all atoms encountered shall be in phase, giving in effect a nearly plane front on the reflected wave. In the diagram, Fig. 9, we have this condition existing for two wavelets also having a plane wave-front, and we may derive the formula representing the relation of wave-length λ , plane spacing d and reflection angle θ . To produce a minimum of interference when the beam is reflected from two consecutive planes, the total added length of path for the second plane must be an exact wave-length or a multiple of it. From the diagram it may be seen that this added portion of the path is $d \sin \theta$ before, and the same after reflection. Hence

$$n\lambda = 2d \sin \theta$$

where n is any integer representing the order of interference. This is the fundamental equation.

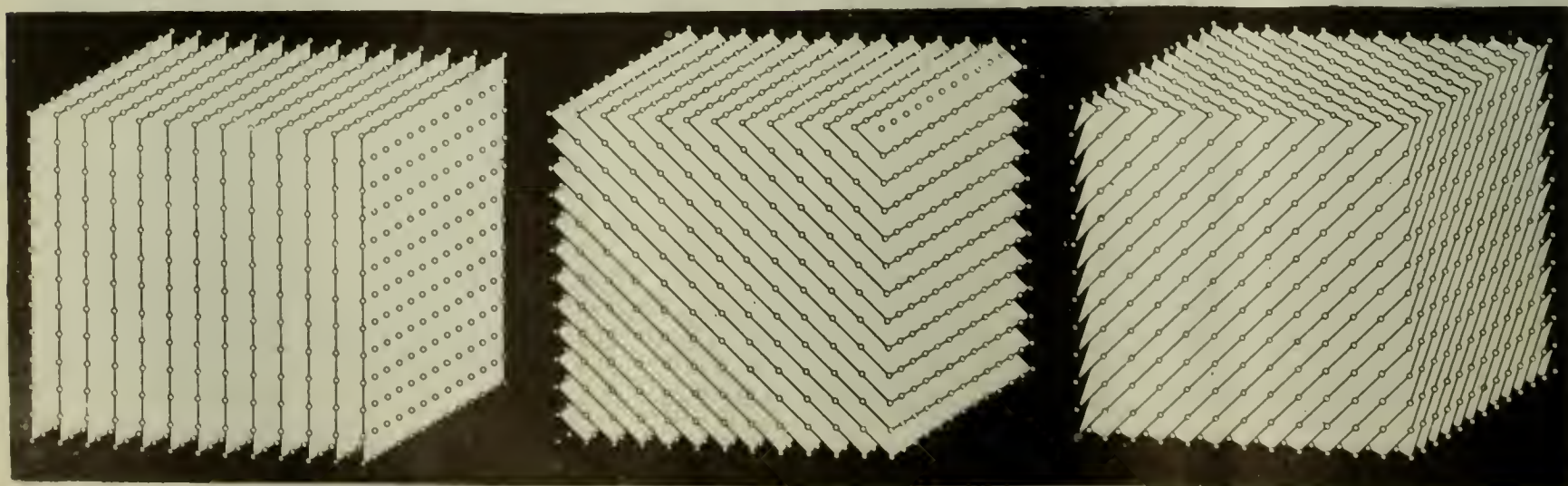


FIG. 8. THREE SYSTEMS OF PARALLEL PLANES THROUGH CUBIC ARRANGEMENT OF ATOMS

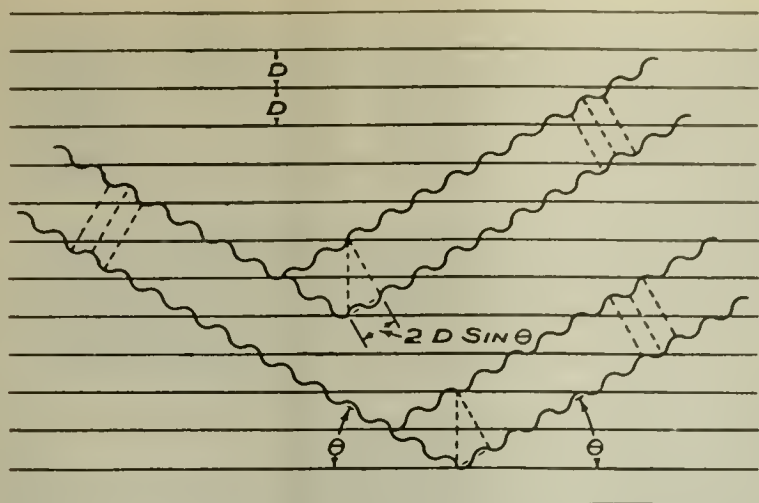


FIG. 9. REFLECTION OF TWO WAVELETS

The correct angle relations for the first three lines of a simple cubic structure of 1 Angstrom size produced by X-rays of 0.712 Ang. are shown in Fig. 10.

Obviously with a narrow monochromatic beam only one line can be reflected from one crystal at a time. But if this crystal could be rotated into every conceivable position we should obtain reflections from every plane spacing possible within the limits set by the fundamental formula. $\sin \theta$ cannot exceed 1, hence when the spacing between atomic planes is less than one-half the wave-length we obtain no reflections. Although the early investigators carefully rotated a single crystal to obtain the measure of the various possible spacings, it is much simpler to obtain many

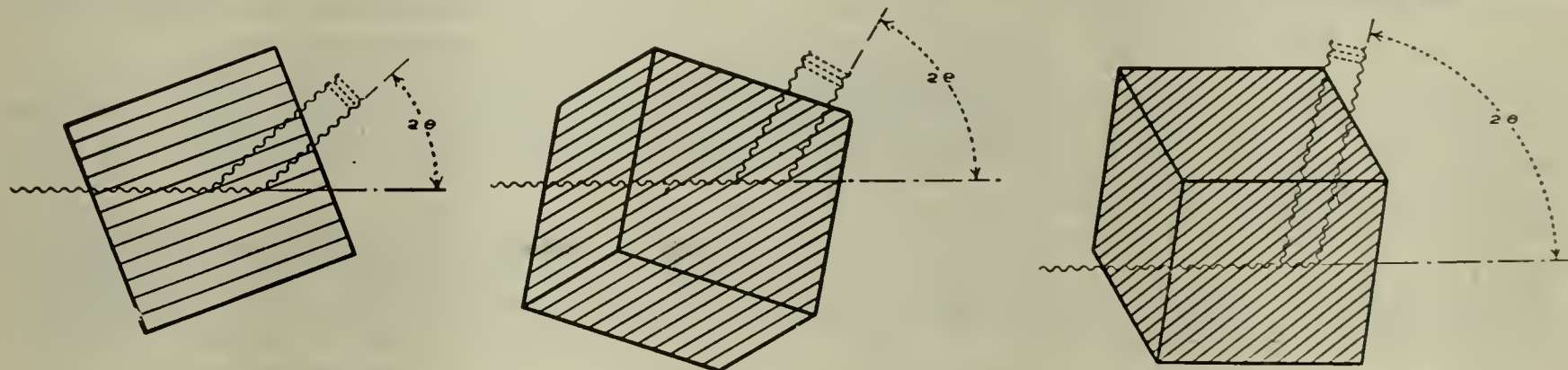


FIG. 10. CORRECT ANGLE RELATIONS FOR FIRST THREE LINES OF SIMPLE CUBIC STRUCTURE

lines from metal simultaneously by a chaotic mixture of many tiny crystals. Such an aggregate will present crystals to the rays in almost every conceivable orientation, and like planes similarly placed in various parts of the mass will co-operate in intensifying the waves reflected.

A fine-grained metal gives a good distribution of smooth lines on the film, while a coarse grained structure is spotted and shows dashed lines, as would be expected. Some months ago the author undertook a study of this phenomenon to obtain a method for grain size determination in materials for which the ordinary method of microscopic examination is inadequate.

The deciphering of a pattern on the film as complex, say, as the one for cementite (Fe_3C) represented in Fig. 11 might well seem impossibly difficult. The method used, of course, is to build up a crystalline lattice whose distances from atom plane to atom plane are such as those indicated by the pattern. The "cut and try" method is the one forced upon the investigator in a large measure, but some circumstances ameliorate this hopeless prospect. The worker in metals finds a very few crystal habits; these are largely in the cubic system, together with a few hexagonal and tetragonal arrangements. Furthermore, Hull and Davey have

added to the convenience of interpreting films by preparing a number of diagrams which show the atomic distances for a large number of possible lattices.⁵ For instance, Fig. 12, reproduced from their paper, shows the spacings for a face-centered tetragonal crystal having all possible ratios of horizontal to vertical axis between 0.1 to 1.5. It may be noted in passing that the body-centered and face-centered cubes occur on this diagram, since a face-centered tetragonal crystal with axial ratio of 0.707 corresponds to the former and an axial ratio of 1.0 to the latter.

The scale of abscissas is logarithmic, so that if the ratios between plane spacings be figured from the exposed film and plotted on the scale at the bottom of the plot, they may be compared directly without regard to the absolute dimensions. In Fig. 12 a strip of paper bears such a series of lines derived from powdered indium, and by trial it is seen to fit well into the position shown, from which it is inferred that it crystallizes in the face-centered tetragonal system, very close to cubic but elongated 6 per cent in the direction of its principal axis. Such, in brief, is the method which allows determination of crystallinity.

It may be seen now that the preparation of the sample is of great importance. For accuracy a small thread of the material about 1 mm. in diameter is preferable, but for many determinations a flat surface of cast or powdered metal placed a few degrees to the beam is desirable. The results are nearly identical whether the surface reflections are obtained or whether the pattern

is made up of the deeper reflection from a transmitted beam. The criterion is the absorption of rays by the material. "Shooting through" is desirable for materials of low atomic weight, but specimens of high atomic weight sufficiently thin for this method are difficult to produce.

If the surface is inherently different in nature from the interior, the superficial reflection may be misleading; naturally oxide is to be avoided.

Powdered crystals should pass a 200-mesh screen;



FIG. 11. REPRESENTATION OF THE FIRST FEW LINES ON THE CEMENTITE PATTERN

some materials thus finely divided still produce spots in the film. Some materials when powdered show a great tendency toward packing into a favored orientation; for instance, graphite is a notorious offender. The author mixes such materials in heavy shellac solution and stirs up the paste, which subsequently dries without any tendency to orient itself selectively. Such tiny

⁵"Graphical Determination of Hexagonal and Tetragonal Crystal Structures From X-Ray Data."

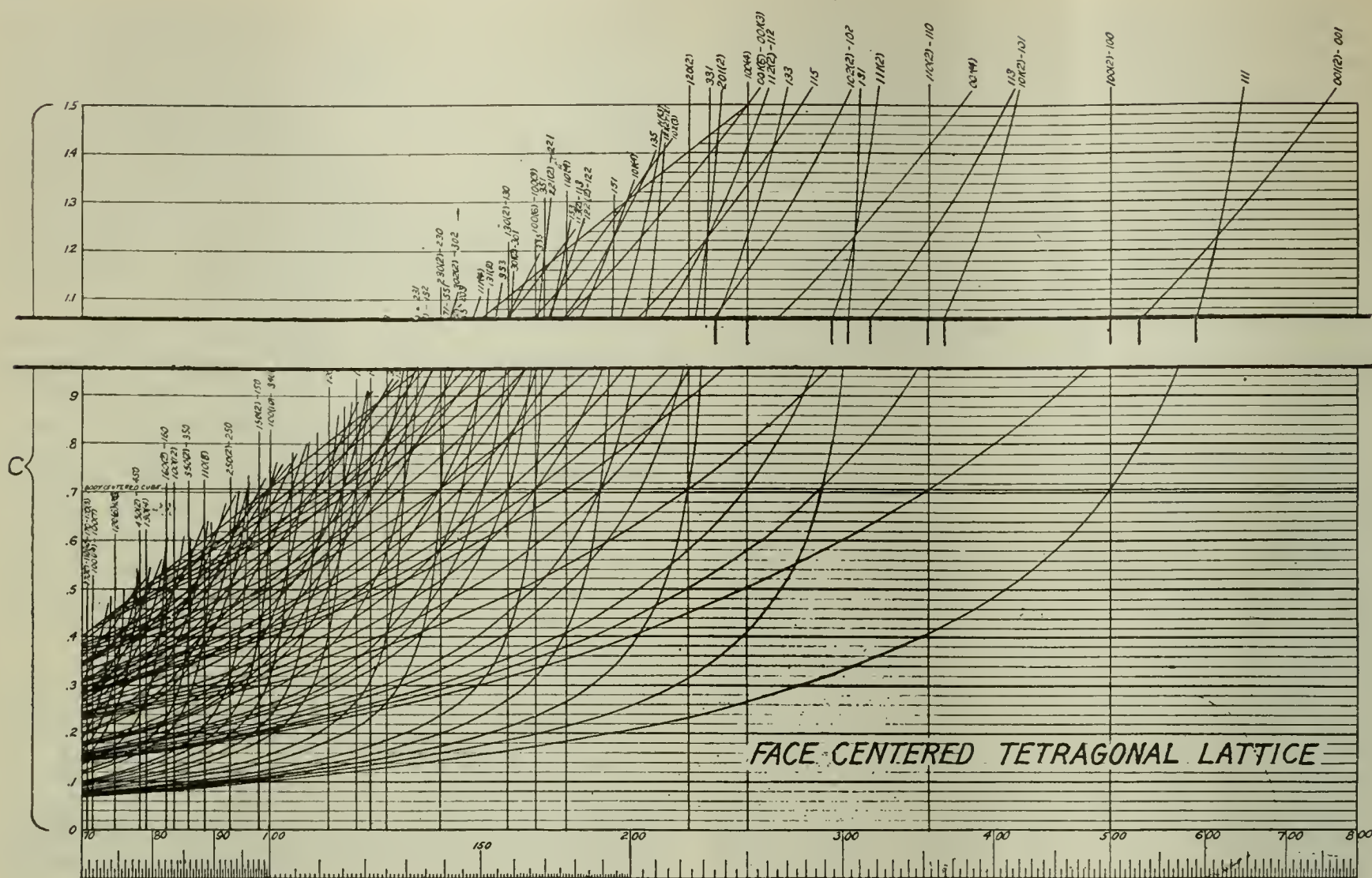


FIG. 12. INDIUM PATTERN COMPARED WITH FACE-CENTERED TETRAGONAL PLOT

briquets are frequently strong enough to use in the same manner as solid metal would be used. As small an amount of binder should be used as will adhere the mass, for any amorphous material will produce sufficient random scattering to cause a general blackening of the film.

The difference in atomic volume between some materials cannot be discerned from the patterns

the less divergent lines resulting from the wide spacings of the heavier atoms alone. Thus with AgCl we obtain only the face-centered cubic pattern of half the atoms in the compound. The reader may satisfy himself by visualizing two interpenetrating face-centered cubic lattices. The result is a simple cubic system of half the size. Fig. 13 shows this pattern along with elemental silver, and it is apparent that the spacing of the planes in elemental silver bears a fixed relation to the planes of silver chloride. In a good film there is a faint trace of the simple cubic pattern superimposed upon the face-centered pattern of the heavier material. With salts in which the atoms are of similar atomic weight such as NaF, KCl and MgO, the simple cubic pattern is dominant and only a faint trace of the pattern of the like atoms shows.



FIG. 13. PATTERN OF METALLIC SILVER (ABOVE), COMPARED TO PATTERN OF SILVER CHLORIDE (BELOW); SHOWING EFFECT OF DIMENSIONS IN SPACE LATTICE

obtained, and indeed they may conceivably be identical. Thus tungsten and molybdenum are just sufficiently different to give patterns which with fine definition do not coincide. An austenitic manganese steel pattern is indistinguishable from the pattern of nickel. But in most cases the pattern is absolutely characteristic of one substance. Hence here is a qualitative analytical method of wide application.

The applications of the method will not be discussed in this paper, but the behavior of some types of substances will give some idea of the problems which may find a solution in crystal structure study.

In the case of compounds it so happens that very often the lighter atoms are unable to "interfere out"

Fig. 14 shows comparatively the patterns of three closely related lattices of the cubic system. It is interesting to note that in all the cubic patterns obtained the versines of the angles on the film (not the half angles) bear an integral relation to one another. This becomes more obvious when one recalls the relation $\sin^2 \theta =$



FIG. 14. PATTERNS FROM THREE CLOSELY RELATED CUBIC LATTICES

a—Simple cubic; edge = 2.55 Ang. b—Face-centered cubic; edge = 2.55 Ang. c—Simple cubic formed by two face-centered lattices of size b, the new arrangement having edge = 1.275 Ang.

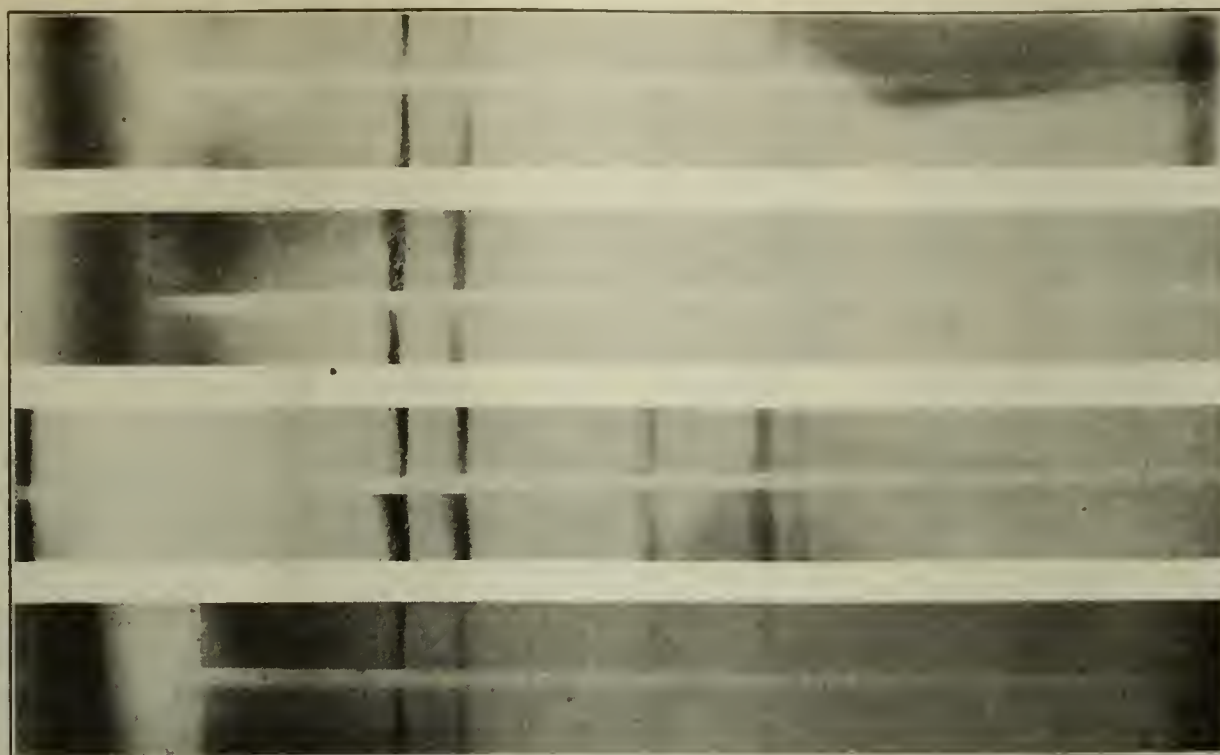


FIG. 15. NICKEL PRESERVED IN ITS SOLID SOLUTIONS
a (above)—Pure nickel. *b*—40:60 nickel:chromium. *c*—30:70 nickel:iron.
d—50:50 nickel:copper.

$\frac{1}{2} (1 - \cos 2\theta)$. In the cubic system $\sin \theta$ is proportional to the square roots of certain integers, as was mentioned in a previous paragraph. Thus this function in the face-centered pattern forms the ratios 3, 4, 8, 11, 12, 16, 19, 20, 24, 27, 32, 35, 36, 40, etc.

In the case of mixtures, the method yields a film

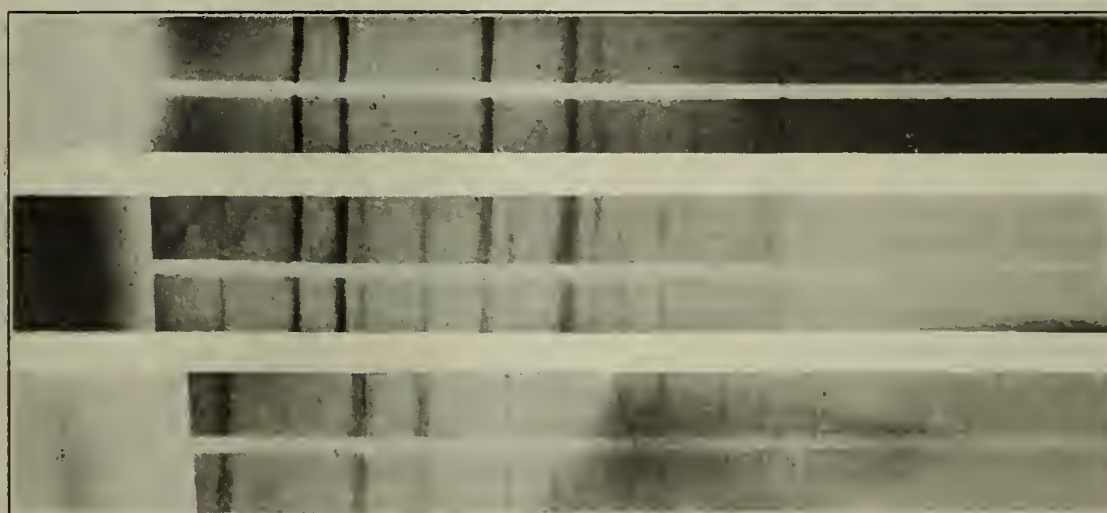


FIG. 16. ALUMINUM (ABOVE), SILICON AND THEIR EUTECTIC

which contains the characteristic lines of both materials. For reasons which are too involved for discussion some materials give weak lines with exposures that produce strong lines with other materials. Hence in mixtures we may find a great disparity in the intensity of the two patterns, which cannot be accounted for by the proportions present. However, in the case of mixture of similarly reflecting substances, the relative intensity is a fair measure of constitution. The author has been able to secure a strong pattern from a constituent which made up only about 9 per cent of the volume of the specimen and very weak lines from considerably lesser proportions. On the other hand, one material which

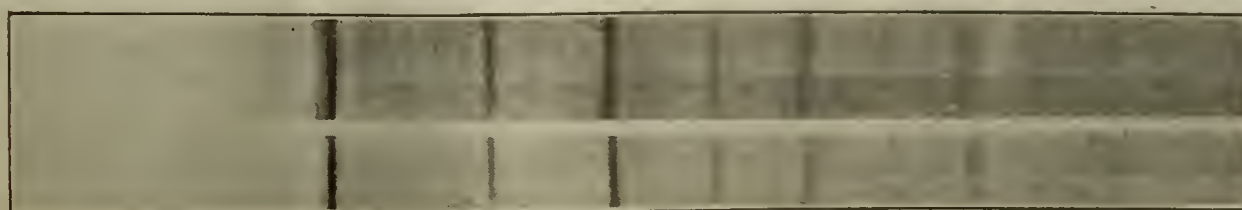


FIG. 17. WHITE CAST IRON

appeared to occupy about 40 per cent of the volume yielded no visible pattern. As a method of quantitative estimation the method holds little hope.

In Fig. 15 we may see that the lattice of nickel has not been changed by the addition of 70 per cent iron, 40 per cent copper and 60 per cent chromium. It seems likely therefore, at least in the case of metals having limited solubility in the solid, that the atoms of solute simply replace up to a certain proportion of the atoms of the solvent in more or less uniform distribution without materially distorting the lattice. Presence of additional solute creates a new phase—a new crystal lattice consisting of intermetal-

lic compound or the solute element itself containing in its lattice more or less of the solvent. If the second phase is capable of existing with composition overlapping the limit of the first, we say there is complete or continuous solid solution such as Cu:Ni or Ni:Cr.

In the case of some continuous solid solution types of binary alloys, the author was able to show the presence of two crystal lattices existing simultaneously, exactly as would be expected from certain compositions and heat-treatments. Presumably at higher temperature one of the forms might entirely disappear.

Eutectic mixtures usually show coarser grain characteristics for the pattern of one of the constituents than for the other. Fig. 16 shows the eutectic of aluminum and silicon and a faint trace of the cementite is revealed in the white cast iron of Fig. 17.

Probably one of the most striking uses of the method is the determination of allotropy. The verification of

the allotropy of iron and cobalt attracted the author immediately. There is no mistaking the difference in pattern of alpha and gamma iron represented in Fig. 18.

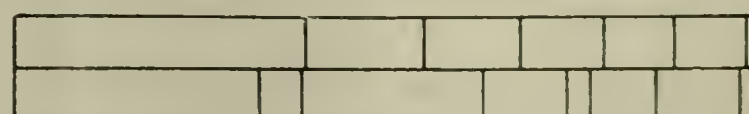


FIG. 18. PATTERNS OF ALPHA IRON (ABOVE)
 AND GAMMA IRON

Some metals severely worked in one direction produced films in which the lines corresponding to one or more spacings are extremely weak. This is due probably to the persistence of favorably oriented grains and hence a predominance of certain spacings in the beam from a particular direction.

Judging from some preliminary tests, it seems possible that some light may be thrown

upon the matter of the unusual embrittling of certain metals observed when they are subjected to nascent hydrogen or when plated out from solution in the cold. The actual number of intermetallic compounds which exist in the copper-tin-zinc series may be verified with comparative ease by the method of study applied to the problems mentioned. This work has been begun in the spectrometers of the author's equipment.

UNNOTICED POTENTIALITIES

To one who reads critically, the incompleteness and superficial character of this account will be apparent. The possible applications of the method have been much more attractive than refinement of the process, and this fact is by no means concealed in the description. One cannot but be impressed by the potentialities of an implement of research so "fine-grained" that it reveals the mode of association of the atoms themselves. With this in mind it is perhaps not surprising that illuminating information regarding the allotropy of iron and the hardening of steel has been yielded by the spectrometer in the few months since its design and installation in the author's laboratory. At any rate this comparatively new line of attack upon problems of physical metallurgy bids fair to produce some of the next set of answers to the interminable questions "how" and "why."

Notes on Aluminum Die-Castings

BY F. A. LIVERMORE

DIE-CASTING may be defined as metal castings made by forcing molten metal under pressure in a metallic mold or die. It is necessary to keep this definition in mind to avoid confusing this process with other permanent mold-casting processes.

Only alloys of comparatively low melting point have been successfully die-cast but the finished castings are extremely accurate and free from all irregularities. Aluminum die-castings not exceeding 1 in. in any direction can be cast with an accuracy of 0.0005-in., the resultant castings possessing smooth surfaces which can be polished without intermediate machining.

Die-castings in aluminum weighing 30 to 40 lb. each are now being turned out in considerable quantities. Aluminum pistons and other parts for automobile and airplane engines have been made, which are subject to severe strain at high temperatures when the tensile strength of the metal is generally very poor. Such castings would have a strong tendency to brittleness but for the characteristic high thermal conductivity as compared with iron and steel.

SUITABLE DIES AND DIE-CASTING ALLOYS

In the first attempts to die-cast aluminum the problem of obtaining a suitable die material presented serious difficulties. This problem, however, has been solved by the use of various alloy steels. The proper gating and venting of the dies are also problems that arise daily, and on the solution of these problems depends largely the success or failure of the operation. Chromium-vanadium steel is generally used, although in some cases cast-iron dies are used for castings of simple design.

Just what constitutes a good die-casting alloy is a subject of unusual interest; a few of the important requirements outside of the usual physical properties demanded of alloys are:

Solvent Action. The solvent action of the alloy on the iron containing pot and the die must not be too great. Overheated aluminum dissolves iron very rapidly. Analyses of aluminum die-castings on the market will show an iron content of from 1 to 3 per cent. Although the presence of iron in aluminum presents no serious objections in sand-cast alloys, the absorption of the above 3 per cent iron considerably raises the melting point and the alloy becomes viscous and unsuitable for making die-castings.

Elongation. The elongation of the metal is of vital importance in determining the die-casting properties of an alloy. Not only is it desirable to know the elongation of an alloy when cold, but it is of greater importance to determine the elongation at various temperatures varying from the melting point of the alloy down to normal temperatures. The reason for this becomes obvious when the physical phenomena of the die-casting process are considered. Let us assume that a ring 12 in. in diameter is to be die-cast in a metallic mold around a metallic core. When the molten metal comes in contact with the mold it changes state, solidifies, which is accompanied by a shrinkage in volume. The metallic core, not being compressible, retains its size and form, so that the die-casting is subject to a "stretching" action and if the ductility of the alloy at this temperature is not high enough to withstand this strain, the casting will crack.

It is well known that the addition of a "hardener," say copper, reduces the elongation of aluminum. An aluminum alloy containing 12 per cent of copper will show less elongation than an alloy containing only 6 per cent of copper when testing it at normal temperatures. Nevertheless the 12 per cent copper alloy has a greater elongation at high temperatures than the 6 per cent and consequently the 12 per cent alloy is better able to withstand the casting stresses to which it is subject in the die-casting process.

The zinc-base alloys are not suitable for casting in metal molds (especially if commercial spelter is used), for they absorb iron from the molds and show a striking tendency to hot-shortness. An alloy of 92 per cent aluminum, 7 per cent copper and 1 per cent manganese gives very good results for die-casting under pressure, since this alloy sets forth a practical compromise between the antagonistic requirements of low melting point, high tensile strength and ductibility at temperatures just below the point of solidification.

DIE-CASTING

The metal to be die-cast is melted in the furnace crucible and the temperature of the furnace regulated by means of a pyrometric installation, so that the alloy is kept at a uniform temperature about 10 deg. C. above the melting point of the alloy.

The assembled dies are heated to about 500 deg. F. (260 deg. C.) and fixed over the nozzle of the machine. The sprue-cutting bar is released back, thus opening the nozzle, and the metal molten is forced into the dies by air pressure.

When the mold is full the sprue-cutting bar is brought to position, thereby cutting off the supply of metal. The die is opened, the casting removed, the die reassembled and the operations are repeated.

The dies should be lubricated now and then, this facilitating the removal of the casting and protecting the die surfaces; a mixture of lard-oil, beeswax and graphite is used for this purpose.

Air Bubble Viscosimeter

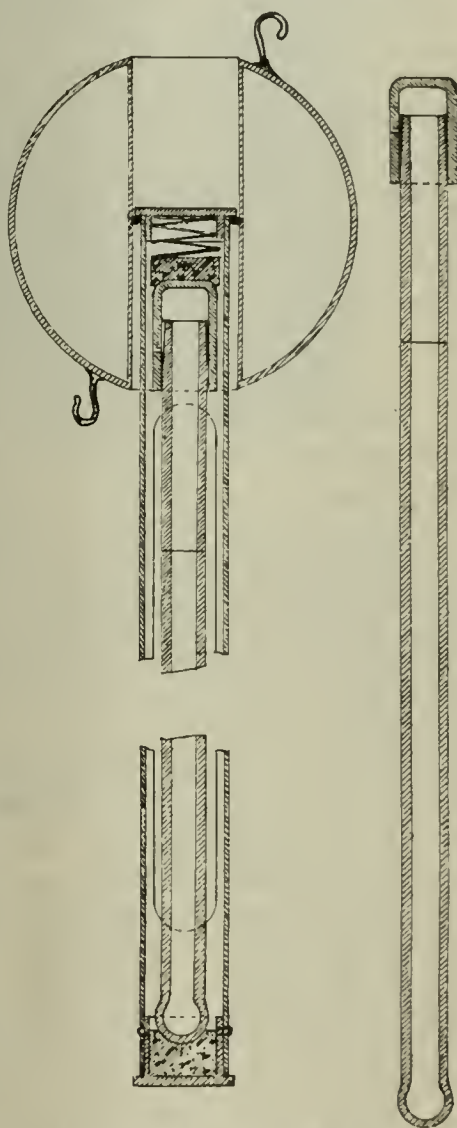
BY VICTOR R. ABRAMS,* JOSEPH T. KAVANAGH†
AND CHARLES H. OSMOND§

THE principle that a restricted air bubble, confined within a tube of definite small diameter, will move upward by influence of gravity through a mass of oil, the action being duplicate under identical conditions, and that this rate is a function of the viscosity of the oil, has been applied in the construction of a compact, portable type of viscosimeter.

This viscosimeter, named by the authors the "Atreco" viscosimeter, requires only a very small quantity of oil for operation, is capable of rapid manipulation and has an experimental error no greater than that obtained with the Saybolt Universal viscosimeter.

The instrument consists of a piece of glass precision tubing, 21 cm. long with an internal diameter of 5.2 mm. One end of the tube is sealed by blowing thereon a bulb of spherical shape about 8.5 mm. in internal diameter. The opposite end is ground with a slight taper and a cap is made to fit thereon. By grinding the cap on the end of the tube an airtight contact is made. Previous to this grinding, a small hole is made through the side of the cap for overflow when filling with oil. A "V" shaped groove is cut in the cap end of the tube to act as a trough, for outflow in conjunction with the small hole in the cap. By grinding off the end of the tube, air space in the cap can be modified, until proper size of bubble is obtained. It has been found that an air chamber which will produce a bubble 17 mm. long $\pm$ 2 mm. is very satisfactory. Two lines are etched or engraved around the external circumference of the tube, about 10 cm. apart, with the included space at the middle section of the length of the completed tube.

The tube, after being thoroughly cleaned and dried, is filled with the oil to be tested. The cap is adjusted so that the hole in its wall is over the overflow trough in the tube. The tube is now immersed in a water bath at the desired temperature of the test, allowing the cap to be above the water level. The oil will expand and escape through the overflow trough and hole. When no further expansion is noted, the cap is turned, thus sealing the tube with its contents of oil and air. The tube is then placed within its holder (see illustration) and the entire instrument is placed in the water bath.



ATRECO VISCOSIMETER

This bath should be in the form of a glass cylinder, so that the instrument is plainly visible when looking through its walls. The water bath should be maintained at the desired temperature of the test.

Invert the tube, thus allowing the bubble to rise. This first run is not recorded. As rapidly as possible make five determinations by inversion of the tube after each one, making sure that the bubble has traversed the entire length of the tube. The determination is made by observation of the number of seconds and fractions thereof that elapse between the passing of the bubble from one line on the tube to the second line, care being taken that the notation is always made at the same point of the bubble. The average of these five determinations, when multiplied by the factor governing the calibration of the tube, will give the Saybolt Universal value (seconds) of the oil at the desired temperature. The bath must be maintained at this temperature for accurate determinations.

CALIBRATION

The Atreco viscosimeter is calibrated in the following manner: A duly certified standard Universal Saybolt viscosimeter is used to obtain the viscosities of a group of oils ranging from 80 to 475 seconds Saybolt at 100 deg. F. Check runs are made of each oil until a Saybolt Universal value is obtained that can be considered accurate. Care must be taken in standardizing oils on the Saybolt instrument not to re-run the same sample, as it has been found that if the same oil is re-run a number of times, the values obtained may vary considerably. The retained samples are then tightly sealed until ready for use in standardizing the Atreco viscosimeter. The tube of the Atreco viscosimeter is now filled and the oil expanded at a temperature of 100 deg. F., as noted in method of operation, the surplus oil being forced out through the opening in the cap. The cap is adjusted to seal the tube and the tube is placed in the metal holder or container for convenient and accurate form of suspension; the instrument is immersed in a water bath kept at 100.25 deg. F. and allowed to remain a few minutes for the purpose of stabilizing temperature. The instrument is now inverted, thus causing the bubble to rise. The first run is not recorded, being made to allow the oil to wet the internal wall of the tube thoroughly. Five runs are now made (by inversion of the instrument), measuring the exact time required for the same point of the air bubble to travel from one mark to the other. The exact average of the five runs in seconds is taken as the true time. This average result divided into the Saybolt Universal viscosity gives the factor of the instrument.

For accuracy, it is advisable to take four oils with respective viscosities of 90, 130, 230 and 475 Saybolt seconds at 100 deg. F. and obtain the resultant factors. It will be noted that the factors so obtained will agree to within a few hundredths, a variation liable to experimental error. These facts apply to tubes within the dimension limits given and will show deviations as hereafter noted when other size tubes are used.

This method of calibration has proved thoroughly practical and results obtained are within the range of accuracy claimed for the instrument. The use of distilled water as a calibrating liquid is not practicable.

As shown in Table II the presence of adulterants produces no effect on the usefulness or accuracy of the instrument. It will be noted that results show deviations of approximately 0.5 per cent. and it is believed

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that by using ordinary care and technique, variations should not be more than 1 per cent of the Saybolt Universal outflow time on oils of viscosity not less than 80 seconds Saybolt Universal.

It was suggested by J. M. Maris that a pocket type viscosimeter might be developed by the application of Stokes' law, which relates to the movement of an unrestrained sphere in a mass of fluid. This was found impracticable after study, confirming results obtained by Prof. Mills in the study of measurement of viscosity by use of an air bubble. Thus the restricted bubble type of instrument was developed.

LIMITATION OF THE INTERNAL DIAMETER OF THE TUBING

The first point of consideration, after experimentation had demonstrated that a restricted bubble could be used for definite determinations, was the internal

TABLE I. CALIBRATION OF ATRECO VISCOSIMETERS FOR THEIR SAYBOLT FACTOR

Oil	Saybolt	Sec.	Tube 1 *Length, 10 cm. Diameter, 5.2 mm. Length of bubble, 17 mm.		Tube 5 Length, 9.4 cm. Diameter, 5.15 mm. Length of bubble, 17 mm.	
			Time, Sec.	Factor	Time, Sec.	Factor
1	86.8		8.4	10.33	9.6	9.04
2	145.6		14.1	10.32	16.2	9.00
3	229.0		22.2	10.31	25.5	9.00
4	475.2		46.1	10.31	52.7	9.02
			Tube 18 Length, 9.95 cm. Diameter, 5.2 mm. Length of bubble, 17 mm.		Tube 19 Length, 9.95 cm. Diameter, 5.3 mm. Length of bubble, 17 mm.	
			Time, Sec.	Factor	Time, Sec.	Factor
5	92		7.9	11.64	7.3	12.60
6	146.6		12.6	11.63	11.6	12.63
7	234.6		20.1	11.66	18.5	12.68
8	475.2		40.8	11.64	37.6	12.63

* Length distance between etched lines.

diameter of the tubing. Precision tubing was found essential for accurate results. Tubing with an internal diameter of from 3.0 mm. to 7.0 mm. was tried, but it was found necessary to limit the internal diameter to 5.0-5.6 mm. in order to operate practically with both high and low viscosity oils.

The final procedure was the selection of a proper sized tube to give a definite relative value to the Saybolt viscosity. Many trials were made with tubes of the following internal diameters: 5.0, 5.1, 5.2, 5.3, 5.4, 5.5 and 5.6 mm., using the same length of bubble and under as nearly identical conditions as possible.

Results showed that the tubes with an internal diameter of 5.0 and 5.1 mm. had factors which decreased as the viscosity increased; tubes with an internal diameter of 5.4, 5.5 and 5.6 mm. had factors which increased as the viscosity increased, but tubes with an internal diameter of 5.2 and 5.3 mm. had factors which produced results differing by not more than the experimental error.

The limits for the internal diameter of the tube were therefore determined to be 5.2 and 5.3 mm. A tube of internal diameter within these limits gives variations which compare with Saybolt variations for the same oil, thus yielding values which may be converted into Saybolt seconds by use of a constant factor for each tube. The time of operation of a tube of this diameter is neither too short for accuracy nor too long for convenience.

The middle section of the glass tube was chosen for observation to eliminate possible end effects and to allow sufficient time for the bubble to assume a constant condition.

The end of the tube was blown with enlargement,

corresponding to the cap end, in order to retard the bubble and thus permit sufficient time for proper observation.

Constant volume of the bubble is obtained by provision of the overflow at cap end of the tube and through the small hole in the cap. This constant volume was considered necessary for proper operation.

Observation of a tube in operation shows that the passage of the bubble upward is made possible by the displacement downward of a volume of oil equal to the cross-sectional area of the bubble times the distance swept through. This displacement takes place as an annular flowing film surrounding the bubble and produces a capillary corresponding to that in a short tube viscosimeter. As far as can be observed this capillary film is of uniform thickness for any definite condition when the tube is in a vertical position, but its uniformity is rapidly destroyed and the movement of the bubble accelerated by any small variation from the vertical.

Table I shows the results obtained in the calibration of four separate Atreco viscosimeter tubes for their Saybolt factor. Table II shows typical results obtained, using four separate instruments and a number of oils covering a Saybolt viscosity range of 90 to 476 at 100 deg. F.; the error in seconds between the actual determination and the factor determination; the absence of any effect upon the results when mineral oils containing adulterants, such as may be used in compounded oils, re tested.

USES OF THE INSTRUMENT

This instrument is applicable in a number of cases where small samples of oil only are obtainable. The average tube requires for operation about 4 c.c. of oil.

Another use for this instrument is the obtaining of the viscosity-temperature curve of an oil in a relative short time as compared with the usual method. As the results of the Redwood, Engler and Barbey instruments are all convertible to the Saybolt values, it can readily

TABLE II. COMPARATIVE RESULTS OF ATRECO AND SAYBOLT VISCOSITY

Oil	Time, Sec.	Tube 1 Factor 10.3			Time, Sec.	Tube 5 Factor 9.00		
		Atreco Visc.	Saybolt Visc.	Dif.		Atreco Visc.	Saybolt Visc.	Dif.
1	8.4	86.5	86.8	0.3	9.6	86.4	86.8	0.4
2	14.1	145.2	145.6	0.4	16.2	145.8	145.6	0.2
3	22.2	228.7	229.0	0.3	25.5	229.5	229.0	0.5
4	46.1	474.8	475.2	0.4	52.7	474.3	475.2	0.9
9*	9.0	92.7	92.7	0	....	....	....	....
10*	10.8	111.2	111.3	0.1	....	....	....	....
11*	15.0	154.5	155.8	1.3	....	....	....	....
12*	17.3	178.2	178.3	0.1	....	....	....	....
		Tube 18 Factor 11.64				Tube 19 Factor 12.63		
		Atreco Visc.	Saybolt Visc.	Dif.		Atreco Visc.	Saybolt Visc.	Dif.
5	7.9	92.0	92.0	0	7.3	92.2	92.0	0.2
6	12.6	146.7	146.6	0.1	11.6	146.5	146.6	0.1
7	20.1	234.0	234.6	0.6	18.5	233.7	234.6	0.9
8	40.8	474.9	475.2	0.3	37.6	474.9	475.2	0.3

* Compounded specially for test.

be seen that a conversion factor may be determined to give results comparable to any of these instruments.

There is also the possibility of the use of the Atreco instrument in the field, or where the laboratory methods are not possible or practical. In this case the bath would be eliminated and the reading made at air temperature. The viscosity as obtained at this temperature might be converted into viscosity at 100 deg. F. and at least an approximate value obtained that would yield sufficient information until a more accurate determination could be made.

Laboratories of the Atlantic Refining Co.,
Philadelphia, Pa.

Resistance Type Electric Furnace Tested for Steel Melting

THE value of the arc furnace of the Heroult type in the production of the highest grades of steel has become so well known that it is now generally accepted that steel of crucible quality can be made without difficulty in these furnaces, and already a large part of the highest quality of steel is so made.

However, it has been found difficult to replace all the crucible pots on account of the difficulty in pouring ingots from a ladle without some sculling. One reason why they are still used for some high-grade steels is the convenience of the small size pots for special mixtures, allowing small heats to be poured; and the fact, as

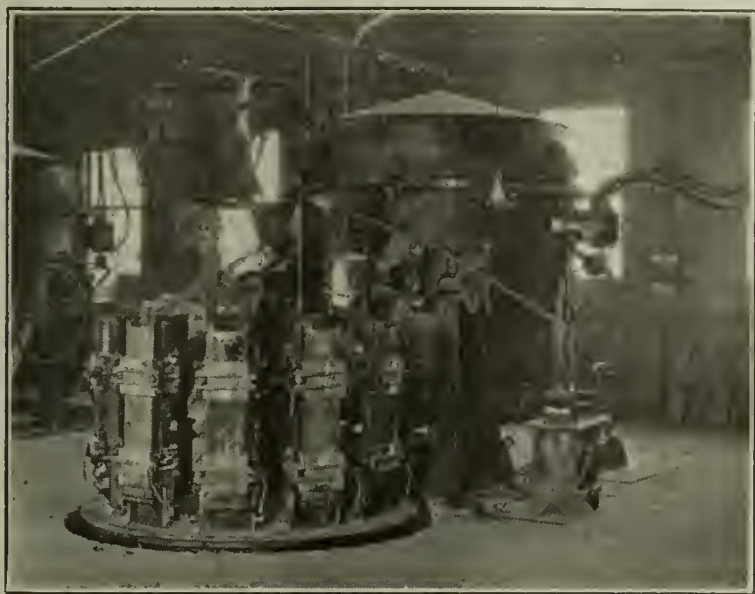


FIG. 1. BAILY FURNACE AND CASTING TABLE USED FOR MELTING STEEL

mentioned above, that the existing type of arc furnace in service requires a ladle in order to pour the charge into the molds, which gives a marked difference in the teeming temperature of the metal between the first ingot poured out of the ladle and the last ingot, as well as the loss of metal in the form of scull in the ladle.

In order to obviate these difficulties in the existing type of electric unit, the Electric Furnace Co. has recently carried out experiments in its laboratory at Salem, using its resistance type furnace, with the view to adapting it for that portion of crucible quality steel now handled in pots. The company's 1-ton furnace is built in the nose-tilting type, alongside a casting table on which molds are mounted (Fig. 1), so that the metal can be poured directly to the molds without any ladle at all, which is the practice where these furnaces are used in brass-rolling mills. This gives uniform temperature throughout the pour, eliminates the ladle entirely and makes the pouring condition analogous to that of crucible practice.

Tests showed that there was no difficulty in keeping steel of as low carbon content as 0.05 per cent at good pouring temperature. The maximum temperature obtained on the hearth was 1,850 deg. C.

The test sheets (Table I) show not only the temperature obtained but the melting rate as well. These tests and subsequent tests indicated that crucible quality steel can be made and poured in small furnaces of this type with a current consumption of not to exceed 1,200 kw.-hr. per ton, which, while much higher than the figures obtained in arc practice, nevertheless will produce steel much more economically than by crucible practice.

TABLE I. STEEL RUN TEST IN A BAILY ELECTRIC FURNACE, SALEM LABORATORY, THE ELECTRIC FURNACE CO.

Date	Time	Amp.	Kw.	Voltage	Bath Temp., Deg. F.	Meter Reading, Kw.-Hr.	Remarks
2/21/21	8 p.m.	1,040	68	60	3,002	200,454	No. 6 Cone down 3,002 F.
	9 p.m.	1,020	67	60	3,030	.....	
	10 p.m.	1,080	70	60	3,050	.....	
	11 p.m.	1,080	70	60	3,080	.....	
2/22/21	12 p.m.	1,100	70	60	3,110	.....	No. 29 Cone down
	1 a.m.	1,140	74	60	3,100	.....	
	2 a.m.	1,180	76	60	3,100	.....	
	3 a.m.	1,140	75	60	3,090	.....	
	4 a.m.	1,180	75	60	3,070	.....	
	5 a.m.	1,160	75	60	3,060	.....	
	6 a.m.	1,080	71	60	3,050	201,185	
	7 a.m.	1,160	75	61	3,060	.....	
	8 a.m.	1,120	73	61	3,080	201,333	
	9 a.m.	1,040	67	60	3,090	201,391	
	9:30 a.m.	1,000	65	61	3,100	201,421	600 lb. boiler plate scrap charged
	10 a.m.	1,260	100	75	3,080	201,462	
	11 a.m.	1,240	90	70	3,070	201,553	
	12 a.m.	1,240	92	69	3,090	201,647	
	1 p.m.	1,380	98	70	3,110	201,733	
	1:30 p.m.	1,400	100	69	3,120	201,792	400 lb. boiler plate scrap charged
	2 p.m.	1,320	95	74	3,120	201,840	
	3 p.m.	1,240	90	70	3,140	201,924	20 lb. limestone charged 4:10
	4 p.m.	980	65	64	3,090	202,009	5 lb. roll scale charged 4:40, poured at 4:52

The furnace used for the steel test was a standard 7-ft. diameter, brass-melting furnace, having a hearth capacity of 2,000 lb.; and in addition to the 4½-in. fire-brick lining used in brass melting, a 9-in. magnesite brick lining was placed directly inside. The roof was made of 9-in. silica soap shapes, and was not insulated.

Synopsis of Recent Chemical & Metallurgical Literature

Elastic Properties of Steel After Overstrain.—Research Department Report 45, issued by the Woolwich Arsenal, England, under authorship of R. H. Greaves, is abstracted in the *Iron and Coal Trades Review*, July 15, 1921. Tables I and II give an outline of the main results of the study. Samples 3 and 5 were overstrained in compression, then tested in tension, and it was found that the elastic limit had fallen almost to zero. A marked reduction in the virgin

TABLE I. ANALYSES OF MATERIALS TESTED

Mark	Material	C	Si	Mn	S	P	Ni	Cr
1	1-in. bar.....	0.34	.....	.....	.....	.....	.....	.....
2	Normalized proof shot...	0.50	0.16	0.70	0.048	0.056	.....	.....
3	2½-in. bar.....	0.77	0.12	0.34	0.03	0.027	.....	.....
4	12-in. howitzer jacket*...	0.34	0.10	0.64	0.031	0.025	3.65	.....
5	Cast 12-in. H.E. shell (heat-treated).....	0.32	0.24	0.49	0.031	0.024	2.12	1.45
6	1-in. bar, air-hardened and tempered.....	0.30	0.16	0.26	0.017	0.028	1.95	5.23

* Tested transversely.

elastic limit in tension occurred even after low-temperature annealing. Cold-drawn gun wire is also known to be more reluctant to recover its original elastic limit than the same normalized steel after less severe overstrain.

It is evident that, in general, recovery of the virgin elastic limit after overstrain in tension proceeds slowly at atmospheric temperature (in some cases very slowly) and more rapidly with increased temperature. A high-temperature softening anneal, of course, must be avoided. Time for recovery varies directly with the degree of overstrain. Rate of recovery also depends upon composition and heat-treatment (being slow for hard steels).

Interpreted in terms of the amorphous theory, the author points out that amorphous material generated at crystal-line slip planes is initially in a mobile condition, and on reloading allows the steel to acquire a permanent set at

comparatively low loads—hence the lowered elastic limit. Unloading is accompanied by a return flow of the viscous material, resulting in a greater contraction than corresponds to the elastic contraction of the crystalline material, a backward creep which sometimes continues after all load is removed. These experiments indicate a considerable

TABLE II. EFFECT OF REPEATED TESTS ON ELASTIC LIMIT

Mark	First Overstrain	Complete Recovery of Elastic Limit	Effect on Young's Modulus	Partial Recovery of Elastic Limit
(1)	1.5 per cent stretch	10 min. at 100 deg. C.	Restored.....	.....
(1)	6.5 per cent stretch	40 min. at 100 deg. C.	Small decrease	.....
(2)	Moderate stretch..	12 hr. at 100 deg. C....	Restored.....	32 mos. at atmosphere
(2)	Further and repeated stretches..	1 hr. at 195 deg. C....	Restored.....	.....
(4)	2 per cent stretch...	1 hr. at 200 deg. C....	.....	33 mos. at atmosphere
(5)	Moderate stretch..	31 mos. at atmosphere. 2 hr. at 100 deg. C.... 1 hr. at 195 deg. C....	See note 1....	.....
(6)	Moderate stretch..	See note 2.....	Restored.....	1 hr. at 350 deg. C.

NOTE 1.—Modulus, originally low, was raised after recovery from overstrain. Successive loadings caused progressive approach to the proportional line up to the load applied, the successive permanent sets tending toward zero. The proportionality reached by loading and unloading in this way was quite fictitious, as an indication of the elasticity of the material, and corresponded to a much reduced modulus.

NOTE 2.—Proportional limit very difficult to determine, but recovery not complete after 1 hr. at 350 deg. C.

variation in viscosity of this yielding material. The amorphous material "sets" or becomes rigid in some manner after a certain time, depending on the temperature. It is still thought to be non-crystalline, but in a hard, non-yielding or vitreous condition, and as such prevents further slip on the same gliding planes and stiffens the mass of the metal.

Recent Chemical & Metallurgical Patents

American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Process of Producing Formaldehyde.—The commercial production of formaldehyde from methanol by catalytic oxidation requires relatively pure raw materials and temperatures of 400 deg. C. or higher. It has been found that by using vanadium pentoxide as the catalyst it is possible to produce better yields of formaldehyde from the methanol, that the catalyst is not affected by poisons such as acetone and water, which are the common impurities of methanol, that it reacts at a sufficiently low temperature to be below the decomposition point of formaldehyde and that a large excess of air is beneficial to the reaction. A temperature as low as 225 deg. C. can be used and it is claimed that methanol containing as much as 5 per cent of acetone will give satisfactory yields. (1,383,059; George C. Bailey and Augustus E. Craver, assignors to The Barrett Co. of New Jersey; June 28, 1921.)

Manufacture of Acetaldehyde.—Howard W. Matheson, of Shawinigan Falls, Que., Canada, has patented an improved process for producing acetaldehyde on a continuous, commercial scale and without the formation of resins and condensation products of the aldehyde. It is also claimed that with the new process there is a saving in the amount of catalyst required. The process consists of passing commercial acetylene through dilute sulphuric acid, containing not more than 6 per cent of acid and a small amount of a mercury salt. The gas is passed through in greater excess than is required to form the acetaldehyde. The reaction is carried out at comparatively low temperature and pressure, thus avoiding the danger and corrosive action common to the older process. The mercury salt is very slowly reduced and does not remain in suspension in the liquid, but settles to the bottom of the reaction vessel,

where it can be easily drawn off. The large excess of acetylene carries the aldehyde out of the reaction liquid as soon as it is formed, so that it does not remain in contact with the acid a sufficient length of time, nor is it subjected to a sufficiently high temperature to form aldehyde resin or crotonaldehyde or other undesirable products. The yield of aldehyde is large, equaling almost the theoretical amount, and is produced very rapidly. (1,384,842; July 19, 1921.)

Acid-Resisting Alloy.—Colin G. Fink, of Yonkers, N. Y., assignor to Chile Exploration Co., of New York, has been granted a patent for an alloy to be used for withstanding the corrosive action of mixtures of sulphuric, nitric and hydrochloric acids such as are sometimes encountered in the acid liquors in the electrodeposition of copper. The alloy he describes contains lead, tin and thallium. The lead may, if desired, contain some hardening agent such as barium, which may be present in amounts up to 3 per cent. A typical example of this type of alloy had the following composition: lead, 70 per cent; tin, 20 per cent, and thallium, 10 per cent. The thallium content may be varied, however, from 3 to 65 per cent and as much as 25 per cent of tin may be used. (1,384,056; July 12, 1921.)

Halogenating Hydrocarbons.—If toluene or its homologues are chlorinated or brominated in the vapor stage, at the temperature of the boiling hydrocarbon, it is necessary that the reaction be carried out in strong light and in the presence of a catalyst such as sulphur or phosphorus. Furthermore there is often a loss of the hydrocarbon carried away in the acid gas evolved, and this gas is extremely corrosive to equipment. There is also a loss caused by the formation of nuclear halogenated products. In a recently patented process the halogen is introduced into the hydrocarbon while the latter holds in suspension an alkali-metal carbonate. It is claimed that the reaction is more rapid than could otherwise be effected at low temperatures and in the absence of light and in the presence of iron or other substances which act as catalysts for the nuclear halogenation. The corrosive action is minimized. The process is particularly applicable for producing such compounds as benzyl chloride, benzal chloride and benzotrichloride, with the production of but relatively small amounts of nuclear chlorinated products such as chlor-toluene. (1,384,909; Chauncy C. Loomis, assignor to Semet-Solvay Co., of Solvay, N. Y.; July 19, 1921.)

Production of Anhydrous Antimony Trichloride.—A continuous process of making antimony trichloride, which has recently been patented by Oliver C. Ralston, of Niagara Falls, N. Y., consists of passing chlorine gas through crushed antimony metal submerged beneath a bath of molten anhydrous antimony trichloride. The chlorine is supplied at a rate sufficient to maintain the bath in a molten state due to the exothermic reaction between the antimony and the chlorine. The trichloride is withdrawn from the reaction chamber in either liquid or vapor phase and subjected to subsequent distillation for refining purposes. Because of the constant presence of an excess of antimony metal, a product free from the objectionable antimony pentachloride is obtained. (1,384,918; assigned to Hooker Electrochemical Co., of New York, N. Y.; July 19, 1921.)

Canadian Patent

Leading-in Wire or Platinum Substitute.—This wire is composed of a core of a low expansion metal or alloy and an outer sheath or sleeve of copper whose coefficient of expansion is decidedly above that of glass. The resultant expansion coefficient of this compound wire is substantially the same as that of glass. One advantage of using copper as the sheath metal, besides its high electrical conductivity, is the great affinity of the copper oxide for glass in a semi-molten condition. That is to say, the copper will cement itself to the glass "hermetically" at the ordinary temperatures used in sealing-in operation. The wire is suitable for incandescent lamps, mercury arc rectifiers, etc. (Can. Pat. 212,365. Colin G. Fink, assignor to Canadian General Electric Co., Ltd., Toronto. July 5, 1921, Cf. British Pat. 23,775, 1912.)

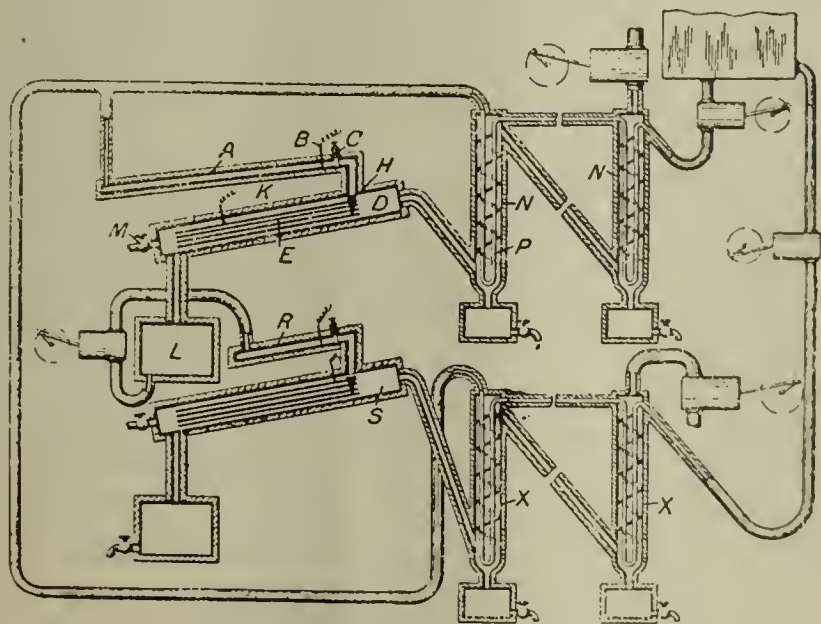
British Patents

For complete specifications of any British patent apply to the Superintendent, British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Pickling Metals.—A bath for removing scale from iron or steel articles contains ferrous sulphate and sulphuric acid. To accelerate the action, hydrochloric or nitric acid, or both, may be introduced. As an example, the solution contains 38 lb. of ferrous sulphate dissolved in 300 gal. of water and 112 lb. of sulphuric acid (sp.gr. 1.84). In addition, 16 lb. of nitric acid or 20 lb. of hydrochloric acid with 12 lb. of nitric acid may be added to the solution. (Br. Pat. 163,868. Rustproofing Syndicate, Ltd., Westminster, and T. F. Newman, London; July 20, 1921.)

Glycerine.—Glycerine is produced by fermenting sugar solutions containing a mixture of about equal weights of alkali bisulphite and sulphite. The mixed sulphites may be added in successive small quantities to a proportion corresponding to the percentage of glycerine desired, the proportion of acetaldehyde and alcohol being greater the less the proportion of sulphites; and the liquid may be maintained approximately neutral by successive additions of alkali bisulphite solution or by increasing the proportion of bisulphite in the additions of the mixed sulphites. In an example in which the maximum glycerine yield was required, 311 gal. of a solution of crude cane sugar equivalent to 788 lb. glucose was fermented by 40 lb. of yeast at a temperature of 25-37 deg. C. for nine days, and during the first five days 176 gal. of mixed sodium sulphite and bisulphite solution equivalent to 545 lb. Na_2SO_3 was added in doses first of 40 lb. and then of 30 lb. mixed salts in 16 gal. of water. In this way, 336 lb. glycerine, 172.2 lb. acetaldehyde, and 37.4 lb. alcohol were produced. (Br. Pat. 164,034. A. T. Cocking, Sutton, Coldfield, and C. H. Lilly, Birmingham; July 20, 1921.)

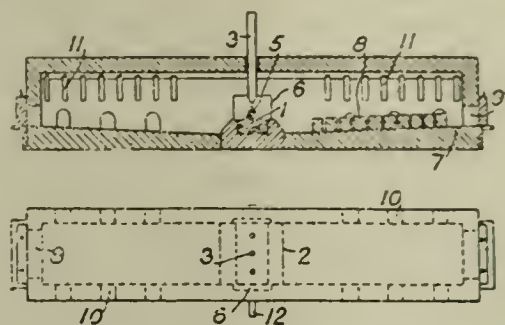
Distilling Petroleum Oils, Distillates and Tars.—In distilling petroleum oils, distillates and tars, the oil is forced by a pump through preheating tubes *P* in the condensers *N* and through a tube *A* heated by an electric coil and is admitted through a valve *C* into an evaporator *D* heated by a surrounding electric coil or by other means. The liquid is distributed by funnels *H* on to a series of inclined plates *E*.



The vapors are withdrawn by a pump, which maintains a reduced pressure in the evaporator, through a series of condensers *N* maintained at different temperatures by the pipes *P* through which the oil supply flows in series. The residual liquid from the evaporator *D* passes to a vessel *L* from which it is forced through a similar heater *R* and evaporator *S*, in which it is treated with air to yield asphalt. Vapors evolved in the evaporator *S* are withdrawn through a series of condensers *X* cooled by passage of crude oil through tubes contained within them. Steam may be admitted to the evaporator through a valve *M*. Temperature-regulators *P*, *K* are fitted to the heater *A* and evaporator *D*. In a modified apparatus, the heaters and evaporators are heated by gas or oil fuel burners, the residue from the first evaporator is passed through the cooling

coils of the condensers connected to the asphalt chamber, and is passed through an intermediate heater and evaporator before being treated to form asphalt. Cracking of the oils may be obtained by heating them above 400 deg. C. (Br. Pat. 163,363. V. C. Illing and J. Kelly, both of London; July 13, 1921.)

Electric Furnace.—A furnace of the type in which heating is effected by the combined use of arcs and resistances is provided with a floor on one or both sides of the heating zone on which a number of objects may be placed for preheating or other purposes. The arcs 5 extend between a number of vertical electrodes 3 and a bed 1 of granulated coke, graphite or the like in a trough 2 of refractory materials provided with a contact member 12. The electrodes may be arranged for direct, single-phase, two-phase or



three-phase current. Blocks 6 of carborundum or the like protect the walls of the furnace at the ends of the bed 1. A slightly inclined floor 7 extends on each side of the bed and is adapted to receive articles to be heated such as ingots 8 through door openings 9. Other openings 10 in the side walls permit the articles treated being moved relatively to the heating zone. Coils, strips or rods 11 are provided laterally of the heating zone to preheat the articles in the furnace. A trough or hearth with a taphole is provided close to the heating zone. The heat may be controlled by lengthening the arcs, disconnecting one or more electrodes or varying the voltage which is applied. (Br. Pat. 164,019; not yet accepted. I. Rennerfelt, Djursholm, Sweden; July 20, 1921.)

Reduction of Iron Ores.—Iron ore in finely grained condition is heated directly up to 1,100 deg. C. or higher—for example in a rotary kiln—and then transferred to a reduction furnace indirectly heated. Fluxes may be added before preheating or may be separately heated and mixed in the reduction furnace, to which is also added carbon or coal as is required for complete reduction of the ore. The temperature is maintained above 1,000 deg. C. but below the melting point of iron. The solid, sintered mass of iron formed is discharged, without admission of air, into another furnace, where it is melted and slag removed; the iron may be further purified and carbonized in another smelting furnace. A part of the gases liberated in the reduction furnace and consisting of carbon monoxide (and hydrogen and hydrocarbons if the fuel is coal) is burned in the heating channels of the reduction furnace, a second part is used for heating the smelting furnace, and a third part may be used for preheating the ore and fluxes by direct contact with the combustion products. (Br. Pat. 163,561. S. J. Vermaes, Delft, and Syndicaat "Electro-Staal." (The Hague, Holland; July 13, 1921.)

Removal of Dissolved Oxygen From Water.—In the removal of dissolved oxygen from water by filtration through iron filings or turnings, the layer of rust on the latter which retards complete oxidation of the filtering medium is reduced by allowing the iron and the rust to react upon each other to give ferrous hydrate. When no longer capable of rapidly absorbing oxygen, a portion of the filter bed is kept full of water until the medium becomes active again. The ferric oxide finally produced is removed from the filter by means of a current of water or steam or by stirring by mechanical means. Iron or steel filings or turnings containing from 0.5 to 6 per cent of manganese are used as the filtering medium. The manganese, acting as a catalyst, hastens the fixation of the oxygen. (Br. Pat. 164,711 and 164,712; not yet accepted. P. Kestner, Boulogne, France; Aug. 4, 1921.)

Current Events

in the Chemical and Metallurgical Industries

Chicago Section, A.C.S., Holds First Fall Meeting

The Chicago Section of the American Chemical Society held its first monthly meeting of the winter season at the City Club on Sept. 23. The paper of the evening was presented by Charles H. MacDowell, president of the Armour Fertilizer Works, and dealt with science and the coming agriculture. In treating the broad subject of conservation of national fertility in the United States the speaker showed the definite research problems ahead of the chemist. The paper will be dealt with more fully in a subsequent issue of CHEMICAL & METALLURGICAL ENGINEERING.

The Chicago Section is growing so large it has become necessary to split into divisions similar to the organization of the semi-annual national conventions. After the discussion on the principal paper of the evening was closed, the members split into two divisions, analytical and synthetic. The discussion on definite subjects was led by able speakers in each division and many members participated. Arrangements have been made for four divisional meetings at the next monthly assembly.

American Gas Association to Meet in Chicago

Although the final program of the American Gas Association's annual convention in Chicago, Nov. 7 to 12, has not been completed, the following papers are announced:

"Why Should Gas Companies Sell Their Tar to Distillers Instead of Working It Themselves?" R. P. Perry.

"Report of Committee on Disposal of Waste From Gas Plants," F. W. Sperr, Jr.

"Report of Purification Committee," A. C. Fieldner.

"Selected and Annotated Bibliography on Gas Purification," A. R. Powell and K. C. Walker.

"The Seaboard Liquid Process of Gas Purification," F. W. Sperr, Jr.

"Effect of Moisture on Activity and Capacity of Oxides for Gas Purification," W. A. Dunkley.

"What Goes On in a Water Gas Machine?" M. E. Benesh.

"Some Experiments With the Mixing of Different Gravity Gases in Holders," H. E. Bates.

"Utilization of Compressed Air in Clearing Gas Piping," J. T. Griffin.

New Oil Companies

During the month of August, new oil companies were organized with an aggregate capitalization of \$141,544,000, including all concerns with an indicated capital of \$50,000 or over. For the first time in the present year the total exceeds that of the corresponding month of a year ago; in August, 1920, the indicated investment of new companies was \$118,370,000. An aggregate of 72 companies was formed in the 1921 August period, as against a total of 69 in July, and 103 in August, 1920. For the first eight months of the present year the showing represents 686 new companies organized in this line, with a total capitalization of \$992,601,600; in the same period of 1920, 2,136 new companies were formed with an aggregate indicated capital of \$1,777,876,000.

Sweden Lifts Export Embargo on Fertilizers

The Swedish Government announces that beginning Oct. 1 the export embargo on raw phosphate and other fertilizers was lifted.

Explosion in German Saltpeter Works

An explosion occurred Sept. 23 in the saltpeter works at Kleinlaufenberg, near Karlsruhe, Germany. Several men were killed and the material damage was considerable.

Lehigh Chemical Society Meets

The first meeting of the 1921-22 season of the Lehigh Valley Section of the American Chemical Society was held in the lecture room of the chemical laboratory, Lehigh University, Bethlehem, Pa., on Wednesday evening, Sept. 28. The meeting was preceded by a dinner at 6:30 at the Bethlehem Club.

The evening was given over to a program devoted to a "Symposium on Engineering Education," with nine or ten speakers dealing with different phases of the subject, each followed by a short general discussion. Each speaker devoted about 5 minutes to his topic. The program was:

General talk, Dr. Edward Hart; "Education for Research," Dr. H. M. Ullman; "Preparatory Education," Prof. A. A. Diefenderfer; "Resume of Educational Talks, New York Meeting," Dr. E. C. Bingham; "Culture Studies for the Engineer," Prof. A. C. S. Fasig; "The College Man and Business," J. T. Baker; "The Self-Made Man," Dr. Joseph W. Richards; "Relation of the College to Industry," Prof. D. S. Chamberlain; "Preparation for Leadership," F. G. Breyer.

Gas Used Successfully Against Old Alabama

The Chemical Warfare Service is more than pleased with the showing made with gas and phosphorus bombs dropped from airplanes on the old battleship Alabama. Even without the ventilation system being in operation, it was shown that the tear gas from the bombs dropped on the ship had penetrated throughout the vessel. As a matter of fact, the whole vicinity was so heavy with tear gas that it was four hours before the boat could be boarded without masks. Even as it was, members of the observing party had frequent use for their handkerchiefs for many hours afterward. The experiment demonstrated clearly that had poison gas been used, instead of tear gas, the entire personnel of any ship would have been compelled to resort to gas masks until the ship could have been cleared of the poison, with the resulting confusion and distraction of attention from offensive duties.

Four 100-lb. phosphorus bombs struck the ship. Three hit the decks and one fell in a fighting top. The resulting spectacle is described as stupendous. The ship was quickly enveloped in smoke and flames. Burning phosphorus was sprayed over the entire ship from the bomb which lodged in the fighting top. The effect in action would have been to blind the ship completely so that it would have been unable to single out targets or to operate its anti-aircraft equipment. Had the Alabama been a hostile ship, it is certain that the phosphorus bombs would have caused a large number of casualties among those on deck.

Demonstrations also were made of flares and signals prepared by the Chemical Warfare Service for airplane use.

Civil Service Examinations

The United States Civil Service Commission announces competitive examinations for the positions noted below on Nov. 2, 1921. Vacancies at the United States Naval Academy, Annapolis, Md., at \$4.80 to \$5.04 per diem, and in positions requiring similar qualifications will be filled from these examinations.

Chemical Laboratorian (Analytical).—The duties of the appointee will be to assist in the physical and chemical laboratories, prepare solutions, set up chemical and physical apparatus, make repairs, and conduct experimental work.

Chemical Laboratorian (Metallurgical).—The duties of the appointee will include physical tests, heat treatment, and metallographic examination of metals; determination of transformation temperatures; calibration of instruments, such as pyrometers; calculation and plotting of results of tests; making sketches and drawings of apparatus.

Rubber Mills at Trenton Operating at Capacity

The different rubber mills at Trenton, N. J., have now practically all resumed operations, including those devoted to the manufacture of automobile tires and tubes and mechanical rubber goods. A survey of the plants shows the following situation:

The Bergougnan Rubber Corp., Whitehead Road, with plant devoted to tire and tube production, is giving employment to about 250 operatives, with schedule including night shift. It is expected to add additional employees to the working force at an early date.

The Ajax Rubber Co., Breunig Ave., is maintaining capacity manufacture for automobile tires and tubes. The plant is running under a 24-hour schedule, six days a week, with current production totaling about 6,000 tires in this time.

The Hamilton Rubber Manufacturing Co., Mead and Prince Sts., manufacturer of mechanical rubber goods and automobile tires, is operating on a basis of from 60 to 75 per cent of maximum capacity.

The Thermoid Rubber Co., Whitehead Road, manufacturer of automobile tires and mechanical rubber goods, is running on a basis of about 70 per cent of normal, with the bulk of production devoted to tires. It is said that other departments of the plant are showing improved conditions, including those devoted to the manufacture of belting, brake lining and hose.

The Empire Tire Co., Mulberry and North Clinton Sts., is operating at a capacity of from 60 to 75 per cent of normal.

Improved Conditions in the Glass Industry

The general improvement in conditions in the glass-manufacturing industry during the past few weeks is leading to the resumption of operations by different plants in this line in all parts of the glass-making sections of the country. Recent plant openings are:

The Jeanette Glass Co., Jeanette, Pa., has started up with two tanks in operation, to develop a capacity of about 90 per cent of normal. Approximately 900 employees have been taken on.

The Central Glass Co., Wheeling, W. Va., has resumed partial production, following a suspension of operations since July 1. About 150 men will be employed at present, and this number is expected to be increased soon.

The Bridgeport Lamp Chimney Co., Bridgeport, near Clarksburg, W. Va., has reopened its plant, giving employment to about 150 men.

After a shut-down of several months, the Gill Brothers Co., Steubenville, Ohio, has resumed manufacture at its local Aeme plant, with one furnace in operation. It is planned to increase the rate of output in the near future.

The Bellaire Bottle Co., Bellaire, Ohio, has reopened its plant on a basis of three days a week until further notice.

The Standard Glass Works, Marion, Ind., has resumed operations at its local plant, following a shut-down of several weeks. The Canton Glass Co., in this same city, is also operating its plant under good capacity, and reports a marked increase in orders.

Waste Alundum Subject to Duty

The Board of United States General Appraisers, New York, has overruled a protest of the Norton Co., Worcester, Mass., relative to the assessment of duty on waste alundum. The alundum, consisting of grains or shavings produced in the process of truing grinding wheels made of the same material (crude artificial abrasive) was classified as waste at 10 per cent ad valorem, under paragraph 384 of the tariff act of 1913. The Norton Co. claimed that the material was entitled to free entry as a crude artificial abrasive under paragraph 479. The evidence submitted in the judgment of the board, failed to sustain the protest.

German Plants Close Down

During the past week the dye works at Höchst-am-Main and the Chemischefabrik at Griesheim have been closed down owing to labor disputes, the owners refusing to grant increases in wages demanded by the workers, according to a Reuter cable from Berlin.

Holyoke Paper Mills Show Increased Business

The general business situation in the Holyoke section is showing a marked improvement at the present time. The textile mills are all working on a schedule at least approximating full time, while one or two concerns are running two shifts.

The improvement in paper manufacturing, while not so marked, has been notable since Sept. 1. Part of this may be only temporary because of large orders for papeteries for the holiday trade, but there is reason to believe that a slow but steady increase of business in all lines is under way.

The paper business is in good shape for a resumption of activities all along the line, for paper stocks in the hands of merchants are low and consequently the new prices made by the manufacturer are quickly passed on to the consumer, while a stiffening in the price of certain grades of rags caused by the rise of cotton prices leads to the belief that this important raw material has reached its lowest level. The pulp manufacturers have to a large extent worked off their inventories. As this pulp was made from wood cut at the highest level of war prices and worked up into pulp at higher prices than have been reached before or since, they had to take losses during readjustment.

Considering freight rates, it is safe to say that pulp is nearly as low as it has ever been and any further reductions can be brought about only by forced liquidation of remaining stocks or by lowering of freight charges. Some foreign pulp is being offered for sale, but a large part of this is of inferior quality.

As in other sections, nearly all manufacturers curtailed or eliminated their research work—not because they regarded it as a luxury but because every avenue of expense must be cut off until some signs of light appeared. Research work will be continued when finances permit.

Freight Movement Increases

During the week which ended Sept. 17, 853,762 cars were loaded with revenue freight on the railroads of the United States, according to reports just received from the carriers by the Car Service Division of the American Railway Association. This is the largest number loaded during any one week, records show, since the week of Dec. 4, 1920.

The total for the week was 105,644 cars greater than that for the previous week, when, however, the observance of Labor Day resulted in a falling off in traffic. It was, however, 137,404 cars less than were loaded during the corresponding period last year and 141,229 less than during the corresponding period in 1919.

Increases in the loading of all commodities over the week before were reported but in making comparisons, consideration must be given to the fact that the week of Sept. 17 contained six full working days, while there was a holiday during the preceding week. Grain and grain products was the only commodity which showed an increase over the corresponding week last year.

Agricultural Chemists to Meet

No less than 250 agricultural chemists are expected to be in attendance at the thirty-eighth annual convention of the Association of Official Agricultural Chemists which will be held in Washington Oct. 24 to Oct. 26. The drug section of the association is to have the center of the stage at this meeting. At the last annual meeting principal attention was concentrated on fertilizers. Those in charge of arrangements make it clear, however, that fertilizers and other sections are in no way to be neglected.

The principal addresses are to be those of Secretary of Agriculture Wallace, Harvey W. Wiley and Senator E. F. Ladd. Both Dr. Wiley and Senator Ladd are past presidents of the association. Dr. Wiley had not expected to be present at this convention, due to the fact that he expected to submit to an operation for cataract of the eye prior to the date of the meeting. The time for the operation has been postponed, however, until November, which will permit of Dr. Wiley's personal attendance at the convention. Neither Secretary Wallace nor Dr. Wiley has announced his subject as yet, but Senator Ladd will speak on "The Agricultural Chemist and His Influence on Agriculture."

Forecast of Beet Sugar Crop

From late reports, covering practically all factories, the United States Sugar Manufacturers' Association has compiled the following detailed forecast of the forthcoming beet sugar crop:

State	Area Planted, Acres	Area Estimated to Be Harvested, Acres	Estimated Tonnage of Beets, Short Tons	Estimated Production of Sugar, Short Tons
California.....	132,232	119,962	1,092,478	173,361
Colorado.....	214,040	201,307	2,280,763	290,400
Utah.....	112,371	99,965	1,434,195	174,535
Idaho.....	49,096	47,174	475,670	61,825
Michigan.....	158,569	143,563	1,118,360	141,241
Ohio.....	40,213	3,848	322,930	45,747
Wisconsin.....	19,900	18,000	177,000	19,250
Wyoming and Montana.....	29,400	28,000	264,000	35,100
Other States*.....	124,905	119,820	1,077,000	135,900
Total U. S.				
1921-22.....	880,326	812,612	8,242,396	1,077,359
1920-21.....	978,500	872,376	8,546,193	1,090,021

* Includes Nebraska, Kansas, Iowa, Indiana, Illinois, Minnesota and Nevada.

The following factories will not operate during the forthcoming campaign: Hamilton City, New Delhi, Chino and Tracy, Cal.; Las Animas, Lamar and Delta, Col.; Filer, Utah; Waverly and Belmond, Iowa.

The factory located at Fallon, Nev., which has been idle for several years, has been purchased by the Lahonton Valley Sugar Co., of Bay City, Mich., and will be operated during the campaign.

On account of litigation the Hooper, Utah, and Preston, Idaho, factories may not operate, although these factories have considerable acreage planted.

In California the campaign is in full swing, the Spreckels factory being the last to start slicing, on the 17th of September. The crop is reported to be from fair to good.

In the Utah-Idaho district the campaign will not be well under way until the first week in October. The condition of the crop in this section is reported to be exceptionally good, with prospects for a large tonnage.

The crop condition in Michigan is reported as fair to good, while in Ohio it is only fair. With the exception of the Toledo factory slicing will not begin until after the first week of October. Several of the plants do not expect to start until after Oct. 15.

Reports from Colorado indicate an exceptionally good yield this year, both as to tonnage and sugar content. It is expected that by the end of this week most of the factories will be in operation.

To Investigate White Clays and Bauxites of Central Georgia

The Ceramic Experiment Station of the U. S. Bureau of Mines located at Columbus, Ohio, has entered into a co-operative agreement with the Central of Georgia R.R. through its industrial agent, J. M. Mallory, and its president, William A. Winburn, whereby the Ceramic Station is to investigate the white clays and bauxites along the right of way of the railroad, the lines of which pass through about 80 per cent of the white clay and bauxite belt of Georgia. The white clay deposits of Georgia are so numerous and extensive that it can be said that this material is practically inexhaustible. A number of deposits are from 20 to 40 ft. in thickness and cover in many instances as much as 200 acres in extent.

Bauxite beds occur especially in the Cuthbert, Republic and Andersonville districts from 4 to 8 ft. in thickness, and deposits are found which vary in composition all the way from kaolin on the one hand to bauxite on the other. According to the geology of these deposits, which occur on the coastal plain, the bauxites are derived from the alteration of kaolin, which was derived from the decomposition of pragmatite and granitic rocks of the Piedmont plateau to the north of the coastal plain. The kaolin was transported by water from the site of its formation and deposited at the lower level, where it was built up in many instances as much as 25 to 30 and even 40 ft. in thickness. The close association between the kaolins and bauxites indicate that the latter was derived from the former by the action of sulphuric acid produced by the dissociation of large beds of pyrites.

The white clays are being mined at a few points, more especially at Gordon, McIntyre, Claymont and Butler, and sold principally to the fillers trade. Bauxites have been mined in the Cuthbert, Toombsboro and Andersonville districts and find uses principally for the manufacture of alum, aluminum and abrasives. For strictly ceramic purposes very little is known of the physical properties of these materials, known as Georgia kaolin, bauxitic clays and bauxites.

The work, which is to be done under supervision of R. T. Stull, chief ceramist of mines, consists in devising better refining methods and the testing of the physical properties of the materials so prepared. For this purpose twenty-four representative samples of two tons each have been gathered by the Central of Georgia R.R.'s representative, Dr. T. Poole Maynard, and delivered to the Ceramic Station. A small-size washing plant is being constructed at the Ceramic Station capable of handling about 1,000 lb. to a charge. The working properties, drying and burning behaviors, burning color and refractoriness of the different separations in the washing process are to be determined. Chemical analyses of these samples are also to be made, since the analyses are important more especially with respect to the highly aluminous clays and bauxites.

New Directory of Canadian Chemical Industries

The Directory of Chemical Industries in Canada, published by the Dominion Bureau of Statistics, has been revised as of Jan. 1, 1921.

In the present edition there are shown the names of more than 800 firms operating over 1,000 plants in Canada. Geographically, plants operated by these firms fall into the following divisions:

Nova Scotia.....	61	Manitoba.....	51
Prince Edward Island..	8	Saskatchewan.....	7
New Brunswick.....	35	Alberta.....	39
Quebec.....	279	British Columbia.....	91
Ontario.....	431	Total.....	1,002

For convenience of reference, as in the first edition, all the products listed under the different firms have been cross-indexed, so that all the concerns known to be making any one article are found under that heading.

The introductory material includes an article on "Canadian Chemical Industries in the Reconstruction Period—Opportunities for Chemical Progress," by S. J. Cook, chief of the mining, metallurgical and chemical branch, and tables of Canadian imports and exports of chemical and allied products during the fiscal years ended March 31, 1914, 1918 to 1921.

Cause of Disaster at Oppau

It has been ascertained definitely, says a Reuter cable from Berlin, that the disaster at the Badische plant in Oppau, Germany, was caused by the explosion of 4,500 tons of a compound of ammonium sulphate and ammonium nitrate, known as ammoniumsulphatsalt peter, which has hitherto been considered as being absolutely free from danger of explosion.

Wholesale Prices Go Lower

Wholesale prices of chemicals and drugs were a trifle lower in August than they were in July, according to statistics gathered by the Department of Labor. The department's index number for August is 161, as compared with 163 in July and 216 in August, 1920. The average price in 1913 equals 100.

Carbon Black Ruling

Carbon black, when produced directly from coal-tar derivatives, such as naphthalene or creosote, comes under the provisions of the dye and chemical control act, according to a Treasury Department ruling.

To Do Research Work on Glass

The Glass Containers' Association has agreed to station a research man at the Bureau of Standards to do work on the fundamental physical chemistry of glasses.

Personal

Dr. J. T. BARKER has returned to his headquarters at Widness, Lancashire, England, after two months' special work at the North American Chemical Co., Bay City, Mich.

C. W. BOTKIN, who has been doing research on the refining of shale oils at the Colorado School of Mines for the past fifteen months, has accepted a position as head of the chemistry department in the New Mexico College of Agriculture and Mechanic Arts, State College, New Mexico.

M. J. CAVALIER, professor of metallurgy in the University of Toulouse, arrived Oct. 1 at Columbia University, where he will take up his work as French exchange professor. Prof. Cavalier will stay until Oct. 30.

JOHN JOSEPH GORRELL, who was formerly connected with the technical direction bureau of the Aluminum Co. of America, at New Kensington, Pa., is now chemist with the Cambria Steel Co. in its laboratory.

THOMAS J. KEENAN has announced his resignation as secretary-treasurer of the Technical Association of the Pulp and Paper Industry to accept the position of editor of *Paper*, in the organization of which he becomes an officer and stockholder.

Dr. J. W. KIMBALL, formerly research chemist with E. I. du Pont de Nemours & Co., has become associated with the National Aniline & Chemical Co. in a similar capacity.

J. GEORGE LEHMAN, Bethlehem Foundry & Machine Co., Bethlehem, Pa., has been appointed chairman of the organization committee of the Association of Chemical Plant Equipment Manufacturers, recently formed.

JOHN C. LEONARD, for a number of years secretary and treasurer of the Johnston Window Glass Co., Hartford City, Ind., has resigned.

Dr. W. LEE LEWIS, professor of chemistry, Northwestern University, Chicago, is lecturing through the Middle Western States in a campaign of public education on the American dye industry and what the proposed tariff means.

ROBERT S. LUNT has been appointed manager of the Boston, Mass., office of E. I. du Pont de Nemours & Co.

Dr. JAMES W. MCBAIN, one of the group of noted English chemists attending the recent annual meeting of the American Chemical Society, gave an interesting address before the members of the Delaware Chapter of the American Chemical Society, at Wilmington, Del., Sept. 20. He spoke upon the subject of the characteristics of sols, gels and curds.

W. H. RANSOM, for the past two years an executive officer at the Old Hickory powder works of the Government, has become connected with the Celluloid Co., Newark, N. J.

JOHN I. TIERNEY, Washington representative of the Manufacturing Chemists' Association, attended the conference of the state manufacturing associations in Chicago, Sept. 29 and 30, at which the plan for American valuation of imports was discussed.

Obituary

SAMUEL STOCKTON VOORHEES, an engineer chemist who had been a member of the U. S. Bureau of Standards staff for the past eleven years, died at Portland, Me., Sept. 23. Mr. Voorhees had gone to Maine in an effort to better his health, which had been bad for several years. He was fifty-four years of age. Mr. Voorhees received his technical education at Lehigh University and at George Washington University. Prior to joining the Bureau of Standards in 1901, Mr. Voorhees served as a chemist in the research departments of the Pennsylvania, the Southern and the New York Central railroads. Funeral services were held in Cincinnati, Sept. 27.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, Oct. 3, 1921.

Business in the heavy chemical market continued to improve during the week and buyers are showing more interest, although they are not inclined to buy much more than their needs. Prices showed a decided tendency to firmness and conditions in the trade are much better than at the beginning of last month. Several of those close to the pulse of trading believe that the last quarter will prove to be the brightest of the year and that the improvement in business will be gradual until after New Year's, when it will be brought to its former normal state. Pressure from foreign sources of supply is lighter on account of labor troubles abroad. Germany especially has been handicapped by labor disputes and by the damage suffered by plants in the Oppau district on account of the explosion there. The situation from the American's point of view, therefore, looks much clearer and has every indication of continued improvement.

Soapmakers are leading domestic consumers in the purchase of chemicals. Many of their requirements have been filled with imported chemicals and among these caustic potash has stood foremost. Paper mills have bought quantities of bleach of domestic origin, but have also taken a great deal of domestic material. Textile mills are buying a variety of chemicals, while glass factories are in the market quite frequently for dense soda ash. Conditions among tanneries seem to be greatly improving and it is believed that some good buying will develop in the very near future. Rumors are current that a short interest has accumulated during the past few weeks in soda ash, and these had a tendency to advance prices. Chemical concerns operating in the basic chemical have bought quite freely, believing that the imports from abroad would make it a good gamble. Labor strikes in England and other countries have restricted the importation of ash, while there are great uncertainties of duty and of shipment. There has been very little heard of imported soda ash during the past few weeks. A stiffening market in cyanide of soda, prussiate of soda and soda ash has been the principal factor in the week's activities. There has been a marked shortage of supplies on the two latter items, especially from importers. Caustic potash has held its recent strength and holders are maintaining firm prices. There have been reductions made by manufacturers of sulphuric and nitric acids. These reductions have not had any serious effect on the market, as sales have been made in the past few weeks at these new figures. Bichromate of potash and oxalic acid are somewhat lower. Small-lot sales of the latter have been quite liberal during the past week.

CHEMICALS

Prices on *carbonate of potash* are easier for the various grades, and the market at the close of the week showed declines. Natural offered for shipment was more plentiful, especially for the 80-85 per cent, and the white calcined was offered around 3c. per lb. There has been a reduction on 66 deg. *sulphuric acid* by makers. Quotations now range from \$17 to \$18 per ton on the 66 deg. acid in tank cars, f.o.b. works. The 60 deg. acid is held at recent levels of \$11@12 per ton. There has been a freer movement noted of late for this chemical at the new prices. Solid *caustic soda* is becoming more firmly established at 4c. per lb. There has been some keen competition among holders of standard goods resulting in the sales of carload lots at slightly lower figures. The offerings of standard brands around the trade are not very heavy and the condition of the market may be described as decidedly fair. Spot *nitrite of soda* was held at 7c. per lb. in most quarters, with transactions noted here and there at slightly lower figures. There has not been very much activity in this chemical and trading is confined chiefly to small quantities. Prices of *ammonium sulphate* are very firm at recent levels. Material in bulk

form at the works is quoted around \$2.15 per 100 lb. Supplies for domestic use are exceedingly scarce and consumers find difficulty locating sufficient supplies. Goods in double bags f.a.s. are held at \$2.50 per 100 lb. *White arsenic* is lower at 5½@6c. per lb. Imported material has had a bad effect on the spot market prices and trading has been of a light routine nature. Higher prices are recorded for spot *prussiate of soda* and it is very doubtful if better than 13c. per lb. could be done on round lot quantities, while sellers in other directions are asking up to 13¼ per lb. Some odd-lot sales went through earlier in the week at 12¾c. a lb. The condition of this market continues quite firm, with inquiries and orders greatly increased. Prices on *soda ash* are holding at the recent advance and the market closed in a firm position. It is understood that sales of large quantities of imported material have been made which have not been delivered. Some large dealers have found themselves confronted with the problem of covering their orders on a rising market. Domestic spot goods in single bags are quoted at \$2.19@2.25 per 100 lb., depending on the seller and quantity. Goods in barrels held at \$2.50@\$2.60 per 100 lb. The *cyanide of soda* market is in a very firm condition and second-hand stocks seemed to be well cleared from the market. The 128 per cent was very firm at 24@25c. per lb., while domestic producers are holding their former quotations of 28@30c. per lb. for the 96-98 per cent. *Zinc chloride* producers are still clinging to their old quotations of 9½@12c. per lb. for the fused and granulated varieties, but are practically out of the market in the face of extremely low prices prevailing for imported material. Large importers quote as low as 6c. per lb. for this material.

COAL-TAR PRODUCTS

Some improvement in buying of intermediates is noticeable, but competition for passing orders continues to hamper the advance in prices. Consumers are still operating conservatively and are not very anxious to take on any additional stocks beyond their present requirements. A moderate amount of selling is recorded in *nitraniline* around 79c. per lb. Some sellers ask up to 82c. per lb., but round lot business can probably be placed slightly under the 79c. level. The market on *dimethylaniline* has stiffened during the past few days and the lowest available quotation for second-hand goods is 42c. per lb., with some holders asking up to 45c. per lb. Most of the low-priced material has been well cleaned out of the market and with production greatly curtailed prices will probably remain firm. Quotations on *beta naphthol* are somewhat steadier, with resellers doing 32@33c. per lb. Makers are maintaining a firm attitude and quote 42c. per lb., although there are constant rumors that any actual round lot orders would not be refused down to 35c. per lb. Manufacturers' prices on *diethylaniline* are lower at \$1@\$1.10 per lb., with only a light demand noted. Makers of *aniline oil* are experiencing some difficulty in turning out large quantities on account of the scarcity of benzene. Figures from producers are quoted at 18@20c. per lb., according to quantity and brand. Resellers are offering material at 17½c. per lb. The retail market appears to have sufficient supplies on hand to meet all requirements and there were rumors around the trade of heavy cuts in quotations, even though the condition of the raw material market is quite uncertain. The demand for *benzoic acid* has fallen off and prices have come down accordingly. The technical is quoted at 50@58c. per lb. and the U.S.P. at 60@65c. The benzene market has continued in its recent firmness. Prices are quite varied, according to the seller. There are some holders asking as high as 49c. a gal. for the pure grade and even at this figure there is very little to be found. Refiners are unable to offer any material on the open market and are experiencing added difficulty in meeting old contracts. Supplies of *naphthalene* are being held by weak resellers, with the demand very light. Offers of flakes are heard around 6¼c. per lb. Manufacturers are still maintaining their old figures of 8½@9¼c. per lb. for the flake and 9½@10½ for the balls, with practically no real sales noted. The *phenol* market has taken on the quiet attitude of the rest of the crudes. Here and there an export inquiry is noted, but no

round lot orders have been seen in the market for some time. Resale material is still held at prices ranging from 8¼@9c. per lb. Government surplus material is being maintained at 12@13c. per lb.

The St. Louis Market

ST. LOUIS, Sept. 30, 1921.

While the market on fine chemicals has been subject to slight fluctuations the past two weeks, the general tone has become much firmer. That the general impression that the bottom in price decline has been reached prevails is reflected in the buying of larger quantities of nearly every item. The market on heavy chemicals shows a similar improvement and many buyers have confidence enough to anticipate their requirements again.

ALKALIS

Caustic soda remains in good demand with price of \$4 per 100 lb., basis 73-75 per cent solid, f.o.b. point of production. *Soda ash* demand is still only fair and manufacturers' schedule prevails. *Bicarbonate of soda* and *sal soda* demand is light, with the former enjoying the better demand of the two, and holding at \$2.60 per 100 lb. in less than carlots.

INDUSTRIALS

Carbon bisulphide is in strong demand, with supplies scarce but prices remaining the same. *Aqua ammonia* demand is very good, with price the same. The *sulphur* demand is routine, with price the same, at \$2.10 per 100 lb. for commercial, in bags.

DRUGS AND PHARMACEUTICALS

Bismuth salts continue to enjoy a good demand. *Salicylic acid* declined 2c., *sodium salicylate* has declined 3c. and *acetyl salicylic* has dropped 2c. per lb. respectively in the past two weeks. As the demand is no lighter these declines are due to competition in manufacture. *Iodides* are in good demand, as are *bromides*. There is a general decline of 5c. per lb. on heavy *bromides*. The *sodium benzoate* demand has eased off. *Zinc stearate* is in good demand, with price the same. *Citric acid* is going normal, with price for imported citric the same as the domestic.

ACIDS

The market on 60 per cent *sulphuric acid* is quiet, with price at \$15@\$16 per ton. The market on the 66 per cent is active, with price still at \$20 per ton. *Nitric acid* demand is quiet. *Hydrochloric* is very slow, with no change in price. The *mixed acids* are likewise very quiet. *Salt cake* enjoys the usual good seasonal demand, with the demand exceeding the available supplies and prices high and firm. On *zinc chloride*, the usual contract withdrawals are being made but no new business is being transacted.

VEGETABLE OILS

Castor oil remains in good demand at price of 11½c. per lb. in heavy returnable drums. *Linseed oil* reached a maximum of 83c. per gal., and has slowly declined and today is quoted at 76c. in cooperage, ex-warehouse, with the demand light. *Turpentine* demand remains the same, with price at 72½c. in 5-bbl. lots.

The Iron and Steel Market

PITTSBURGH, Sept. 30, 1921.

While the general condition of the steel market is probably better than a week ago, it is doubtful whether there is any increase in the actual volume of steel mill bookings, on account of two special factors, the large amount of business that was gathered up in wire products in connection with the advance in prices Sept. 12, and the heavy bookings in sheets in anticipation of the price advances that became effective last week. These two important branches of the finished steel market are naturally quiet at present, the production and shipments being of course heavier than formerly.

The formal reductions in pipe mill products a fortnight ago, chiefly by way of recognizing price cutting from the old lists but carrying some prices below any previous cut rates, does not seem to have had much direct effect upon the volume of demand, but there has been some increase, just as demand was increasing during August.

In bars, shapes and plates, the "heavy rolled products," the showing of the market is not quite clear. The reports commonly made are that business is light in all three lines, but there are some indications that a drive is being quietly made by a number of the mills to book customers up for the near future at special prices and in expectation of establishing slightly higher prices as the open market. It is rumored that on all three products some mills will give regular customers contracts to the end of the year, which virtually means price protection, at 1.60c., though what is openly admitted is only that desirable orders, with specifications attached, and for shipment at mill convenience, are acceptable at this figure.

Whatever may be the details in any given case it is now clear that the steel market as a whole has an upward rather than a downward trend. This condition is not based upon the same volume of demand that used to be required before the war to cause steel prices to advance or even become firm. It is based rather upon the fact of prices having gone farther below actual cost of production than producers are willing to countenance as a permanent condition. Before the war it used to be held that steel prices would not trend upward of their own accord unless mills had an actual operation of better than 75 per cent. In no branch of the finished steel trade, except possibly in sheets and wire products, is there an operation approaching that level, while in those two groups orders were placed by buyers under the spur of an expected price advance, and it is not proved that buying will be resumed at the advanced prices now ruling.

STEEL PRODUCTION

There has been little if any increase in steel production this week as compared with last week, and the general rate, in ingots, may be taken at approximately 33 per cent of capacity. The best demand has been in the lighter lines, sheets, wire products, tubular goods and tin plate, and accordingly the tonnage of steel production is not greatly affected. Bars, shapes, plates and rails show very light production. Probably an upward trend in steel production will continue for a few weeks, bringing about an operation of between 40 and 50 per cent, but unless some radical change occurs in fundamental conditions, such as inception of railroad buying on a fair scale or a large increase in construction work involving steel, no better rate is to be expected, and demand may even taper off in December and January, which are normally dull months in the trade.

The steel mills feel that the price liquidation in finished steel products has been carried too far. Taking the recent prices for wire products and sheets, and current prices for other products, a weighted average shows prices at only 31 per cent above the average level in 1913. The Bureau of Labor's index number of commodities at wholesale, with 1913 standing at 100, was 148 for July and 152 for August, showing an advance and also showing a higher level than obtains in steel, since the index number for steel would be 131.

PIG IRON AND COKE

The pig iron markets throughout the country have continued firm, even though rather inactive. In eastern Pennsylvania there has been a slight advance in the week. The chief activity in the local market has been in purchases by the Standard Sanitary Manufacturing Co., which bought 5,000 tons of foundry iron for its Pittsburgh plant and an equal tonnage for its New Brighton plant, fourth quarter delivery, paying for nearly all the iron the regular price of \$21 valley. The company also bought 5,000 tons for its Louisville plant, taking Southern iron at \$19 Birmingham. Basic remains quotable at \$19 to \$20 valley, and bessemer at \$20.

Connellsville coke is not quotably changed, at \$3.25@\$3.50 for furnace and \$4.25@\$4.75 for foundry, these prices being about 25c. above the average in July and August, the increase being supported by the recent wage advance. Demand on the whole is somewhat better, but the Connellsville trade has been disturbed by the selling of byproduct coke by steel works, requiring the capacity normally for their own requirements. Several operators, formerly indifferent, now seem willing to sell at cost in order to get into operation, trusting to future improvement for profits.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.		\$0 40 - \$0 45
Acetone	lb.	\$0 12½ - \$0 12½	13 - 13½
Acid, acetic, 28 per cent.	100 lbs.	2 75 - 3 00	3 25 - 3 50
Acetic, 56 per cent.	100 lbs.	5 50 - 5 75	6 00 - 6 50
Acetic, glacial, 99½ per cent, carboys	100 lbs.	10 50 - 11 00	11 25 - 10 50
Boric, crystals	lb.	12½ - 13	13½ - 14
Boric, powder	lb.	13 - 13½	14 - 14½
Citric	lb.		44½ - 46
Hydrochloric	100 lb.	1 25 - 1 50	1 60 - 1 75
Hydrofluoric, 52 per cent.	lb.	11½ - 11½	12 - 12½
Lactic, 44 per cent tech.	lb.	09½ - 10	10 - 12
Lactic, 22 per cent tech.	lb.	04½ - 05½	06 - 07
Molybdic, C.P.	lb.	3 25 - 3 50	3 60 - 4 00
Muriatic, 20 deg. (see hydrochloric)			
Nitric, 40 deg.	lb.	06½ - 06½	06½ - 07
Nitric, 42 deg.	lb.	06½ - 07	07½ - 07½
Oxalic, crystals	lb.	16 - 16½	16½ - 17½
Phosphoric, 50 per cent solution	lb.	13 - 13½	14 - 18
Picric	lb.	20 - 25	27 - 35
Pyrogallol, resublimed	lb.		1 75 - 1 90
Sulphuric, 60 deg., tank cars	ton		11 00 - 12 00
Sulphuric, 60 deg., drums	ton		13 00 - 15 00
Sulphuric, 66 deg., tank cars	ton	17 00 - 18 00	
Sulphuric, 66 deg., drums	ton	21 00 - 22 00	22 50 - 23 00
Sulphuric, 66 deg., carboys	ton		
Sulphuric, fuming, 20 per cent (oleum)	ton	21 00 - 22 00	
Sulphuric, fuming, 20 per cent (oleum)	ton	23 00 - 23 50	24 00 - 24 50
Sulphuric, fuming, 20 per cent (oleum)	ton	31 00 - 32 00	33 00 - 34 60
Tannic, U. S. P.	lb.		75 - 85
Tannic (tech.)	lb.	45 - 48	50 - 55
Tartaric, imported crystals	lb.		25 - 26
Tartaric acid, imported, powdered	lb.		27 - 28
Tartaric acid, domestic	lb.		35 - 35
Tungstic, per lb. of WO.	lb.		1 30 - 1 40
Alcohol, Ethyl	gal.		4 65 - 4 90
Alcohol, Methyl (see methanol)			
Alcohol, denatured, 188 proof	gal.		35 - 36
Alcohol, denatured, 190 proof	gal.		37 - 38
Alum, ammonia, lump	lb.	03½ - 03½	04 - 04½
Alum, potash, lump	lb.	03½ - 04	04½ - 04½
Alum, chrome lump	lb.	10 - 11	11½ - 12½
Aluminum sulphate, commercial	lb.	02 - 02½	02½ - 02½
Aluminum sulphate, iron free	lb.	03 - 03½	03½ - 04
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	07½ - 07½	08 - 08½
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	30 - 32	33 - 35
Ammonium carbonate, powder	lb.	07 - 07½	08 - 09
Ammonium chloride, granular (white)	lb.	06 - 06½	06½ - 07
Ammonium chloride, granular (gray)	lb.	06½ - 07	07½ - 08
Ammonium nitrate	lb.	07½ - 07½	07½ - 08½
Ammonium sulphate	100 lb.	2 20 - 2 25	2 30 - 2 40
Amylacetate	gal.		3 25 - 3 50
Amylacetate tech.	gal.		2 50 - 3 00
Arsenic oxide, (white arsenic) powdered	lb.	05½ - 05½	06 - 06½
Arsenic, sulphide, powdered (red arsenic)	lb.	11 - 11½	12 - 13
Barium chloride	ton	43 00 - 45 00	46 00 - 49 00
Barium dioxide (peroxide)	lb.	20 - 21	22 - 23
Barium nitrate	lb.	07½ - 08	08½ - 09
Barium sulphate (precip.) (blanc fixe)	lb.	04 - 04½	04½ - 05
Bleaching powder (see calc. hypochlorite)			
Blue vitriol (see copper sulphate)			
Borax (see sodium borate)			
Brimstone (see sulphur, roll)			
Bromine	lb.	27 - 28	28½ - 30
Calcium acetate	100 lbs.	2 00 - 2 05	
Calcium carbide	lb.	04½ - 04½	05 - 05½
Calcium chloride, fused, lump	ton	23 50 - 24 00	24 50 - 25 50
Calcium chloride, granulated	lb.	01½ - 02	02½ - 02½
Calcium bychlorite (bleach'g powder)	100 lb.	2 75 - 2 80	2 90 - 3 50
Calcium peroxide	lb.		1 40 - 1 50
Calcium phosphate, tribasic	lb.		15 - 16
Camphor	lb.		70 - 72
Carbon bisulphide	lb.	06 - 06½	06½ - 07½
Carbon tetrachloride, drums	lb.	10½ - 10½	11 - 12
Carbonyl chloride, (phosgene)	lb.		60 - 75
Caustic potash (see potassium hydroxide)			
Caustic soda (see sodium hydroxide)			
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	08 - 09	09½ - 10
Chloroform	lb.		38 - 43
Cobalt oxide	lb.		2 00 - 2 10
Copperas (see iron sulphate)			
Copper carbonate, green precipitate	lb.	19 - 19½	20 - 21
Copper cyanide	lb.		50 - 62
Copper sulphate, crystals	lb.	05 - 05½	05½ - 06
Cream of tartar (see potassium bitartrate)			
Epsom salt (see magnesium sulphate)			
Ethyl Acetate Com. 85%	gal.		1 00 - 1 10
Ethyl Acetate pure (acetic ether, 93%)	gal.		40 - 42
to 100%	lb.		12½ - 13½
Formaldehyde, 40 per cent.	lb.	12 - 12½	12½ - 13½
Fusel oil, ref.	gal.		3 25 - 3 75
Fusel oil, crude	gal.		1 50 - 1 75
Glauber's salt (see sodium sulphate)			
Glycerine, C. P. drums extra	lb.		14½ - 15
Iodine, resublimed	lb.		3 50 - 3 60
Iron oxide, red	lb.		10 - 20
Iron sulphate (copperas)	ton	18 00 - 19 00	20 00 - 23 00
Lead acetate	lb.		10½ - 12½
Lead arsenate, paste	lb.	09 - 09½	10 - 11
Lead nitrate	lb.		15 - 20
Litharge	lb.	07½ - 08	08½ - 09
Lithium carbonate	lb.		1 30 - 1 40
Magnesium carbonate, technical	lb.	08 - 08½	09 - 10
Magnesium sulphate, U. S. P.	100 lb.	2 50 - 2 75	
Magnesium sulphate, technical	100 lb.		1 10 - 1 75
Methanol, 95%	gal.		66 - 68
Methanol, 97%	gal.		70 - 72
Nickel Salt, double	lb.		12 - 12½
Nickel salt, single	lb.		14 - 14½
Phosgene (see carbonyl chloride)			
Phosphorus, red	lb.	40 - 41	42 - 45
Phosphorus, yellow	lb.		30 - 35
Potassium bichromate	lb.	11 - 11½	11½ - 12

	Carlots	Less Carlots
Potassium bitartrate (cream of tartar)..... lb.	\$..... - \$.....	\$0.25 $\frac{1}{2}$ - \$0.28
Potassium bromide, granular..... lb.	 -	.15 - .23
Potassium carbonate, U. S. P..... lb.	.20 - .21	.22 - .25
Potassium carbonate, 80-85%..... lb.	.04 - .04 $\frac{1}{2}$	.05 - .06
Potassium chlorate, crystals..... lb.	.07 - .07 $\frac{1}{2}$	.07 $\frac{1}{2}$ - .10
Potassium cyanide..... lb.	 -	.26 - .28
Potassium hydroxide (caustic potash)..... lb.	.05 $\frac{1}{2}$ - .05 $\frac{3}{4}$	.06 - .08
Potassium muriate, 80% K.C.I..... ton	40.00 - 42.50	 -
Potassium iodide..... lb.	 -	2.60 - 2.75
Potassium nitrate..... lb.	.09 $\frac{1}{2}$ - .09 $\frac{3}{4}$	.10 - .12 $\frac{1}{2}$
Potassium permanganate..... lb.	.20 - .21	.22 - .23
Potassium prussiate, red..... lb.	.28 - .29	.29 $\frac{1}{2}$ - .30
Potassium prussiate, yellow..... lb.	.20 - .20 $\frac{1}{2}$	.21 - .22
Potassium sulphate (powdered)..... per unit	 -	1.20 - 1.25
Rochelle salts (see sodium potas. tartrate)	 -	 -
Salammoniac (see ammonium chloride).....	 -	 -
Salt soda (see sodium carbonate)..... ton	 -	20.00 - 25.00
Salt cake (brk)..... oz.	 -	1.35 - 1.38
Silver cyanide..... oz.	 -	.47 - .48
Silver nitrate..... 100 lb.	2.10 - 2.15	2.20 - 2.50
Soda ash, high..... 100 lb.	2.35 - 2.40	2.45 - 2.70
Soda ash, dense..... lb.	.04 - .04 $\frac{1}{2}$	.04 $\frac{1}{2}$ - .05
Sodium acetate..... 100 lb.	2.00 - 2.25	2.50 - 2.75
Sodium bicarbonate..... lb.	.07 $\frac{1}{2}$ - .08	.08 $\frac{1}{2}$ - .08 $\frac{3}{4}$
Sodium bichromate..... ton	5.00 - 5.25	5.50 - 6.50
Sodium bisulphate (nitre cake)..... lb.	.04 $\frac{1}{2}$ - .05	.05 $\frac{1}{2}$ - .06
Sodium bisulphate powdered, U.S.P..... lb.	.05 $\frac{1}{2}$ - .06	.06 $\frac{1}{2}$ - .07
Sodium borate (borax)..... 100 lb.	1.90 - 2.00	2.10 - 2.40
Sodium carbonate (sat. sol.)..... lb.	.07 $\frac{1}{2}$ - .07 $\frac{3}{4}$	.08 - .08 $\frac{1}{2}$
Sodium chloride..... lb.	.24 - .25	.26 - .30
Sodium cyanide..... lb.	.10 $\frac{1}{2}$ - .11	.11 $\frac{1}{2}$ - .12
Sodium hydroxide (caustic soda)..... 100 lb.	4.00 - 4.10	4.15 - 4.75
Sodium hyposulphite..... 100 lb.	2.20 -	2.35 -
Sodium nitrate..... lb.	.06 $\frac{1}{2}$ - .07	.07 $\frac{1}{2}$ - .07 $\frac{3}{4}$
Sodium nitrite..... lb.	.25 - .26	.27 - .30
Sodium peroxide, powdered..... lb.	.04 $\frac{1}{2}$ - .04 $\frac{3}{4}$	.04 $\frac{3}{4}$ - .05 $\frac{1}{2}$
Sodium phosphate, dibasic..... lb.	 -	.21 - .24
Sodium potassium tartrate (Rochelle salts) lb.	.13 - .13 $\frac{1}{2}$	.13 $\frac{1}{2}$ - .13 $\frac{3}{4}$
Sodium prussiate, yellow..... lb.	1.00 - 1.15	1.25 - 1.40
Sodium silicate, solution (40 deg.)..... 100 lb.	.02 $\frac{1}{2}$ - .03	.03 $\frac{1}{2}$ - .03 $\frac{3}{4}$
Sodium silicate, solution (60 deg.)..... 100 lbs.	1.50 - 1.75	2.00 - 2.25
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	.04 $\frac{1}{2}$ - .04 $\frac{3}{4}$	.05 - .06
Sodium sulphide, fused, 60-62 per cent (conc.) lb.	.03 $\frac{1}{2}$ - .04	.04 $\frac{1}{2}$ - .04 $\frac{3}{4}$
Sodium sulphite, crystals..... lb.	.12 - .13	.13 $\frac{1}{2}$ - .20
Strontium nitrate, powdered..... lb.	.05 - .05 $\frac{1}{2}$	.05 $\frac{1}{2}$ - .06 $\frac{1}{2}$
Sulphur chloride, red..... ton	18.00 - 20.00	 -
Sulphur, crude..... lb.	.08 - .08 $\frac{1}{2}$	.09 - .10
Sulphur dioxide, liquid, cylinders ex. a..... 100 lb.	 -	2.25 - 3.10
Sulphur (sublimed), flour..... 100 lb.	 -	2.00 - 2.75
Sulphur, roll (brimstone)..... lb.	.18 - .19	 -
Tin bichloride, 50 per cent..... lb.	 -	.38 - .40
Tin oxide..... lb.	.16 - .16 $\frac{1}{2}$	.17 - .17 $\frac{1}{2}$
Zinc carbonate, precipitate..... lb.	.09 $\frac{1}{2}$ - .09 $\frac{3}{4}$	.10 - .11
Zinc chloride, gran..... lb.	.42 - .44	.45 - .47
Zinc cyanide..... lb.	.11 $\frac{1}{2}$ - .11 $\frac{3}{4}$	.11 $\frac{3}{4}$ - .12 $\frac{1}{2}$
Zinc dust..... lb.	.07 $\frac{1}{2}$ - .07 $\frac{3}{4}$	.08 - .09
Zinc oxide, XX..... 100 lb.	3.00 - 3.25	3.30 - 3.50
Zinc sulphate.....	 -	 -

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude..... lb.	\$1.15 - \$1.20
Alpha-naphthol, refined..... lb.	1.30 - 1.35
Alpha-naphthylamine..... lb.	.30 - .35
Aniline oil, drums extra..... lb.	.17 $\frac{1}{2}$ - .20
Aniline salts..... lb.	.24 - .26
Anthracene, 80% in drums (100 lb.)..... lb.	.75 - 1.00
Benzaldehyde U.S.P..... lb.	1.00 - 1.25
Benzidine, base..... lb.	1.00 - 1.10
Benzidine sulphate..... lb.	.75 - .85
Benzoic acid, U.S.P..... lb.	.60 - .65
Benzoate of soda, U.S.P..... lb.	.52 - .55
Benzene, pure, water-white, in drums (100 gal.)..... gal.	.27 - .32
Benzene, 90%, in drums (100 gal.)..... gal.	.25 - .28
Benzyl chloride, 95-97%, refined..... lb.	.25 - .27
Benzyl chloride, tech..... lb.	.20 - .23
Beta-naphthol benzoate..... lb.	3.50 - 4.00
Beta-naphthol, sublimed..... lb.	.70 - .75
Beta-naphthol, tech..... lb.	.32 - .35
Beta-naphthylamine, sublimed..... lb.	1.90 - 2.00
Cresol, U. S. P., in drums (100 lb.)..... lb.	.16 - .17
Ortho-cresol, in drums (100 lb.)..... lb.	.25 - .27
Cresylic acid, 97-99%, straw color, in drums..... gal.	.70 - .75
Cresylic acid, 75-97%, dark, in drums..... gal.	.60 - .65
Cresylic acid, 50%, first quality, drums..... gal.	.45 - .50
Dichlorobenzene..... lb.	.06 - .09
Diethylaniline..... lb.	1.00 - 1.15
Dimethylaniline..... lb.	.42 - .50
Dinitrobenzene..... lb.	.25 - .28
Dinitrochlorobenzene..... lb.	.25 - .30
Dinitronaphthalene..... lb.	.32 - .40
Dinitrophenol..... lb.	.37 - .40
Dinitrotoluene..... lb.	.25 - .30
Dip oil, 25%, ear lots, in drums..... gal.	.30 - .35
Diphenylamine..... lb.	.60 - .70
H-acid..... lb.	1.10 - 1.20
Meta-phenylenediamine..... lb.	1.15 - 1.20
Monochlorobenzene..... lb.	.12 - .14
Monoethylaniline..... lb.	1.50 - 1.60
Naphthalene, crude, in bbls..... lb.	.06 $\frac{1}{2}$ - .07 $\frac{1}{2}$
Naphthalene, flake..... lb.	.06 $\frac{1}{2}$ - .08
Naphthalene, balls..... lb.	.08 - .09 $\frac{1}{2}$
Naphthionic acid, crude..... lb.	.70 - .75
Nitrobenzene..... lb.	.12 - .15
Nitro-naphthalene..... lb.	.30 - .35
Nitro-toluene..... lb.	.15 - .17
Ortho-amidophenol..... lb.	3.00 - 3.10
Ortho-dichlorobenzene..... lb.	.15 - .20
Ortho-nitro-phenol..... lb.	.75 - .80
Ortho-nitro-toluene..... lb.	.15 - .20
Ortho-toluidine..... lb.	.21 - .25
Para-amidophenol, base..... lb.	1.40 - 1.45
Para-nitrophenol, HCl..... lb.	1.70 - 1.80

Para-dichlorobenzene..... lb.	.15 - .20
Paranitroaniline..... lb.	.79 - .82
Para-nitrotoluene..... lb.	.80 - .85
Para-phenylenediamine..... lb.	1.70 - 1.75
Para-toluidine..... lb.	1.25 - 1.40
Phthalic anhydride..... lb.	.40 - .50
Phenol, U. S. P., drums..... lb.	.08 $\frac{1}{2}$ - .10
Pyridine..... gal.	2.00 - 3.50
Resorcinol, technical..... lb.	1.50 - 1.60
Resorcinol, pure..... lb.	2.25 - 2.30
Salicylic acid, tech., in bbls..... lb.	.18 - .20
Salicylic acid, U. S. P..... lb.	.19 - .22
Salol..... lb.	.60 - .70
Solvent naphtha, water-white, in drums, 100 gal..... gal.	.25 - .28
Solvent naphtha, crude, heavy, in drums, 100 gal..... gal.	.14 - .16
Sulphanilic acid, crude..... lb.	.27 - .30
Tolidine..... lb.	1.30 - 1.35
Toluidine, mixed..... lb.	.43 - .45
Toluene, in tank cars..... gal.	.25 - .28
Toluene, in drums..... gal.	.28 - .31
Xylidines, drums, 100 gal..... lb.	.40 - .45
Xylene, pure, in drums..... gal.	.40 - .45
Xylene, pure, in tank cars..... gal.	.45 - .48
Xylene, commercial, in drums, 100 gal..... gal.	.33 - .35
Xylene, commercial, in tank cars..... gal.	.30 -

Waxes

Prices based on original packages in large quantities.

Payberry Wax..... lb.	\$0.19 - \$0.20
Beeswax, refined, dark..... lb.	.24 - .25
Beeswax, refined, light..... lb.	.28 - .30
Beeswax, white pure..... lb.	.36 - .42
Candelilla wax..... lb.	.24 - .25
Carnauba, Florida..... lb.	.48 - .50
Carnauba, No. 2, North Country..... lb.	.24 - .25
Carnauba, No. 3, North Country..... lb.	.14 $\frac{1}{2}$ - .15
Japan..... lb.	.24 - .26
Montan, crude..... lb.	.05 - .05 $\frac{1}{2}$
Paraffine waxes, crude match wax (white) 105-110 m.p..... lb.	.03 $\frac{1}{2}$ - .03 $\frac{3}{4}$
Paraffine waxes, crude, scale 124-126 m.p..... lb.	.02 -
Paraffine waxes, refined, 118-120 m.p..... lb.	.03 - .03 $\frac{1}{2}$
Paraffine waxes, refined, 125 m.p..... lb.	.03 $\frac{1}{2}$ - .03 $\frac{3}{4}$
Paraffine waxes, refined, 128-130 m.p..... lb.	.03 - .04 $\frac{1}{2}$
Paraffine waxes, refined, 133-135 m.p..... lb.	.04 $\frac{1}{2}$ - .05
Paraffine waxes, refined, 135-137 m.p..... lb.	.05 $\frac{1}{2}$ - .06
Stearic acid, single pressed..... lb.	.09 -
Stearic acid, double pressed..... lb.	.10 $\frac{1}{2}$ -
Stearic acid, triple pressed..... lb.	.11 - .11 $\frac{1}{2}$

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on earload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl..... 280 lb.	\$5.55 - 5.65
Rosin E-I..... 280 lb.	5.75 - 6.25
Rosin K-N..... 280 lb.	6.35 - 6.75
Rosin W. G.-W. W..... 280 lb.	6.90 - 7.40
Wood rosin, bbl..... 280 lb.	6.25 -
Spirits of turpentine..... gal.	.75 -
Wood turpentine, steam dist..... gal.	.73 -
Wood turpentine, dest. dist..... gal.	.72 -
Pine tar pitch, bbl..... 200 lb.	 - 6.50
Tar, kiln burned, bbl. (500 lb.)..... bbl.	 - 11.00
Retort tar, bbl..... 500 lb.	 - 11.00
Rosin oil, first run..... gal.	.35 -
Rosin oil, second run..... gal.	.37 -
Rosin oil, third run..... gal.	.44 -
Pine oil, steam dist., sp.gr. 0.930-0.940..... gal.	1.90 -
Pine oil, pure, dest. dist..... gal.	1.50 -
Pine tar oil, ref., sp.gr. 1.025-1.035..... gal.	.46 -
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla..... gal.	.35 -
Pine tar oil, double ref., sp.gr. 0.965-0.990..... gal.	.75 -
Pine tar, ref., thin, sp.gr. 1.080-1.960..... gal.	.35 -
Turpentine, crude, sp. gr. 0.900-0.970..... gal.	1.25 -
Hardwood oil, f.o.b. Mich., sp.gr. 0.960-0.990..... gal.	.35 -
Pinewood creosote, ref..... gal.	.52 -

Solvents

73-76 deg., steel bbls. (85 lb.)..... gal.	\$0.37 -
70-72 deg., steel bbls. (85 lb.)..... gal.	.35 -
68-70 deg., steel bbls. (85 lb.)..... gal.	.34 -
V. M. and P. naphtha, steel bbls. (85 lb.)..... gal.	.23 -

Crude Rubber

Para-Upriver fine..... lb.	\$0.21 - .21 $\frac{1}{2}$
Upriver coarse..... lb.	.11 $\frac{1}{2}$ - .12
Upriver caucho ball..... lb.	.11 $\frac{1}{2}$ - .12
Plantation—First latex crepe..... lb.	.15 $\frac{1}{2}$ - .15 $\frac{3}{4}$
Ribbed smoked sheets..... lb.	.15 $\frac{1}{2}$ - .15 $\frac{3}{4}$
Brown crepe, thin, clean..... lb.	.15 -
Amber crepe No. 1..... lb.	.17 -

Oils

VEGETABLE

The following prices are f.o.b. New York for earload lots.

Castor oil, No. 3, in bbls..... lb.	\$0.09 $\frac{1}{2}$ - \$0.09 $\frac{3}{4}$
Castor oil, AA, in bbls..... lb.	.11 - .11 $\frac{1}{2}$
China wood oil, in bbls. (f.o.b. Pac. coast)..... lb.	.14 $\frac{1}{2}$ - .15
Cocoonut oil, Ceylon grade, in bbls..... lb.	.10 - .10 $\frac{1}{2}$
Cocoonut oil, Ceylon grade, in bbls..... lb.	.10 $\frac{1}{2}$ - .11
Corn oil, crude, in bbls..... lb.	.09 - .09 $\frac{1}{2}$
Cottonseed oil, crude (f. o. b. mill)..... lb.	.08 - .08 $\frac{1}{2}$
Cottonseed oil, summer yellow..... lb.	.10 - .10 $\frac{1}{2}$
Cottonseed oil, winter yellow..... lb.	.10 $\frac{1}{2}$ - .11
Linseed oil, raw, ear lots (domestic)..... gal.	.73 - .74
Linseed oil, raw, tank cars (domestic)..... gal.	.67 - .68
Linseed oil, in 5-bbl. lots (domestic)..... gal.	.76 - .77

Olive oil, Denatured.....	gal.	\$1.10	—	\$1.20
Palm, Lagos.....	lb.	.08	—	.08½
Palm, Niger.....	lb.	.06½	—	.06½
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.08½	—	.09
Peanut oil, refined, in bbls.....	lb.	.11	—	.11½
Rapeseed oil, refined in bbls.....	gal.	.87	—	.89
Rapeseed oil, blown, in bbls.....	gal.	.91	—	.92
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.09	—	
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.07½	—	

FISH

Light pressed menhaden.....	gal.	\$0.40	—	
Yellow bleached menhaden.....	gal.	.42	—	
White bleached menhaden.....	gal.	.44	—	
Blown menhaden.....	gal.	.48	—	

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$24.00	—	30.00
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	22.00	—	26.00
Barytes, crude, 88% @ 94% ba., Kings Creek.....	net ton	10.00	—	12.00
Barytes, floated, f.o.b. St. Louis.....	net ton	23.00	—	24.00
Barytes, crude, first grade, Missouri.....	net ton	7.00	—	
Blanc fixe, dry.....	lb.	.04	—	.04½
Blanc fixe, pulp.....	net ton	45.00	—	55.00
Casein.....	lb.	.07	—	.10
Chalk, Precipitated, domestic, extra light.....	lb.	.04½	—	.05
Chalk, Precipitated, domestic, light.....	lb.	.04	—	.04½
Chalk, Precipitated, domestic, heavy.....	lb.	.03½	—	.04
Chalk, Precipitated, English, extra light.....	lb.	.04½	—	.05
Chalk, Precipitated, English, light.....	lb.	.04½	—	.05
Chalk, Precipitated, English, dense.....	lb.	.04	—	.04½
China clay (kaolin) crude, f.o.b. mines, Georgia.....	net ton	6.50	—	8.50
China clay (kaolin) washed, f.o.b. Georgia.....	net ton	9.00	—	10.00
China clay (kaolin) powdered, f.o.b. Georgia.....	net ton	13.00	—	20.00
China clay (kaolin) crude f.o.b. Virginia points.....	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points.....	net ton	13.30	—	20.00
China clay (kaolin), imported, lump.....	net ton	12.00	—	20.00
China clay (kaolin), imported, powdered.....	net ton	25.00	—	30.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	net ton	5.00	—	7.50
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27.00	—	30.00
Fullers earth, f.o.b. Mines.....	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Pa.....	net ton	15.00	—	16.00
Fullers earth, powdered, f.o.b. Fla.....	net ton	18.00	—	
Fullers earth, imported, powdered.....	net ton	24.00	—	27.00
Graphite, Ceylon lump, first quality.....	lb.	.06	—	.07
Graphite, Ceylon chip.....	lb.	.04½	—	.05
Graphite, high grade amorphous crude.....	lb.	.00½	—	.02½
Kieselguhr, f.o.b. mines, Cal.....	per ton	40.00	—	
Kieselguhr, f.o.b. N.Y.....	per ton	61.00	—	
Magnesite, calcined.....	per ton	66.00	—	70.00
Pumice stone, imported, lump.....	lb.	.03	—	.40
Pumice stone, domestic lump.....	lb.	.05	—	.05½
Pumice stone, ground.....	lb.	.06	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore.....	net ton		—	10.00
Quartz (acid tower) 1½ @ 2 in., f.o.b. Baltimore.....	net ton		—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton		—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange fine.....	lb.	.50	—	.51
Shellac, orange superfine.....	lb.	.51	—	.52
Shellac, A. C. garnet.....	lb.	.44	—	.45
Shellac, T. N.....	lb.	.44	—	.45
Soapstone.....	ton	12.00	—	15.00
Sodium chloride.....	long ton	12.50	—	13.00
Talc, paper-making grades, f.o.b. Vermont.....	ton	11.00	—	18.00
Talc, roofing grades, f.o.b. Vermont.....	ton	8.50	—	13.00
Talc, rubber grades, f.o.b. Vermont.....	ton	11.00	—	18.00
Talc, powdered, Southern, f.o.b. ears.....	ton	7.50	—	11.00
Talc, imported.....	ton	30.00	—	40.00
Talc, California taleum powder grade.....	ton	18.00	—	25.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	per ton	\$50.00		
Carborundum refractory brick, 9-in.	1,000	1250.00		
Chrome brick, f.o.b. Eastern shipping points.....	1,000	1100.00		
Chrome cement, 40-45% Cr ₂ O ₃	net ton	52-55		
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in car lots, f.o.b. Eastern shipping points.....	net ton	30-32		
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	33-35		
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	35-40		
Magnesite brick, 9-in. straight.....	net ton	65-70		
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	77		
Magnesite brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	40-42		
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	42-45		
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	35-38		

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00	—	\$225.00
Ferrochrome per lb. of Cr. contained, 6-8% carbon, carlots.....	lb.	.11	—	
Ferrochrome per lb. of Cr. contained, 4-6% carbon, carlots.....	lb.	.11	—	.12
Ferromanganese, 76-80% Mn, domestic.....	gross ton	60.00	—	63.00
Ferromanganese, 76-80% Mn, English.....	gross ton	63.00	—	65.00
Spiegeleisen, 18-22% Mn.....	gross ton	25.00	—	27.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.25	—	
Ferrosilicon, 10-15%.....	gross ton	38.00	—	40.00
Ferrosilicon, 50%.....	gross ton	60.00	—	65.00
Ferrosilicon, 75%.....	gross ton	130.00	—	135.00
Ferrotungsten, 70-80%, per lb. of contained W.....	lb.	.40	—	.45
Ferrouuranium, 35-50% of U, per lb. of U content.....	lb.	6.00	—	
Ferrovandium, 30-40% per lb. of contained V.....	lb.	4.25	—	4.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content.....	net ton	\$8.00	—	\$10.00
Chrome ore, Calif concentrates, 50% min. Cr ₂ O ₃	ton	24.00	—	26.00
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard.....	ton	24.00	—	26.00
Coke, foundry, f.o.b. ovens.....	net ton	4.25	—	4.50
Coke, furnace, f.o.b. ovens.....	net ton	3.25	—	3.50
Coke, petroleum, refinery, Atlantic seaboard.....	net ton	12.00	—	13.00
Fluorspar, lump, f.o.b. mines, New Mexico.....	net ton	12.50	—	
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	20.00	—	22.00
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01½	—	.01
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	.20	—	.21
Manganese ore, chemical (MnO ₂).....	net ton	50.00	—	55.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.55	—	.60
Monazite, per unit of ThO ₂ , c.i.f. Atlantic seaport.....	unit	30.00	—	
Pyrites, Spanish, fines, c.i.f. Atlantic seaport.....	unit	.12	—	.12
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.13	—	.13
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.11	—	.12
Rutile, 95% TiO ₂ per lb. ore.....	lb.	.15	—	
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	2.75	—	3.00
Tungsten, wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	3.00	—	3.25
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	1.25	—	1.75
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.25	—	2.50
Vanadium pentoxide, 99%.....	lb.	12.00	—	14.00
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1.00	—	
Zircon, washed, iron free, f.o.b. Pablo, Florida.....	lb.	.04½	—	.13

Non-Ferrous Metals

New York Markets

	Cents per Lb
Copper, electrolytic.....	12.50
Aluminum, 98 to 99 per cent.....	24.50 @ 25
Antimony, wholesale lots, Chinese and Japanese.....	4.60 @ 4.70
Nickel, ordinary (ingot).....	41.00
Nickel, electrolytic.....	44.00
Monel metal, shot and blocks.....	35.00
Monel metal ingots.....	38.00
Monel metal, sheet bars.....	40.00
Tin, 5-ton lots, Straits.....	26.50
Lead, New York, spot.....	4.70
Lead, E. St. Louis, spot.....	4.50
Zinc, spot, New York.....	4.80 @ 4.85
Zinc, spot, E. St. Louis.....	4.40

OTHER METALS

Silver (commercial).....	oz.	\$0.70½
Cadmium.....	lb.	1.00-1.25
Bismuth (500 lb. lots).....	lb.	1.50 @ 1.55
Cobalt.....	lb.	3.00 @ 3.25
Magnesium (f.o.b. Philadelphia).....	lb.	1.25
Platinum.....	oz.	78.00
Iridium.....	oz.	150.00 @ 170.00
Palladium.....	oz.	55.00-60.00
Mercury.....	75 lb.	39.00-41.00

FINISHED METAL PRODUCTS

Warehouse Price
Cents per lb.

Copper sheets, hot rolled.....	19.50
Copper bottoms.....	27.00
Copper rods.....	18.00 @ 18.75
High brass wire.....	15.75
High brass rods.....	13.25
Low brass wire.....	17.25
Low brass rods.....	17.25
Brazed brass tubing.....	25.00
Brazed bronze tubing.....	27.75
Seamless copper tubing.....	19.50
Seamless high brass tubing.....	18.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current	Cleveland	Chicago
Copper, heavy and crucible.....	9.50 @ 10.00	9.25	9.50
Copper, heavy and wire.....	9.00 @ 9.25	8.50	8.50
Copper, light and bottoms.....	7.50 @ 8.00	7.50	7.25
Lead, heavy.....	3.25 @ 3.50	3.25	3.25
Lead, tea.....	2.25 @ 2.35	2.25	2.25
Brass, heavy.....	4.25 @ 4.50	4.50	5.00
Brass, light.....	3.25 @ 3.50	3.25	3.50
No. 1 yellow brass turnings.....	4.00 @ 4.25	4.25	4.50
Zinc.....	2.00 @ 2.25	2.00	2.25

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ½ in. and larger, and plates ½ in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes.....	\$2.88	\$2.88	\$2.88
Soft steel bars.....	2.78	2.78	2.78
Soft steel bar shapes.....	2.78	2.78	2.78
Soft steel bands.....	3.42	3.48	3.48
Plates, ½ to 1 in. thick.....	2.88	2.80	2.80

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Arkansas

CAMDEN—H. M. Jones, El Dorado, Ark., and associates, are planning for the erection of a new oil refinery at Camden, to consist of 2 units, with initial daily output of about 500 bbl.

California

RICHMOND—The Pacific Sanitary Mfg. Co., Fifth and Hensley Sts., manufacturer of sanitary ware, will commence the immediate construction of a 1-story addition to its plant, 100 x 300 ft. The erection contract has been let to Carl Overa, 2105 Roosevelt St.

LOS ANGELES—The Los Angeles Fabricating Co. has filed plans for the erection of a new 1-story steel fabricating plant, 95 x 160 ft., estimated to cost about \$80,000. The Austin Co., Los Angeles, has the construction contract.

VISTA—The Sierra Clay Products Co., Sparks, Nev., H. O. Hague, president, is planning for the construction of a new brick-manufacturing plant at its clay properties in the Truckee River canyon, near Vista. The initial plant will be supplemented at an early date by a works for the manufacture of pottery and other burned clay products.

Florida

LEESBURG—The Grass Fibre Pulp & Paper Corp., recently organized with a capital of \$1,000,000, has construction under way on its new local plant to be equipped for the manufacture of paper pulp from sawgrass. The works will have an initial capacity of about 40 tons. It is planned to have the factory ready for operation at an early date. W. F. Stovall is president; and E. R. Lacey, vice-president and general manager.

Indiana

INDIANAPOLIS—The Parker Tire & Rubber Co., 264 Allen Ave., will hold in abeyance the completion of unit No. 2, at its tire-manufacturing plant. The foundation work for the structure has been completed; it will be 2-story, 100 x 600 ft., and is estimated to cost about \$300,000, with machinery. Paul P. Parker is president. George L. Whitsit, company address, is engineer.

MARION—The Upland Flint Bottle Co. has resumed production at its plant, after a shutdown of several weeks, giving employment to about 250 men.

Kentucky

SMITHFIELD—The Ohio-Kentucky Fluorspar & Lead Co., recently organized, is planning for the installation of equipment on properties acquired, previously operated by the North American Co. The present plant has a capacity of about 150 tons per day, and this output will be doubled. The company is capitalized at \$1,000,000. F. B. Moody is general manager.

Massachusetts

PEABODY—The Morse Blacking Co. has commenced the construction of an addition to its plant, 1-story, 22 x 125 ft. A portion of the structure will be equipped as a laboratory and the remainder for the manufacture of color-finishes for leather tanning work.

BOSTON—The Massachusetts Oil Co. is perfecting plans for the construction of a new branch works on Pequot Ave., New London, Conn.; it will consist of a number of buildings.

CHARLESTON—Fire, Sept. 16, destroyed a portion of the 3-story works of the Eastern Metal & Refining Co., 60 Roland St., with loss estimated at about \$18,000.

Mississippi

JACKSON—The Central Cotton Oil Co. is reported to be planning for the immediate rebuilding of the portion of its plant, destroyed by fire Sept. 14, with loss estimated at about \$75,000.

New Jersey

NEWARK—The Krepecraft Co., recently organized with a capital of \$20,000, has leased a portion of the plant of the Universal Caster & Foundry Works, Jackson Ave., for the establishment of a new plant for the manufacture of crepe-paper products. The structure consists of a total of about 8,000 sq. ft. of floor space, and will be remodeled and equipped immediately for the new line of manufacture. The office of the company will be located at 129 Jackson Ave. Fred E. Rothermel and Fred Schuler head the company.

BELLEVILLE—The Bob White Chemical Co., 39 Broadway, New York, N. Y., is planning for the construction of a new plant in the vicinity of Belleville. Application for permission to erect the structure has been made to the local town officials. The company is perfecting plans for the erection of a new laboratory and works structure at Ogdensburg, N. Y. It was formerly known as the Morgan Chemical Co.

TRENTON—The Star Porcelain Co., Muirhead Ave., manufacturer of electrical porcelain products, is taking bids for the erection of a 1-story addition to its plant, 50 x 82 ft.

NEWARK—The Art Metal Works, 7 Mulberry St., is arranging for the immediate installation of a new gas-recovery system at its branch works at 45 Manufacturers Pl.

New York

ALBANY—The Pittsburgh Plate Glass Co., Pittsburgh, Pa., and 103 Hunters Point Ave., Long Island City, N. Y., has awarded a contract to Bame & Cardell, Central Ave., Albany, for the erection of a new local plant on Tivoli St., to be 2-story, 103 x 180 ft., and consisting of a factory, power house and warehouse.

MECHANICVILLE—Fire, Sept. 16, destroyed a portion of the plant of the Duffney Brick Co., including drying department, boiler and engine rooms, and other works departments, with loss estimated at close to \$200,000, including equipment. The plant will be rebuilt.

SYRACUSE—The Onondaga Pottery Co., 1858 West Fayette St., has commenced excavations for its new pottery on Court St. for the manufacture of general ware, estimated to cost in excess of \$300,000 with machinery. The building contract has been awarded to Dawson Bros., Union Bldg. B. E. Salisbury is president.

Ohio

CLEVELAND—The Rail Welding & Bonding Co., 2400 Woodland Ave., has awarded a contract to the Austin Co., 16122 Euclid Ave., for the erection of a 1-story and basement plant addition, 90 x 180 ft.

CUYAHOGA FALLS—The Duro Brick Mfg. Co. is perfecting plans for the rebuilding of the portion of its plant recently destroyed by fire with loss estimated at about \$75,000.

AKRON—The Mason Tire & Rubber Co. is arranging for enlargements in its plant to double, approximately, the present capacity. A portion of the present works will be remodeled to accommodate the installation of considerable new machinery. It is proposed to have the entire plant ready for service early in the coming year, with output of about 4,000 tires and 4,000 tubes per day.

CANTON—Fire, Sept. 14, destroyed a portion of the plant of the Republic Rubber Co., with loss estimated at about \$20,000.

TOLEDO—The Spltzer Paper Box Co., 3501 Monroe St., has awarded a contract to the Henry J. Spieker Co., Elm and Utica Sts., for the erection of its proposed 3-story

plant addition, 30 x 80 ft., estimated to cost about \$50,000. George R. Rheinfrank, Gardner Bldg., is architect.

Oklahoma

MUSKOGEE—The Oklahoma Producing & Refining Co. is planning for extensions and improvements in its local oil refinery. It is proposed to increase the production by about 20,000 bbl. a month; a number of new stills will be installed, and the storage capacity increased to about 350,000 bbl. of crude oil and 110,000 bbl. of refined products. The work, including equipment, is estimated to cost about \$150,000. Meadquarters of the company are at Tulsa, Okla.

Pennsylvania

READING—The Electric Manganese Steel Co. is completing plans for the erection of a new 1-story foundry in the Brush Valley section, to be 1-story, 40 x 140 ft., and estimated to cost about \$50,000. It will be equipped for the manufacture of steel castings. William H. Dechant & Son, Baer Building, are engineers.

EASTON—The Forbes Aluminum Products Co., recently organized under Delaware laws with capital of \$500,000, has plans in preparation for the erection of a new local plant, estimated to cost in excess of \$100,000. The company is represented by the Corporation Trust Co. of America, du Pont Bldg.

NEW CASTLE—Frank A. Seiberling, president of the Lehigh Tire & Rubber Co., formerly the New Castle Tire & Rubber Co., is said to be negotiating for the purchase of the plant and property of the Portage Tire & Rubber Co., Portage, Ohio, now operating under a receivership, with an offer of \$750,000 for the assets. Upon acquisition, the plant will be operated in conjunction with the local works. Mr. Seiberling was previously head of the Good-year Tire & Rubber Co.

Tennessee

JELLICO—The Jellico Firebrick Co. is arranging for the immediate installation of new equipment at its plant for the manufacture of firebrick, facebrick and other burned clay products. The company recently filed articles of incorporation with a capital of \$100,000. Frank L. Smith is secretary and treasurer.

Texas

MEXIA—The Mexia Refining Co., Telephone Exchange Bldg., has awarded a contract to Charles V. Miller, Fort Worth, Tex., for the erection of its proposed new local oil refinery. The plant will be equipped to develop an output of about 3,000 bbl. a day, and is estimated to cost about \$250,000. The machinery installation is expected to aggregate \$150,000 in cost. Construction will be inaugurated at once.

ROTAN—The Patton Cement Plaster Co., recently organized with a capital of \$350,000, is arranging for the erection of a local plant for the production of plaster. It is proposed to develop a capacity of about 400 tons of material a day. An elevator, 75x300 ft., will be constructed. J. W. Patton is president, and E. W. Maben, secretary and treasurer.

MARSHALL—The Darco Corp., du Pont Bldg., Wilmington, Del., a subsidiary of the du Pont Powder Co., of the same address, has acquired a tract of property at Marshall, totaling 160 acres, to be used as a site for its proposed new plant for the manufacture of Darco, a product produced from lignite and to be used in connection with the manufacture of glucose and kindred specialties. The new plant is estimated to cost about \$1,500,000, and will be equipped to give employment to about 500 men.

AUSTWELL—The Austwell Oil Mill Co. is reported to be planning for the immediate rebuilding of the portion of its plant, recently destroyed by fire.

GORMAN—The Shell Torpedo Co., recently organized, has commenced the erection of a new plant on local site for the manufacture of nitroglycerine and other explosive products. The initial works will have a capacity of 1,200 qt. of material per day. Frank Kirk is president, and A. W. Samberson, vice-president and general manager.

Utah

SALT LAKE CITY—The Utah Iron & Steel Co. has preliminary plans under way for the erection of a number of additions to its works at Midvale, Utah, to include a new blast furnace, sheet mill, general rolling mill and other subsidiary buildings, estimated to cost about \$3,000,000, complete.

The company has increased its capital from of \$2,500,000 to \$5,000,000, with 50,000 shares of common stock, no par value, to finance the expansion.

Virginia

BARBER—The Ohio C. Barber Lime Co., affiliated with the Ohio C. Barber Fertilizer Co., Akron, O., is now operating at its new local plant, producing lime from a natural deposit without burning. Extensive capacity is planned. The company was organized recently with a capital of \$600,000. Clarence W. Perkins is president.

New Companies

THE BULLET PROOF & NON-SHATTERABLE GLASS CORP., New York, N. Y., has been incorporated with a capital of \$500,000, to manufacture special glass products. The incorporators are B. C. Fox, S. Tekulsky and P. Abrams. The company is represented by Hartman, Sheridan & Tekulsky, 152 West 42d St.

THE ROGERS FOUNDRY Co., Detroit, Mich., has been incorporated with a capital of \$35,000, to manufacture iron, steel and other metal castings. The incorporators are C. O. Rogers, Monroe, Mich.; William Reinhold and Alexander Hungler, 448 Yale St., Detroit.

THE BOLIVAR COTTON OIL Co., Bolivar, Tenn., has been incorporated with a capital of \$75,000, to manufacture cotton oil products, with plant at Shelby, Miss. The incorporators are L. B. Wilkinson and C. T. Jacobs, both of Bolivar.

THE MOLDED PRODUCTS Co., Boston, Mass., has been incorporated with a capital of 1,000 shares of stock, no par value, to manufacture composition and molded products of various kinds. Henry L. F. Kreger is president; and Bennett Sanderson, Littleton, Mass., treasurer.

WELSEY & Co., INC., Brooklyn, N. Y., has been incorporated with a capital of \$20,000, to manufacture oils, greases, etc. The incorporators are M. V. and R. S. Welsey, and F. M. Hill. The company is represented by E. J. Treacy, 15 Park Row.

THE ESSENTIAL OIL Co., New York Ave. and Mulberry St., Trenton, N. J., has been incorporated with a capital of \$250,000, to manufacture oil products. The incorporators are John F. Wharton, August G. Roesele and Harry J. Engels.

THE OHIO VALLEY FLUORSPAR Co., Cave In Rock, Ill., has been incorporated with a capital of \$60,000, to operate fluorspar and other mineral properties and refineries. The incorporators are C. R. Hamilton, U. G. Gullett and C. E. Seward, Cave In Rock.

THE CHIPLEY LEATHER MFG. Co., Chipley, Fla., has been incorporated with a capital of \$25,000, to manufacture leather products. A local plant is now in course of construction. J. B. Guess, Jr., is president; and W. H. Faust, secretary and treasurer.

THE PATUXENT CLAY PRODUCTS Co., 32 South Calvert St., Baltimore, Md., has been incorporated with a capital of \$1,000,000, to mine and manufacture clay products; operate a refinery for metal ore reduction, and kindred manufacture. The incorporators are Henry N. Hanna, Arthur R. Kasson and Herbert W. Holmes.

THE TRINITY OIL CORP., Wilmington, Del., has been incorporated with a capital of \$3,000,000, to manufacture refined petroleum products. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington.

THE KAISER-RADICK CORP., New York, N. Y., has been incorporated with a capital of \$50,000, to manufacture chemicals and chemical byproducts. The incorporators are J. D. Kaiser, H. I. Dorn and C. M. Rose. The company is represented by Samuel Sperling, 1540 Broadway.

THE CHEMICAL DEVELOPMENT Co., 73 Eppert St., East Orange, N. J., has filed notice of organization to manufacture chemical products. Paul D. Manning, 133 Washington Ave., represents the company.

THE PETROLEUM PRODUCTS Co., Jacksonville, Fla., has been incorporated with a capital of \$25,000, to manufacture oil products. B. E. Bennett is president; H. R. Simcox, secretary; and J. G. Woods, treasurer.

THE PURE LINE Co., New York, N. Y., has been incorporated with a capital of \$10,000, to manufacture chemicals and affiliated products. The incorporators are I. Cole, J. F. Kunzman and S. F. Mead, 158 West 50th St.

THE VALLEY FOUNDRY Co., Cumberland R. I., has been incorporated with a capital

of \$50,000, to manufacture iron, steel and other metal castings. The incorporators are M. M. McKenna and Walter L. Slims, Cumberland; and Frank Gross, 120 Hutchings St., Roxbury, Mass.

THE NON-ACID FERTILIZER & CHEMICAL Co., Lakeland, Fla., has been incorporated with a capital of \$600,000, to manufacture chemical and fertilizer products. C. W. Dean is president; H. E. Memmlinger, vice-president and treasurer; and T. L. Willson, secretary, all of Lakeland.

THE SCHOENFELD-GUTTER Co., New York, N. Y., has been incorporated with a capital of \$25,000, to manufacture magnifying glass and other glass products. The incorporators are M. and P. Schoenfeld, and L. Gutter. The company is represented by D. E. Goldfarb, 35 Nassau St.

THE CHEMICAL SALES Co., 356 East Illinois St., Chicago, Ill., has been incorporated with a capital of 100 shares of stock, no par value, to manufacture and deal in chemical products. The incorporators are Joseph Cohen and Aaron T. Rubin.

THE WATTS-JAY Co., Jacksonville, Fla., has been organized under state laws to manufacture fertilizer products. Lemuel P. Jay is president; and John W. Watts, Jr., secretary and treasurer, both of Jacksonville.

THE MOHAWK TANNING Co., Gloversville, N. Y., has been incorporated with a capital of \$10,000, to manufacture leather products. The incorporators are S. F. Sackheim, M. Barnett and O. Brauns. The company is represented by W. S. Cassidy, Gloversville.

THE BEAR RUBBER MILLS CORP., San Antonio, Tex., has been incorporated under Delaware laws with capital of \$1,000,000, to manufacture rubber products. The incorporators are Donald E. Cameron, Charles Massey and Claude J. Kelly, San Antonio. The company is represented by the United States Corporation Co., 65 Cedar St., New York, N. Y.

THE HAYWARD RUBBER Co., Philadelphia, Pa., has been incorporated under Delaware laws with a capital of \$200,000, to manufacture tires and other rubber products. The incorporators are William C. and L. T. Zimmerman, Philadelphia; and E. C. Boyd, Wilmington, Del. The company is represented by Harry P. Joslyn, Ford Bldg., Wilmington.

THE FARADOX RADIUM LABORATORIES, INC., 1012 North Clark St., Chicago, Ill., has been incorporated with a capital of \$30,000, to manufacture radium and radioactive products. The incorporators are Burrell J. Cramer, Frank D. Levan and Harry Linder.

THE JOHN & PETERSON OIL CORP., Tulsa, Okla., has been incorporated with a capital of \$150,000, to manufacture petroleum products. The incorporators are Willard John, J. P. Peterson and Charles P. Yadon, all of Tulsa.

HERBERT S. MICHAEL, INC., 1701 North Charles St., Baltimore, Md., has been incorporated with a capital of \$100,000, to manufacture chemicals and affiliated specialties. The incorporators are Herbert S. Michael, LeRoy R. Hatter and Clayton C. Dobbs.

THE AMERICAN BRASS & ALUMINUM FOUNDERS Co., 6833 South Irving Ave., Chicago, Ill., has been incorporated with a capital of \$35,000, to manufacture brass, bronze, aluminum and other metal castings. The incorporators are Robert C. Fingol, Harry J. Sanding and Anton A. Sikora.

THE COLUMBIA REFINING Co., Cleveland, O., has been organized under Delaware laws to manufacture refined oil products. The incorporators are Rosecoe M. Ewing, James L. Lind and R. C. Heil, Cleveland. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington, Del.

THE THUNDERBOLT POWDER Co., Wilmington, Del., has been incorporated under state laws with capital of \$100,000, to manufacture powder, explosives and kindred products. The company is represented by the Capital Trust Co., Dover, Del.

THE SUPERIOR ALUMINUM CORP., New York, N. Y., has been incorporated with a capital of \$25,000, to manufacture aluminum and other metal products. The incorporators are W. Bichwit, S. Brodsky and G. C. Woolf. The company is represented by J. L. Bernstein, 5 Beekman St.

THE OLEAN WASH PAINT & VARNISH REMOVER Co., Syracuse, N. Y., has been incorporated with a capital of \$10,000, to manufacture chemical compounds and affiliated specialties. The incorporators are F. P. Malpass, G. W. Fox and E. L. Day. The company is represented by Higbee & Malpass, University Block, Syracuse.

THE T. C. OIL CORP., Columbia, S. C., has been incorporated under Delaware laws with a capital of \$200,000, to manufacture refined oil products. The incorporators are R. A. Cooper and W. A. McSwain, Columbia; and T. C. Hadley, Montgomery, Ala. The company is represented by the American Guaranty & Trust Co., Wilmington, Del.

THE METALLOY Co. OF BALTIMORE, Baltimore, Md., has been incorporated with a capital of \$10,000, to manufacture metal products. The incorporators are John L. Brown, Louis S. Houghton and William B. Rearick, 1728 Mulliken St.

THE PALO MOTOR OIL Co., 38 North Clark St., Chicago, Ill., has been incorporated with a capital of 50 shares of stock, no par value, to manufacture petroleum products, lubricating oils, etc. The incorporators are Harry J. Myerson, William H. Treder and Harry Berger.

Capital Increases, Etc.

THE WORLD'S FERTILIZER PROCESS Co., Sharpsburg, Pa., manufacturer of fertilizer products, has filed notice of increase in capital from \$200,000 to \$500,000.

THE CORRUGATED PAPER PRODUCTS Co., 221 West 26th St., New York, N. Y., has filed notice of increase in capital from \$25,000 to \$125,000.

THE PORTAGE TIRE & RUBBER Co., Portage, O., has filed a petition in bankruptcy, with estimated liabilities stated at \$1,705,000, and assets about \$400,000.

THE ADVANCE COLOR Co., 833 Magnolia Ave., Elizabeth, N. J., has filed a petition in bankruptcy.

THE ZEGLER TIRE & RUBBER Co., 1346 Rawson St., Chicago, Ill., has filed notice of change of name to the Chicago City Rubber Works, Inc.

THE BISON CHEMICAL Co., Buffalo, N. Y., has filed notice of dissolution under state laws.

THE SUPERIOR CHEMICAL Co., Joliet, Ill., has filed notice of change of name to the Calbakpo Co., at the same time changing its headquarters to 4100 Fillmore St., Chicago, Ill.

THE FEDERAL CHEMICAL Co., Nitro, W. Va., has filed notice of increase in capital from \$250,000 to \$500,000.

DAVID E. ALLEN, INC., Yonkers, N. Y., operating a foundry for the manufacture of metal castings, has filed notice of increase in capital from \$25,000 to \$75,000.

THE MAGNOLIA PETROLEUM Co., Dallas, Tex., has filed notice of increase in capital from \$15,994,941 to \$27,460,134.

THE HAMILTON NOVELTY GLASS Co., 2344 West Harrison St., Chicago, Ill., has filed notice of change in name to the Hamilton Glass Co.

Manufacturers' Catalogs

THE WHEELER CONDENSER & ENGINEERING Co., Carteret, N. J., has just received from the printer its catalog on "Wheeler Condensers," which illustrates and describes a complete line of condensers and accessories for stationary and marine service—including Wheeler condensers, vacuum pumps, centrifugal pumps, cooling towers, condenser tubes, feed-water heaters, etc. Among the recent engineering improvements are: A new design of a 26-in. vacuum surface condensing equipment adapted for engine work and dispensing with combined auxiliary pumps; the steam jet air pump, with combined inter-condenser and heater operating at a maximum efficiency without complicated and expensive accessories; the jet condenser, with expansion joint between condenser body and a turbine, and a centrifugal pump having a special vertically split casing. In a section devoted to Crescent Brand condenser tubes, the precision that enters into each step of the manufacture of the highest quality tubes is explained. A condenser data sheet is included with each copy.

THE AUTOMATIC & ELECTRIC FURNACES, LTD., London, has sent a copy of its new catalog describing Wild Barfield electric furnaces, showing the wide range now manufactured by this company. Attention is called to Bulletin 20, which has been written with the idea of explaining to works employees that the best results in hardened steel are obtained by hardening at the non-magnetic point.

THE BROWN HOISTING MACHINERY Co., Cleveland, O., has produced a new clam-

shell bucket which is a powerful digger and has manganese steel digging edges which can be replaced when worn. Bronze bushings are used and throughout the bucket is designed to reduce wear. This is all described in a leaflet which will be furnished upon request to anyone interested.

THE STEERE ENGINEERING CO., Detroit, Mich., has issued a leaflet on Purifier Trays.

THE GRINNELL CO., INC., Providence, R. I., has issued two catalogs: One describing the complete line of textile driers manufactured by the drier division of this company, and the other giving data on the compartment driers used in the chemical, pharmaceutical, dyestuff and color industries. Illustrations and specifications are given. Copies will be sent to anyone interested.

THE COLORADO IRON WORKS CO., Denver, Col., is distributing two leaflets, on "The Skinner Roaster" and "The Akins Flotation and Aeration Machine."

THE DAYTON-DOWD CO., Quincy, Ill., announces its new catalog, No. 246, on centrifugal fire pumps. Numerous photographs of installations and tests are shown.

THE ASHLAND FIREBRICK CO., Ashland, Ky., calls attention to four bulletins which have just been published, on "Firebrick for Rotary Cement Kilns," "Boiler Settings," "Firebrick for Glass Plants" and "Refractories for Oil-Burning Furnaces."

THE YOUNGSTOWN BOILER & TANK CO., Youngstown, O., has issued Bulletin 400, covering its tanks for the storage of gasoline, alcohol, benzene, asphalt, grease, brine, fuel oil, water, oils, soap, benzene, chemicals, etc. Illustrations are given of the different types, and purposes, together with a table of capacities.

THE EASTON CAR & CONSTRUCTION CO., Easton, Pa., in its bulletin on "Quarry Car Practice" illustrates and describes cars used by cement mills.

THE CARRIER ENGINEERING CORP., Newark, N. J., issues each month an interesting booklet entitled "The Weather Vein." The May issue was called the "Drying Number," the June issue the "New Home Number," the July issue the "Dehumidification Number," the August issue "The Motion Picture Number," the September number the "Ceramic Number." Many interesting articles are included in these booklets on air conditioning to the practical requirements of industry.

THE PALO CO., New York City, has issued a leaflet on the New Spencer Abbe refractometer which is illustrated and described.

THE WESTINGHOUSE ELECTRIC & MFG. CO., East Pittsburgh, Pa., in a leaflet just issued describes in detail the auto-transformer, switching mechanism, the contacts, the overload relays, and many other features of type A auto-starters.

THE MANISTEE IRON WORKS CO., Manistee, Mich., has issued Bulletin 7, on "Manistee Vacuum Evaporators." Single and multiple effect units are described, together with a general synopsis of the salt industry, past and present, and the principle and economy of vacuum evaporation as applied to concentration and crystallization.

THE DORR CO., New York, in Bulletin No. 16 illustrates and describes continuous agitation and continuous counter-current washing in the chemical industries.

THE DOVER BOILER WORKS, New York, has issued specification and notes on steel stacks and tanks for factories, power houses, office, loft and apartment buildings, etc. This booklet contains a practical non-technical form of specification, with supplementary shop notes for the use of architects and engineers.

THE AMERICAN ROLLING MILL CO., Middletown, O., has issued an attractive publication, "Arnico in Picture and Fact." This is a well printed and bound piece of publicity on behalf of a well-known American product. Manufacture of ingot iron sheets is shown by a series of a hundred or more excellent photographs, each operation being described briefly in a caption. Then comes a section showing the various forms of roofing and roofing accessories, culvert pipe, small tanks, etc., which are made at the main plant. Finally about 80 pages are devoted to a comprehensive set of tables of weights of sheets and plates of various gages, lengths and finishes.

THE KEWANEE BOILER CO., Kewanee, Ill., has issued Catalog 76, covering complete data on Kewanee firebox boilers, including drawings and dimensions.

THE M. W. KELLOGG CO., New York, calls attention to a new attractive book on

"Power Plant Piping." This company, which has been called upon to solve many intricate piping problems, has gathered the more important elements of this knowledge and has crystallized them into the story which is contained in this book. It deals with the scope of its service, specifications for piping, the different kinds of pipes and piping, the size and design of the piping system, expansion of pipes, fittings, flanges, flow of water and steam, joints, etc. Another publication just issued by this company is on "Kellogg Hammer Welding" which is a process of making leak-proof vessels for the chemical industries. Both these catalogs are well illustrated.

THE STANDARD CAP & SEAL CORP., Chicago, Ill., has issued a booklet on "Standard Capping Machines," both hand or power operated.

THE LINK-BELT CO., Chicago, Ill., in its new steel chain data book 475 describes the heavier rugged steel chains used for power transmission, and also elevating and conveying chains. In book 215 this company describes the Uniroll and Multiroll idlers, and give also the correct method of figuring belt conveyors, price lists which will enable the user to determine the cost of a complete conveyor or any portion of a conveyor, examples suggesting correct type of belt conveyors and illustrations of typical installations.

THE HARBISON-WALKER REFRACTORIES CO., Pittsburgh, Pa., has issued a leaflet on "Metakase Magnesite Brick" for electric steel furnaces.

F. J. RYAN & CO., Philadelphia, has issued two leaflets: "Mircs Universal Oil Burner" and "Mircs Oil Fired Portable Rivet Heating Furnace." Copies of these bulletins will be sent upon application.

THE DANIEL M. LUEHRS CO., Cleveland, O., has issued two circulars describing its patented electrically heated oil systems. The Oil-Roasting System was designed primarily for the roasting of food products in deep fat or vegetable oils and the Liquid Heat System was designed to maintain temperature in pipe lines, pumps, asphalt and tar roofing machinery, jacketed kettles and evaporators. The heart of these systems consist of the electric oil heater and method of controlling the temperature. The oil-roasting system can be adapted for such work as paraffine impregnation and the heating of paraffines and other solids having a melting point less than 550 deg. F. and which will melt free and not clog up the pump or heater. Inasmuch as the electric heaters operate at a temperature only a few degrees higher than the temperature of the oil leaving the heater, the danger from carbonizing is greatly reduced. This makes it possible to use this system where accurate temperature control is desired and where material is liable to injury due to high temperatures.

THE GEORGE J. HAGAN CO., Pittsburgh, Pa., has issued four new catalogs. Bulletin LF 103 is on liquid fuel burners for the generation of steam; Bulletin LF 104 is on auxiliary apparatus for storing, transporting and conditioning liquid fuels; Bulletin LF 102 is on oil burners for combination oil and gas burners for industrial furnace application, and Bulletin LF 105 is on standardized heat treating furnaces of the combustion type for steel hardening, carbonizing, and annealing—non-ferrous metal annealing and similar metal heating operations. Each booklet is well illustrated.

THE HARDINGE CO., New York, calls attention to Section 1 of its No. 7 catalog, which has been revised and which embraces both wet and dry grinding problems. This section deals with the principle of operation of the conical mill and gives a general description of its uses in the industrial, mining and special fields.

THE YARNALL-WARING CO., Philadelphia, Pa., in Bulletin 4-1401, with supplementary sheet 2, explains the recent development of Yarway balanced control valve in both angle and globe patterns, with several forms of operating mechanisms. This equipment was designed primarily for use in conjunction with Yarway Lea V-Notch recording meter, but is also used on heaters and tanks that need regulating equipment. Pamphlet DT-1601, which is entitled "Tight in Two Places," describes Yarway double tightening valves for use on acid lines, soot-blowing systems, for locomotive service and pneumatic systems in addition to boiler blow-off use. Copies will be sent to anyone interested, upon request.

BAKER & CO., INC., Newark, N. J., announces the publication of a booklet on platinum, which contains the historical summary of platinum, occurrence of platinum ore, the platinum metals and uses of platinum, its allied metals and alloys.

THE NASH ENGINEERING CO., South Norwalk, Conn., has issued two new bulletins, No. 16 describes and illustrates the Jennings hytor condensation motor-driven centrifugal pump, which is designed to handle condensate from steam-heating or drying systems. They may be used to handle any liquid which will not attack the pump interior. In Bulletin 17 the Jennings hytor air line vacuum heating pumps, electric motor drive, for use on air line vacuum heating system or any service requiring air to be exhausted under a vacuum not exceeding 20 in. of mercury are described and illustrated. The illustrations in both catalogs show the machinery in natural colors.

THE TITANIUM ALLOY MFG. CO., Niagara Falls, N. Y., in a leaflet announces the offering of the facilities of the Commercial Service Department of the physical, metallurgical and metallographic laboratories to manufacturers and others interested in metallurgical and mechanical lines.

THE RAILWAY & INDUSTRIAL ENGINEERING CO., Greensburg, Pa., is putting on the market a rocking cableway for handling materials which is described in a four-page booklet.

THE NEW ENGLAND TANK & TOWER CO., Everett, Mass., has issued a booklet, No. A-121, descriptive of a "Nett-Co." product, the direct-connected motor-driven agitator drive.

THE AJAX ELECTROTHERMIC CORP., Trenton, N. J., in a recently published circular treats the Ajax-Northrup high-frequency induction furnace as a laboratory tool, which is used for melting steel, brass, silver and other metals and for heat-treating, carbonizing, annealing, etc.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its seventy-fourth meeting at Toronto, Canada, Dec. 27 to 31, 1921.

AMERICAN CERAMIC SOCIETY will hold its twenty-first annual meeting at St. Louis, Feb. 27 to March 2, 1922.

AMERICAN GAS ASSOCIATION will hold its third annual convention in the Congress and Auditorium Hotels, Chicago, the week of Nov. 7. More than 100 manufacturers will exhibit their latest gas-burning appliances.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its annual winter meeting at Baltimore, Md., Dec. 6 to 9. Headquarters will be at the Southern Hotel and the sessions will be held in the Engineers' Club.

AMERICAN MINING CONGRESS AND NATIONAL EXPOSITION OF MINES AND MINING EQUIPMENT will hold its twenty-fourth annual convention in the Coliseum, Chicago, Oct. 17 to 22.

ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS will hold its thirty-eighth annual convention at the Washington Hotel, Washington, D. C., Oct. 24-26.

INDUSTRIAL COST ASSOCIATION will hold its second national conference at Pittsburgh, Pa., Nov. 2-4, with headquarters at the William Penn Hotel.

INDUSTRIAL RELATIONS ASSOCIATION OF AMERICA will hold its annual convention at the Waldorf-Astoria, New York, Nov. 1-5.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

SOCIETY OF INDUSTRIAL ENGINEERS is holding its fall meeting at Springfield, Mass., Oct. 5 to 7.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

The following meetings are scheduled to be held in Rumford Hall, the Chemists' Club, New York: Oct. 7—American Chemical Society, regular meeting; Oct. 14—Société de Chimie Industrielle, regular meeting; Oct. 21—Society of Chemical Industry, Grasselli Medal; Nov. 11—American Chemical Society (in charge), Society of Chemical Industry, American Electrochemical Society, Société de Chimie Industrielle, joint meeting; Nov. 18—American Electrochemical Society, regular meeting; Dec. 2—Society of Chemical Industry, regular meeting; Dec. 9—American Chemical Society, regular meeting.

CHEMICAL & METALLURGICAL ENGINEERING

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How May Research Be Fostered?

A PLEA for a restricted use of the word "research" was made in these columns not long ago, using as a basis DR. HYDE'S admirable outline of investigative work in science and engineering. Doubtless many who read those words agreed with DR. HYDE that the word "research," meaning a diligent and critical investigation in seeking facts or principles, clearly includes the five items in his classification, and would hold the editorial writer guilty of overdrawing a picture merely to emphasize his point of view. They would be inclined to use the word research as a generic term, modified by descriptive adjectives when necessary.

However that may be, undoubtedly all will agree that the unqualified word research or the phrase "pure scientific research" accurately describes patient searching in nature for evidences of hitherto unknown phenomena, and that such researches are of the utmost value in furnishing the fundamental basis of scientific and engineering progress. All will agree that too few qualified men are now engaged in such work, and the problem of instituting and stimulating research has been argued at length.

One result of this discussion is the conclusion that research ("pure scientific research," if you must, to be precise) can best be done in the future where it has always been done in the past: in universities or in endowed laboratories. Investigators in these institutions do not need to worry whether the things they are bringing to light can be capitalized immediately at a satisfactory profit. The highest type of university professor, as a matter of fact, is continually urged to extend the limits of his knowledge, not only because he must do so in order to fulfill his mission as an instructor, but because he realizes that his science is a growing thing, and he is the husbandman.

This urge from within is the researcher's motive power. Researches, in fact, cannot be directed. Imagine EUCLID examining his calendar after breakfast to find that this day he was to square the circle! Or that LIVINGSTON, in the trackless jungle, could be directed to discover Victoria Falls!

Undoubtedly, the researcher must be free! Various agencies which are now bestirring themselves to stimulate research would do well to bear this thought in mind. Acting on it they can do the most good. Perhaps they can see to it that the research professor receives a salary which will enable him to live without grinding economy in the dignified manner the importance of his work warrants, and permit him to visit freely at other institutions where interesting work is in progress. Relieve him of petty administrative detail. Then go away and leave him alone! For the true researcher has the same spirit as DAVY CROCKETT; he will move on as soon as he can see his neighbor's smoke.

Finding the Effect of American Valuation

MR. FORDNEY'S tariff has retired to the chambers of the Senate Finance Committee and the orders are that it is not to be disturbed—at least during the present session of Congress. Tariff problems have for the moment given way to discussions, discussions, discussions on taxation and unemployment. But we are reminded occasionally that the important policy of American valuation is still in abeyance, notwithstanding that it is the framework upon which the entire tariff must be built.

A few months ago a small group of prominent manufacturers met at the Chemists' Club of this city and organized the American Valuation Association, which has since been carrying on a vigorous campaign in favor of this change in our methods of assessing ad valorem duties. The press has been flooded with arguments and propaganda for its adoption and meetings of manufacturers have been held all over the country. In the meantime associations of importers, some of the large department stores and other tradesmen have been equally active in opposing the measure. It is obvious that this important issue must not be decided by either of these agencies nor by a Congress supplied only with partisan information obtained from these selfish sources.

American valuation of imports is generally referred to as an untried experiment, the effect of which can be studied only after the principle is adopted. We seem to lose sight of the fact that the true effect is susceptible of determination in advance. The importers' invoices in the Custom House and the manufacturers' sales records contain data which will show exactly what would have been the results had such a plan been in operation last week, last year or ten years ago.

Recognizing the good that such an investigation might accomplish, Congress recently placed a substantial appropriation at the joint disposal of the Treasury Department and the Tariff Commission and instructed these agencies to make an exhaustive study of American valuation. Formal announcement has not been made as to the complete plans for this co-operative work, but a director has been appointed and at least one conference has been held with manufacturers and representatives of the trade.

We had hoped that the investigation might be of a non-political nature and we were therefore surprised to learn that the directorship has been conferred on a former secretary of the Republican National Committee. However, he may have been selected for his appreciation of scientific tariff making, so we still believe the investigation can be made worth while. Information of unusual industrial significance can be obtained from a comprehensive study and a judicious sifting of facts and figures. American valuation holds much at stake for the chemical industry and we are justified in insisting that the plan be put to a thorough and impartial test.

Electrochemists At Lake Placid

ANIMATED discussion marked the technical sessions of the Lake Placid meeting of the American Electrochemical Society, a complete report of which will be found elsewhere in this issue. Organic electrochemistry was represented on the program by several papers, but the most interesting contributions to the subject came out in discussion following Mr. LIDBURY's assertion that the topic was of little or no practical importance. This brought several members to the defense with brief statements of what is being done industrially with organic electrochemistry. Unfortunately the speakers could not go into detail regarding their work, but enough was said to show that organic electrochemical industry is an accomplished fact in this country and that we can confidently look forward to further development and specific applications that will be made public in due time.

A valuable contribution was made to the old but ever new subject of corrosion by J. NEWTON FRIEND, whose theory, while not pretending to finality or completeness, aids in explaining some phenomena hitherto unexplained or but partly understood. In the symposium on electro-deposition Mr. BLUM's papers were of first importance, showing the influence of the crystal structure of the base metal on the nature of the deposit of the plated metal. Important conclusions were also presented on the effect of addition agents and their relation to current density. In the symposium on the electric furnace in non-ferrous metallurgy there was a natural, though not wholly unavoidable, tendency toward commercialism that should not encroach too far on the scientific and engineering aspects of the subject. A judicious mixture of papers by furnace users as well as by manufacturers will avoid giving such a program too much of the trade aspect. Mr. ST. JOHN'S paper can be commended as a fair and impartial exposition of the influence of different types of electric furnace on non-ferrous metallurgy.

The meeting was held amid delightful surroundings that offered opportunity for sport and recreation between technical sessions. Golf, mountain climbing and lake bathing for the hardy ones were among the daily diversions which added to the regular activities left few idle hours. Nor were indoor sports entirely lacking. The club menus printed in Mr. DEWEY's simpler spelling added zest to the game of deciphering the code in order to get enough to eat. Careful inquiry revealed no converts to the new orthography, and some were found who said that *apl py* and *cofi* didn't even taste like mother's justly famous brands.

Baltimore has been selected for the spring meeting and plans are already under consideration by energetic local members. The earlier convention of the American Institute of Chemical Engineers in the same city in December should in no way detract from the success of the electrochemical meeting. Industrial plants in ample number and variety will be open to inspection and the meeting will take on a character quite different from the last two, which have been held at resorts wholly lacking in industrial attractions. Each type of meeting place has its merits and demerits, and while some would always prefer the industrial city, we think the Society gains by occasionally selecting the pleasure resort. Much depends on the appropriateness of the technical program—a point that the directors are keeping in mind.

Railroad Rates And Business Activity

IT IS DOUBTFUL whether any really good purpose is served by the talk now so prevalent that recovery in business activity is prevented or at least greatly retarded because of the failure of railroads to reduce their freight rates. That shippers should discuss this matter with railroad officials is eminently proper, but talking to the general public is another thing altogether. The public has absolutely no voice in the matter. One may admit that it was representatives of the public who passed the transportation act, but the act more than justifies the present rates, for it authorized the Interstate Commerce Commission to set rates calculated to yield the railroads 6 per cent. Under the rates thus fixed the railroad earnings during the first six months of this year were at an average rate of 1.8 per cent a year, while in July the earnings were at the rate of 4.5 per cent. There is a large deficiency, and the commission cannot order reductions, which are feasible only by voluntary act of railroad officials.

We are not proposing that facts be concealed from the public, but when the public is told that failure to reduce rates is responsible for any prolongation of the business depression a one-sided view if not an entirely erroneous view is promoted. The public is not equally well informed as to the revenue needs of the railroads, in view of earnings reports through July, nor is it given adequate arguments that reductions in rates would greatly stimulate business.

For several months past much that has been printed and much that has been said in private conversation has been in emphasis of the bad features of the business situation, while the good features have been slurred over. A year ago it was being said that we needed harder and more efficient work, while today much is said of the men who are out of employment, some of them being idle because they refuse to accept reasonable wages, and practically nothing is said of the hard and efficient work of those who are in employment, although a fair count might show the latter to outnumber the former six or eight to one. If all who work, not simply those who are called artisans or common laborers, were reckoned with, the proportion would probably be eight or ten to one.

It is considered a debatable question whether majorities are always wrong or only usually wrong. It is a fairly safe working rule that if a remedy for a state of affairs is generally urged it is a false remedy. As suggesting the correctness of this statement one can recall various periods before the war when the talk throughout business circles was that the Interstate Commerce Commission should permit the railroads to advance freight rates so that the railroads would buy things and make business good. Now many men—and quite possibly the same men—want rates reduced even though the railroads have not been making their bare expenses.

There is one subject, on the other hand, in which publicity would do a great deal of good, and that is the matter of wage rates and working conditions in the building trades. Some of their peculiar doings have been aired, but the subject will stand much more publicity, and such publicity would be a vastly greater help toward improving business and industrial conditions than saying to the public that it cannot expect improvement in business until by some chance freight rates are reduced.

And Now the Question:

"What Is the Chemical Engineer?"

THAT puzzling enigma, What is a chemist? remains unanswered, but in the meantime some badly needed light is being shed on the more complex problem of defining the status of the chemical engineer. Dr. BAEKELAND in his recent address before the International Meeting of the chemical societies stressed the importance of bringing the public to a complete realization of the duties of both the chemist and the chemical engineer and of their contribution to our modern civilization. In referring to the confusion existing in the mind of the layman, he declared: "What appears even less obvious is the relation of the chemist to the chemical engineer. It is less known that a man may be a scientific star of the first caliber and yet incapable of utilizing his science in the industries or of applying it in the many other ramifications of the economics of our civilization."

We believe that one of the reasons for the lack of a definite understanding of the functions of the chemical engineer is the failure of some of our colleges and universities to recognize chemical engineering as a branch of the engineering profession. They do not place the subject on a parity with civil, mechanical and electrical engineering, but relegate it to a position of little importance either by lumping it in with their chemistry courses or otherwise hiding it away in their colleges of arts or sciences. Only a few of the more forward-looking institutions have completely divorced their curricula in chemistry and chemical engineering and have wisely placed the latter courses in their engineering colleges. In the survey of chemical engineering education made by a committee of the American Institute of Chemical Engineers and summarized in our issue of June 15, the reader was impressed by the wide variance of opinion as to what constitutes chemical engineering. This was evidenced by the fact that in the seventy-eight institutions considered at that time about 225 different studies were being taught to chemical engineering students and in no two institutions were the chemical engineering courses identical or even substantially alike. Permitting a certain amount of specializing is undoubtedly a wise policy, and the student, under proper supervision and within reasonable limits, should be allowed to choose his own line of development. It is obvious, though, that much standardizing in our chemical engineering education is necessary, and this can best be promoted by a definite knowledge of what is required of the chemical engineer and in what fields his energies are to be expended. The failure to equip the graduate with sufficient knowledge to cope with engineering problems or the overdevelopment of the engineering viewpoint without a thorough grounding in the fundamentals of chemistry are mistakes which some of our institutions have made and are continuing to make. It is not out of place, therefore, to weigh carefully the words of one who has been successful in the thoroughly practical phases of chemical engineering. We continue to quote from Dr. BAEKELAND'S address: "The chemist, confined by the walls of his classroom, his laboratory or his library, sometimes fails to exercise sufficiently his sense of proportion. He is inclined to concentrate too much on only the part of the subject with which he is confronted. He is apt to neglect other considerations, which, although unimportant from a scientific viewpoint, frequently carry with them the very elements of success or failure in practical applica-

tions. Nor are the engineers, as a class, free from being carried away by a one-sided point of view, although it is admitted that their way of grappling with a problem is more along quantitative considerations. The ways of thinking and acting of the chemist and of the chemical engineer are often along decidedly different points of view, yet if these can be compromised, or harmonized, they bring forth good engineering."

Unemployment

Among Engineers

CURIOSLY enough, one overoptimistic person expressed the view at the President's conference that there was no unusual amount of unemployment at the present time. How fortunate it would be if a meeting called to find work for idle hands to do should discover its job already done, simply because there was no idleness!

Engineers, members of what is now a "feast or famine" profession, generally would agree with the more pessimistic view—that jobs are few and far between. Chemists and metallurgists particularly have been through lean months. Many large firms have been slashing right and left into their appropriations for investigative work, forgetting their war-time experiences, when they clamored for competent technical men to show them how to produce an acceptable article. Some have even gone so far as to curtail their expenditures for publicity.

It is all very well for the detached philosopher to remark, "Oh, very well, executives who regard research as a luxury would not profit by the findings of their laboratory anyway." But true though that may be, it does not make it any easier for the idle technical man to locate new work worthy of his talents, or comfort the engineer who is earning bread and butter as an analyst or a "man at the fire."

As we see it, the big problem of seasonal employment of engineers will not be solved until the public realizes that the increasing vigilance of engineering control is necessary in order that any manufactured product can reach the ultimate consumer with the greatest perfection and the least waste en route—that is to say, until the people of the United States know that the engineer is essential to a quality product at a reasonable price.

From this standpoint it is apparent that some time will elapse before the engineer will come into his own, and many faint-hearted and unfit will take an easier way. But this is his undoubted destiny, and the rewards to the strong will be great.

Many agencies are hastening the day of public appreciation of the engineer: The Federated American Engineering Societies has its greatest opportunity for usefulness in this very direction; the technical press has never been more influential nor more representative of the dignified calling of its subscribers; but first and foremost, the individual engineer is and must be the most powerful exponent of his own worth. No matter how hard hit he may be by the present industrial depression, he can show his neighbors and employers that he is by a wide margin a better man than another of no technical or scientific training. Such a man, of course, is a good citizen and lends his aid in every movement to improve living conditions and uphold the ideals of our Government. Such a man, perhaps needs no admonition of ours, but in view of the many signs that the trough of depression has passed, he may be heartened to the long pull ahead by a cheery "God speed."



LAKE PLACID IN THE ADIRONDACKS, NEW YORK

Meeting of the American Electrochemical Society

Report of the Fortieth General Meeting Sept. 29 to Oct. 1, 1921—Papers on Corrosion and Electrolysis—Symposiums on Non-Ferrous Metallurgy and Electrodeposition—Meeting of the Board of Directors—Social Features

THE fortieth general meeting of the American Electrochemical Society was held Sept. 29 to Oct. 1, 1921, at the Lake Placid Club in the Adirondacks. Largely due to the untiring efforts of President Smith and William M. Corse the meeting was one of the most enjoyable and sociable ever held by the society. Seldom in the history of the society has there been such an opportunity for the forming and cementing of friendships. The beautiful surroundings and exhilarating air put every one in the best of moods and was conducive to sparkling wit and joyous laughter. Never before were so many electrochemists' wives in evidence.

The three mornings were devoted to the reading and discussion of papers. President Acheson Smith presided. On Thursday the two general themes introduced were corrosion and electrolysis; on Friday the symposium on non-ferrous electrometallurgy was held, and on Saturday the symposium on electrodeposition.

Papers on Corrosion

ALKALINE AND ALKALINE EARTH METALS IN CONNECTION WITH NON-FERROUS ALLOYS

The first paper of the Thursday, Sept. 29, session was by Charles Wickers of Buffalo on "Experiences With Alkaline and Alkaline Earth Metals in Connection With Non-Ferrous Alloys." The author reported on a number of experiments which tended to show that metallic sodium could not be used satisfactorily for deoxidizing copper but that when added to molten copper or bronze in the form of an alloy such as sodium-tin, it appears to produce an alloy of superior torsional strength. Of the alkaline earth metals, calcium is valueless in producing solid copper castings, nor has it any value in bronze. As a deoxidizing agent in copper,

calcium is at its best when combined with an acid element such as silicon, and this combination is improved by a third element. This latter combination is being used with success for the production of copper castings possessing very high electrical conductivity. Barium and strontium appear slightly more promising than calcium, but he stated that a large amount of foundry research work is necessary before their actual value is known.

This paper was of particular interest to the electrical engineers present and it was pointed out by C. G. Schluederberg of the Westinghouse company and John A. Seede of the General Electric Co. that high electrical conductivity was absolutely essential if the copper castings were to be used in electrical apparatus. It was suggested that castings deoxidized by Vickers' new alloy be compared with Weintraub's castings purified by boron suboxide. Colin G. Fink of South Yonkers emphasized the importance, when selecting a deoxidizer for copper, of taking into account the melting points of the products formed. If calcium is used, the calcium compounds resulting must preferably be fluid and readily rise to the surface of the molten copper. Prof. Joseph W. Richards added that it was equally important to have the product agglomerate rapidly.

ELECTROLYTICALLY PRODUCED CALCIUM-BARIUM-LEAD ALLOYS COMPRISING FRARY METAL

William A. Cowan, L. D. Simpkins and G. O. Hiers contributed a paper on "Electrolytically Produced Calcium-Barium-Lead Alloys Comprising Frary Metal." They gave a detailed account of their study made at the research laboratories of the National Lead Co. on the development of Frary metal and of its production by electrodeposition from a low melting point mixture of cal-

cium and barium chlorides over a bath of molten lead as cathode.¹

In the discussion, Charles H. Proctor of the Roessler & Hasslacher Chemical Co. referred to his experience in recasting 12 per cent antimonial lead and the difficulty of preventing dross from segregating in spots. Would the addition of small percentages of Frary metal to the melt eliminate or reduce this evil? Would it be better than the use of the green hickory poles? Prof. Richards called attention to the very low efficiency of the Frary metal cells or pots operating at 2,000 amperes and 10 volts.

ELECTROLYTIC CORROSION OF THALLIUM-LEAD ALLOYS

Tests made on a series of lead alloys were outlined in a paper on "Electrolytic Corrosion of Thallium-Lead Alloys" by Colin G. Fink and Charles H. Eldridge of South Yonkers. The alloys were cast into anodes and submitted to electrolytic corrosion in an acid copper sulphate electrolyte containing both hydrochloric and nitric acids. Thallium is one of the few metals whose lower oxide is more stable than the higher oxide; another distinctive feature of thallium is that when alloyed with lead the fusion curve rises decidedly above that of either constituent, whereas the melting point of most other binary lead alloys is lower than that of at least one of the constituents. A minimum anodic corrosion loss of 1.2 lb. per 100 lb. of copper deposited resulted with a lead anode containing 10 per cent Tl and 20 per cent Sn,² as compared with 65 lb. loss for ordinary lead. In general it was found that lead alloys with high melting points are more resistant to corrosion. The low corrosion losses are largely due to a very adherent protective film formed during electrolysis.

Discussing the thallium-lead alloys, Henry Howard of Cleveland referred to the possible substitution of one or the other of these for ordinary lead in the construction of sulphuric acid chambers. George B. Hogaboom of the Scovill Manufacturing Co. called attention to the need of a high melting point solder that would withstand enameling oven temperatures. In reply, it was stated that lead-thallium alloys readily dissolve copper and silver and it would therefore seem that a lead-thallium or a lead-thallium-tin alloy would answer the high-temperature requirements.

A NEW THEORY OF THE CORROSION OF IRON

Dr. J. Newton Friend of Birmingham, England, has made an exhaustive study of the corrosion of commercially pure iron, as a result of which he has developed an entirely new interpretation of the mechanism of corrosion. According to this theory, iron in coming into contact with liquid water in the presence of air or oxygen slowly oxidizes to ferrous hydroxide. This, however, is produced in the colloidal condition—a state in which it is usual for many substances to be particularly reactive. The ferrous hydroxide hydrosol now undergoes oxidation to a higher hydroxide hydrosol, ferric hydroxide sol being produced in the most favorable circumstances. This higher hydrosol is now alternately reduced in contact with the iron and oxidized again by atmospheric oxygen, thus catalytically accelerating the oxidation of the metal. When the sol flocculates or

precipitates out, it yields rust. If this theory is correct, it will be clear that all processes, whether physical or chemical, which effect the precipitation of positive colloids should tend to retard corrosion, and, on the other hand, those which tend toward the stabilization of positive colloids will enhance corrosion. These conclusions have been substantiated by the results of numerous experiments.

The paper was discussed at length by Dr. Fink; in concluding his remarks he suggested that Friend's theory ought to be borne in mind when studying the corrosion of metals other than iron. W. E. Hughes in writing from London referred to a recent experimental confirmation of Friend's theory by A. Ackermann.³ Ackermann observed under the microscope the formation of ferric hydroxide and that this colloidal substance is the first product of a series of reactions which finally result in rust. Hughes closes his letter with the remark that the fundamental problem, however, is still unsolved, since Dr. Friend does not tell us what the forces are that operate to cause the conjunction of the iron atoms and hydroxyl groups of which the hydrosol is composed. "What forces operate to produce the colloid? In the answer to this question lies the statement of the cause of the corrosion of iron."

RUST PREVENTION BY SLUSHING

The practical side of the problem of the corrosion of iron was emphasized in the paper on "Rust Prevention by Slushing," presented by Dr. Haakon Styri. He described the results of a series of investigations made under his direction at the S.K.F. research laboratory in Philadelphia. The conclusion arrived at was that a prerequisite for protection against rust by greases is a thorough cleaning of the steel parts by an aqueous solution, preferably by an oil emulsion which leaves a thin oil film for short time protection. Such oil emulsion is also a very good grinding liquid. It protects from rust and gives a fine finish.

Dr. Styri's paper was discussed by President Acheson Smith, Charles Proctor and others. Dr. William Blum of the Bureau of Standards said that the Government has difficulties in preventing the corrosion of various munitions in storage, but has found that simple slushing compounds would satisfactorily combat corrosion. Prof. Richards referred to a Japanese sword in his possession which had been slushed with oil containing very finely divided lead. After years of exposure there is no visible corrosion.

Papers on Electrolysis

TRANSFORMER OIL SLUDGE

Three general types of transformer oil sludges were discussed by C. J. Rodman of the Westinghouse Research Laboratories. The first, or asphaltic, sludge is produced by the oxidizing action on poor transformer oils such as contain unsaturated compounds, water, small resinous bodies and certain accelerators or catalysts. Examination of the sludge showed that it consisted largely of hydrocarbons of high molecular weight containing oxygen. Thus it may be considered as a combination of oxyasphaltic compounds. It is the most general form of sludge. It collects upon the active parts of the transformer, thus preventing the dissipation of heat. If moisture-free its electrical properties are fairly good. The second type, or soap sludge, is a good

¹This paper will be printed in a subsequent issue of CHEMICAL & METALLURGICAL ENGINEERING.

²U. S. Pat. 1,384,056, July 12, 1921, CHEM. & MET. ENG., vol. 25, No. 14, p. 668, Oct. 5, 1921.

³Kolloid Z., vol. 28, p. 270 (1921).

moisture and oxygen carrier. It forms slowly and it is difficult to remove entirely by filtration. The third type, or the carbon sludge, is due to electrical breakdown.

Commenting on Mr. Rodman's paper, W. S. Moody of Schenectady described a series of tests carried out at the General Electric plant which led to the conclusion that when the oil was exposed to air there was much sludging and in the absence of air there was practically none. Accordingly an auxiliary tank was connected to the transformers and all air excluded.

ELECTROLYSIS OF ORGANIC COMPOUNDS

Dr. Raymond Freas, of New Orleans, submitted a paper on "Factors Influencing the Electrolysis of Organic Compounds," in which he discussed the factors entering into electrolytic reduction and described a convenient experimental arrangement used in their study.

Dr. C. J. Thatcher of New York, who has been manufacturing large quantities of organic chemicals electrolytically for a number of years, called attention to the interesting fact that the product could be varied by changing the charge of the electrode from negative to positive or *vice versa*.

ELECTROLYTIC DISSOCIATION OF CYANAMIDE AND OF SOME OF ITS SALTS IN AQUEOUS SOLUTIONS

Prof. Naoto Kameyama of the Tokyo Imperial University forwarded a manuscript on "The Electrolytic Dissociation of Cyanamide and of Some of Its Salts in Aqueous Solutions." He found that sodium acid cyanamide in aqueous solutions is hydrolyzed at 25 deg. C. to the extent of 4.5 to 12.9 per cent in the dilutions of 10 to 80 liters per gram mol, respectively. If this hydrolysis is prevented by an excess of cyanamide, dissociation occurs to almost the same extent as in the case of sodium formate. Under similar conditions unhydrolyzed calcium acid cyanamide dissociates to the same extent as magnesium formate or calcium nitrate. The primary dissociation constant of cyanamide, as an acid, at 25 deg. C., was found to be 5.42×10^{-11} ; the conductivity of the cyanamide anion being 54.4 at 25 deg. C.

ELECTROLYTIC OXIDATION OF THE LEUCO-BASE OF MALACHITE GREEN

Alexander Lowy and Elmer H. Haux gave an account of their experiments carried out at the University of Pittsburgh on "The Electrolytic Oxidation of the Leuco-Base of Malachite Green." They stated that it is usually oxidized on a commercial scale by a slight excess of the theoretical quantity of lead peroxide, which must be carefully prepared, and used in the form of a thin aqueous paste. The insoluble lead compounds are then filtered, the filtrate heated and the soluble lead salts precipitated with sodium sulphate. In order to ascertain the possibility of substituting electrical energy for chemical energy, forty-four experiments were carried out by the authors. The conclusions arrived at indicate the necessity of a catalyst, an elevated temperature for efficient oxidation, a low concentration of the leuco-base in the anolyte, and sulphuric acid as solvent and electrolyte. The highest dye yield was obtained with uranyl sulphate as catalyst, platinum cathode, and nichrome gauze anode in dilute sulphuric acid solution, at a temperature of 85 deg. C.

A very animated discussion ensued in which Messrs. Burwell, Lidbury, Thatcher, Fink, Howe and Lowy participated. Dr. Arthur W. Burwell of Chagrin Falls, Ohio, announced that the Reliance Aniline & Chemical

Co. at Poughkeepsie was producing commercially hydroquinone directly from benzene by electrochemical methods. He stated furthermore that the Western Reserve Chemical Co. of Cleveland had been making tons of phthallic anhydride for the past four years. Dr. Lowy added that since writing his paper new results have been obtained: The yield of malachite green has been as high as 67 per cent, as compared with 60 per cent by the older processes. He displayed samples of yarns that had been dyed by the "electric malachite" and had been tested at the du Pont laboratories. The color yield was up to 100 per cent strength; the solubility as good as that of ordinary malachite, in some cases even better. Experiments are now in progress on the electrolytic oxidation of dimethylaniline to dimethyl violet.

ELECTROLYTIC PRODUCTION OF SODIUM PERBORATE

Peder Chr. Alsgaard presented a paper on the "Electrolytic Production of Sodium Perborate," in which he embodied the results of his work at Cornell University. The chemical properties and industrial uses of sodium perborate were reviewed and a detailed account was given of the research work by Arndt and Valeur on its preparation by the electrolysis of a borax solution containing sodium carbonate. In order to develop the technical and commercial utilization of the electrolytic process, the experiments of Valeur were repeated on a large scale, and although certain difficulties were encountered, practically all of the earlier results were confirmed. From these experiments it was possible to furnish the facts and figures necessary for the technical design and calculation of the costs of production.

Commenting on Mr. Alsgaard's results, Prof. Richards reported that he had visited the electrochemical plant at Fredriksstad, Norway, this past summer and witnessed the introduction of the new Moltkehansen perborate process. Mr. Alsgaard added that in this new process cyanide is used to prevent reduction of perborate by iron. Dr. F. A. Lidbury of Niagara Falls emphasized the importance of keeping the concentration of iron low in order to get good yields.

THE ELECTROLYTIC OXIDATION OF HYDROCHLORIC ACID TO PERCHLORIC ACID

Prof. H. M. Goodwin and Dr. E. C. Walker, 3rd, of the Massachusetts Institute of Technology have presented the results of their investigations on the best conditions under which hydrochloric acid may be electrolytically oxidized to perchloric acid. They studied the effect of concentration of acid, current density, duration of electrolysis and temperature of the yield.¹

GRAPHIC CONTROL OF ELECTROLYTIC PROCESSES

B. G. Worth of New York outlined briefly his method of "Graphic Control of Electrolytic Processes." It was found by research in a chlorate plant that the high yields for the particular type of cell, electrodes and other chemical and electrical features depended principally on the varying relations among three factors: two chemical factors which may be called *A* and *B* (representing concentrations of two compounds in question) and the third factor, the temperature, called *T*. It was calculated from the reactions that in order to get the best results a certain numerical relation must exist between *A* and *B*. *A* was incapable of direct control, being the result of establishment of equilibrium, but *B*

¹The paper will be printed in full in a subsequent issue of this magazine.

was controllable by addition agents. Knowing *A*, it was possible to compute what *B* should be, which figure was called "Proper *B*" (*PB*). Accordingly a system was inaugurated by which the contents of each cell were analyzed daily and the results plotted by weeks. From the curves it was obvious that whenever the *B* advanced or receded beyond a certain point remedial measures had to be taken. In practice this was a simple matter, as it necessitated only a change in the rate of feeding addition agents. After a while it became possible to anticipate changes by extending the curve by extrapolation and then making proper changes 24 hours in advance, thereby forestalling what otherwise would have been a falling-off of efficiency.

Mr. Worth's paper was discussed by Dr. Schluederberg of Pittsburgh. He commented favorably upon the method and added that it is of particular value to the young electrochemist entering the employ of one of our large factories and desiring to familiarize himself with details in plant operation.

PROF. RICHARDS' TALK ON SCANDINAVIA

At the conclusion of the Thursday morning session Prof. Richards gave a very enjoyable talk on his recent experiences in Scandinavia and reported that the Söderberg electrode is rapidly displacing the older types. In Norway at one of the metallurgical plants the Söderberg is carrying 1,000 amp. At an electric steel plant a tilting Heroult furnace is equipped with Söderbergs which are fed in sections 2 m. long. There are no additional complications as compared with the older types of electrode. The capacity of the Heroult is 6 tons and the distance between metal and roof is about 1 meter. At another plant large aluminum-cased Söderbergs up to 18 in. square were just being tried out on the aluminum cells. The consumption of the electrode in the bauxite bath was very uniform, the ends of the electrodes remaining plane parallel.

Symposium on Non-Ferrous Electrometallurgy

INFLUENCE OF THE ELECTRIC FURNACE ON THE METALLURGY OF NON-FERROUS METALS

The opening paper of the symposium was "The Influence of the Electric Furnace on the Metallurgy of Non-Ferrous Metals," presented by H. M. St. John of the Detroit Electric Furnace Co., in which he gave a general review of the changes which the electric furnace is making in the non-ferrous metallurgical practice and showed that by using electric melting, products of higher quality are produced with less labor and wastage than when using fuel-fired furnaces.

The paper was enthusiastically received and a very lively discussion followed in which both furnace builders and furnace users participated.

RESISTANCE TYPE ELECTRIC FURNACE

T. F. Baily presented a paper on "The Resistance Type Electric Furnace in the Melting of Brass and Other Non-Ferrous Metals." He enumerated the points to be considered in the selection of an electric furnace and is of the opinion that, when taking into consideration the total cost per ton of merchantable castings or bars produced and the adaptability over a wide range of alloys, the resistance type of furnace comes more nearly filling all the requirements than any other type of furnaces.

H. M. St. John and H. W. Gillett of Ithaca, N. Y., took exception to some of the claims made by Baily.

John A. Seede of Schenectady advocated a more general application of electrode regulators. Dr. Fink referred to the melting of copper in the Baily furnace and Dr. Richards brought up the question whether the color of the metal had any effect on the speed with which the melting temperature is attained in a furnace where the heat is indirectly applied. St. John and Gillett maintained that at high temperatures the color of the metal has no effect on thermal efficiency. At low temperatures, however, as Mr. Seede reported, it was found that aluminum absorbed heat 7 per cent as fast as copper. Mr. Baily added that temperatures up to 1,850 deg. C. are practical in his furnace and that he had successfully melted 0.05 carbon steel.

ELECTRIC VS. FUEL-FIRED FURNACE PRACTICE

N. K. B. Patch of the Lumen Bearing Co. in his paper, "Comparison of Electric Furnace Practice With Fuel-Fired Furnace Practice," related his experiences with a Baily and a Detroit Rocking furnace as compared with fuel-fired furnaces. The outstanding advantage of the electric furnace is its cleanliness and comfortable working conditions. On the other hand, a fuel-fired furnace still has a decided advantage over the electric furnace in the consideration of first cost.

Mr. Patch's paper was commented upon by Messrs. Gillett, Richards, Howard, Lidbury and others. C. B. Gibson of Pittsburgh and George K. Elliott of Cincinnati contended that it was almost impossible to draw cost comparisons, the prices for fuel and electric power varying in different localities. Dr. Richards mentioned that during a recent visit to the Lumen Bearing Co.'s plant he noted with much satisfaction that the outside of the furnaces had been painted white. According to his experience, this bright outer surface increases the thermal efficiency by 10 per cent.

MODERN DEVELOPMENTS IN THE BRITISH BRASS INDUSTRY

Ernest A. Smith of the British Non-Ferrous Metals Research Association submitted a detailed exposition on the "Modern Developments in the British Brass Industry." There appears to be comparatively little scope in Great Britain for electric furnaces of large capacity such as the Ajax-Wyatt, Detroit Rocking, and the Baily, in which the bulk of the electric brass melting is done in America. These furnaces require large and expensive installation and must be operated continuously on one or at most two standard alloys before any material saving can be shown. These conditions do not apply to a large majority of the British works, many of which have only an average daily output of from 500 to 600 lb.

ELECTRIC SILVER SMELTING

One of the most interesting papers of the symposium and one which included a number of novel features was the paper by H. A. DeFries of New York on "Electric Silver Melting." Silver melting in the electric furnace eliminates high crucible cost and the necessity of an experienced melter, which are essential to gas- or oil-fired crucible practice. Distinction is made between pouring temperatures of bar silver (1,038 to 1,093 deg. C.) and of rolling mill and casting silver (1,293 to 1,304 deg. C.), when casting horizontal molds.⁵

Mr. DeFries' paper gave rise to lengthy discussions.

⁵For a description of the operating conditions for melting fine and sterling silver, melting outfit arrangement, cost and a comparison of the qualities of electric and crucible silver see *CHEM. & MET. ENG.*, Sept. 14, 1921, p. 507.

Mr. Hogaboom emphasized the importance of a high pouring temperature which can be so readily attained in the case of the electric furnace. Dr. E. F. Northrup of Trenton reported that over a million ounces of silver had been melted in his furnaces. In order to eliminate holes and flaws in the rolled sheets he has found it good practice to transfer the crucible from the electric furnace to an oil-fired furnace and permit the melt to soak for a time. Such metal when cast and rolled was free from flaws. In commenting upon the use of the iron block in the molten silver Dr. Fink said that after a number of heats the surface of the block showed very characteristic erosion marks, which would seem to prove that chemical reaction was taking place.^o

ELECTRIC MELTING OF NICKEL SILVER

Prof. F. C. Thompson of Sheffield University, England, communicated a brief note on his experience on "The Electric Furnace Melting of Nickel Silver." The author's opinion is that the arc furnace is satisfactory only where all the constituents of the melt are non-volatile. When dealing with nickel silver this type of furnace ceases to be very useful as a result of the large volatilization of zinc around the electrodes. Experiments carried out in a small Kjellin induction furnace have not yielded results which possess much promise. Resistance furnaces would appear to be satisfactory. He then discussed the advantages of the use of such furnaces from the purely technical point of view—namely, reduction of the loss in zinc to less than 1 per cent, the occlusion of gases is minimized and a tougher alloy results owing to less carburization. He concluded by stating that where local conditions render it economically advisable the electric furnace of the external heating type possesses technical advantages, especially where large quantities of scrap require to be remelted.

Mr. St. John took exception to Prof. Thompson's conclusion that the resistance type of electric furnace is the only possibility for nickel silver, since he had confined himself to stationary furnaces.

ALUMINUM-COPPER ALLOYS

Robert J. Anderson, of the U. S. Bureau of Mines, contributed a paper on "Aluminum-Copper Alloys," which constitutes an exhaustive treatise on the manufacture, properties and uses of the commercial aluminum-copper alloys employed in the United States. The classification of these alloys is shown in Table I. When dealing with their corrosion he stated that the question of the corrosion of the light aluminum-copper alloys under various conditions of service has not yet been thoroughly investigated, although numerous isolated

tests of particular compositions have been made under many conditions, and that it would be of the greatest interest to obtain data with regard to the effect of various additive elements, in small percentages, upon the corrosion of the usual light aluminum-copper alloys.

ELECTRIC FURNACES OF THE MUFFLED ARC TYPE

H. A. Winne of the General Electric Co. presented a paper on "Recent Developments in Electric Furnaces of the Muffled Arc Type." A number of new types of muffled arc furnaces for melting brass, bronze and similar non-ferrous alloys and metals were described. The larger rectangular shell type furnace was compared with new designs for smaller units having capacities of 1,500 lb. or less per hour. Among the many advantages claimed for the muffled arc furnaces described by the author are that little space for heating elements is required, metal losses by volatilization are reduced, a neutral or reducing atmosphere is maintained, and load fluctuations are small. They are adaptable to intermittent operation; other features are accessibility of hearth, low electrode consumption and small expense of refractories.

REFRACTORIES FOR ELECTRIC FURNACES

The increasing importance in selecting the right refractories for electric furnaces was brought out in the following two papers:

Electric Furnace Purification of Zirkite.—J. C. Thompson of Cornell University reported the preliminary results of his investigation on the possibilities of electric furnace purification of zirkite. He found that 90 to 95 per cent of the silicon may be largely removed from siliceous zirkite ore by heating a mixture of ore and carbon to above 2,220 deg. C. in an electric furnace. The best results appear to be obtained by feeding into an arc furnace a mixture of ore and coke, the amount of carbon being approximately that required to transform only the silicon to the carbide. The existence of stable double carbides of silicon and zirconium or of solutions of silicon carbide in solid zirconium carbide is suggested as an explanation of the incomplete removal of silicon when carbon in excess of that required to form only silicon carbide is used. Zirconia sufficiently pure for refractory purposes might be obtained from zirkite ore by removing the silicon in an electric furnace and following this by treatment with chlorine or phosgene to remove the iron. In conclusion Dr. Thompson discussed the refractory properties of zirconium carbide and the factors which limit its use.

In commenting on Dr. Thompson's findings, Frank J. Tone of the Carborundum Co. suggested using an excess of iron to remove all of the silicon in the zirkite. The small amount of ferrosilicon formed during the reaction might be removed magnetically. Gillett doubted very much whether such magnetic separation were at all possible; according to his experience it was impracticable. Fink pointed out that part of the iron would be tied up as ferrozirconium. As compared with magnesium oxide or thorium oxide, zirconium oxide is readily reduced at high temperatures. L. E. Saunders of the Norton Co. suggested that Dr. Thompson check his analytical results and try out his ideas on a comparatively large scale, since his present small-scale results are somewhat misleading.

Physical Characteristics of Specialized Refractories.—M. L. Hartmann and W. A. Koehler presented the results of their work at the Carborundum Research Laboratories on the cross breaking strength of special-

TABLE I. COMPOSITION OF INDUSTRIAL LIGHT ALUMINUM-COPPER ALLOYS

Approximate Composition Elements, per Cent		Used for
Al*	Cu	
98	2	Rolling, forging and sand casting.
97	3	Rolling, forging and sand casting.
96	4	Sand casting.
95	5	Sand casting.
94	6	Sand casting.
93	7	Sand casting.
92	8	Sand casting, die casting and permanent mold casting.
90	10	Sand casting, die casting and permanent mold casting.
88	12	Sand casting, die casting and permanent mold casting.
86	14	Sand casting.

* This refers to commercial aluminum containing the usual impurities in subordinate amounts.

ized refractories. The average data are given in Table II.

TABLE II. SUMMARY OF AVERAGE CROSS BREAKING STRENGTHS

	Modulus of Rupture		Ratio	R at 1,350° C. R at 20° C.
	Lb. per Sq. In. 20 deg. C.	Lb. per Sq. In. 1,350 deg. C.		
Recrystallized carborundum (Refrax).....	2,312	2,437	1.05	
Bonded carborundum (Carbofrax A).....	2,103	2,274	1.08	
Bonded carborundum (Carbofrax B).....	2,651	2,129	0.805	
Bonded carborundum (Carbofrax C).....	2,215	1,918	0.866	
Silica No. 1.....	608	145	0.228	
Silica No. 2.....	491	178	0.363	
Magnesia.....	1,388	136	0.098	
Fireclay.....	665	113	0.170	
Bauxite.....	1,315	99	0.075	
Chrome.....	1,392	22	0.014	

Discussing the paper, Mr. Saunders warned against basing conclusions on but a few observations. For example, there are clays that have a decidedly higher modulus of rupture than that reported by Messrs. Hartmann and Koehler. Replying to Dr. Richards, Mr. Tone said that one of the large zinc smelters is using carborundum retorts and that these have been found entirely satisfactory.

AN ELECTRIC STEAM GENERATOR FOR LOW VOLTAGE

The first paper of the Saturday, Oct. 1, session was entitled "An Electric Steam Generator for Low Voltage," by F. A. Lidbury and F. A. Samps. The authors described a 250-kw. capacity electric steam-generating unit of the water-resistance type designed primarily for operation at 100 volts, but which could be used without much modification up to 500 volts.

In commenting on his own paper Dr. Lidbury called attention to the lamentable lack of reliable data on the conductivity of electrolytes at temperatures of 100 deg. and above. Frederick T. Kaelin of the Shawinigan Water & Power Co. described the electric steam generator in his plant.

Symposium on Electrodeposition

EFFECT OF PRESSURE ON OVERVOLTAGE

Prof. H. M. Goodwin and Dr. L. A. Wilson of the Massachusetts Institute of Technology presented a paper on "The Effect of Pressure on Overvoltage." Experiments were described in which the overvoltage of hydrogen against copper, nickel and mercury electrodes was determined under pressure varying from one atmosphere to a few centimeters of mercury. The values were determined by the bubble method, at room temperature, under conditions of very low current density, after a state of constant polarization had been established. The results in all three cases showed a rapid decrease at low pressures, confirming the hypothesis recently advanced by MacInnes and Adler to explain overvoltage phenomena.

RESEARCHES ON THE ELECTRODEPOSITION OF IRON

W. E. Hughes of London in his paper on "Researches on the Electrodeposition of Iron" presented the results of the work conducted by many investigators in this field, together with remarks and comments based upon his own experience. The different baths are classified as sulphate solutions, chloride solutions, and sulphate-chloride solutions. He then discussed various researches upon other solutions.

A very lively discussion followed. W. E. Ruder of Schenectady told of his studies of the magnetic properties of electrolytic iron. Dr. Fink referred to the use of electrolytic iron in place of Swedish iron and the

increasing difficulty of obtaining a clean scrap on account of the large quantities of alloy iron (copper, nickel, etc.) in use today. Dr. Blum of the Bureau of Standards discussed the cost item and reported that at present nickel plating is cheaper and more serviceable than iron or steel plating. Bradley Stoughton called attention to the large commercial electrolytic iron plants in France making boiler tubes. The product analyzes 99.97 per cent Fe and is as malleable as pure copper, due partly to the very low carbon content (0.008 per cent C.). He also commented on the large-scale tests of leaching sulphide iron ores with ferric chloride and then depositing out the iron electrolytically. The ferrous chloride is oxidized back to ferric chloride, and this is used in leaching fresh batches of ore. The product analyzes 99.99 per cent Fe. Henry Howard and A. W. Burwell questioned the practicability of the process. F. A. Lidbury surmised that there would be serious anode troubles with a highly corrosive liquor such as ferrous-ferric chloride. G. W. Elmen believed that the chief interest in electrolytic iron was in connection with the use of iron for magnetic purposes, even though Mr. Ruder seemed to think otherwise.

ELECTROLYTIC SOLUTION AND DEPOSITION OF COPPER

Prof. Thomas Roland Briggs of Cornell University presented in his paper on "Electrolytic Solution and Deposition of Copper" the results of his thorough and painstaking research on this subject. He has arrived at conclusions contrary to the general views held by Luther, Foerster, Addicks, Aldrich, Witherell and others and found that the electrolytic behavior of copper in solutions containing copper ions may be accounted for by means of two electrochemical processes: (1) The change from copper to cuprous ion or the reverse; and (2) the change from cuprous to cupric ion or the reverse. When copper dissolves electrolytically at the anode, cuprous ions are formed first. Similarly, at the cathode, copper can be deposited only by the discharge of cuprous ions. The cuprous ions formed at the anode may be removed either by electrolytic oxidation or by chemical means, depending upon conditions. If the removal of cuprous ions is entirely electrolytic, copper dissolves as bivalent metal. If removal is entirely chemical, copper dissolves as univalent metal. If at the cathode cuprous ions are supplied entirely by electrolytic reduction, copper is deposited as bivalent metal. If cuprous ions are supplied entirely by chemical means, copper is deposited as univalent metal. This theory has been successfully applied to the electrolytic behavior of copper in cyanide, chloride and sulphate electrolytes. The theory is a general one and can be adapted to metals other than copper.

Briggs' paper was discussed by Messrs. Fink and Blum, who emphasized the importance of having a good working hypothesis, such as that of Briggs, in conducting researches in electrolytic refining or electroplating.

ELECTROMETALLURGY OF ZINC

W. R. Ingalls, in his paper on the "Electrometallurgy of Zinc," referred to the plants at Great Falls, Trail and Risdon. Under favorable conditions zinc can be produced electrolytically at these plants on terms as low as to permit it to meet any competition. The limitations of the process are that it must be conducted on a large scale and the cost per unit of capacity is greater than that of the ordinary distillation plant. The electrothermic process has been successfully practiced in Scandinavia, especially at Trollhattan in Sweden and Sarps-

borg in Norway. The electrolytic process produces a high-grade zinc at less cost per ton of ore than in the electrothermic method.

Edwin W. Hale of New York, in discussing Mr. Ingalls' paper, stated that according to his electric zinc smelting experience a safe estimate for power consumption is 1,600 kw.-hr. on a 35 per cent zinc ore. In addition to the zinc, he recovered the lead as base bullion and copper as matte. The big advantage of electrothermic smelting is the automatic saving of the by-products. Prof. Richards stated that the furnaces in operation at Trollhattan were not strictly resistance furnaces, but modified arc furnaces. Another interesting process he had witnessed abroad was the recent invention of Cornelius for conglomerating blue powder by rubbing. C. S. Witherell of New York pointed out that the success of any zinc process was dependent upon the quality of the product. A lead-free zinc is in great demand, in particular for alloy work, and there is very little of this product on the market today. The blue powder Dr. Richards referred to contains 20 per cent lead, and accordingly after conglomeration it is necessary to redistill.

STUDIES ON THE ZINC CYANIDE PLATING SOLUTION

In a recent issue of *CHEMICAL & METALLURGICAL ENGINEERING* (vol. 25, page 607) it was estimated that the potential aggregate production of electrolytic zinc for the world amounts to about 250,000,000 lb. per year. The electrolyte is zinc sulphate. Reviving the interest in the cyanide electrolyte, Dr. Chris. J. Wernlund of the Roessler & Hasslacher Research Laboratories, Perth Amboy, reported at length upon "Deposition of Zinc From the Zinc Cyanide Solution." It would seem that although the sulphate electrolyte has much in its favor for the winning of zinc from its ores, in plating practice the cyanide bath is to be preferred. Mr. Wernlund has evolved a zinc cyanide plating solution which will operate successfully under the most trying commercial conditions—i.e., at very high current densities in mechanical plating units where the cleaning of the work is often poor. Following is the composition of the bath recommended, the weights being expressed in ounces per gallon: zinc cyanide 8, sodium cyanide 7, NaOH 1 to 2, Na_2CO_3 4, NaF 1, corn sirup 1, gum arabic $\frac{1}{2}$; temperature of solution 40 to 50 deg. C.; voltage 3 to 5. Very smooth, grayish-white deposits were obtained. The electrolyte does not deteriorate on standing idle.

Dr. Blum took exception to Mr. Wernlund's sweeping conclusions, since the tests at the Bureau of Standards (Bureau of Standards Paper 195) indicated that high concentration NaOH zinc cyanide baths were preferable. Charles H. Proctor referred to the ever-increasing rigidity of the automobile specifications on plated parts. Mr. Wernlund replied that he had tried Horsehead anodes and obtained a porous anode coating of copper and lead. Prof. Richards suggested using as anodes the new zinc cathodes as produced at Great Falls and at Park City without first melting into special shapes, thus avoiding introduction of impurities during melting. Both Richards and Blum lamented the loose way in which the term "throwing power" is used by platers. There are many factors to be considered, such as ion (and not merely "metal") concentration, specific conductivity, and spacing of electrodes, as Witherell added, before fair comparisons are at all possible. George B. Hogaboom, in his usual enthusiastic style, discussed the

increasing importance of closely controlling the compositions of the electrolyte by analytical and physico-chemical means.

ELECTRODEPOSITION OF LEAD-TIN ALLOYS

W. Blum and H. E. Haring of the Bureau of Standards presented a paper on "The Electrodeposition of Lead-Tin Alloys." In the effort to find a satisfactory metallic coating for the inside of air-flasks of naval torpedoes, James S. Groff, chief chemist of the Naval Torpedo Station at Newport, R. I., discovered that it is possible to deposit electrolytically from either fluoborate or fluosilicate solutions an alloy of about 50 per cent lead and 50 per cent tin which has the desired properties. This process, which has been patented by Mr. Groff¹ is now used successfully for the above purpose by the Navy Department. At the request of that department, the Bureau of Standards conducted an investigation to determine the most favorable conditions of operation, and the authors found that it is possible to deposit from fluoroborate solutions alloys of lead and tin, which are finer grained than either of the metals deposited under similar conditions. Lead and tin can each displace the other from such solutions, until an equilibrium is reached, at which the two metals have the same potential. During continued electrolysis with lead-tin anodes, of solutions containing lead and tin, the ratio of the metals in the deposit always tends to approach that in the equilibrium solution.

Charles H. Proctor mentioned that automobile manufacturers would certainly welcome any improvement in applying solder to small steel parts that would lose their temper if heated by the ordinary soldering operations.

William Blum's paper on "The Structure and Properties of Alternately Electrodeposited Metals" will be published in a subsequent issue of *CHEMICAL & METALLURGICAL ENGINEERING*.

Report on the Activities of the Research Council

At the conclusion of the symposium, Paul Moore reported briefly on the activities of the Research Council. The Council was endeavoring to raise enough capital to permit investigators such as Dr. Blum to go on with their investigations unhampered. It is proposed to solicit a subscription of \$100 from each of the large plating concerns. As regards the subject of corrosion a steering committee has been selected, of which William M. Corse is chairman and Dr. Colin G. Fink secretary. The Alloys Information Service and the Committee on Tables of Constants are making good progress.

Meeting of the Board of Directors

The directors of the society met at dinner Thursday evening and again at luncheon Saturday noon.

The invitation of the Baltimore chemists and engineers was definitely accepted. Accordingly, the spring meeting of the society will be held at Baltimore. William H. Boynton of 509 Rose Hill Terrace, Baltimore, is chairman of the committee on arrangements. At this coming meeting there will be a symposium on Electromotive Chemistry in charge of Dr. William C. Moore of the U. S. Industrial Alcohol Co.

The board voted to increase the price of the bound volumes to \$4 to meet the increased cost of publication. It was furthermore decided to publish a ten-year index covering volumes 21 to 40 inclusive.

The Division on Electrodeposition was formally in-

¹U. S. Pat. 1,364,051, Dec. 23, 1920.

augurated. This division covers the fields of electrolytic refining, electroplating, electrogalvanizing, etc., with Dr. William Blum of Washington as chairman.

The resignation of Dr. P. G. Salom, for many years treasurer of the society, was accepted and Messrs. Hering, Salom and Richards were appointed a committee to report on the finances of the society. A nominating committee comprising Messrs. Fink (chairman), Hering, Mott, Lidbury and Gibson was instructed to report back to the board before Dec. 1. The committee is not an "electing" committee, as is the case in some societies; it will suggest several names for each office of the society to be filled during the term 1921-1922.

Social Features

The outstanding social event that will be remembered for many days to come was the "swimming race" up Mount MacIntyre, in which the ladies in particular distinguished themselves.

An exceptional treat was offered the members on Thursday evening when Prof. Harlow Shapley of the Harvard University Observatory gave a very fascinating illustrated lecture on "Chemistry and the Stars." Remarkable views of the heavens were shown taken through the Mount Wilson telescope, the largest in the world. It was amusing to hear mere electrochemists discussing nebulosity, nebium and light-years.

The subject of Friday evening's lecture was "Practice of Forestry on National Parks," a very timely and fitting topic. Colonel T. S. Woolsey, Jr., told of the practice in both Europe and America. The timber supply of this country, he said, will last but twenty years more at the present rate of consumption. It takes from 100 to 150 years to grow saw timber; pulpwood requires 40 to 50 years. In discussing the pulpwood growth, Dr. William H. Gesell of Bloomfield referred to the use of catalysts in hastening the growth of trees. Experiments are being conducted by the Brown Co.

Dr. Melvil Dewey, president of the Lake Placid Club, extended a hearty welcome to the society and outlined briefly the history and purposes of the Lake Placid Club.

A cordial reception and tea was tendered the members and their guests at Dr. Dewey's home, situated in the most beautiful spot in the Adirondacks. Here Dr. Dewey demonstrated the secrets of successful filing and his well-known decimal system.

The one pastime which found favor in the eyes of the greatest number of members was golf. Some enthusiasts played nine holes even before breakfast. On Saturday evening Dr. J. V. N. Dorr, chairman of the golf committee, distributed the prizes. L. J. Buck received a fine club for the best score in the kickers' handicap. John B. Glaze got a second prize, a Monel metal golf head. Dr. Parmelee, editor of CHEM. & MET., and Mr. Terry of the Dorr Co. were rewarded for the most sensational plays in the foursome. Mr. Corse drew four golf balls, and Mr. Baily a tee for modesty in the kickers' handicap, having asked for a handicap of 68. To Mrs. Baily was awarded the ladies' prize, a ball which will automatically retrieve. At 10 o'clock Saturday evening the club arranged for a magnificent fire and water spectacle on Mirror Lake.

Sunday morning, amid animated farewells, the many who had come in automobiles departed, and as they passed and repassed each other on the downward trail, goodbyes and parting sallies flew from car to car. Thus ended what will be remembered by all as one of the most delightful episodes in their lives.

Water-Power Resources of Canada

During the past two years there has been under way in the Dominion Water Power Branch of the Canadian Department of the Interior a careful re-analysis and computation of Canada's water-power resources. All existing stream flow and power data available from dominion and provincial sources have been systematically collated, analyzed and co-ordinated with a view to preparing, on a uniform basis from coast to coast, revised estimates of the power available. While the analysis is not yet finally completed, sufficient progress has been made to warrant the publication of the figures given herein.

The figures listed in the accompanying table are based upon rapids, falls and power sites of which the actual existent drop or the head possible of concentration is definitely known or at least well established. The power estimates have been calculated on the basis of 24-hour power of 80 per cent efficiency for "ordinary minimum flow" and "estimated flow for maximum development."

An analysis of the water-power plants scattered from coast to coast concerning which complete information is available as to turbine installation and satisfactory information as to stream flow gives an average machine installation 30 per cent greater than the six-month flow maximum power. Applying this, the figures quoted therefore indicate that the at present recorded water-

AVAILABLE AND DEVELOPED WATER POWER IN CANADA

Province	—Available 24-Hr. Power at 80% Efficiency—		Turbine Installation, Hp.
	At Ordinary Min. Flow, Hp.	At Est. Flow for Max. Dev. (Dependable for 6 Mos.), Hp.	
British Columbia	1,931,142	5,103,460	304,535
Alberta	475,281	1,137,505	32,492
Saskatchewan	513,481	1,087,756	.....
Manitoba	3,270,491	5,769,444	83,447
Ontario	4,950,300	6,808,190	1,052,048
Quebec	6,915,244	11,640,052	925,972
New Brunswick	50,406	120,867	21,180
Nova Scotia	20,751	128,264	35,774
Prince Edward Island	3,000	5,270	1,933
Yukon and Northwest Territories	125,220	275,250	13,199
	18,255,316	32,075,998	2,470,580

power resources of the dominion will permit of a turbine installation of 41,700,000 hp. In other words, the present turbine installation represents only 5.9 per cent of the present recorded water-power resources.

The total hydro-power development installed during the past year or now under construction represents approximately 560,000 hp. of installed capacity. This figure includes only the initial installations of plants under construction, not their ultimate designed capacity.

Should the rate of water wheel installation during the past fifteen years be maintained, there will be installed in 1925, 3,360,000 hp.; in 1930, 4,110,000; in 1935, 4,860,000, and in 1940, 5,600,000. There is every reason to expect that the rate of growth in utilization will be accelerated rather than retarded.

The water power now developed in Canada represents an investment of \$475,000,000. In 1940, should the rate of growth in installation during the past fifteen years be continued, this investment will have grown to over \$1,000,000,000. The present development represents an annual equivalent of 18,500,000 tons of coal, which, valued at \$8 per ton, represents \$148,000,000. In the year 1940 these annual figures will, with the foregoing assumption, have become 42,000,000 tons and \$336,000,000.

Industrial Training and Selection of Personnel

An Analysis of Some of the Common Shortcomings of Industry and School—Outline of the Basic Principles Underlying Modern Methods of Selecting and Training Employees, and Some Helpful Suggestions for Solving Personnel Problems

BY C. R. DOOLEY

Manager, Personnel and Training, Standard Oil Co. (New Jersey)

“**S**QUARE pegs in round holes” is an old figure, though none the less true; yet it contains an implied suggestion that round pegs in round holes, all working smoothly, would be an ideal condition. Not so—that is, if the fitting of the pegs and holes is to be done by some automatic system, even a scientific one. In the end people will not be content with being put in their right places; the process must be self-determinative. Otherwise life is not worth living, and as long as dictated authority rules there will be unrest and terrible waste. No one will or can do his best unless he is following his own ambitions, developing his own life. How then can individual freedom be co-ordinated into a single effective effort for the good of the whole community? This is the whole problem of industrial organization, toward which I hope to be able to contribute a few helpful suggestions—not a solution—in connection with the selection and training of men and women within industry.

WISE POLICIES OF RECOGNITION AND PROMOTION

First, the progress of any individual within an industry must be according to merit, and merit alone. Recognition and promotion must have nothing to do with family relationships, society or club memberships, personal whims of high officers or even the ownership of the business. There must be no more chance of a position of foremanship being given to a man because of his connection with the general manager than the captaincy of an athletic team should go to the owner of the athletic field.

Recently an officer of a large corporation needed a secretary and proposed the daughter of an old friend, to whom he was indebted for many favors. However, the personnel manager was able to persuade him to advance one of the young women within the company, thus preserving the morale among a hundred young women, each of whom hopes for advancement and works diligently to deserve it.

The chance for recognition may be one in a thousand, but upon that spark of hope hangs the highest grade of efficiency. Nothing is so deadening as the hopelessness of recognition in the face of inherited or political advantages. Merit is of course not always easy to determine, even when an honest effort is made. In the last analysis one man's merit is largely another man's judgment. But men do not resent the frank honest judgment of their superiors so long as they know they've had a fair chance. Every day one hears criticism of favoritism, but over a long experience I have never heard an honest judgment criticized even if very disappointing.

Perhaps the second most deadening influence to initiative and creative effort is a blanket seniority rule. A good rule, other things being equal—but other things

never are equal. In matters of discharge as well as promotion the personal record and personal qualities alone should count. Such a policy is a far greater stimulus to young men than increased wages.

Assuming now that our policy is “Let the best man win,” how is he to be selected with reference to the work he is to do, and then how is he to be introduced to his work? These are big questions, and again I can only make a suggestion or two.

ADAPTABILITY OF THE INDIVIDUAL

It is a fallacy that all men are created equal. Each of us can do certain things better than other things, therefore we should not expect all young men to climb the same ladder to success. A promising young salesman may be poor at routine office work, yet he may need a certain amount of experience in the office before he is given a larger sales position. Indeed a good sales manager may not be an especially successful salesman. A chemist producing many improvements in processes each year may not be the man to place as manager of the research department.

It is difficult to transfer a man successfully from one general branch (such as manufacturing, accounting and selling) of a business to another branch, not only because his previous experience has been so decidedly different, but because of certain fundamental native qualities of mind and personality. Most men, if started right, will advance most successfully by remaining within a given branch of a business. Then again men differ as to their adaptability to outside or inside work, and also as to their ability to start new enterprises or to close and finish them. Some men are by nature individualists; they work best absolutely alone; system and assistance hamper them. These must not be discharged for lack of discipline, but used where their kind is needed. Others need the close association of other men's minds in order to contribute their best. These are organization men, better for planning than executing. So all men should be considered as to their type—manufacturing, accounting, commercial, financial, promoting, scientific, office, field, organization, etc.

Men of middle life are obviously selected because of their attainments, personal or technical. They will largely take care of themselves, but young men should be selected for their potentialities, their native qualities and possibilities of development.

BASIS FOR SELECTING YOUNGER MEN

Confining our attention from now on to the problem of the young man, the basis of his selection should be a series of rather personal questions in an effort to find out a great many things the man has done since he was a small boy and what his motives have been.

As a child did he wear out the toys his parents bought him, or did he invent and make his own playthings? If he sold papers, what methods did he devise to carry on the business and did he operate his own business or carry papers for another man? If he worked his way through school, just how did he do it? How much money has he earned during vacations? At what kind of work? What did he do with his money? If he has had several jobs since leaving high school, what were they and why did he change? Is his purpose always placed ahead of the pleasure of the moment? To have done his duty is expected, but how clearly has he had some kind of plan even in boyhood?

If he carried responsibilities as a boy, he will be apt to carry them well as a man. If he had a commercial interest as a boy, he probably will continue in that as a man; and if he was clever with simple mechanical devices as a boy, he will continue to exercise a constructive imagination with mechanical things as a man. A few fundamental types of men seem to hold true clear back to their earliest recollections. Some of these types are: inventive or constructive engineering, analytical or research engineering, commercial individualist, and commercial organizer.

The interview, of course, should include all such personal data as age, parentage, place of birth, business of parents, habits, athletic interests, height, weight, color, etc. Some rules may hold true generally but there are many exceptions, and only when you know the whole story of a man can you make a final estimate.

IMPORTANT QUALIFICATIONS TO BE CONSIDERED

There are many desirable personal characteristics, and each interviewer will emphasize different ones. There can be no one standard list of qualifications for all interviewers to use, but anyone attempting to select young men should adopt some list of qualifications which he believes more or less describe a man. I have found that different men pick equally good men, although each uses different methods and each calls the important qualification by different names. In general, the following characteristics may be considered in selecting young men for training in any business:

1. *Moral Fiber*.—Integrity, honesty, reliability, a spirit of helpfulness, modesty, refinement, ability to work in an organization, co-operativeness, tactfulness, etc. In short, those things which make a man liked and respected and trusted among his fellow-men. He is acceptable.

2. *Personal Power*.—Originality, initiative, resourcefulness, vision, ability to discriminate between essentials and non-essentials; courage, readiness to accept responsibility, understanding of men, etc. In short, those things which designate a man as an original contributor in some way to the world's progress. He gets things done.

3. *Technique*.—Technical knowledge, special experience, kinks of a trade or profession, data, formulas, etc. In short, those facts which he acquires either from books or from experience. He knows how.

To summarize these points in the reverse order, the third represents the required tools with which he works; the second is his ability to use these tools; and the first is his character, or his passport which permits him to work with the rest of us.

The majority of young men, especially those graduating from college, have the first of these qualifications

and a considerable portion of the third; but, on the other hand, two-thirds of them are lacking in the second.

THE BASIC PRINCIPLE IN EFFECTIVE TRAINING

With this general philosophy as a background, it is necessary to develop a method of training which will not only teach men a certain number of technical formulas but will develop within them the originality and initiative necessary to successful original application of these formulas. After a number of years of experimenting with young men varying in age from fourteen to thirty, some having only a part of the public school education and some having been graduated from college, there is one universal deduction which may be stated here as the basic principle in all effective education or training, whether in the academic class room or the practical shop.

Technical information should be presented to students in the form of jobs or problems or projects or questions, and these should be presented in advance of formal explanation of methods of solution.

Many problems simply take the form of questions, but the answer to these questions should never be given in systematic form. Of course, the problems and questions must be arranged in some order of difficulty, so that each problem means a step forward. Obviously a young machinist should not be started on a gear-cutting machine before he has had some of the simple bench and lathe work, or a young salesman should not be sent to the most difficult customer first. On the other hand, each job that is put up to either of these two men should be a real job and not have all of the punch taken out of it by being thoroughly explained beforehand. Memorized lectures do not stick with us; or if they do, they never become a part of our real experience. They are always superficial in their relation to our best actions.

MUCH TIME AND PATIENCE REQUIRED

It is a difficult and serious task to teach by this method. It takes time and much patience. For the head of a department to explain carefully to his young assistant all of the difficulties which the young assistant is likely to encounter during the day, or to explain nothing, but merely storm at him at the end of the day after he has made a mistake, are both easy things to do.

The old "sink or swim" methods produce poor swimmers and many drownings. On the other hand, too many swimming lessons given on land take all of the spirit and initiative out of men by teaching them in detail how swimming is done but never how to swim.

The right thing to do and the difficult thing to do is to give just enough fundamental information at the beginning to set the boundaries or policies within which the young man is expected to act, and then at a later time to discuss with him the details of his experience in a way which will help him to analyze them and come to his own correct conclusions.

Many department heads object to instructing new men continuously and losing them even to other departments within the same organization. They prefer low-grade men who "stay put" to men of larger ability and ambition. There may be a question as to the number of high-grade men to train in any one organization, but there can be no doubt as to the most effective method of training, and further this method will show that all men are better than had been supposed—and that some are a great deal better.

When this process becomes too burdensome to the executive staff, it is time to set up a special training school. The method is simple: First you provide a series of actual work assignments where the experience is real, and then you provide a series of class meetings for discussion of each man's experience, following an outline of problems and questions which are given him in advance.

The instructor now becomes a mere referee who decides disputes and sees to it that the men do not get wrong information. He insists that the answers to all questions be deduced from the personal experience of each man, and by continual quizzing he keeps the men going in the right direction. A lecturer is the poorest kind of a teacher for developing real personal power. Occasionally a lecture or talk given by some officer or expert has a good effect by way of general inspiration, but this part of an educational program should be a small percentage.

SELECTING THE PROPER SORT OF TEACHER

The best kind of teachers are men selected right from the offices or shops, each man an authority in his subject. All men who are competent workers do not make good teachers, but all teachers should be competent in their work or profession and should be engaged in the practice of it, giving only a portion of their time to teaching.

In addition to being competent at his work, a teacher should have an inspiring personality and an enthusiastic way about him to get under the skin of young men. Generally a man who is competent at work and who expresses a keen desire to teach purely for the love of helping young men makes a good teacher. Such a man should be young enough to be flexible so that the head of the training department can mold him in the understanding and practice of this general philosophy of teaching. He must be interesting and his class meetings must be interesting.

METHODS OF INSTRUCTION WHICH DEVELOP INITIATIVE

This is the whole trouble with teaching. We teach young people how things have been done instead of why they are done or, better yet, we should teach them to think out for themselves the "why." Instead we standardize forms to be memorized and call it education. We not only standardize arithmetic, but we standardize the method in which it shall be presented, adopting a full set of technical terms. For example, when the young student finishes simple interest in the public schools he turns over a page and begins compound interest, which he has heard from his fellow students a grade ahead of him is exceedingly difficult, and accordingly he enters upon its study with diffidence.

Now the fact is that, mathematically speaking, there is no such thing as compound interest. It is only simple interest repeated with a new principal. The new principal is the old principal plus the interest for a given period which a man has been unable to pay when due. The reason that it is due on a given date and that after that it becomes a part of the new principal is purely a matter of custom among people, and has nothing to do with mathematical principles. If this were explained in connection with problems in simple interest and then the name "compound interest" given merely incidentally as a convenient term to use in talking about such a

problem, the whole subject of compound interest would disappear.

The same thing is true of electricity, which I have studied thoroughly, practiced intensively and taught personally to almost every kind of student. Some of the electrical theory is complex and difficult, but a great deal of it is exceedingly simple when stripped of its mysterious terms.

The average shop mechanic pays profound respect to a piece of blue paper covered with white lines, and yet blueprinting has nothing to do with mechanical drawing, but is only a means of cheap duplication. Even the principles of drawing are mystified by a technique called "projection." Mechanical drawing is a language used to express ideas in terms of flat surface pictures and is not a matter of beautiful lettering and shading of lines. The fundamentals are as simple as arithmetic and could easily be taught in the grammar grades without either blue paper or expensive drawing tools.

We continually shroud ourselves in technical terms which we endeavor to force young people to memorize, and in so doing we tend to crush what originality and initiative they have in the beginning. In teaching technical subjects only fundamental principles should be considered and great emphasis should be placed upon their correct application to original problems, free from tradition and customs. Of course, as society is organized, a certain amount of form is called good. We must have correct spelling and some style to our dress, and yet the moment form begins to add to our dignity rather than to our efficiency we begin to stifle initiative and originality.

BRINGING THE INDUSTRY AND THE SCHOOL TOGETHER

All of this is a very roundabout way of saying that in our training processes we must first of all develop what we may call industrial intelligence and not merely require routine memorized formulas and standardized methods. We must encourage men to vary from things as they are today. We must stimulate the research point of view, the habit of eternal inquiry after better ways, for only through this can we ever hope to develop the leaders of the future.

This can be done normally and without forcing by beginning with the work, or the job, and approaching the student with a discussion of many questions about the job. If the student rises to the occasion and comes back with original contributions, you know he is growing and it is your business, employer as well as teacher, to keep him growing to the limit of his capacity. Some men will never respond greatly, and therefore will continue in the routine performance of their present work. All of us cease to respond sooner or later and thereby we find our level.

The trouble with our schools has been that they artificially pull people above their levels by forcing memorized formulas.

The trouble with industry has been that it artificially holds men below their levels through lack of opportunity to study out the science underlying their work, and through arbitrary authority.

When these two things are brought together—when the spirit of the teacher pervades industry and the spirit of production furnishes the background for education, then all people will find their levels automatically and remain there without chafing under arbitrary authority.

To make this function in practically any organization, two kinds of training must be provided: (1) That which young men just starting into business are obliged to take because of a company's determination to select and train for efficiency. (2) That which any man in the business who is ambitious to improve himself may take according to his own option.

THE THREEFOLD PURPOSE OF TRAINING

In both cases, however, the method of teaching should be the same and should have a threefold purpose: (1) To inspire the highest quality of American manhood, although if a man has not a fine moral fiber, integrity, honesty, reliability, etc., he is not worth the trouble of training. (2) To discover and develop personal power in the use of knowledge under new and trying circumstances. (3) To establish a certain amount of accurate fundamental knowledge.

No matter how large and complex the organization, each individual must be treated upon his own record, as an individual in open frank honest competition with his fellows. Training courses, for the most part optional, must be available to guide young men and women in working out their ambitions and to assist department heads and officers of concerns in the discovery of latent talent. The routine work of the day serves well to develop character, to test out loyalty, obedience, thrift, etc., but it is often not stimulating and intellectual depths are not challenged. On the contrary, practical problems presented by an inspiring instructor in the class room appeal to the intellectual powers and bring out latent abilities not hitherto suspected. Moreover a training program fills young employees with the belief that they have a chance, that the "Old Man" is now going to play square with them. With this attitude of mutual confidence and mutual helpfulness the pegs will find their proper holes naturally.

Personnel adjustments to be successful must be done impersonally by the authority that comes from skill and special knowledge and not the authority of official position.

There are managing talents and special abilities among the rank and file of people, if those in authority will only take the trouble to find them—and be willing to give them a chance according to their true merit.

New York City.

Canadian Linseed Oil Industry in 1918

Though no statistics from which comparisons can be drawn have been compiled previously to those just issued by the Canadian Bureau of Statistics for 1918, the production of flax seed and the manufacture of linseed oil in Canada are industries that are beginning to assume considerable proportions. During 1918 more than 6,000,000 bu. of flax seed was produced, about half of which, having a value close to \$8,000,000, was exported. Of the remainder 1,360,000 bu. was used for the manufacture of oil, and from this was produced 1,144,000 gal. of crude and 738,000 gal. of refined linseed oil, having a combined value of \$4,063,000, and 24,366 tons of oil cake, having a value of \$1,374,500.

Seven plants, representing an investment of \$2,500,000 for land, buildings and machinery, were in operation during the year and nearly \$200,000 was distributed in wages. Sundry byproducts, such as greases, stearine and fertilizers, also were manufactured at the several plants.

Hardness Variations in Heat-Treated Steel

BY CARLE R. HAYWARD

IN STUDYING the properties of different steels the writer has often been struck by the fact that the center of a heat-treated bar is with rare exceptions harder than the material nearer the edge. This difference in hardness has been most noticeable when testing with the Shore scleroscope, for a majority of the specimens have been only $\frac{3}{4}$ in. in diameter and the Brinell tests were taken only at the center.

I have made no extensive series of tests to study adequately the progressive change in hardness from center to circumference, but a few figures giving values obtained with several steels may be of interest and may possibly call forth others from other investigators.

One steel with an analysis C 0.42, Si 0.07, Mn 0.79, S 0.015, P 0.016 after quenching in water from 850 deg. C. and reheating to 400 deg. gave the following hardness tests on a polished cross-section:

Time Reheated	Shore Test at Center	Shore Test Near Edge
15 min.	30	28
30 min.	29	25
1 hr.	27	20
4 hr.	26	19

In another series of tests the steel used had the following analysis: C 0.46, Mn 0.56, S 0.055, P 0.010.

The specimens $\frac{3}{4}$ in. in diameter were quenched from 850 deg. in tap water and reheated to 300 deg. for 5 min., 15 min., $\frac{1}{2}$ hr., 1 hr., 2 hr. and 4 hr. Another piece in the original condition was annealed at 850 deg. for 15 min. and cooled in the furnace. The scleroscope tests on a polished cross-section were as follows:

Time Reheated	Shore Test Center	Av. of Six Tests Nearer Edge
Quenched	45	42
5 min.	30	24
15 min.	32	27
30 min.	25	20
1 hr.	25	17
2 hr.	29	25
4 hr.	32	28
Annealed	17	15

Although these results seem somewhat inconsistent, one striking point is brought out. In 5 min. reheating, the hardness dropped to two-thirds the figure found for the quenched specimen and remained approximately constant for 4 hr. In every case the center was harder than the average of the remaining surface.

Another steel of nearly the same composition was quenched in the same way as above, but the reheating was carried out at 400 deg. C. Composition of steel: C 0.44, Mn 0.58, S 0.042, P 0.007.

Time Reheated	Shore Test Center	Av. of Six Tests Nearer Edge
Quenched	47	43
5 min.	36	33
15 min.	32	22
30 min.	27	23
1 hr.	23	17
2 hr.	27	19
4 hr.	25	21
Annealed	18	16

With the exception of the 1 hr. treatment the figures are in this case consistent. The drop in hardness during the first 5 min. heating is again striking, though in this case it is only 20 per cent instead of 33, as in the 300 deg. heating.

A third $\frac{3}{4}$ -in. steel bar varying slightly from the last two was quenched in the same way, but reheated to 500 deg. C. Composition of steel: C 0.48, Mn 0.58, S 0.048, P 0.007.

Time Reheated	Shore Test Center	Av. of Six Tests Nearer Edge
Quenched	44	45
5 min.	30	26
15 min.	25	18
30 min.	26	21
1 hr.	20	17
2 hr.	26	22
4 hr.	28	23
Annealed	20	17

The tests on these specimens were somewhat erratic, but again the same tendency is brought out.

All the above figures were obtained incidental to other tests. In order to see what effect heating to 700 deg. would have on the hardness three pieces of the last steel were quenched and heated for 20 min., 1 hr. 10 min., and 2 hr. respectively at 700 deg. C. The results were as follows:

Time	Shore Test at Center	Shore Test Half Way to Edge	Shore Test Near Edge
20 min.	24	20	17
1 hr. 10 min.	23	20	15
2 hr.	23	19	15

These results are nearly the same as on the annealed specimens. It is interesting to note that practically the full effect took place in the first 20 minutes.

Some pieces of $\frac{3}{4}$ -in. round carbon tool steel containing 90-100 point carbon were quenched in water from 850 deg. C. and reheated for 20 min., 1 hr. 10 min. and 2 hr. at 350 and 600 deg. C. The hardness results were as follows:

Time of Reheating	Shore Test at Center		Shore Test Half Way to Edge		Shore Test Near Edge	
	350°	600°	350°	600°	350°	600°
20 min.	29	26	27	25	25	23
1 hr. 10 min.	30	25	28	24	28	22
2 hr.	30	24	28	22	27	20

Again there is a difference between the center and the edge, but not so great as in medium-carbon steel.

All the figures thus far presented are with the Shore instrument. In order to get some results with the Brinell machine some pieces of 2-in. steel shafting 2 in. long were quenched in water from 850 deg. C. and reheated to 350 and 600 deg. for 20 min., 1 hr. 10 min. and 2 hr. They were then sawed at the middle, polished in cross-section and tested.

Time	Shore Test at Center		Shore Test Half Way to Edge		Shore Test Near Edge	
	250°	600°	350°	600°	350°	600°
20 min.	24	22	23	21	22	20
1 hr. 10 min.	24	22	23	21	22	20
2 hr.	23	23	22	21	22	21

The Brinell hardness of the last specimen was center 149, half way to edge 137, near edge 126.

This steel is so low in carbon that the Shore test shows little variation either for temperature or time. The Brinell numbers are more divergent than the Shore numbers.

DISCUSSION OF RESULTS

The figures, taken at random as they are from the writer's files and obtained from a variety of steels, are in no sense an adequate research into hardness phenomena from which definite conclusions may be drawn.

There are several indications regarding the effect of temperature and time on hardness which more data might confirm or disprove, but one fact is outstanding: All cases cited and many more which are not mentioned in this paper show a greater hardness at the center than near the edge, regardless of heat-treatment. This is not due to decarburization, for the tests were made far enough from the edge to avoid this.

The probable explanation is either the McCance inter-strain theory or possibly the theory recently published by Jeffries and Archer.

All steel on cooling is subjected to internal strains varying in intensity with the rate of cooling. Even a steel very slowly cooled is subject to a small amount of this strain. It is evident that in all cases the effect is greatest at the center of the specimens and according to the new theory a variation in hardness is to be expected. Once hardening by slip or interference in grain growth is produced, varying from center to outside, it is impossible to eradicate it completely. At drawing temperatures near the critical range equalization is approached, but if it is ever attained during heating, which may fairly be doubted, a slight differentiation takes place during cooling. E. E. Thum has suggested to the writer that at least part of the excess hardness at the center, especially that shown after complete annealing of the specimens, may be due to the segregation which always occurs to some extent at the center of an ingot and persists in rolled bars. This fact should not be overlooked, for it is a reasonable explanation of at least part of the phenomena. The entire explanation can be found only by a careful research involving chemical analyses from center to circumference supplementing the hardness data and microscopic analysis. It seems fair to assume that it is practically impossible under ordinary heat-treatment conditions to expect a bar of steel to be homogeneous in hardness throughout its cross-section.

Wood Acids*

"Acid" is a term used by many to designate almost any kind of chemical which has a corrosive action, and, in the same loose sense, the term "wood acid" is used in explanation of any unusual quality in a wood, such as taste, odor or corrosion of metals in contact with the wood. As a matter of fact, only three chemicals correctly called acids have been found existing free in wood; these are tannic acid, acetic acid and formic acid. Tannic acid is very feeble and has very little corrosive action on metals. The two other acids are also feeble in comparison with sulphuric, nitric or hydrochloric acid.

A very small amount of acetic acid and a still smaller amount of formic acid apparently exist in all native woods, probably as the result of a slow action of water on wood at ordinary temperatures. All native species are also alike in that both of these acids can be produced very readily from them by the simple action of steam or hot water, a reaction for which there is no simple preventive treatment. Acids formed in the wood by the agency of steam or hot water are doubtless responsible for the results frequently attributed to acid supposed to have been in the wood originally.

The amount of acid normally present in any native wood is not sufficient to warrant its rejection for any purpose involving contact with metals.

*From U. S. Forest Products Laboratory Technical Notes.

The Amorphous Metal Hypothesis

The Amorphous Metal Cement Hypothesis Is the Only Satisfactory Explanation of the Properties of the Grain Boundaries in Metals—The Role of Amorphous Metal in Plastic Deformation and Particularly in Producing Hardness Has Been Greatly Exaggerated

By ZAY JEFFRIES AND R. S. ARCHER

ALTHOUGH solid metals are in the main undoubtedly crystalline in structure, there is reason for supposing that they may exist partly in an amorphous condition, and that those portions which are amorphous may exert a very important influence on the properties of the aggregates. This view was first advanced some twenty years ago by George T. Beilby¹ largely as a result of his studies on the nature of polished surfaces. It has since been elaborated and extended, notably by Rosenhain², so that the amorphous metal hypothesis now occupies an important but somewhat uncertain position in modern metallographic theory. It is the purpose of this article to recount the principal elements of this hypothesis and to present a critical discussion and a statement of the hypothesis which is believed to be consistent with the results of recent research.

DEFINITION OF "AMORPHOUS"

Crystalline materials are characterized by the orderly arrangement of their constituent particles—i.e., atoms or molecules—in definite geometrical patterns. Materials whose molecules do not possess any such regularity of arrangement are amorphous. The term "amorphous" is thus in the broadest sense directly opposed to crystalline. A further distinction must be made. Wood is a material which is decidedly not crystalline, and yet because of the processes of its growth it possesses definite directional properties. The arrangement of its atoms or molecules is not entirely haphazard. The same is true of all vegetable and animal tissues. In order to define more specifically what he meant by the term amorphous in connection with metals, Beilby used the qualifying adjective "vitreous," narrowing the field to "substances which in some degree resemble the glass-like form assumed by the silicates when they are solidified from the molten state."

Amorphous solids are essentially undercooled liquids of great viscosity. The constitution of the liquid is preserved and with it the property of fluidity, masked from casual observation by the high viscosity. Glass may be taken as an example. On cooling from the molten state it passes in a continuous manner from a liquid which can readily be poured to the solid we know at ordinary temperatures with a hardness comparable to that of the hardest steel. In spite of this hardness, a rod of glass supported at the ends will sag or "flow" under its own weight in the course of months or years.

It has been pointed out in a previous article³ that the regularity of atomic arrangement in crystals leads to mechanical weakness along certain crystallographic planes. The absence of such planes of weakness in amorphous materials leads to great hardness at low temperatures. The hardness and strength of amor-

phous materials will be discussed later more fully. For the present it is merely necessary to say that the amorphous modification in most metals is regarded as being harder and stronger than the crystalline at ordinary temperatures.

AMORPHOUS FILMS ON RUBBED SURFACES

The studies of Beilby referred to above showed that the operation of polishing causes a surface flow of the material being polished. The action of abrasive materials is essentially one of cutting. The grinding of a metal surface by an abrasive such as emery consists in the cutting of minute grooves, the emery particles acting as cutting tools. When such a surface is polished or burnished, the surface layers of the metal are caused to flow, bridging or filling up the grooves left by the emery. Working with the mineral calcite (calcium carbonate), which is especially suitable for such observations, Beilby found that the flowed surface possessed certain properties which distinguished it from the unpolished crystal face. It was harder, as tested by the loaded needle, and its hardness was the same in all directions, whereas the hardness of the natural crystal face varied according to the direction in which it was measured.

Perhaps the most significant thing is the way in which the polishing operation gradually smoothes over the scratches, finally obliterating them and leaving a surface with an appearance "absolutely homogeneous and vitreous like a coating of varnish or enamel." Furthermore that this smooth surface is merely a coating is demonstrated by the fact that the scratches are again revealed when the surface layer is dissolved in hydrochloric acid. Beilby concluded that the flowed material is rendered amorphous by the action of polishing. This amorphous film was assumed to be in a condition of great mobility at the instant of formation so that under the influence of surface tension it would assume a very smooth surface. It was then supposed to solidify or "set" in the final hard glassy state.

It had already been shown that the permanent deformation of metals takes place by a kind of block movement on certain crystallographic planes known as gliding planes or slip planes. Beilby postulated that the rubbing of the crystal fragments over each other on the slip planes generates films of amorphous metal comparable to the surface films produced by polishing. Like the surface films, they were supposed to pass through a mobile stage and then become hard and rigid. Now the ductile metals are greatly hardened and at the same time made brittle by deformation carried out below the annealing temperature, whether such deformation be effected by cold-drawing, rolling, pressing or other means. According to Beilby's theory, this "hardening" results from the formation at all the internal surfaces

¹See references and footnotes on page 704.

of slip or shear of mobile layers similar to those produced on the outer surface by polishing. These layers retain their mobility for only a very brief period and then solidify in a vitreous amorphous state, thus forming a cementing material at all surfaces of slip or shear throughout the mass." The increased hardness is thus attributed to the presence of a framework or matrix of a modification of the metal possessing greater specific hardness than the crystalline modification.

After this stiffening of the metal, further deformation is forced to take place on new slip planes, thereby producing more amorphous metal and still greater hardness. There is a practical limit to the amount of cold deformation that a metal will endure. Further attempts cause rupture. Thus in wire-drawing if the process is carried too far the wire draws hollow or splinters. Even before this stage is reached maximum hardness and strength are produced. Over-drawing reduces the strength. This is regarded by Beilby as due to the exhaustion of available crystalline material. The crystalline modification of the metal is regarded as the sole source of plasticity and when the available supply is exhausted the metal becomes incapable of further deformation.

RECRYSTALLIZATION

Metals which have been hardened by cold-work are softened by heating to a suitable temperature. The softening is accompanied by the restoration of ductility and by the substitution of a clearly crystalline structure of equi-axed grains for the disordered structure found after cold-working. This operation is called "annealing," and is a regular part of most industrial processes involving the cold deformation of metals. The softening is explained by Beilby's theory as due to the recrystallization of the amorphous metal produced by the cold-work. Disappearance of the amorphous metal of course involves the simultaneous disappearance of the hardness and brittleness supposed to be due to it.

Crystallization of an amorphous solid or undercooled liquid is a common occurrence. Glass and vitreous silica crystallize or "devitrify" when exposed for a long time to temperatures at which they are somewhat soft. The presence of crystalline nuclei greatly facilitates this transformation. Beilby considers the recrystallization of metals to be strictly analogous to that of other amorphous materials in the presence of nuclei. The nuclei are the fragments supplied by the breaking up of the original crystalline grains. The amorphous metal is regarded from the physicochemical viewpoint as identical with the liquid phase. Hence it must be unstable at all temperatures below the melting point of the metal and is prevented from reverting to the stable crystalline form only by its rigidity due to the low temperature. On raising the temperature of a metal the atomic mobility becomes sufficient for the unstable amorphous phase to crystallize about the nuclei already present.

OTHER METHODS OF PRODUCING AMORPHOUS METAL

Beilby did not consider deformation to be the only means for the production of amorphous metal. He recognized that it is not possible to retain metals in the amorphous condition by rapid cooling from the molten state, as is the case with glass, vitreous silica and many other typical amorphous solids. He did, however, advance the suggestion that "the evolution of a dissolved gas when a critical point is reached may so

effectually prevent or modify crystallization that the metal is hardened." And again, "Sometimes a very minute addition of a second substance to a pure metal is sufficient to prevent crystallization in the regular way, or even to prevent it altogether. The product is then more rigid and less plastic than the pure metal." This statement was offered as an explanation of the fact that solid solutions of two metals are usually harder than the pure metals, the case of gold and silver being mentioned as an example. Another suggestion was that amorphization might be brought about by flow occurring in a cooling mass as a result of shrinkage strains. Certain samples of electro-deposited copper are found to be very hard and to possess a structure somewhat resembling that of cold-worked metal. Annealing causes recrystallization and softening. From these observations Beilby concluded that "the deposition of the metal under conditions of strain had caused the molecular aggregation to be of the amorphous type." These suggestions are interesting to note in tracing the development of the theory. Beilby sums up thus:

"The development of the maximum intrinsic hardness of the metals can thus be brought about in many different ways, but in every case it appears to depend on the special development of the cohesive forces which is associated with the amorphous or non-crystalline aggregation of the molecules."

WHAT CEMENTS CRYSTALLINE GRAINS TOGETHER?

In 1912 Beilby's hypothesis received a very important extension, consisting in the proposition that the amorphous phase exists not merely in cold-worked metals but is also a normal constituent of all metals in the form of an intergranular cement.* Beilby's original hypothesis that amorphous metal is formed on slip planes during plastic deformation was put forth to explain hardening. The postulation of an amorphous intergranular cement was advanced to explain an entirely different set of phenomena, which will now be briefly described.

When pure metals that are in what may be called "a normally healthy condition" are broken, the path of fracture is found to pass almost exclusively through the grains, rather than between them. The grain boundaries appear to be stronger than the grains themselves, rather than weaker, as might be expected. When metals are broken at temperatures just under their melting points, however, the conditions are reversed, fracture following the grain boundaries.

Permanent deformation of metals consists of plastic deformation of the crystalline grains, by the process of slip or gliding. If the grains possess any inherent plasticity, as is normally the case in the ductile metals, then fracture through the grains is necessarily preceded by some plastic deformation of the grains and a general deformation of the metal as a whole. Transcrystalline fracture is therefore accompanied by a ductile break. Intergranular fracture at high temperatures, on the contrary, takes place in a brittle manner—i.e., with little if any general deformation of the metal. The cohesion between grains has become so small that they pull apart before sufficient load can be transmitted to deform them.

The assumption that the grains of metals are held together by a cement of a vitreous amorphous nature explains these phenomena in a very satisfactory manner. At the lower temperatures this cement is hard

*See references and footnotes on page 704.

and strong, so that the necessary loads can be transmitted to the grains to deform them and finally cause rupture to pass through them. As the temperature is raised the amorphous cement gradually softens⁵ so that at high temperatures it is very weak. The grains then readily pull apart without any appreciable deformation.

TIME FACTOR IN LOADING AMORPHOUS MATERIAL

Since the atoms (or molecules) of amorphous materials do not occupy fixed positions with respect to one another, such materials can be deformed by the gradual shifting of the relative positions of their particles. The atoms in a crystal of metal are held in substantially fixed positions in the crystal lattice. Deformation therefore takes place by the simultaneous movement of a large number of atoms. A correspondingly large number of atomic cohesion "bonds" must be broken at one time. The result is that the strength (or what is the same thing, its elastic limit in shear) of a crystal is definite. The cohesion bonds in an amorphous material may be broken very gradually—almost one atom at a time, we might say. The force required to produce deformation is therefore very small. Such small forces must of course act for considerable periods of time in order to effect appreciable deformations.

There is a distinct and important time effect in the rupture of metals at high temperatures. At any given temperature which lies well above the annealing temperature of the metal but not too close to the melting point, either intergranular or transcrystalline fracture can be produced at will by varying the rate of applying the load. This is illustrated by some tests carried out on copper wire at a temperature of 950 deg. C.⁶

Time Required to Break	Tensile Strength	Type of Fracture
1 minute	710 lb. per sq.in.	Intergranular, brittle
5 seconds	2500 lb. per sq.in.	Transcrystalline, ductile

It will be noted that not only is the type of fracture changed by increasing the rate of loading but the strength is very greatly increased. This is explained on the assumption of an amorphous intercrystalline cement by the known properties of solid amorphous materials. Attention has already been called to the fact that glass will flow under its own weight acting for a long period of time, whereas it is perfectly elastic up to a stress of perhaps 30,000 lb. per sq.in. under loads acting for short periods. The typical combination of fluidity and hardness possessed by amorphous solids is perhaps illustrated even better in the properties of pitch. At ordinary temperatures pitch can be pulverized by means of hammer blows. If the particles of powder thus produced are put in a receptacle the force of gravity alone is sufficient to weld them into a single coherent mass of pitch. This welding may require considerable time, but it is so effective that even the air bubbles are slowly forced to the surface. Pitch can be deformed into any shape desired if sufficient time is taken. A barrel of pitch, for example, can be emptied by allowing it to flow very slowly from a small hole. At any time during this process of flow, a sharp hammer blow will shatter into fragments the stream of flowing pitch. Pitch is thus either hard and brittle or soft and plastic according to the rate of deformation attempted. Resistance to rapid deformation is very great, but deformation can be effected slowly by extremely slight forces.

Now the crystalline grains of a metal are supposed to be held together by an amorphous metal cement whose

properties at high temperatures resemble those of pitch at ordinary temperatures. At the freezing point of the metal the liquid or amorphous metal has practically no resistance to deformation. At the same time the crystalline metal has very considerable resistance to deformation. The case is similar to that of water and ice at the freezing point of water. As the metal cools, the undercooled liquid or amorphous metal at the grain boundaries increases in viscosity so that at very low temperatures it has great hardness. At the same time the hardness and strength of the crystalline metal increase, but at a less rapid rate. At "high temperatures," which in the case of metals means at temperatures above that of recrystallization, the amorphous metal is softer than the crystalline.

Suppose a piece of metal such as the copper wires mentioned above be subjected to a small tensile load which is insufficient at the temperature of the test to deform the crystalline grains (the force required to deform a crystal is practically independent of any time effect). If this small load is allowed to remain on the test specimen, it will in time cause flow in the viscous amorphous cement and the grains will finally be pulled apart, without having themselves undergone any deformation. The fracture will then be of the intergranular, brittle type.

Suppose a similar specimen to be loaded rapidly to a much higher stress. The amorphous cement will sustain high stresses for short periods of time, so that if the load is applied rapidly enough, a stress can be reached which is high enough to deform the crystalline phase. Fracture will then take place through the grains instead of between them, and will be accompanied by considerable general deformation of the piece as a whole.

HYPOTHESIS OF AMORPHOUS METAL CEMENT

This is in brief the amorphous metal cement hypothesis as proposed by Rosenhain. It was advanced primarily to account for the cohesion between the grains of a metallic aggregate and the changes in cohesion with change in temperature. The development of the hypothesis leads, of course, to conclusions regarding other phenomena, particularly hardness. The amorphous metal at the grain boundaries was supposed to be the same as that proposed by Beilby as the cause of the hardness produced by cold deformation. Any increase in grain boundary surface must therefore result in an increase in hardness. This afforded a ready explanation of the fact that the hardness of metals increases as the grain size becomes smaller. Carrying the idea to the extreme, Rosenhain proposed that the great hardness of hardened steel is due to "the presence of an extremely minute network of amorphous layers" surrounding the very fine grains of alpha iron which result from the rapid transformation of gamma iron. He regarded the amorphous iron as being especially hard in this case because of iron carbide in solution.

Beilby's theory of hardening by the formation of amorphous metal and Rosenhain's conception of an amorphous intercrystalline cement comprise what may be called the fundamental ideas of the amorphous metal hypothesis. These ideas have in some form gained a rather wide acceptance in England and America, although they have not been so favorably received on the Continent. There is at present no unified opinion regarding the details of the hypothesis, which is quite to be expected considering its newness and its speculative nature. It must be recognized that this hypothesis

⁵See references and footnotes on page 704.

concerns some of the most important properties of metals and therefore deserves very careful inquiry and consideration both as to the fundamental ideas and their detailed development.

CAN METAL BE PRODUCED ENTIRELY AMORPHOUS?

The first question to be considered should perhaps be that of the reality of amorphous metal. It is possible by means of the X-ray spectrometer to literally "look into" a metal and recognize the presence of crystalline material. Unfortunately, however, there is no such positive test for the presence of amorphous material. The most direct proof of the reality of amorphous metal would of course be the production of metal *entirely* in the amorphous condition. Beilby attempted to do this by mechanical deformation and he selected wire-drawing as a suitable process because of its drastic nature. After having drawn wires of silver, copper and gold to as much as fourteen times their original lengths, he concluded that they still contained crystalline metal and that it is impossible by mechanical deformation to convert a metal entirely into the amorphous modification. In addition to the microscopic observations upon which his conclusion was largely based, there is an abundance of confirming evidence of a more positive nature.

Beilby considered that he had produced a totally amorphous mass of metal by compressing very fine gold powder precipitated from aqueous solution. He described his product as harder and less plastic than other forms of gold, and also resistant to recrystallization at 350 deg. C., or about 100 deg. C. above the temperature required for the recrystallization of cold-drawn gold wires, a property he attributed to the absence of crystalline nuclei. It is now known that chemically precipitated metallic powders, even when composed of the finest particles, are perfectly crystalline, so that masses formed by compressing them are themselves predominantly crystalline.

It is quite certain that no totally amorphous mass of solid metal has been produced. A little consideration of the molecular structure of amorphous bodies is interesting in this connection. The materials which are most readily obtained in amorphous form, such as pitch, glass and vitreous silica, always have several atoms to the molecule. Some of the chemical elements, of which sulphur is an example, can also be obtained in an amorphous condition. A sulphur molecule contains eight atoms. Metals are monatomic in all conditions of aggregation and therefore crystallize more freely. A single atom can obviously find its place in a crystal lattice more easily than can a molecule containing several atoms. It will therefore be very difficult to obtain metals in an entirely amorphous solid state.

POSSIBLE STRUCTURES AT GRAIN BOUNDARIES

The best evidence for the existence of amorphous metal is probably to be found in the conditions at grain boundaries. In the original statement of their intercrystalline cement hypothesis Rosenhain and Ewen advanced the idea that the crystallization of metals takes place by the addition of crystal units containing large numbers of atoms. In the region where two crystals abut against one another—that is, at the grain boundaries—there would have to be some metal which could not attach itself to either crystal because of being too small in amount to form crystal units. Furthermore, since the crystalline grains have different orientations, the units or blocks of one would not fit

in with the blocks of the other, and interstices of irregular shape would be left which could not be filled up with other crystals no matter what their orientation. The metal remaining in these interstices must then retain the structure of the liquid—i.e., must be amorphous.

The diagram in Fig. 1 shows this condition in a schematic way, the shaded areas representing the interstices filled with amorphous metal.

This conception is no longer tenable, inasmuch as it now appears quite certain that the "crystal units" consist of one atom each. The actual conditions must nevertheless be very similar, in a qualitative way and on a smaller scale, to those represented in the diagram.

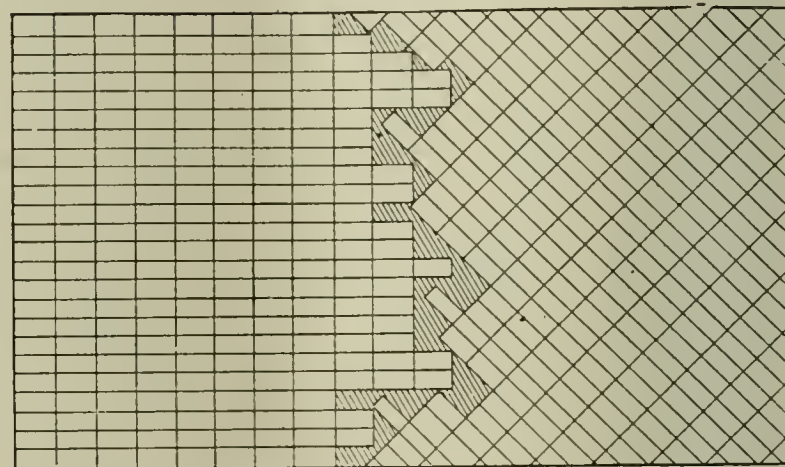


FIG. 1. HYPOTHETICAL CONDITION AT GRAIN BOUNDARY (ROSENHAIN AND EWEN²)

Certainly where two crystals of different orientation meet it is not geometrically possible for all of the atoms present to have places in an undisturbed space lattice without leaving some voids.

There are three possible conditions: (1) There are voids between the two crystals; (2) there is a zone in which some of the atoms are held in *both* crystal lattices, in which case the lattices would be distorted at the surface of contact; or (3) there is a zone of disorganized or *amorphous* metal.

There is no way known at present of determining the actual structure at the grain boundaries of metals. It is certain that, under various conditions of temperature and rate of loading, metals behave as they would if their grains were held together by a cement of a substantially amorphous nature. There are many other properties of metals which are consistent with the assumption of an amorphous cement, and none, to the author's knowledge, which are inconsistent. The hypothesis is thus plausible from the structural viewpoint and logical in that it offers satisfactory explanations of the properties of the grain boundaries of metals. This is enough to justify the utilization of the idea as a working hypothesis—but we can go even further. The amorphous metal cement hypothesis is at the present time the *only* satisfactory explanation of the effect of temperature and rate of loading on the strength and manner of rupture of metals. This fact confers upon it an added degree of probability.

IMPURITIES AT BOUNDARIES

The only alternative theory that has been advanced is based upon the assumption that even in what are ordinarily termed "pure" metals there are appreciable quantities of impurities forming eutectics melting below the melting point of the metal. When the metal is heated to high temperatures, these eutectics melt and

form molten layers around the grains of solid metal. The molten layers have very little strength and hence allow the grains to be pulled apart on the application of small loads. There are a great many objections to this explanation. The phenomena to be explained occur with great distinctness in metals of the very highest purity. Any eutectic that might be present in such a pure metal would necessarily have a very high melting point, little short of that of the theoretically pure metal. In any case the melting point of the eutectic would be *fixed*. This is not the case with the temperature separating intergranular from transcrystalline fracture, which varies with the rate of loading or duration of load. Furthermore, intergranular fracture can be produced at any temperature from the recrystallization temperature to the melting point. The intergranular eutectic hypothesis is untenable from this point of view. An additional objection is that it does not sufficiently explain the time effect, especially on the tensile strength such as quoted on p. 699 for copper.

In the authors' opinion it is justifiable to conclude that the metal at the grain boundaries is or simulates an amorphous material. It is not possible to reach any definite conclusions regarding the degree of disorganization of this material or the thickness of the films around the grains. Although definite information on these points is desirable, it is not necessary to the formulation of a useful theory. The essential fact is that the grain boundary metal possesses mechanical properties like those of a vitreous amorphous substance.

The amorphous cement occupies a very important place in the structure of metals, inasmuch as it is continuous. Nevertheless, the amount of crystalline metal is so preponderant that as a rule metals never exhibit properties like those of an entirely amorphous material. In the tests of metals at high temperatures which have

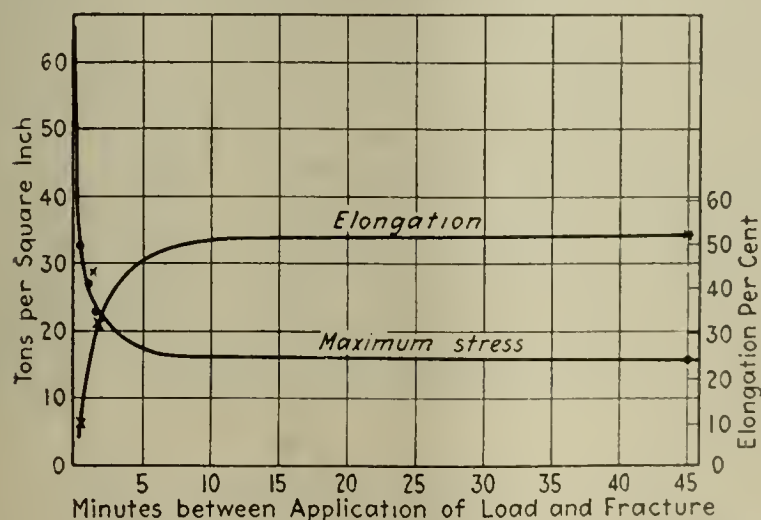


FIG. 2. EFFECT OF RATE OF LOADING ON ZINC-ALUMINUM-COPPER ALLOY (ROSENHAIN, HAUGHTON AND BINGHAM)

been referred to, the tensile strength varies with the rate of loading in the same manner as that of an amorphous material. That is, the longer the time taken in breaking the specimen the smaller the load required. The elongation, on the contrary, follows an exactly opposite course. Metals broken by small loads acting for long periods of time show little if any elongation while an amorphous material like pitch or glass (at a red heat) shows more elongation the slower the loading.

ZN:AL:CU ALLOY OF PECULIAR PROPERTIES

An alloy has recently been described which is of special interest for the reason that both its strength and its ductility are affected by the rate of loading in

the same manner as are those of amorphous materials. The alloy is the ternary eutectic of zinc (89 per cent), aluminum (7 per cent) and copper (4 per cent). The principal metal, zinc, recrystallizes at room temperature so that the "high-temperature" phenomena of less fusible metals like iron are in this case obtained at ordinary temperatures. The properties are shown best by the alloy after it has been subjected to considerable rolling at about 250 deg. C. A strip of the metal in this condition can be bent double between the fingers, if the bending is carried out slowly, taking, say, five minutes. An attempt to bend the strip quickly causes it to break

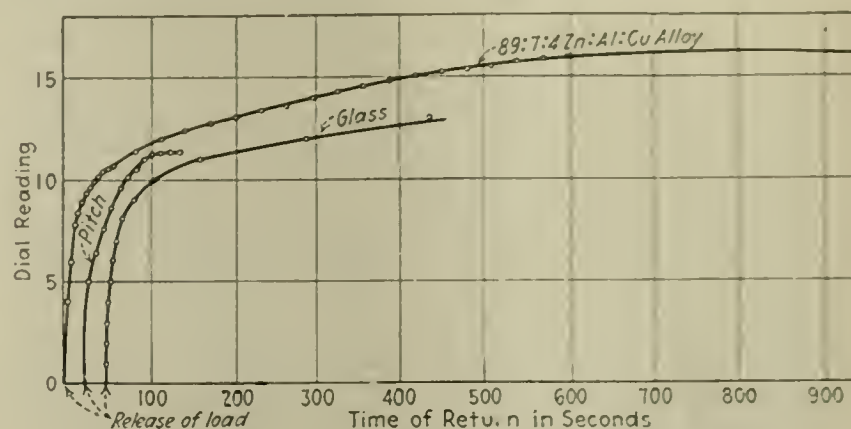


FIG. 3. RETURN FLOW OR CREEP IN RECENTLY DEFORMED ZINC-ALUMINUM-COPPER ALLOY, PITCH AND GLASS (ROSENHAIN, HAUGHTON AND BINGHAM⁷)

with a sharp snap. This is exactly the behavior that would be expected of an amorphous material like pitch. This simple experiment demonstrates in a qualitative way the effect of rate of loading on the properties of this alloy. A quantitative expression of the same effects is found in the curves reproduced in Fig. 2.

This alloy resembles amorphous materials in another respect—namely, the return flow or "creep" after deformation. If a strip of amorphous material like pitch is bent in a given direction and then released, it springs back somewhat in the opposite direction, but does not immediately assume a stable position. It continues to creep back slowly at a steadily diminishing rate. All metals with the exception of single crystals behave in a similar manner, but the creep is usually so slight that rather sensitive instruments are required to detect it. Rosenhain's alloy exhibits this property to a degree comparable with pitch. The curves in Fig. 3 show the return creep for three materials, plotted to the same scale except that for glass the deformations are magnified $14\frac{1}{2}$ times.

The exceptional degree to which this alloy resembles materials that are entirely amorphous is attributed by the present authors to a very fine grain size stable at temperatures normally in the recrystallization range. The alloy consists of the three structural constituents of the ternary eutectic. These crystalline constituents are divided very finely by the rolling process. Grains of a pure metal broken up in this way by deformation carried out above the recrystallizing temperature promptly unite so that the metal is left in a moderately coarse-grained condition. In this case, however, the eutectic constituents cannot unite, and by interfering with grain growth in the matrix (zinc) cause the final grain size to be very small. This, coupled with the probable high specific hardness of the crystalline constituents, accentuates the effect of the properties of the grain boundary metal. The discovery of the properties of this alloy is important, because this is the

only case on record in which the properties of the amorphous "phase" completely mask those of the crystalline constituents in a metallic aggregate.

OTHER PROPERTIES OF GRAIN BOUNDARIES

There are many phenomena for which the amorphous metal cement hypothesis furnishes a convenient explanation, but for whose explanation the assumption of an amorphous cement is not necessary. They are therefore not to be regarded as strong evidence for the existence of an amorphous metal cement, but merely as facts which are consistent with the hypothesis. One group of such facts may be comprised in the statement that the grain boundaries of metals are particularly subject to chemical attack and to the penetration of gases. A bronze can be disintegrated into its individual crystals by the action of mercury (Desch),⁸ which dissolves away the grain boundary metal. Dickenson⁹ has shown that certain failures of manganese bronze were caused by the penetration of solder between the grains while the metal was under tensile stress. The solder must of course be molten to have this effect. It is usually necessary in this as in other cases of a similar nature for the metal to be under tension in order for any rapid intergranular penetration to take place.

Cold-worked articles of brass, such as cartridge cases, are subject to a type of failure known as "season cracking." After standing for some time, perhaps years, the article develops cracks which are shown by microscopic examination to be intergranular. It has been shown that season cracking can take place in the entire absence of corrosive agencies. There is no doubt, however, that corrosion either by the atmosphere or by other agencies greatly hastens the process. Brass articles are often tested for susceptibility to season cracking by immersion for a short time in a solution of mercurous nitrate. Metallic mercury is liberated and penetrates the grain boundaries of the brass where tensile stress exists. Cracking then follows quickly.

In the carbonizing of steel the carbon penetrates by way of the grain boundaries. The penetration is probably largely due to an actual penetration of carbon monoxide gas, although it is partly due to diffusion of carbon from the surface. This diffusion also follows the grain boundaries, as can be seen by reheating a graphitized iron to temperatures above the critical and then cooling rapidly.¹⁰ The carbon will be found to have been reabsorbed into the iron by way of the grain boundaries.

Commercially pure copper is embrittled to a ruinous extent by annealing in a reducing atmosphere, such as hydrogen. The hydrogen is supposed to penetrate the metal and reduce the copper oxide which is always present. The steam formed is unable to escape and its disruptive force is the cause of the bad effect on the copper. In this case again the penetration of the hydrogen takes place partly by way of the grain boundaries.

Many other examples could be cited to illustrate this susceptibility of the grain boundaries to attack. It is to be assumed that the amorphous cement supposed to exist at the grain boundaries is electro-positive to the crystalline metal, since it more closely resembles the liquid in structure and therefore has a higher internal energy content. This would account for its greater susceptibility to chemical attack and penetration by molten metals. The penetration by gases would be ascribed to the freedom of motion of the atoms in the amorphous metal, which would not present a rigid

barrier to the penetration of gas molecules as would the fixed atoms in the crystal lattice. These facts can also be explained on the assumption that the structure at the grain boundaries of metals consists of two perfect crystal lattices interlocking with the formation of voids free from any amorphous metal.

"VACUUM ETCHING"

Another phenomenon closely allied to these is one known broadly as "vacuum etching." Rosenhain and Ewen sought to demonstrate the existence of amorphous metal at the grain boundaries by determining the relative losses in weight of coarse- and fine-grained metals when heated in vacuo. They showed that the losses of the fine-grained specimens were much greater than those of the coarse-grained specimens, and attributed this to the presence of greater quantities of amorphous metal, which is quite logically supposed to have a higher vapor pressure than the crystalline metal. These observations are, however, explained with equal satisfaction on the basis of any of the three possible grain boundary structures mentioned above.

Special attention has been called by one of the authors¹¹ to the flow of metals at high temperatures. In making filaments for certain classes of electric lamps, it is desirable to have tungsten wire which will not sag under its own weight when heated to high temperatures. It has been found that at high temperatures fine-grained wires sag much more than do coarse-grained wires. This is consistent with the theory that the sagging consists in *flow* in the layers of amorphous cement around the grains. Small grains would lead to greater flow because of more grain boundary surface. An alternative explanation is that the sagging of the wires consists in a migration of the grain boundaries—that is, grain growth—under the influence of stress and temperature. Such grain growth would take place in a direction tending to relieve the stress, which would cause the wires to sag. The greater sagging of the fine-grained wires would be due to the greater boundary surface and to the greater tendency of small grains to grow. It is probable that this is a factor in the observed flow (although not the only one), but such a mechanism does not account for the strength properties of the grain boundaries. The authors therefore prefer to consider that the grain boundaries are amorphous, because this accounts for all of the observed properties.

AMOUNT OF AMORPHOUS METAL PRODUCED BY COLD-WORK

The question of the formation of amorphous metal during plastic deformation is perhaps more difficult than that of its existence at grain boundaries. There is again no direct evidence and there are in this case no phenomena which cannot be explained without assuming the formation of amorphous metal on all of the slip planes. Beilby advanced his hypothesis primarily as an explanation of hardening. It is the opinion of the present authors that hardening can be satisfactorily accounted for on the basis of a rearrangement of crystalline material, as described in a previous article.³ Any amorphous metal formed would of course contribute to the hardening, but it is not necessary to assume its presence for this purpose.

Beilby's hypothesis was, as indicated above, based largely on his studies of polished surfaces. Having concluded to his satisfaction that the surface layers of

polished metals are in an amorphous condition, he assumed that the internal friction on slip planes during deformation also generates layers of amorphous metal. There is some doubt that the surface layers of polished metals are entirely or even largely amorphous, but even granting that they are entirely amorphous, this cannot be considered as more than a suggestion that similar layers are formed on the internal surfaces of slip. The processes—polishing and slip—differ in two important respects. The friction in polishing is between the metal and a dissimilar surface, usually a cloth charged with fine particles of hard metallic oxide. Secondly, the amount of relative motion between the two surfaces in the case of polishing is enormously greater than in the case of crystalline displacement by slip.

BEILBY'S ORIGINAL HYPOTHESIS IMPOSSIBLE

A rough calculation will suffice to show that Beilby's hypothesis as originally proposed is impossible. According to this hypothesis, as well as the ideas prevailing among its adherents in England and America at the present time, amorphous metal is developed at *each* slip plane and slip occurs only *once* on each plane. From many observations of slip bands, made mostly on fairly coarse-grained specimens, it appears that the maximum extent of motion along a slip plane during a single deformation ranges from 1,000 to 5,000 atom diameters, seldom greater. It also appears that the extent of slip is less the smaller the grain size. Normally, therefore, the average extent of a single slip is probably well under 1,000 atom diameters. Assume, for example, a single crystal in the shape of a 1-in. cube, of a metal having 100,000,000 atoms per linear inch. Assume that slip generates amorphous layers two atoms in thickness, which is about the minimum that could be considered amorphous. The number of possible slip planes on the cross-section would then be 50,000,000. A slip on each of these planes to an extent of 1,000 atom diameters would result in a general extension of 500 in., after which all of the metal would be amorphous.

But copper can be extended by cold-swaging and drawing, without intermediate annealing, to as much as 5,000 times its original length and the metal is still preponderantly crystalline! Tungsten wire drawn to 200,000 times its original length without intermediate annealing still gives perfect X-ray patterns, showing that it is predominantly crystalline! Beilby's scheme of plastic deformation is not consistent with such facts.

The wires of copper, silver and gold with which Beilby experimented were in no case drawn to more than fourteen times their original lengths, and he stated that the maximum strength was reached after drawing to from three to five times the original length. This increased strength and hardness he attributed to the formation of layers of amorphous metal, yet the proportion of metal converted to the amorphous condition would not have to be so very large. The greatest possible proportion actually so converted in his wires may be judged by the fact that wires drawn one thousand times as much are still predominantly crystalline. We believe, therefore, that any amount of amorphous metal that may be produced by drawing a wire to five times its original length could not in itself be responsible for the increased hardness and strength.

The abundance of crystalline material left in a cold-drawn wire is further shown by the fact that wires drawn until they have lost practically all of their ductility when tested at ordinary temperatures regain their

ductility to a large extent on cooling to the temperature of liquid air. Ductility is at low temperatures dependent on the presence of a very considerable amount of crystalline metal, since amorphous metal is considered to become increasingly hard and brittle as the temperature is lowered.

The evidence shows that whatever amorphous metal may be formed during cold deformation is very much less in amount than indicated by Beilby and generally held by the adherents of his hypothesis. It follows that the importance attached to the specific hardness of amorphous metal as the cause of hardening has also been greatly exaggerated.

WHAT CAUSES A SLIP TO HALT?

The conclusion that there are not formed on *all* of the surfaces of slips vitreous amorphous layers which prevent further slip on those surfaces does not preclude the possibility that some amorphous metal is produced during plastic deformation. A little consideration will show us that the block movements on slip planes, or "slips," may be divided into two rather distinct classes.

When a single crystal of metal is broken in tension, it might be expected that the final failure would take place on the first plane on which slip occurs. Such, however, is not the case, since large single crystals of ductile metals are themselves ductile and draw out under tension into the form of wedges. This shows that failure does not occur on the first slip plane. We must conclude that something happens during the process of slip which causes the resistance to further slip on that plane to be *greater* than the resistance to the starting of slip on some new plane. The slip may be said to be "self-stopping."

In ordinary pieces of metal which are aggregates of many small grains it is probable that only a small proportion of the slips are self-stopping. The majority of the slips are brought to rest by end resistance. There is every indication that the resistance to further movement on the surfaces of such slips is *less* than the resistance to the starting of slip on a new plane. At the beginning, therefore, a slip plane is a surface of weakness.

All this amounts merely to saying that a certain amount of *movement* or of *time*, or both is required for the building up of resistance on a slip plane. The "weakened and building-up" stage corresponds to the "mobile" state of Beilby. It may be that amorphous metal is actually in process of formation in this stage. The later stage when the slip has become self-stopping undoubtedly represents an altered structural condition at the surface of slip, which must necessarily involve some local disorganization of the crystalline metal. This disorganization may or may not be sufficient in kind and depth to justify the assumption of *vitreous* amorphous layers. The indications are that the disturbance does not penetrate very deeply and also that the differences in orientation between two adjacent crystal fragments are never very great. *Certainly the surface condition at slip planes even in the self-stopping stage does not prevent further movement on the same surface.* In the first stages of slip there is no reason to assume the presence of any amorphous metal, and in the later stages it is not justifiable to assume the presence of vitreous layers so rigid as to prevent further slip.

At the grain boundaries the conditions are different. The shapes of the original grains must change in a manner depending on the change in shape of the piece

of metal taken as a whole. No matter what the direction of extension, the grain boundary surface is increased by cold-work. Each slip intersecting a grain boundary produces one "lapped-over" fragment the surface atoms of which may be utilized to increase amorphous metal at the grain boundary. As deformation becomes severe, the grain boundary layer of amorphous metal should become thicker by the same process. It is the authors' opinion that the chief generation of amorphous metal by cold plastic deformation occurs here.

SUMMARY

1. Certain properties of cast metals or metals which have been worked and annealed are satisfactorily explained only on the assumption that the metal at the grain boundaries is in a substantially amorphous condition.

2. There is not at present sufficient evidence to determine whether this grain boundary metal possesses the perfectly amorphous structure indicated by the term *vitreous*. There is, however, enough evidence to justify the assumption that the grain boundary metal possesses the essential deformational and strength characteristics of typical vitreous amorphous materials.

3. The hypothesis that crystalline grains of metal are cemented with amorphous metal—i.e., the amorphous metal cement hypothesis—is not inconsistent with any of the known properties of metals.

4. Plastic deformation at temperatures below the temperature of recrystallization generates additional amorphous metal at the boundaries of the original grains.

5. There is no means of estimating with any exactness the quantities of amorphous metal which may be present under various conditions. There is certainly more amorphous metal in severely cold-worked metals than in annealed metals. Even the most severely cold-worked metals are predominantly crystalline. The amorphous metal hypothesis is a qualitative rather than a quantitative conception, so that it is perhaps not necessary to form very definite ideas as to the possible quantities of amorphous metal.

6. The formation of vitreous amorphous metal at all the internal surfaces of slip in the manner postulated by Beilby is not possible, and the hardness produced by cold-working can be readily explained without the assumption of such amorphization.

7. There is developed on some of the surfaces of slip a condition of cohesion greater than that in the undeformed crystal. This condition may presumably be due to a locally disorganized structure, but the assumption of a layer of *vitreous* amorphous metal is not necessary nor is it consistent with all of the facts.

8. Whereas the amorphous metal theory of deformation postulates that when slip has once occurred on a particular plane, no further slip on that plane is possible, the evidence available indicates not only that further slips on a "used" plane are possible but that they *must* occur in the course of the maximum deformation that can be effected.

9. The conception of an intergranular amorphous metal cement furnishes a very good explanation of certain deformational and strength properties of metals and a very useful working hypothesis. The importance attached to the specific hardness of amorphous metal as a cause of hardening has been greatly exaggerated.

REFERENCES AND FOOTNOTES

1. "The Hard and Soft States in Metals," G. T. Beilby, *Jour. Inst. Metals*, No. 2, 1911, pp. 5-43.

2. "Intercrystalline Cohesion in Metals," Rosenhain and Ewen, *Jour. Inst. Metals*, No. 2, 1912, pp. 149-185.

3. "The Slip Interference Theory of the Hardening of Metals," Zay Jeffries and R. S. Archer, *CHEM. & MET. ENG.*, vol. 24, p. 1057, June 15, 1921.

4. The conception of an amorphous cement between the grains of metals was published practically at the same time by Bengough (*Jour. Inst. Metals*, No. 1, 1912, pp. 123-190) and by Rosenhain in a discussion of Bengough's paper.

5. It was Bengough's view that the amorphous cement disappeared entirely at high temperatures and that the intergranular fractures were due to the absence of any cementing material. Rosenhain's view that the lessening of the cohesion between the grains is due to the **softening** rather than the disappearance of the amorphous metal was considered preferable by Bengough and is now generally accepted by the adherents of the amorphous metal theory.

6. "Effect of Temperature, Deformation and Grain Size on the Mechanical Properties of Metals," Zay Jeffries, *Trans. Am. Inst. Min. Engrs.*, vol. 60, pp. 474-562.

7. "Zinc Alloys With Aluminum and Copper," Rosenhain, Haughton and Bingham, *Jour. Inst. Metals*, No. 1, 1920, pp. 261-317.

8. "The Solidification of Metals From the Liquid States," Desch, *Jour. Inst. Metals*, No. 2, 1919, pp. 240-263; *CHEM. & MET. ENG.*, vol. 21, p. 773 (Dec. 24, 1919).

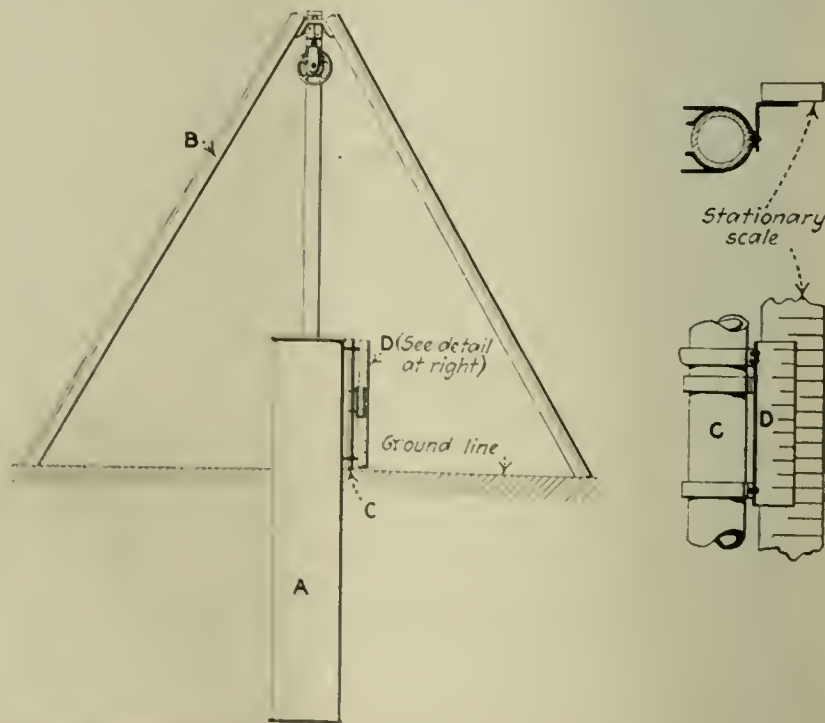
9. See reference 8, discussion by Dickenson.

10. "Graphitization of White Cast Iron," R. S. Archer, *Am. Inst. Mining Engrs.*, February Meeting, 1920.

11. "The Amorphous Metal Hypothesis and Equi-Cohesive Temperatures," Zay Jeffries, *Trans. Am. Inst. of Metals*, 1917, p. 300.

Volumetric Measurements of Pulpwood

In making pulpwood measurements and yield determinations it is often desired to ascertain the solid contents of a piled cord. The apparatus used for that purpose at the Forest Products Laboratory consists of (A) a galvanized tank set in the ground, with a volume of about 1.75 cu.ft. per ft. of length; (B) a tripod placed over the tank for raising and lowering the heavier sticks; (C) a glass gage on the side of the tank, calibrated to read in cubic feet and decimals thereof; and (D) a simple vernier scale attached to the glass gage to permit closer reading to five thousandths of a cubic foot. Ten divisions on the vernier equal nine divisions



on the stationary scale. Graduations on the stationary scale are in tenths and five hundredths of a cubic foot.

Before immersing each stick, the water level in the gage should be at or slightly above the zero mark. The stick is immersed and held just below the surface of the water by a pointed rod stiff enough to overcome the buoyancy of the largest and driest pieces without bending. One gage reading is made before and one during the immersion of the stick, the difference giving its volume.

The Fine Art of Lime Burning*

Complete Mechanical Handling of All Materials and Precise Technical Control of All Operations Have Been Provided For in the New Plant of the Rockland & Rockport Lime Corporation
—Crushing Plant—Kilns—Charging Equipment—Storage and Packing

BY GEORGE B. WOOD†

EACH individual limestone requires its own peculiar heat-treatment to produce a lime of desired qualities. A certain limestone, for example, may best be hard-burned slowly at low temperature for furnishing lime to a causticizing plant. It may best be light-burned at low temperature for building lime and it may best be light-burned quickly at high temperature for lime to go to the hydrating plant.

Dr. Holmes, of the Lime Association, is undoubtedly going to discover a lot of valuable truths along these lines, but such knowledge will profit us little until we build lime-burning plants capable of operating under stabilized conditions of physical and chemical control.

With these requirements in mind, as well as maximum heat efficiency and minimum labor operating costs, what should we demand of the modern limekiln?

1. Continuous mechanical feed of rock and continuous mechanical discharge of lime. When lime is properly burned it should be immediately taken away, not left to soak in the heat and gases for four to six hours.

2. Positive control of temperature.

3. Positive control of draft.

4. Positive control of burning period and lime discharge.

5. Positive control of combustion.

6. Minimum temperature of flue gases and cool lime ready for immediate handling and shipment as it leaves the kiln.

The new plant at Rockland, now nearing completion, is capable of meeting all of these requirements and based on the results of an accurate test with our stone will undoubtedly show a saving of 50 per cent in labor cost and very probably a saving of 50 per cent in fuel consumption over the former old-fashioned methods with hand-fired kilns.

ROCK-CRUSHING PLANT

The first requirement for maximum efficiency and uniform quality is uniform-sized stone going into the kiln. Our new rock-crushing plant at the quarry (Fig. 1) is not unique in any particular feature except for provision in the storage bin of three separate compartments, making possible three different classifications of quality of rock going to the kilns. The plant consists of a 48 x 42-in. Traylor jaw crusher set entirely below grade, permitting a trainload of rock (twenty-five to thirty 4-yd. standard-gage dump cars) to run down by gravity, dumping one car at a time into the crusher. An air hoist facilitates dumping of cars and an electric car puller starts the train whenever cars fail to move by gravity. Each car holds between 5½ and 6 tons of rock, and we recently dumped through the crusher as a

test twenty-five cars in 22 minutes. A pan bucket elevator 84-ft. centers with buckets 42 in. wide carries the rock to the top of the structure, where a shaking grizzly separates the 3-in. and smaller stone from the kiln stone. A revolving screen and a small auxiliary gyratory crusher sizes small stone for the crushed stone market. A 14-in. belt conveyor 100 ft. long, discharging into an abandoned quarry, disposes of the surplus fine stone when there is not a market. This spill conveyor



FIG. 1. ROCK-CRUSHING PLANT

eliminates all the additional handling cost in winter time from small stone frozen solid in bins and cars. The storage bins hold a total of 900 tons of the various sized stone and discharge from the bottom and the side into cars on two loading tracks. All machinery is electrically driven.

LOCATION AND SHIPPING FACILITIES

The kilns, hydrate mill, barrel factories and warehouses are all located at the waterfront of Rockland harbor, and the quarries are situated a mile and a half inland. The lime company owns and operates a standard-gage steam railroad, a belt line around the city which is a switching terminal and feeder for the Maine Central R.R. Coal and cooperage stock are received by water, lime is shipped by both rail and water and the Lime Rock R.R. distributes rock and coal and handles all the freight cars for the various plants. The railroad has 13 miles of main line and sidings, four locomotives and 495 4-yd. dump cars which are maintained and repaired in the company's own shops.

With this explanation of plant conditions, it will be understood why we have adopted at the new kiln plant a rather new and unusual method of rock storage and kiln-charging machinery.

LIMEKILNS

The new lime plant comprises a battery of six Mount kilns with two Morgan mechanical producers centrally located and one horizontal tubular boiler. The plant is

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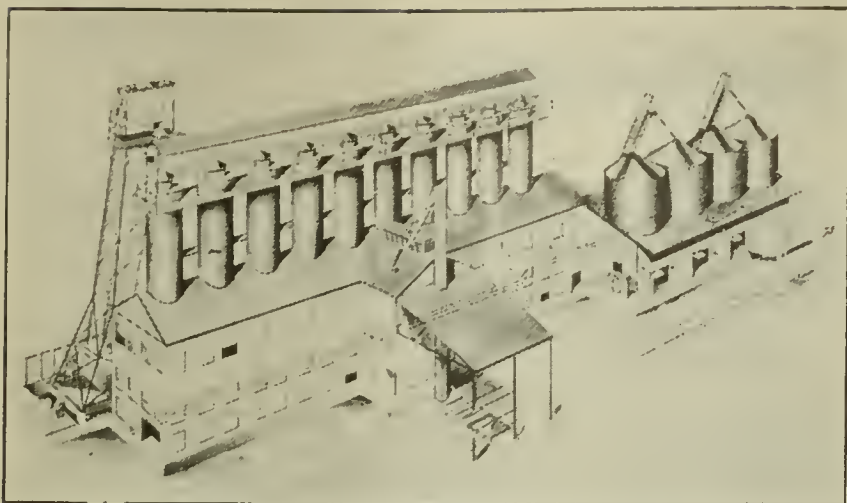


FIG. 2. GENERAL ARRANGEMENT OF LIME PLANT

designed with provision for two additional kilns at either end to make a future battery of ten kilns. The ultimate extension of the plant is indicated in Fig. 2. The boiler is fired with producer gas, but the setting provides for a mechanical coal stoker to be installed in the future when ten kilns are put on the two producers.

The kilns (see Figs. 3, 4 and 5) are 10 ft. outside diameter and 75 ft. high above foundations. The brick lining stops at a height of 55 ft., where the gases are drawn off by induced draft through waste gas flues leading to a duplicate system of motor-driven exhaust fans. The top 20 ft. of the kiln is unlined and holds a reserve storage of 45 tons of rock. The rock is charged through an air-tight charging bell at the top of the kiln, which is operated by compressed air. The draft of each kiln is regulated from the floor by a cable leading to a damper on the exhaust flue. Water-cooled valves regulate the flow of gas through tuyères on two opposite sides of each kiln. Constant gas pressure is maintained at the producers by automatic regulators. Air for combustion is drawn from the bottom of the kiln through the hot lime below the fires, preheating the air before meeting the gas for combustion and thoroughly cooling the lime before it discharges from the kiln.

The lime discharges continually through an annular opening at the bottom of the cooling cone onto a slowly revolving circular table. The speed of the table determines the rate of discharge and may be regulated for each kiln independently through the simple shift of a lever. A 24-in. steel pan conveyor receives the continuous discharge of lime from all the kilns and carries it into the lime sorting and packing building.

The coal arriving at the plant is dumped from cars into a track hopper, where it is crushed and elevated by machinery into a 100-ton storage bin over the gas producers. The producers are fed and poked mechanically and also by machinery discharge their ashes at fixed intervals into cars spotted on a depressed railroad track which runs through the kiln building. Soot traps in the main gas flues also empty direct into cars on this track.

TEMPERATURE CONTROL OF KILNS

Each kiln is fitted with two pyrometers, one at the high-temperature zone and one at the top. A cabinet at each kiln contains the indicating instrument with a two-way switch as well as a draft gage permanently connected to the kiln. The high-temperature pyrometer of each kiln is also permanently connected by special cable to graphical recording instruments located in the superintendent's office. Thus the foreman on duty can at all

times note the temperature and draft readings of each kiln and make adjustments to maintain predetermined continuous operating conditions. Also the superintendent may look at the six continuous red ink lines on the chart in his office and know without doubt if the temperature went wrong on any of the kilns during the day or night.

TECHNICAL CONTROL OF KILNS

Here is the time to introduce the plant chemist and his three assistants, perhaps more properly termed chemical engineers. The assistant chemist on duty through an 8-hr. shift will be the cock of the walk. At fixed intervals he makes quick analyses of producer gas and flue gases, notes the kiln temperature and the lime and knows without guesswork what to do. By his

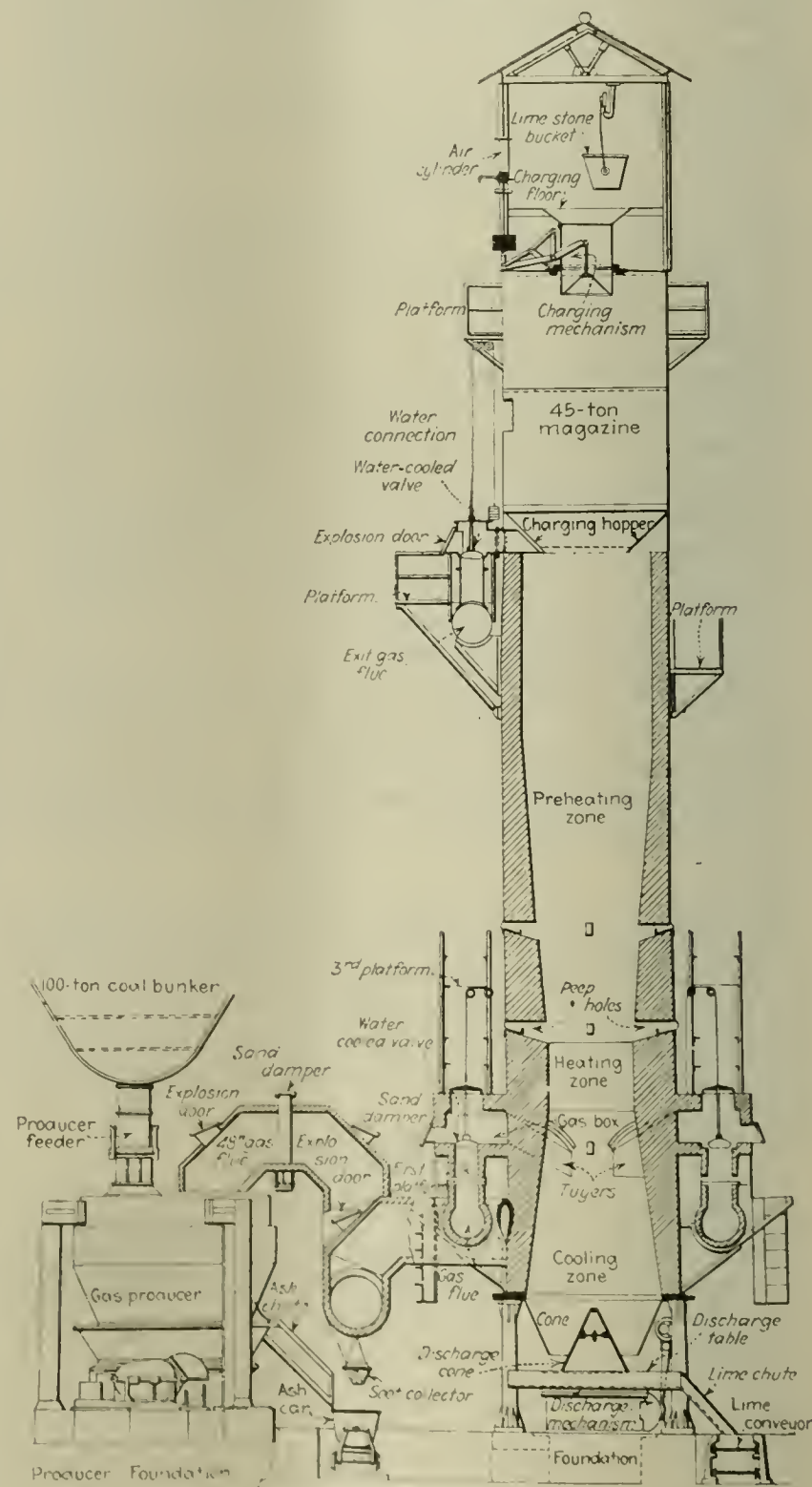


FIG. 3. MOUNT KILN IN SECTION

orders the boss kiln tender closes a gas valve here, opens a draft damper at some other kiln, speeds up the discharge of one kiln or slows down another. Again he may order the producer operator to speed up the coal feed on No. 1 producer or open the air damper on the blower of Producer No. 2. If draft conditions and flue gas analyses persist in acting queerly on Kiln No. 5, we may find the assistant chemist and the kiln boss looking

in the observation ports and finally discovering on the operating platform at the third level that the kiln is hung up on one side and must be barred down immediately.

Here, then, is a kiln plant that can almost talk if it is treated in the manner which it deserves.

Let us suppose there is a periodic shortage of cars, the lime bins are nearly full and we must slow up production. With this plant the temperature may be lowered and the discharge slowed down to operate the whole plant at one-half production. The lime may be somewhat different from that burned at high temperature, but it will be good lime, not like some we used to get when we had to plug the old-fashioned kilns. When



FIG. 4. KILNS UNDER CONSTRUCTION

cars come again in two days the young assistant chemist orders the temperature up, the drafts brought back and then the lime discharge gradually increased until early in the afternoon the plant is again in full swing at maximum production. Perhaps, however, just to romance a little, Kiln No. 1 is still kept at lower temperature because that kiln is filling an order for lime to the toothpaste trade and Dr. Holmes has very definitely determined that lime for this use should be burned under such conditions.

CHARGING KILNS

We will now go outside the kiln building and observe the method of charging rock into the kilns. This feature is perhaps the most unusual part of the new plant design. Consideration has been given to the fact that this plant is located near the residential section of the city and therefore in addition to no smoke there must be as little noise as possible, particularly during the night. Large rock storage provided at the kilns overcomes a temporary breakdown on the railroad system and the kiln-charging mechanism is designed for a ten-kiln plant with capacity to charge 700 tons of rock within an 8-hr. workday. The rock arriving in trainloads at the kilns is dumped from an overhead trestle into a side hill storage extending the full length of the kiln battery and capable of storing in the neighborhood of 3,000 tons. A concrete base and wooden bulkhead with discharge gates for each kiln forms the front wall of this continuous storage bin. Between this bulkhead and the kilns is located a traveling skip hoist (clearly shown in Fig. 5), which acts as a single mechanical charging machine for the entire battery of kilns.

This is a steel structure 105 ft. high, the base measuring 34 x 26 ft., counterweighted with concrete and supported on car wheels which travel on 80-lb. railroad rails. Electric hoisting and haulage engines, with automatic control, are located in a steel house on the base of the structure and power is taken from trolley wires attached to the kiln building. Two skip cars hung in balance travel on separate rails to the top of the structure, where they dump automatically into a common receiving bin discharging into the rock hopper of the kiln. Operation is entirely automatic from push button control. The operator on a platform at the base of the structure opens a rock gate and fills the skip on his right with 3 tons of rock, closes the gate and pushes a button. The skip travels to the top, dumps and stops, bringing the second skip to the bottom opposite the gate on his left. The operator fills the second skip, again pushes the button, and so continues until the kiln is filled. He then takes the handle of a controller and moves the whole structure as a motorman moves his trolley car along the rails, until it comes abreast the next kiln and another pair of gates in the rock bin. One man operating the machine and one man at the top of the kilns will constitute the labor necessary at the kiln plant to put 700 tons of rock into ten kilns. The machine will ordinarily travel the length of the row of kilns filling them in the morning and repeat the operation in the afternoon. The storage magazines in the kilns will keep them fed with rock from that time until the next morning.

The mechanical draft and mechanical operation of these kilns make it possible to burn the smaller sizes of stone from the quarry. This is true particularly with stone which does not fine up in burning, and we expect to be able to burn our Rockland stone in sizes down to as small as 2 in. If practical operation proves it advisable, the stone can be classified at the crusher plant and

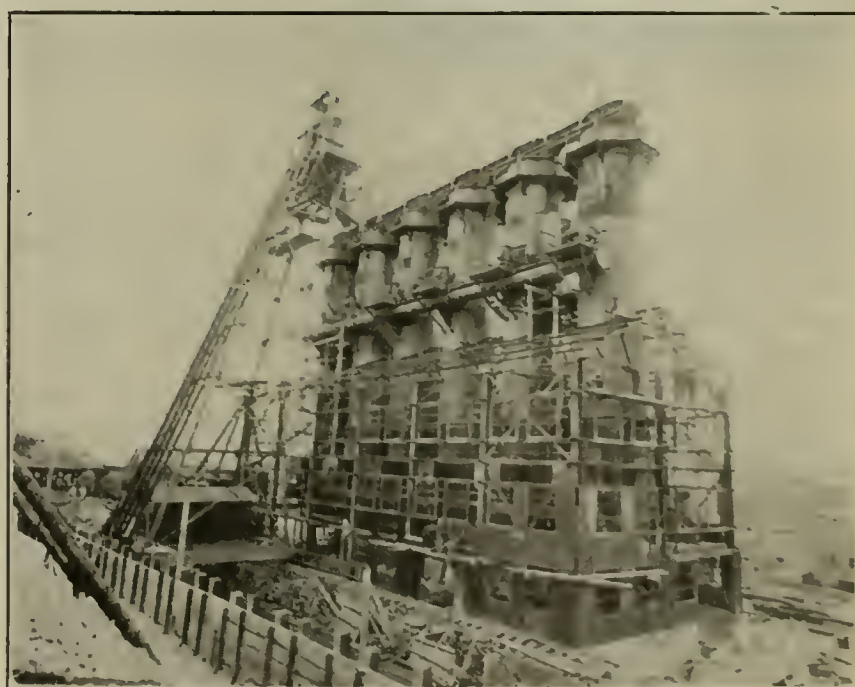


FIG. 5. TRAVELING SKIP HOIST FOR CHARGING KILNS

bin partitions provided at the kiln storage, making it possible to run certain kilns independently on certain sizes or certain quality of stone.

This completes the details of the lime-burning plant and we will now follow the lime on its course into the storage and packing buildings. Here we see how simplified the process may be when lime comes continuously and cool from the kilns instead of by periodic batches drawn hot onto a floor or into bins to cool.

The storage and packing building is a two-story fire-proof steel structure 108 x 60 ft. and adjoining the kiln building. As the lime conveyor enters this building it rises and discharges the lime over a bar grizzly, separating it into fines and lump deposited respectively onto two parallel pan conveyors which are elevated 3 ft. from the floor and act as a sorting table.

Here will be stationed one man on continuous duty for each 8-hr. shift, sorting into selected lump lime and common lime quality. The larger lumps are broken to remove possible core, black lime or possible brickbats are discarded and second quality lump lime is transferred from the selected side to the common lime side of the sorting table.

These conveyors discharge into bucket elevators, which carry the lime to the top of four overhead steel storage bins, each with a capacity of 500 tons. Two of these are shown under construction in Fig. 6. The storage bins are cylindrical, 25 ft. in diameter, with cone top and bottom. Special gates and shaking chutes discharge from the bins through the side of the building,



FIG. 6. LIME-STORAGE BINS

loading directly into box cars with a Pratt box car loader or directly into dump cars to go to the hydrate mill. Each bin has two barrel-filling chutes so designed that the operators may sort the lime as packing. This makes possible a second inspection of all lime filled into barrels.

The second story of the building is for empty barrel storage where one or two men are on duty to receive and pile new barrels from the barrel factory and to pass them into the feeding chutes leading to the lime packers on the lower floor. The lime packer takes each empty barrel from the chute, like taking a paper drinking cup, and fills it to required weight on a specially fixed counterweight scale. Trimmers put in the heads and trim the barrels and stevedores truck it direct into cars which may be spotted on railroad tracks at either side of the building. All lime will be packed only for immediate shipment except when anticipating rush shipments such as 7,000 large barrels to be loaded into a barge cargo for the New York market or 2,000 small barrels for a schooner shipment to Boston.

In such cases it is possible to store on the floor of the packing house 2,500 barrels at a time. Provision is being made to install at a later date a slow moving conveying platform which is level with the floor and follows a continuous rectangular course around the cen-

tral storage area. The man at the chute will fill a barrel with lime and place it on the moving platform, which immediately takes it out of his way. The trimmers will head up the barrels on the platform as it travels along and eventually the finished packages reach the desired place where they may be put directly into a car for shipment or onto the floor for storage.

Excepting the cases of emergency shipment, all packing and shipping will be daytime work six days a week. On Sundays and nights the lime goes into storage, the only men on duty being the eagle-eyed inspectors at the sorting table. There should be no loss from old lime air-slaking in barrels, and with storage capacity in air-tight bins for 2,000 tons of lime, the normal fluctuations of market demand should be discounted, making possible more uniform capacity operation of the kilns. All machinery is electrically driven with power bought at 2c. per kw.-hr. All the lime, coal and rock handling equipment was designed and furnished by the Link Belt Co.

Chemical Industry Power and Fuel Data

BY H. GOODWIN, JR.

THERE has recently been completed and shortly there will be issued the Report of a Superpower System for the Boston to Washington region. This has been made under the U. S. Geological Survey to determine the feasibility and economy of a "superpower" electrical system proposed to supply power to all at reasonable rates and to use waterpower to the fullest extent, by these two means conserving the nation's fuel resources.

The Bureau of the Census has co-operated in this by supplying data from the 1919 Census of Manufactures (soon to be published) prepared in a new and special form to facilitate analysis of the power and fuel requirements of each industry. The accompanying figures for the chemical industry will serve to supplement the general data given on p. 470 of the Sept. 7 issue.

POWER AND FUEL USED BY CHEMICAL INDUSTRIES

Table I gives a summary of the power and fuel used by the chemical and allied industries in the "superpower zone." The divisions are quite clear, but a few of the industries included under "all other chemicals" might be mentioned as follows: Acids, drugs, dyestuffs, fertilizer, ink, oils, paints, salts, soap, etc.

The column headings are self-explanatory except the next to the last column. On account of the great variations in the proportions of anthracite and bituminous coal used in the different industries, it was necessary to reduce them to common terms for comparative purposes. Most of the anthracite used is in the small sizes with low heating value. Further, boiler efficiencies are lower with anthracite than with bituminous coal. So it was determined that 1 long ton of anthracite as used in the industries is equivalent to 1 short ton of bituminous, and conversion was made accordingly to arrive at the total.

The total fuel used by all the manufacturing industries (excludes electric central stations, residences, etc.), in the "zone" was 53,463,513 tons, compared with 11,986,628 for the chemical industries, showing that the latter account for 22 per cent of the total fuel within the zone. But 7,500,000 tons are used in the manu-

TABLE I. SUMMARY OF POWER AND FUEL USED BY CHEMICAL AND ALLIED INDUSTRIES IN SUPERPOWER ZONE

Group	Data from 1919 Census of Manufactures						Fuel Used			
	Establishments			Power Supply Equipment			Coal		Total Equivalent Bituminous, Short Tons	Coke, Short Tons
	Total No.	Using Power No.	Ave. Hp.	Aggre- gate, Hp.	Prime Movers, Hp.	Purchased Power, Hp.	Anthracite, Long Tons	Bituminous, Short Tons		
Coke, excluding gas house coke.....	10	10	3,975	39,746	20,732	19,014	4,077	4,019,770	4,023,436	36,945
Explosives.....	23	23	850	19,522	16,049	3,473	40,157	251,416	287,489	0
Gas, illuminating and heating.....	265	202	540	108,197	103,792	4,405	1,229,102	2,399,383	3,502,208	603,629
Petroleum refining.....	21	21	3,167	66,517	65,020	1,497	1,037,653	388,913	1,322,800	222,156
All other chemicals.....	2,937	1,853	156	289,867	184,965	104,902	993,197	1,956,813	2,850,695	39,840
Total.....	3,256	2,109	248	523,849	390,558	133,291	3,304,186	9,016,295	11,986,628	907,570

facture of coke and gas, being largely converted into other forms of fuel. This leaves 4,500,000 used for power and process purposes in the other chemical industries, and this is 8 per cent of the grand total. So the place of the chemical industries in any fuel program is most important.

The total aggregate power used by all the chemical industries is 523,849 hp., which is approximately 6 per cent of the 9,069,471 hp. used by all the industries in the zone. The average size of the plants in this industry is large, 248 hp., as compared with 119 hp. for all industries.

DISTRIBUTION BY SIZE OF PLANT

Table II shows the special details for the analysis of the general chemical industry ("all other chemicals" of Table I). The same column headings appear here, considerably expanded, but all are self-explanatory. Particular attention is directed to the first two columns, as these show the special and unusual features of the

tabulation. There are four main groups, establishments using: (1) No power, (2) steam power only, (3) purchased electrical power only, (4) all other power. Each of these main groups (except "no power") is subdivided by plant size into three groups, 200 hp. and 500 hp. being the dividing lines. These groups and sub-groups are carried through all the power and fuel items. Thus there is given for each size plant and character of power supply the total power and the fuel associated with its use. The greater fuel economy of the plants purchasing power is evident, but on account of the varied nature of the processes involved conclusions are somewhat limited. However, the large use of live steam in chemical plants with independent development of power would appear to confirm the great economy of purchased power shown.

The Superpower Report will show detail tables for over fifty industries, and the system proposed will provide a convenient reliable source of power for the proper electrification of all industries.

TABLE II. POWER AND FUEL USED BY GENERAL CHEMICAL INDUSTRY

Grouped by character of power supply
Data from 1919 Census of Manufactures

Character of Power Supply	Plant Size Hp.	Power Supply Equipment												Operated Total Hp.	by Electric Motors No.	Purchased Motors Hp.	Energy Other Hp.
		Establishments		Total Hp.	Steam Engines		Steam Turbines		Internal Combustion Engines		Water Wheels						
		No.	Average Hp.		No.	Hp.	No.	Hp.	No.	Hp.	No.	Hp.					
No power		1,084	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Steam Power Only																	
1-200.....	344	63	21,714	21,714	497	21,620	7	94	....	....	....	....	....	....	....	....	....
201-500.....	69	328	22,756	22,756	198	20,656	11	2,100	....	....	....	....	....	....	....	....	....
501 and above.....	53	1,480	78,476	78,476	379	49,196	81	29,280	....	....	....	....	....	....	....	....	....
Sub-total.....	466	262	122,946	122,946	1,074	91,472	99	31,474	....	....	....	....	....	....	....	....	....
Purchased Electric Power Only																	
1-200.....	943	22	20,788	....	....	....	....	....	....	....	....	....	20,788	3,459	20,788	....	....
201-500.....	41	312	12,805	....	....	....	....	....	....	....	....	....	12,805	1,083	12,805	....	....
501 and above.....	19	1,180	22,488	....	....	....	....	....	....	....	....	....	22,488	1,172	22,488	....	....
Sub-total.....	1,003	56	56,081	....	....	....	....	....	....	....	....	....	56,081	5,714	56,081	....	....
All Other Power																	
1-200.....	281	52	14,674	9,194	187	6,225	7	346	134	2,237	16	386	5,480	779	4,869	611	....
201-500.....	49	321	15,733	9,698	121	8,028	2	225	26	615	8	830	6,035	580	6,035	0	....
501 and above.....	54	1,490	80,433	43,127	459	30,824	21	8,697	30	2,017	13	1,589	37,306	2,455	37,306	0	....
Sub-total.....	384	288	110,840	62,019	767	45,077	30	9,268	190	4,869	37	2,805	48,821	3,814	48,210	611	....
Total (power).....	1,853	155	289,867	184,965	1,841	136,549	129	40,742	190	4,869	37	2,805	104,902	9,528	104,291	611	....
Grand total.....	2,937	....	289,867	184,965	1,841	136,549	129	40,742	190	4,869	37	2,805	104,902	9,528	104,291	611	....

Character of Power Supply	Plant Size, Hp.	Electric Motors						Fuel Used			
		Establishments		Total Hp.	Run by Current Generated in Establishment		Anthracite, Long Tons	Bituminous, Short Tons	Total Equivalent Bituminous, Short Tons	Coke, Short Tons	
		No.	Average Hp.		No.	Hp.					
No power.....		1,084						17,747	38,978	54,953	327
Steam Power Only											
1-200.....	344	63	466	4,867	466	4,867	88,393	186,889	266,443	6,072	
201-500.....	69	328	1,192	12,562	1,192	12,562	60,491	190,625	245,666	5,364	
501 and above.....	53	1,480	5,309	63,872	5,309	63,872	304,617	736,776	1,010,933	10,509	
Sub-total.....	466	262	6,967	81,301	6,967	81,301	453,501	1,114,290	1,522,442	21,945	
Purchased Electric Power Only											
1-200.....	943	22	3,459	20,788	....	....	123,834	87,017	198,468	3,597	
201-500.....	401	312	1,083	12,805	....	....	9,016	46,344	55,458	1,648	
501 and above.....	19	1,180	1,172	22,488	....	....	14,180	86,066	98,828	180	
Sub-total.....	1,003	56	5,714	56,081	....	....	147,030	220,427	352,754	5,425	
All Other Power											
1-200.....	281	52	914	5,636	135	767	52,270	69,402	117,345	2,595	
201-500.....	49	321	841	8,577	261	2,542	71,528	67,974	132,351	3,593	
501 and above.....	54	1,490	3,510	49,691	1,055	12,385	250,121	445,742	670,850	5,955	
Sub-total.....	384	288	5,265	63,904	1,451	15,694	374,919	583,118	920,546	12,143	
Total (power).....	1,853	156	17,946	201,286	8,418	96,995	975,450	1,917,835	2,795,742	39,513	
Grand total.....	2,937	...	17,946	201,286	8,418	96,995	993,197	1,956,813	2,850,695	39,840	

Coking Mid-Continent Coals*

DURING the latter part of 1917 the attention of the Department of Commerce was directed to the Roberts coke and gas oven through the efforts made by the American Coal & By-Products Coke Co. to obtain Government support for this enterprise. This matter was referred to the Bureau of Standards for action.

The promoters of this process claimed a number of advantages for this oven which it was said were not embodied in other types. Among these were the following: (1) Ability to coke so-called non-coking coals



FIG. 1. GENERAL VIEW OF THE DOVER BYPRODUCTS CO. PLANT

and produce a satisfactory grade of metallurgical coke from high-volatile mid-continent coals; (2) larger yields of byproducts recovered than from other types of ovens; (3) more substantial construction than possible with existing types of ovens; (4) greater degree of flexibility of heat control than with existing types of ovens; and (5) increased earning power per oven over the other types of ovens.

At this investigation it appeared that the ovens were operating in a fairly satisfactory manner, and although the bureau was not able to verify these claims to any great extent in such a short period, the indications were that the oven could be developed into a commercial success. Therefore the Bureau of Standards reported to the Assistant Secretary of Commerce on Dec. 15 as follows:

"We do not hesitate to recommend favorably this type of oven for further consideration, for we feel sure that benefit to the Government and the people may be expected from the commercial development of the process."

ADVISABILITY OF STUDYING THE COKING OF MID-CONTINENT COALS

In addition to the lack of coke-oven plants, climatic conditions during the winter months of 1917-18 greatly reduced the coal supplies of the existing plants. Transportation of large quantities of coal became increasingly difficult as the severe winter weather continued and as the railroads became choked with materials moving toward the seaboard. This particularly interfered in the maintenance of the production at full capacity on the part of the coke ovens in the central section of the country, since most of the existing plants in this section were dependent for their coal supplies upon so-called Eastern coal. Likewise, with the increase of

traffic more and more coal was used by the railroads and the use of raw coal in boiler plants and in other industrial activities, and in the heating of dwellings, factories, etc., due to the extreme cold and lack of other fuels, depleted the supply of fuels for these ovens.

Accordingly the utilization of much of the undeveloped fuel resources of the country became a question of paramount importance. Attention was forcibly directed to the large quantities of mid-continent coal available, particularly in Indiana and Illinois, but which was not being used. Inasmuch as the steel production of large plants, such as those at Gary, Ind., and Joliet, Ill., was sometimes reduced to 30 per cent through lack of coke, it was evident that some relief was essential.

Since it was claimed for the Roberts oven that it was able to produce a first-class grade of metallurgical coke from these mid-continent coals, it was natural that this type of oven should be looked upon as a proper agency to aid in the forestalling of the crisis which seemed imminent, as well as to assist in the development of these hitherto unused coal resources of the country. Therefore using the bureau's report of Dec. 15, Mr. Roberts endeavored to interest the Government in aiding in the further development of his process and to construct two plants, one at East St. Louis, Ill., and the other at Chicago, Ill., which would use coal from the Illinois (mid-continent) field, thus avoiding the long railroad haul and accelerating the production of coke, toluene, etc.

TEST CONDUCTED BY THE BUREAU

Since the Dec. 15, 1917, report of the bureau was only a recommendation for further consideration, early in March, 1918, the Secretary of Commerce, acting by direct instructions from the President, ordered the bureau to conduct an operating test of the Roberts oven installation at Canal Dover and to associate with itself the Bureau of Mines and the Geological Survey in this work. Accordingly plans were immediately made for



FIG. 2. PUSHER SIDE OF COKE-OVEN BATTERY

such a test, and representatives of the bureau proceeded to Dover on March 18, but found that it was not feasible to begin the test at the time specified owing to a lack of boiler capacity.

The ovens at Dover were operating at this time on Cambridge (Ohio) coal, which, although somewhat similar to the mid-continent coals, bears a striking resemblance to the Eastern coking coals.

It was decided, however, that the test should be conducted with the same coals which would be used at East St. Louis and Chicago; therefore the bureau was

*Extracts from miscellaneous publication 46 of the Bureau of Standards entitled "War Work of the Bureau of Standards." This represents the first public announcement of results of the investigation conducted during 1918.

instructed to assist in obtaining the necessary coal for this test, together with the required boiler parts. This the bureau proceeded to do, but, hindered by numerous construction and transportation delays, it was not until April 26 that the test was officially started.

Quantitative observations of all parts of the plant operation were undertaken and were continued twenty-four hours each day, including Sundays, until May 11. During this test 4,800 tons of Illinois coal was used in the ovens, and all of the usual byproducts, including light oil, ammonia and tar, were recovered and either carefully weighed or measured. The coal used was shipped from the Royalton, Sesser and Orient mines in Franklin Co., Ill., and the Ayrshire mine, Pike Co., Ind. This work was conducted by twenty-two representatives of the Bureau of Standards and nine members of the regular staff of the Bureau of Mines; five consulting engineers were also present at the request of the Bureau of Mines to advise concerning the work.

The bureau's representatives were in charge of the test and responsible for observations of all work done about the coke oven, the byproduct department, the light-oil department and the other accessory operations. Exact records were made of the charging and discharging of the ovens, the quantities of tar, ammonia liquor, light-oil (containing benzene, toluene, etc.), and gas produced during the test period. Samples of all these materials were regularly taken, and analyses or tests of these samples made at appropriate intervals. Likewise, high-temperature measurements at various parts of the battery were carried on during the test.

The Bureau of Mines was responsible for the sampling of the coal at the mines, as it also was for the sampling and analysis the coal as it was unloaded in Dover for the test, and for the sampling, weighing and analysis of the coke produced from the test coal.

Because of mechanical difficulties the regenerators were not used during the test; therefore the ovens were not operated upon pre-heated air, but upon cold air. This precluded the making of any surplus gas, as it was necessary to use all that was obtained in heating the ovens. Difficulty was also experienced in the uniformity of the heating of the oven walls, the ends particularly being noticeably cold.

RESULTS OF TEST AT DOVER

The coke produced from three of the test coals was satisfactory as to quantity and quality, the yield being substantially the same as that obtained from other byproduct ovens. On the basis of dry coal, the yield of dry coke was 69.5 per cent, and the percentage of the sizes of dry coke to total coke were furnace size 75.1, nut 16.8 and breeze 8.1 per cent. A sufficient amount of coke was not produced by the ovens to operate the 500-ton blast furnace adjacent to the plant without the use of additional coke from other sources. Since the furnace was not able to operate at more than three-fourths capacity and since the quantity of coke had to be increased by the addition of outside coke to the extent of from 30 to 50 per cent, it was impossible to determine the real metallurgical value of the coke. However, the opinion of the superintendent of the blast furnace was that when 100 per cent of this Illinois coke was used it would make a satisfactory blast-furnace fuel with the furnace at full capacity.

The yield of toluene both as to quantity and quality was good and amounted to about 0.43 gal. per ton of dry

coal, and the yield of benzene amounted to 1.55 gal. per ton of dry coal. The yield of other byproducts per ton of dry coal were as follows: Ammonium sulphate, 26 lb.; tar, 10.7 gal., and gas about 10,000 cu.ft. However, on the basis of the quantity of these materials actually in the gas, the yields were somewhat higher than those quoted.

CONFERENCE AT PITTSBURGH

After the test at Dover was completed, a conference, which was arranged by the Bureau of Mines, was held in Pittsburgh on May 22, and the observations and results of the tests were discussed at length. Substantial agreement was reached as to what had been demonstrated by the test and what the results signified, and a report of this conference was made to the Secretary of Commerce on May 25, which was signed jointly by the directors of the Bureau of Standards and the Bureau of Mines. The report was as follows:

The Roberts oven produced a satisfactory grade of metallurgical coke from three of the four coals used. These coals have not heretofore been used to make metallurgical coke in commercial quantities. The gross yield was substantially the same as that obtained by other byproduct ovens. The coke was mixed with about an equal amount of coke from other sources, because of the limited supply of Dover coke, and was used in a blast furnace running at about three-fourths capacity. A satisfactory grade of pig iron was produced. The superintendent of the furnace is of the opinion that he could operate satisfactorily with this coke alone and at full capacity.

The quantity and quality of the gas produced were good. After removing the byproducts all the gas was used in the process of coke making. An excess of gas will be available when regenerators are in successful operation.

The quantity of byproducts in the gas was good. The amount of tar, toluene, benzene, etc., in the gas was about the same as is obtained in other ovens when high-volatile coals are used and was greater than the average yields from low-volatile coal, or the usual mixture. The amount of ammonia in the gas was very good.

The construction of the ovens is substantial. The heating system of the Dover plant leaves something to be desired in the matter of uniform heating of walls, and the regenerators for pre-heating air have not been in operative condition. Experience with the plant shows it can be improved in some particulars, and the company believes successful pre-heating of air and uniform heating can be demonstrated in a short time. It was necessary to run the test without regenerators, and as their use is essential for most efficient operation under usual conditions and in normal times, this further demonstration is believed to be necessary.

The Roberts Co. immediately proceeded to carry out the agreed program for a further demonstration, but great mechanical difficulty was experienced in putting the ovens into shape for this purpose, and it was not until the latter part of September that it was possible to complete the work.

FURTHER WORK AT DOVER

Since the War Industries Board had requested that a complete operating test be made with mid-continent coal, 1,500 tons of Orient and 1,000 tons of Ayrshire coal were secured for this test, and arrangements made whereby the coke would be stored until a sufficient amount had been accumulated, so that the blast furnace could run for several days at full capacity on 100 per cent Illinois coke.

The test began on Oct. 12, with the same methods pursued as were carried on in the May test, but before evening on Oct. 14 the representative of the Roberts Co. requested that the demonstration be stopped, since the

quality of the coke and the condition of the plant showed that it was not possible to make a successful demonstration at this time. The bureau acceded to the request, and after conference with the War Industries Board decided that until the company could demonstrate that the Roberts ovens could coke 480 tons of coal per day, the bureau would not consider another test.

CONCLUSIONS

From the investigation of these subjects by the Bureau of Standards the following facts have been demonstrated:

1. At least the majority of the coals from Franklin Co., Ill., and some from Pike Co., Ind., located in the mid-continent field, can be coked in byproduct coke ovens, and a fairly satisfactory grade of metallurgical coke can be produced. Likewise byproducts of reasonable quantity and good quality can be obtained from these coals.

2. The Roberts process at the time of these tests was still in the development stage, but credit should be given to Mr. Roberts for his work in connection with the coking of these coals. His efforts along these lines undoubtedly did much toward arousing interest among other coke-oven operators looking toward the use of mid-continent coals.

3. The bureau believes that at least some of the coal from the mid-continent field should be used in the coke-oven plants in the central section of the country. Even though the coke, on the whole, proved not to be uniformly as satisfactory as that from the so-called coking coals, the advantage due to the elimination from the coke-oven plants in the Eastern section will go far in overcoming any lack of quality of the coke. There can be no doubt that where domestic coke is wanted these coals can fulfill all requirements. Such uses will materially aid in the proper development of the fuel resources of the country.

Turret Furnace for Heat-Treating

A TURRET furnace with rotating hearth, to be used for the heat-treatment of iron and steel, has recently been installed at the plant of the Nash Motors Co., Kenosha, Wis., by the George J. Hagan Co., of Pittsburgh. Fig. 1 shows a view of the interior of the hearth. It may be noted that the stationary walls and arch are formed of specially shaped refractories, the clearance space between moving and stationary parts being closed underneath by means of a continuous sand seal. Fig. 2 shows an exterior view of the furnace, incased in sheet iron, properly reinforced. The rotating hearth itself is laid on a steel structure rotating on a series of twenty roller bearings. Six different speeds of rotation are available, from one complete rotation in thirty minutes to one in twenty-five minutes. Charging and discharging is done through adjacent doors, operated with compressed air. As shown in Fig. 1, a baffle wall extends across the heating chamber between the two doors to prevent the heated metal being chilled when charging cold material.

The first two-thirds of the furnace is maintained at a somewhat higher temperature than the remaining portion, this latter portion being a finishing or "soaking" zone.

All heating elements are separately connected to a General Electric control board, the temperature being



FIG. 1. INTERIOR OF THE HEARTH

automatically controlled by a two-point Leeds & Northrup potentiometer.

At night the current is switched off and the furnace loaded with iron or steel castings for annealing. In the morning the temperature will be about 1,000 deg. F., 40 minutes being required to reheat the furnace back to the working temperature—in the neighborhood of 1,525 deg. F. The furnace itself is 19 ft. outside diameter by 7 ft. high, while the diameter of rotating hearth is 15 ft., height 2 ft., and width 5 ft. It treats about 3,000 lb. per hour.

Some of the advantages claimed for this type of furnace are, first, a uniform rate of heat absorption, eliminating any distortion of long parts; second, an assurance that no metal will become overheated; third, practical elimination of scale, resulting in very much decreased time and acid consumption in pickling; fourth, the labor involved has been cut in half, from six to three men. The most important factor, however, is that the man in charge of the equipment may be supplied with a heat-treating ticket on which is shown the kind and number of pieces to be treated, the drawing temperature and speed of rotation of furnace hearth, and it is then an assured fact that these particular pieces will receive the particular treatment intended.

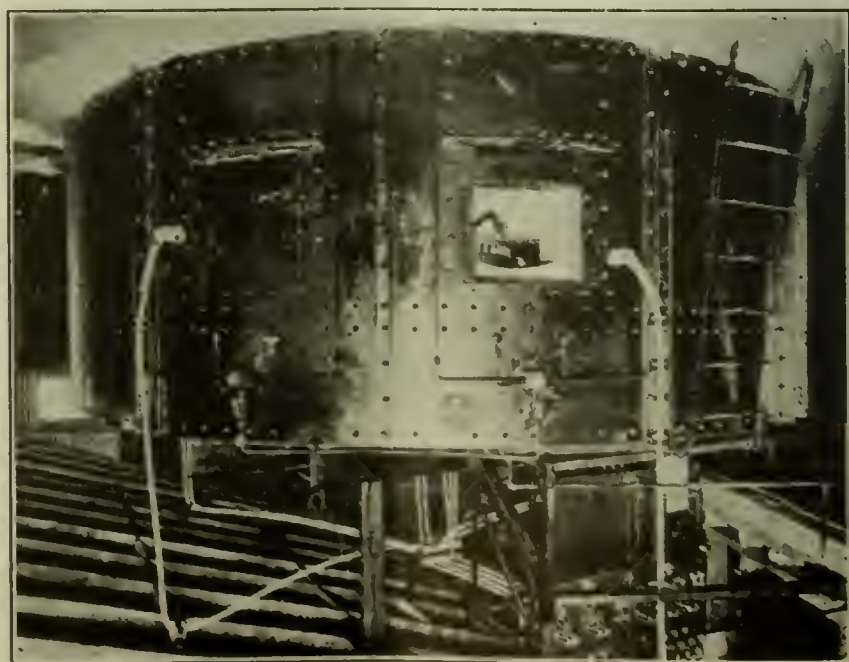


FIG. 2. EXTERIOR VIEW OF THE FURNACE

General Purpose Crawling Tractor Crane

THE Type BC "Industrial" crawling tractor crane, illustrated in the accompanying photograph, manufactured by the Industrial Works, Bay City, Mich., has been developed to meet the need for a full-revolving tractor crane which can be operated independently of rails. The crane is built in two types—the Type BC, with a capacity of 20,000 lb. at 12 ft. radius, is equipped with continuous crawling tractor belts; the Type BT, with a capacity of 18,000 lb. at 10 ft. radius, is equipped with four broad-gage tractor wheels.

The maximum utilization of yard storage space is realized with the use of these cranes, because their field of usefulness is not limited by railroad tracks, as in the case with the railroad crane. Having exceptionally



GENERAL PURPOSE CRAWLING TRACTOR CRANE

large capacities in ordinary lifting, they prove a valuable adjunct in those many erection jobs which are inaccessible to the railroad crane.

They can be equipped to handle a hook and block, grab bucket, drag scraper bucket, wood grapple, electric lifting magnet, shovel dipper and pile driver leads with drop hammer.

Operation is by means of an internal-combustion engine which has the advantages of being always ready for immediate use. When not in operation no fuel is consumed and it is not necessary, as often with a steam-operated machine, to have a licensed engineer as operator. Up to the capacity of the motor any combination of clewing, hoisting the load and varying the radius may be made.

The crane is equipped with a 30-ft. beam made up of two channels strongly latticed with angles and tie plates.

The steering of the crawling tractor crane while propelling is accurately controlled by the operator from his position in the revolving upper-works, by manipulation of the friction clutches and brakes controlling the motion of each tractor belt. By means of these clutches and brakes either tractor belt can be readily and instantly disconnected from the motor while the other belt continues traveling at the normal rate of speed.

The disconnected tractor belt can be held stationary by applying the brake, can be allowed to coast with the brake and clutch both disengaged, or the clutch can be allowed to slip, thus allowing operator to turn as sharp or as wide a corner as he may select. All the clutch-, brake- and lever-mechanism for steering is located in the revolving upper-works, where it is simpler and much more accessible than when a portion or all of this mechanism is located on the car-body.

Book Reviews

INDIA RUBBER GOODS MANUFACTURE. By "Factory Manager." London: Maclaren & Sons, Shoe Lane. Price \$7.75.

It is a pleasure to review the work of one who has honestly tried to set down his own experience and to describe in detail his best methods. This book is evidently the work of one who has actually been a factory manager. He knows how things are made. He is to be commended for producing such a detailed description of rubber goods manufacturing as he knew it. The work is quite voluminous, 484 pages, and discusses in more or less detail almost every phase of rubber goods manufacture.

However, it will be at once apparent to the American reader that it does not properly describe American practice. The reviewer is not familiar with English methods and cannot say as to how well they are covered. In so far as our methods are concerned the book covers those in vogue about five years ago. Except for druggists' sundries and mechanical goods the formulas given have been out of use for many years. Organic accelerators were unknown in the author's time. Black was used for coloring purposes only. Today most formulas of merit contain one or the other or both.

But do not let this worry the reader. The book contains many useful and valuable pointers in regard to the factory handling of various products. In a few lines the old methods are still followed.

Perhaps the only criticism in addition to being somewhat antiquated is that items of small importance, such as cash mats, are discussed to almost the same length as pneumatic tires, a subject of infinitely greater value.

From the mechanical goods and druggists' sundries standpoint the work is well done. Sizes and specifications are of course not applicable to American practice, but they give the reader an approximate idea of construction.

ANDREW H. KING.

Synopsis of Recent Chemical & Metallurgical Literature

Properties of Molybdenum Steels.—A paper giving tests on heat-treated Mo and Cr:Mo steels was presented by H. J. French before the recent meeting of the American Society for Steel Treating. The important features determined may be summarized as follows:

1. Steel containing 0.20 per cent carbon and 1 per cent molybdenum.

1. For each maximum temperature of heating there is a critical rate of cooling which will lower A_{r_1} . The higher the initial temperature the slower is the rate of cooling required to produce the lowered transformation, but by whatever combination this is produced the position of the "low point" is fixed within a narrow temperature range: about 525 deg. C. (975 deg. F.). Its suppression can readily be brought about, however, by increasing the rate of cooling.

2. A high temperature transformation is observed slightly above and almost merging with A_{r_1} when the steel is cooled from temperatures at or above 960 deg. C. (1,760 deg. F.) at a rate of temperature change approximating 0.15 deg. C. (0.27 deg. F.) per second, but is not observed when cooling at a much faster rate.

3. A_{r_2} is fixed at about 760 deg. C. (1,400 deg. F.) independent of the maximum temperature of heating or rate at which the steel is cooled.

4. The most suitable temperature from which to harden the steel is in the neighborhood of 910 deg. C. (1,670 deg. F.). Free ferrite is found after quenching from 830 deg. C. (1,525 deg. F.), but the observed changes in mechani-

cal properties with rise in quenching temperature within this range cannot be explained by known changes in carbon or iron, by differences in the rate at which the steel passes through the critical ranges resulting from changes in initial temperature of cooling, by unsatisfactory hardening or by the lowered A_{r1} transformation (except as related to a molybdenum change), for they are opposite to the changes found in plain carbon steel under similar conditions of treatment.

5. For the production of definite tensile strength, water-quenching is to be preferred on account of the higher proportional limit, ductility and impact values obtained, and conversely better tensile properties are obtained for a given impact resistance.

6. Raising the quenching temperature from 910 deg. C. (1,670 deg. F.) to 980 deg. C. (1,795 deg. F.) does not materially alter the mechanical properties of the steel when subsequently tempered at a relatively high temperature 540 deg. C. (1,000 deg. F.).

II. Steel containing 0.27 per cent carbon, 0.9 per cent chromium and 0.5 per cent molybdenum.

7. The A_{r1} transformation is first split and lowered when cooling from 960 to 1,000 deg. C. (1,760 to 1,830 deg. F.) at about 0.15 deg. C. (0.27 deg. F.) per second, the "low" point being observed at about 480 deg. C. (895 deg. F.). In water-quenching from the highest temperature, a lower hardness is obtained than when similarly cooling from 960 deg. C. (1,760 deg. F.). In this respect the chromium:molybdenum steel behaves similarly to steel containing 0.20 per cent carbon and 1 per cent molybdenum except that the observed changes are produced from higher temperatures.

8. In normalizing the chromium:molybdenum steel, a low limit of proportionality and impact resistance is obtained when using temperatures between about 780 to 845 deg. C. (1,450 to 1,550 deg. F.).

9. The fact that no material changes in tensile or impact properties are produced by oil-quenching the chromium:molybdenum steel from a wide range of temperatures when subsequently tempered at 540 deg. C. (1,000 deg. F.) has been confirmed. To produce high impact values in the hardened steel, a tempering temperature in the neighborhood of 650 deg. C. (1,200 deg. F.) is required.

Effects of Surface Scratches.—An important paper on this subject was read before the recent Engineering Conference of the British Institution of Civil Engineers by Prof. E. G. Coker. He noted that the importance of having a smooth surface in metals exposed to a high stress has been recognized by many engineers who impart a high degree of finish to their work, especially in cases where an intense stress varies cyclically, as in the moving parts of high-speed machinery. The increased strength and extension due to a high degree of polish in a tension test-piece has also been frequently noted, and the elimination of scratches appears to be of importance in many other cases.

It seems likely that the scratches produced by ordinary machining operations may be considered as minute notches in the surface, probably with plane or curved sides inclined at a considerable angle and rounded off at the bottom of the notch by curves with radii much greater than the average size of the unit of crystalline structure of the metal. If a scratch is made in the edge of a plate in tension, it may be shown¹ that a mean tension of one-third the yield point or even less will cause a permanent set at the scratch, while, if the load is alternating, these indentations gradually penetrate farther and farther into the material, apparently along planes inclined at 45 deg. to the line of pull in ductile bodies—that is, along the planes of maximum shear stress.

In a group of scratches sufficiently close to affect one another, the combined result is, naturally, still more noticeable, and the failure of a material under a comparatively moderate mean stress, due to surface scratches, is not difficult to understand, especially if the loading is of an alternating kind.

The form of the scratch is all-important. A scratch pro-

ducing a semi-circular groove in the material may raise the stress to about double the average stress, while a groove with straight sides at 45 deg. and a radius at the apex of one-eighth of the depth gives an increase of rather less than five times the mean stress. Increased sharpness of curvature at the bottom of the notch produces still greater local stress, and this latter may easily cause a fine crack to develop and produce failure owing to its rapid extension.

Surface of Liquid Steel.—Cosmo Johns read a short paper before the British Association, Sept. 13, 1921, on why liquid steel at 1,600 deg. C. was able to preserve its surface unoxidized. The author pointed out, as reported in *Iron and Coal Trades Review*, that this was especially noticeable in steel as it flowed from the furnace into the ladle. He had previously suggested that the obvious explanation was that the vapor of the steel formed a protecting medium, but there was some objection to this theory. He had noticed that sparks were given off the metal when it was being poured, and also that floating above the stream was a greenish fume. He found this to consist of minute spheres which on analysis proved to be all magnetic oxide of iron. It was not easy to get pure samples of this fume because of the impurities in the surrounding atmosphere, but he did succeed in getting some samples and made observations on a complex alloy containing other metals than iron. He found, as he had expected, that if the analysis of this oxidized material was calculated to the metallic elements from which it was formed, the result differed in no marked degree from the original steel as regards chemical composition.

Recent Chemical & Metallurgical Patents

British Patents

For complete specifications of any British patent apply to the Superintendent, British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Cellulose Ethers.—Alkyl ethers of cellulose, more particularly ethyl and methyl ethers, are prepared by treating cellulose or its near conversion products not soluble in alkali, such as mercerized cellulose, with a suitable alkylating agent in the presence of alkali, under such conditions that (1) the quantity of water present or added, disregarding water formed during the process, is at no stage of the etherification greater than about four times the weight of cellulose and preferably not in greater amount than about one-half and one-and-a-half times this weight, or it may even be as low as the natural humidity content of the cellulose, and (2) the total quantity of alkali is at least equal to and preferably exceeds by 3-19 or more times the weight of water present or added. The ethers so obtained are characterized by their insolubility in hot or cold water and by the fact that they are not precipitated from alcoholic solution by alcoholic solutions of alkali; and the same properties hold in the case of the intermediately formed partly etherified ethers. The requisite quantities of water and alkali are added prior to the alkylating process, or partly or entirely during the process, either continuously or by stages; and the alkylating agent is introduced all at once or continuously or in stages, but preferably in such a manner that an excess of alkali is always present. For making highly ethylated ethers it is necessary to employ relatively to one molecular equivalent of cellulose, $C_6H_{10}O_5$, 8-20 molecules of alkali and 5.9 molecules of diethyl sulphate. The temperature of the reaction varies according to the alkylating agent selected, etc.; in the case of diethyl sulphate, the temperature may be between room temperature or even lower, and 88 deg. C., but preferably below 55 deg. C.; with dimethyl sulphate, it is preferred to keep the temperature at 0 deg. C., or even lower; and in the case of alkyl halides the temperature is preferably raised to some point between 50 and 80 deg. C.

¹E. G. Coker, "Photo-elastic Measurements of the Stress Distribution in Tension Members Used in the Testing of Materials," *Min. Proc. Inst., C. E.*, 1921.

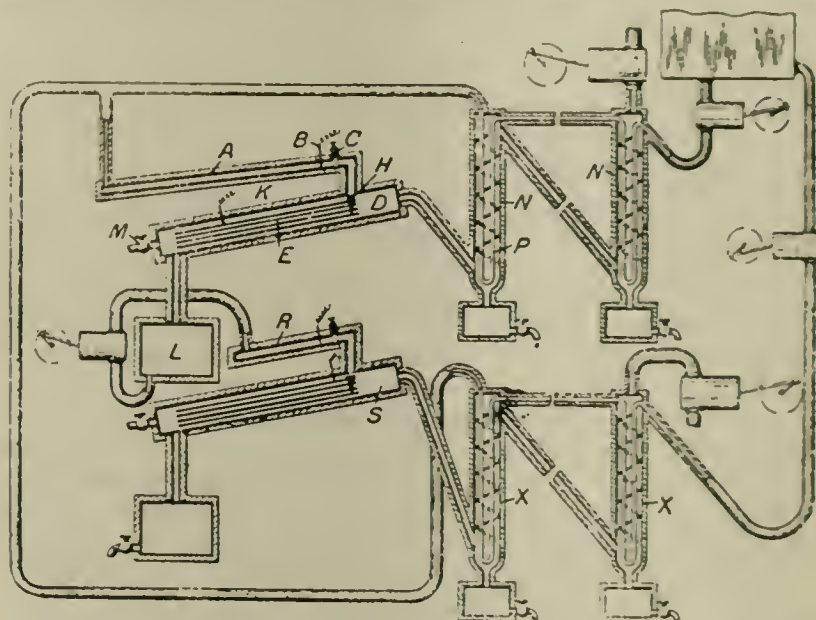
The reaction is accelerated by the addition of contact substances such as powdered copper or copper salts or hydroxides. It is advantageous to carry out in the reaction in the presence of liquid diluents such as benzene, which do not themselves suffer etherification, since such addition facilitates mixing and renders the reaction more uniform. In examples, one molecular equivalent of cellulose, etc., is kneaded with four molecules of caustic soda and an equal weight of water, and 1-2 molecules of diethyl sulphate are added while maintaining the temperature at 40-55 deg. C. or between ordinary temperature and 30 deg. C., with subsequent additions of 4-6 molecules of powdered caustic soda and 2-3 molecules of diethyl sulphate, and 4-6 molecules of caustic soda and 2-2½ molecules of diethyl sulphate, the products being eventually separated and washed with water; one molecular equivalent of cellulose, etc., is impregnated with an equal weight of water, kneaded with four molecules of caustic soda and 1½ molecules of diethyl sulphate added while keeping the mixture at a temperature of 40 deg. C., with subsequent additions at intervals of caustic soda and diethyl sulphate until a total of 12-18 molecules of the former and 6-8½ molecules of the latter have been added; one molecular equivalent of cellulose, etc., is impregnated with 20 per cent caustic soda and after standing is squeezed or centrifuged until the mass contains an amount of water equal to the weight of cellulose, whereupon 4½ molecules of caustic soda are added and the process continued as in the first example above; one molecular equivalent of cellulose, etc., is treated with a 50 per cent solution of 4 molecules of caustic soda, the mass thoroughly kneaded, then two molecules of dimethyl sulphate are added while maintaining the temperature at 5 to 10 deg. C., and subsequently 4-6 molecules of caustic soda and 2-3 molecules of dimethyl sulphate, and 4-8 molecules of caustic soda and 2-3½ molecules of dimethyl sulphate; and in these examples the diethyl and dimethyl sulphate may be introduced as a solution in an equal weight of benzene. By employing mixtures of different alkylating agents, "mixed" ethers may be obtained; or the cellulose may be partly etherified while employing one or more alkylating agents and then further etherified with another or others. The ethers obtained according to the above process may be employed in the manufacture of films, artificial filaments, celluloid-like masses, electric insulating materials, varnishes, dopes and coating materials. Aralkyl ethers, such as benzyl cellulose, and mixed ethers can be prepared in a similar manner. (Br. Pats. 164,374, 164,375 and 164,377. H. Dreyfus, London. July 27, 1921.)

Bornyl Esters; Borneol; Isoborneol.—Esters are prepared from turpentine and an acid, such as formic, acetic, butyric, sebacic, benzoic, salicylic, but preferably oxalic acid with the aid of a liquid "catalyst" such as methylene chloride, chloroform, carbon tetra-chloride, ethylene chloride or bromide, tetra-chlorethane or trichlorethylene; benzene and acetone are less effective. The "catalyst," turpentine, and anhydrous oxalic acid may be heated together at 115 to 125 deg. C., sufficient of the "catalyst" being used to bring the boiling point of the mixture to the required temperature. The product is mainly the neutral bornyl oxalate, from which excess of turpentine and the "catalyst" may be distilled first in vacuum and then in steam, and may be re-used. The ester is saponified by soda, and the solid alcohol oxidized to camphor by known methods. With sebacic acid, an acid ester is obtained. (Br. Pat. 164,357; not yet accepted. L. Darrasse and E. Darrasse of Paris and L. Dupont of Vincennes. July 27, 1921.)

Celluloid From Cellulose Ethers.—In the manufacture of solutions, films, artificial filaments, celluloid-like masses, electric insulating materials, varnishes, coating and other compositions, preparations and articles having as a basis the cellulose ethers described in specifications 164,374, 164,375 and 164,377, the alkylated sulphonamide derivatives or preparations described in specifications 132,283 133,353 and 154,334 are employed as high boiling point solvents or plastic-inducing agents; the cellulose ethers, esters used alone or mixed with other ethers, esters or derivatives of cellulose, and in conjunction with the sulphonamides there may be used other high boiling-point solvents such as triacetin, and lower boiling-point solvents or liquids, and other additions such as triphenyl or tricresyl phosphate, castor oil,

aliphatic derivatives of urea, coloring matters, filling materials, etc. In an example, a celluloid is prepared from an ether obtained according to the examples given in specification 164,374, using, as a high boiling-point solvent, benzene mono-methyl sulphonamide, toluene-o-monoethyl sulphonamide or mixtures of isomeric xylene mono-methyl or mono-ethyl sulphonamides, in conjunction with triphenyl or tricresyl phosphate, and alcohol or alcohol-benzene; the hardness of the product is adjusted by increasing and decreasing simultaneously the proportions of sulphonamide derivative and triphenyl or tricresyl phosphate. In another example describing a solution for use in the manufacture of films or as a varnish, the ether is dissolved in alcohol or alcohol-benzene, and the sulphonamide derivative added with or without triphenyl or tricresyl phosphate. (Br. Pat. 164,384, 164,385 and 164,386. H. Dreyfus, London. July 27, 1921.)

Forming Asphalt From Petroleum Residue.—The residue from the distillation of petroleum oils, distillates and tars is treated to form asphalt by heating it under pressure to 250-300 deg. C. and distributing it over inclined plates in a chamber heated to the same temperature, though which a current of air is passed. The apparatus is combined with



apparatus for distilling oils, etc., described in specification 163,363. (See CHEM. & MET. ENG., p. 669, 1921.) The oil, heated by passage through the tubes *P* in condensers *N* and through a tube *A* heated by an electric coil is distributed by funnels *H* onto inclined plates *E* in a chamber *D* also heated by a surrounding electric coil. The vapors evolved are withdrawn by a pump and condensed fractionally in a series of condensers *N*. The unevaporated residue passes to a vessel *L* and is pumped through a second heating tube *R*, and distributed over inclined plates in a heated chamber *S* to which air is admitted through a cock *U*. Vapors evolved in the chamber *S* are withdrawn through a series of condensers *X* cooled by passage of crude oil through pipes contained within them. In a modified apparatus, the heating tubes and evaporations are heated by gas or oil fuel burners, the residue from the first evaporator is passed through the cooling coils of the condensers connected to the asphalt chamber, and is passed through an intermediate heater and evaporator before being treated to form asphalt. (Br. Pat. 163,656. V. C. Illing and J. Kelly, both of London; July 13, 1921.)

Purifying Illuminating Gas.—A process for the purification of illuminating gas consists in first treating the gas in a washer with a liquid consisting of a solution of a ferrous salt and milk of lime and then with the solid residue filtered from the above-mentioned liquid after this residue has been exposed to the air and mixed with sawdust. In the first stage, the cyanogen in the gas forms prussiate of lime and remains in solution and part of the sulphuretted hydrogen forms iron sulphide which remains in the residue. In the second stage the residue when exposed to air forms a purifying material of ferric hydrate mixed with sulphur, sulphate of lime, carbonate of lime, etc., which removes the remainder of the sulphuretted hydrogen. (Br. Pat. 164,310; not yet accepted. Société du Gaz de Paris. July, 27, 1921.)

Current Events

in the Chemical and Metallurgical Industries

American Engineering Council

Unanimous election of M. E. Cooley, dean of the College of Engineering and Architecture of the University of Michigan, to be president of the American Engineering Council of the Federated American Engineering Societies was announced at a meeting of the executive board in Washington, Sept. 30. Dean Cooley's connection with the University of Michigan dates back to 1881; his influence on engineering practice in the United States therefore needs no emphasis. Among his many honors, the most recent was presidency of the American Society of Mechanical Engineers.

Resolutions were adopted expressing the opinion that the Lampert bill to remedy conditions in the Patent Office "provides the least increases in force and salaries which can possibly stop retrogression . . . and enable it to recover an efficient condition." Opposition was also voiced to the Stanley bill, a bill which requires that alien-owned patents must be worked in this country within two years else outsiders may obtain licenses to develop them.

In view of the unemployment among engineers, the need of a well-financed unified employment service and the inadequate contributions which the constituent societies can make toward such activities, a committee was appointed to work out a plan whereby interested organizations may co-operate in forming a "paid employment service, but in reduced fees to members of supporting organizations."

Government contracts were discussed at length, and the board made the following recommendations: "That Government work be normally carried out through unit price, or lump sum contracts, or by the purchase and hire method. Where none of the above methods are applicable to conditions, that the cost-plus method be used, in which the contractor is refunded the actual cost of the work, plus an accorded compensation which increases if the work is done below the estimated cost of the work and decreases if the work costs more than estimated, but never sinks below zero"; that an effort be made to standardize Government contracts and that partial payments be promptly made to contractors without the use of intermediaries.

In view of the business depression, it was decided not to hold an engineering assembly next January. The committee in charge of the arrangements was converted into a program and entertainment committee for the annual meeting of the council to be held in Washington in January.

The applications for membership of the Vermont Engineers Society and the Associated Engineers of Spokane were approved.

To Make Steel From British Columbia Magnetite

The Vancouver Magnetite Steel Smelting Co. has made arrangements to erect a 50-ton electric smelter at Nanaimo, on Vancouver Island, B. C., provided satisfactory arrangements can be made with the city. The city has appointed a committee to confer with Messrs. Fraser and Lewis of the company, and it is probable that a satisfactory understanding will be reached.

The company claims to have spent \$67,000 in experimental work and to have produced a high-grade steel from British Columbia magnetite. It will develop its own water power from the Nanaimo River; it claims to have \$5,000,000 of British capital behind it. The company is not purposing to use any new process, but those that have already been tried and proved in Norway and Sweden.

Increased Production of Alsatian Potash

It is reported that the Alsatian potash mines will double their output during October and that they will probably produced during 1922 10,000 tons of potassium chloride per month. Large quantities will be available for export.

Unemployment Decreases in Chemical Industry

An increase in the number of men employed in the chemical industry was shown during September, according to the figures of the U. S. Employment Service. The increase on Sept. 30 as compared with Aug. 31 was 2.6 per cent.

Chemical Tonnage on Railroads

Chemicals and explosives contributed 1,260,098 tons to the freight tonnage on class 1 railroads during the second quarter of 1921. Fertilizers to the extent of 1,800,407 tons were handled during the second quarter. The amount of vegetable oils moved was 262,808 tons. Pulpwood to the extent of 1,196,094 tons was shipped during that quarter. The figures are those of the Interstate Commerce Commission.

Metric System Bill Hearing

Hearings on Senator Ladd's metric system bill were to have begun Oct. 11. Among the witnesses who probably will appear in favor of the bill are Harvey W. Wiley, former chief of the Bureau of Chemistry; S. L. Hilton, president, American Pharmaceutical Association; Dr. Charles L. Parsons, secretary, American Chemical Society; William J. Schieffelin, a drug manufacturer of New York; Theodore H. Miller, works manager of the De Laval Separator Co., and Howard Richards, Jr., secretary, American Metric Association, of New York.

The executive board of American Engineering Council, which met in Washington Sept. 3, decided to take no part in the metric system controversy.

Iron and Steel Electrical Engineers Chicago Meeting

During the week of Sept. 19 the Association of Iron and Steel Electrical Engineers held its fifteenth annual convention at the Hotel La Salle, Chicago. Educational features included exhibits of representative manufacturers of electrical steel mill apparatus and inspection trips to plants in Chicago.

The fuel economy program was conducted under the auspices of the new section on Combustion Engineering. Fuel papers presented included "Fuel Requirements in Steel Mills," by S. E. Leahy; "Control of Boiler Operation," by W. S. Flannigan; "General Use of Oxygen in the Steel Mill Industry," by E. A. W. Jefferies, and "Waste Heat Utilization for Steam Generation," by G. R. McDermott.

The paper on "Fuel Requirements in Steel Mills" dealt with the various forms of fuels and touched upon the economic considerations such as transportation, storage and distribution, outlining some of the peculiar requirements and reasons why it is desirable to use various fuels in various steel mill operations. In the discussion on this paper attention was called to the desirability of taking occasional heat balances to assist in planning improvements and in properly proportioning the blast-furnace gases between the different services. Coke breeze is being used in increasing amounts in smaller plants, with an efficiency of 60 to 65 per cent. In especially designed waste heat boiler 27 tubes wide and 24 tubes high, efficiencies as high as 80 per cent have been secured as compared with the usual 70 per cent. Coke-oven gas has been burned with good results in open-hearth furnaces, but greater capacities are obtainable with tar.

In Mr. Jefferies' paper, on the "Influence of Cheap Oxygen on Economy of Fuel and Time," it was shown that the problem of cheap oxygen has been solved. When made at the rate of 4,000 cu.ft. per minute it can be produced for 8c.

per 1,000 cu.ft., as compared to the present rate of \$10 to \$15 per 1,000 cu.ft. when bought in the usual storage cylinder. In general, the process consists of liquefying the air by compressing and subsequent expansion to distill off the nitrogen in the liquid air columns.

In the steel industry and in other fields, the availability of cheap oxygen constitutes prospects of the greatest conceivable importance. The author intimated that fuel gas of 400 B.t.u. could be produced for 8c. per 1,000 cu.ft. The gas contained about 60 per cent carbon monoxide, which has a higher flame temperature than any other gas in general use, making it more desirable than coke-oven or natural gas.

Uses of oxygen in the open-hearth furnace, in the blast furnace and many miscellaneous places such as cutting metal welding and stimulating combustion were briefly touched upon by the author. The discussion centered upon combustion temperatures that would prevail when enriching in oxygen and the impossibility of present refractories withstanding such temperatures. If used in a power plant, it would necessitate the redesign of boilers and furnaces.

G. R. McDermott reviewed what has been accomplished in the utilization of waste gases for steam generation and pointed out sources of waste heat which may be available, referring in particular to open-hearth furnaces, soaking dips, reheating furnaces, malleable melting furnaces, forge furnaces and gas engines using blast-furnace gas.

To utilize the source of waste heat from blast-furnace gas the author has designed a high-mass velocity, fire-tube single-pass waste heat boiler to take the exhaust at a temperature of 850 deg. F. from 3,300-kw. gas-engine units. Based on an average load of 3,000 kw., it was estimated that the boiler would generate 2.6 lb. net of steam per kw.-hr. at the switchboard. Heat and absorption phenomena in direct-fired and waste-heat boilers were compared and the relative merits of water-tube and fire-tube boilers as absorbers of waste heat, the author favoring the last-mentioned type.

The officers elected for the coming year were: President, W. S. Hall, electrical engineer, the Illinois Steel Co.; first vice-president, R. B. Gerhardt, electrical engineer, the Bethlehem Steel Co.; second vice-president, L. F. Gailbraith, electrical engineer, the West Penn Steel Co.; treasurer, James Parrington, electrical superintendent, LaBelle Iron Works; secretary, J. F. Kelly, Pittsburgh, Pa.

The headquarters of the association are 1007 Empire Building, Pittsburgh, Pa.

Stainless Iron

According to the *Ironmonger* (London), a new stainless steel has been put on the market by three British firms in bars and sheets. It is derived from the well-known stainless steel, and differs from the latter principally in that it contains carbon less than 0.10 per cent. Carbon-free chromium or ferrochromium is thus required, either of which are expensive substances. Therefore the new metal is more expensive than brass, but it is easier to keep clean. This new low carbon chromium-iron alloy is distinctly softer than stainless steel and is thus suited to various manipulations: a wide range of uses in forging, pressing and stamping. Already success is reported in producing automobile wheel disks, hoods, bodies and other products subject to corrosion or tarnishing, thus eliminating painting and varnishing.

Reduced Duty for Earthenware Embossed in Mold

The Board of United States General Appraisers, New York, has handed down a ruling sustaining a number of protests against the assessment of duty at 40 per cent on imported earthenware embossed in the mold. The assessment at such rate under the provisions of paragraph 79 of the act of 1913 covers "decorated earthenware." The importers' claim, sustained by the board, covers an assessment of 35 per cent under the same paragraph, for "earthenware, not decorated."

Lecture Course in Burning of Clay Products

A course of twenty-five lectures on the burning of clay wares, firing of boilers in the pottery, firing efficiency and other phases of fuel combustion is being arranged at the School of Industrial Arts, Trenton, N. J.

Central Steel Co. Merger

Steel mill properties with combined assets in excess of \$20,000,000 have been brought together in the merger just completed of the Central Steel Co., the National Pressed Steel Co. and the Massillon Rolling Mill Co., all of Massillon, Ohio.

The new corporation, it is announced, takes the name of the Central Steel Co. and the following officers have been elected: Chairman of the board of directors and president, R. E. Bebb; first vice-president, F. J. Griffiths; second vice-president, C. C. Chase; third vice-president, H. M. Naugle; secretary and treasurer, C. E. Stuart.

The merger of the three companies brings the Central Steel Co. into prominent position among the largest steel producing corporations of the country, with complete modern equipment and facilities for producing all kinds of commercial alloy steels, hot- and cold-rolled sheets, hot-rolled strip steel and light structural steel sections in a combined annual output of 450,000 to 475,000 tons of finished material.

The Central Steel Co. brought to the merger ten open-hearth furnaces of 65 to 75 tons capacity, 34-in. blooming mill, 24-in., 18-in. and 12-in. finishing mills, 24-in. sheet bar mill, cold-drawing and heat-treating departments and a record of being the largest producer of strictly alloy steels in United States. The Central company annual tonnage runs from 300,000 to 325,000 tons.

The National Pressed Steel Co., which will function in the future as a division of the Central Steel Co., is a producer of hot-rolled strips and plates and finished structural steel joist sections with a present capacity of approximately 100,000 tons annually. Equipment is all modern and includes slab furnaces, annealing furnaces, complete pickling and finishing facilities, electro-driven hot-rolling mill with gage range from No. 15 to 1 in., widths up to 24 in. and lengths up to 130 ft., cold-forming steel lumber section mills, electric welders and other equipment for furnishing steel lumber finished and painted ready for use.

The Massillon Rolling Mill Co., which also will be operated as a division of the Central Steel Co., brings to the merger twelve hot sheet mills, sixteen cold sheet mills, eighteen annealing furnaces and complete equipment and facilities for turning out a complete line of sheet steel.

Declining Importance of Chilean Nitrate

Those charged with the operation of the Panama Canal see in the large decrease in nitrate shipments a factor having an important bearing on canal traffic. "The interests of the Panama Canal are affected," they state, "not only because nitrate made up one-third of the total northbound cargo in 1920, but because the smaller number of shipments has had an adverse effect on bulk cargo moving in the opposite direction. Vessels which carry coal cargoes south usually return with nitrates, so the decay of one involves a corresponding decline in the other."

The canal authorities attach importance to the following analysis of the nitrate situation by A. Bertrand, the delegate in Europe of the Association of Nitrate Producers:

"Before 1908, nitrate had but one rival, sulphate of ammonia, with a development very inferior to nitrate. From 1909 to 1913 cyanide and nitrate of calcium began to make their appearance, while at the same time the production of sulphate of ammonia increased much more than that of nitrate. In 1913, in its turn, synthetic ammonia made its appearance, though in a small proportion. In that year nitrate was still dominant.

"In 1917 the development of nitrate reached its maximum capacity. Synthetic ammonia was produced to a maximum degree in Germany in 1918. Sulphate of ammonia, extracted from coal, seems to have reached its full development in Germany and the United Kingdom and especially in the United States, while it continues to increase in other countries, notably Australia and Japan. At the present moment, the production of chloride of ammonia and other new salts is being encouraged for the purpose of fertilization.

"To sum up, nitrate, which represented 56 per cent of the world's total fertilizer production in 1913 to 1917, has fallen today to less than 35 per cent, according to the most favorable calculations, and it seems threatened with a descent to still lower depths in the current year."

Rubber Manufacturers' Association Organized

Rubber manufacturers at Trenton, N. J., have perfected plans for the organization of a new association, to be known as the Rubber Manufacturers' Association of New Jersey. The new organization is designed for mutual benefit of members, exchange of plans and ideas and for the general betterment of trade conditions. The trustees elected for the ensuing year include John S. Broughton, the United Globe & Rubber Co., president; Charles E. Stokes, an official of the Home Rubber Co., vice-president; A. Boyd Cornell, of the Hamilton Rubber Co., secretary, and W. H. Sayen, Jr., connected with the Mercer Rubber Co., treasurer. Offices will be located in the Broad Street Bank Building, with V. B. Wicoff as representative.

Personal

Dr. ELMER D. BALL has been chosen by the Secretary of Agriculture to be the first director of scientific work. The office was created in the last agricultural appropriation bill so as to provide an official who would be in immediate general charge of all research work in the department. Through Dr. Ball an effort will be made to co-ordinate and correlate the scientific work of the department in a way to make it more effective in the study of national problems having a bearing on agriculture.

M. J. CAVALIER, professor of metallurgy in the University of Toulouse, France, was the guest of honor at a meeting of the New York Section, American Institute of Mining and Metallurgical Engineers, on Oct. 5. Responding to a toast, he spoke on the influence of French universities on industries, and of the great expansion of the French metallurgical and electrochemical industry since the beginning of the war. As exchange professor, Dr. Cavalier will divide his time among Columbia, Harvard, Yale, Cornell, Johns Hopkins, Massachusetts Institute of Technology and the University of Pennsylvania.

J. D. CLARKE, general counsel for the Midwest Refining Co., Denver, Col., has been elected vice-president of the company to succeed R. D. Brooks, resigned.

MORTIMER ELWYN COOLEY, dean of the College of Engineering and Architecture of the University of Michigan, has been elected president of the American Engineering Council of the Federated American Engineering Societies. Dean Cooley assumes office at once and will carry out an extensive program in the interest of the public and the profession of engineering.

A. L. HALVORSEN of Perth Amboy, N. J., is planning to spend October and November in Germany and Norway inspecting the various activities in industrial chemical research and cyanide hydrometallurgy.

MILTON R. LOURIA, who completed his chemical engineering course at Columbia University last June, has been appointed instructor in chemistry at the University of Maine for the current year.

P. L. PALMERTON has been named chief of the newly established rubber division of the Bureau of Foreign and Domestic Commerce.

LINCOLN T. WORK has been appointed instructor in chemical engineering at Columbia University for the year beginning Oct. 1. Mr. Work completed three years of graduate work in the department of chemical engineering at Columbia last June.

Prof. ALFRED H. WHITE, director of the department of chemical engineering, University of Michigan, addressed the Rotary Club at Bay City, Sept. 20, on "The Chemistry of War."

Friends of Dr. HENRY M. HOWE will be sorry to know that for several weeks he has been practically confined to his bed with rheumatism.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, Oct. 10, 1921.

Business in the heavy chemical market during the past week has been steadily improving and inquiries for a variety of minor commodities have been more plentiful. The general tone of the market was much stronger than during the past few weeks owing to the scarcity of spot material in resale quarters. Although buyers are still operating in a conservative manner, the volume of business has increased as the demand for finished products becomes greater. The general feeling in the trade is that a gradual revival will feature the market for the rest of the year.

The feature of the week's trading was the pronounced strength of prussiate of soda, cyanide of soda and soda ash. The market on these products closed very firm, with sellers showing very little desire to sell at the existing low prices. There has been an increased inquiry for solid caustic soda and the market is responding to increased buying orders. The demand for this material has been chiefly from domestic consumers. Soda ash is another chemical that has displayed considerable strength during the past few days. Glass factories are the foremost in the field of domestic consumers for this chemical and an increased inquiry has also been evidenced from smaller buyers. Bichromate of soda was reported a shade easier by some resale merchants in the final trading, while leading factors maintained their former price range.

CHEMICALS

Sellers of *bichromate of potash* ask 11@11½c. per lb., with several sales reported at the inside figure. The movement in this chemical has been somewhat dormant of late with the few inquiries passing calling only for small lots. Spot material does not seem to be plentiful, but competition is keeping prices irregular. Spot *carbonate of potash* has moved very quietly during the week and the market closed nominal at 4½@4¾c. per lb. for the 80-85 per cent, calcined. Imported *chlorate of potash* is offered at 6¾@7¼c. per lb., according to the quantity and seller. There has been no change noticed in the domestic goods and first hands quote their former price of 12c. per lb., f.o.b. works. Some sales have been recorded on spot *caustic potash*, 88-92 per cent, at 5½c. per lb. Offerings of this material were not heavy, but buyers were not eager to keep in line with the advance and therefore the demand eased up considerably. Shipment prices from Germany ranged from 5@5½c. per lb., with goods afloat held at 5c. Small lot sales of *bichromate of soda* were reported on the spot market at slightly lower figures. Quiet conditions for this chemical are responsible for the shading among holders of resale goods. Additional lots of standard brands were reported in the market at 7½@7¾c. per lb. A sale of 10 long tons was recorded early in the week at 7½c. per lb. f.a.s., N. Y. The late advances in solid *caustic soda* are being well maintained on spot and the market closed in a very favorable condition. Inquiries for small lots from various consuming quarters were quite frequent during the entire week and sales have been reported at \$4.05@\$4.15 per 100 lb., according to seller and quantity. At the works 3¾c. per lb., basis 60 per cent, was quoted for contracts on carload quantities. Sales of German *cyanide of soda*, 125-128 per cent, were recorded at 25c. per lb., with an exceedingly small supply of spot material around the market. Conditions in this chemical seem to be exceptionally bright and holders are backward in offering any round lots at present levels. Leading factors in *nitrite of soda* reports sales at 6¾c. per lb. The prevailing quotation was 6¾@7c. per lb., depending upon seller and quantity. There has been very little change in the attitude of consumers and operations have been confined chiefly to small quantities. Domestic *bleaching powder* in large drums is quoted at 21c. per lb., f.o.b. works. Sales of imported material have been made at 2c. per lb.,

ex-dock duty paid, while shipments from abroad are quoted at \$1.90 per 100 lb. The general demand for bleach from the various consuming trades has remained very active with paper mills leading the buying. Light *soda ash*, in single bags, is holding steady with sales reported at \$2.10@\$2.15 per 100 lb., depending upon the quantity. Sales of barrels are reported by dealers at \$2.45@\$2.50 per 100 lb. The feeling around the trade continues quite firm and a fair amount of business is passing at the above figures. Sales of small lots of *carbon tetrachloride* are reported at 11c. per lb. Larger quantities can be purchased below this figure, the price depending upon the quantity of the order. Prices on *muriate of potash* are slightly easier at \$38@\$40 per ton. Prices on spot *nitrate of soda* are somewhat firmer at \$2.25@\$2.30 per 100 lb.

COAL-TAR PRODUCTS

Conditions in the coal-tar products industry seem to be much brighter than at any time this year. There are still a few products where surplus stocks remain large and an undertone of weakness is noted on these, but on most of the other items there seems to be a healthier situation and holders show very little desire to loosen stocks at figures regardless of value. Manufacturers are operating in a more conservative manner, limiting their output to the actual requirements of the trade so that no stocks will accumulate. Buyers are showing more interest and are purchasing in larger quantities. Stocks of *naphthalene* are still heavy and holders are making concessions to realize some cash on their old stocks. The demand is very light, with prime white flakes offered at 6½c. per lb. Producers' prices remain unchanged at former levels. Resale *benzene* is still very difficult to locate and where small lots can be obtained a premium must be paid. Odd lots in drums have sold at 40c. per gal. for the c.p. grade. Refiners quote 28@33c. per gal., but cannot make any deliveries for some time. Supplies of *aniline oil* are still plentiful, but production has been greatly curtailed and any pronounced buying will undoubtedly strengthen the market considerably. Sales at 17½@18c. per lb. were recorded, according to quantity and seller. Odd lot sales of *beta-naphthol* were reported at 31c. per lb., but the general asking price around the market is 32c. First hands quote up to 40c. per lb., but are willing to shade this figure on actual business. Supplies seem to be quite abundant. Makers of *salicylic acid* quote the technical grade at 18@20c. per lb. The U.S.P. is being sold by second hands at 19c. per lb. The low prices quoted by first hands on *diethylaniline* has stimulated business to some extent and inquiries were more noticeable than any time during the year. Sales were made at \$1@\$1.10 per lb., depending upon the quantity. Low priced *dimethylaniline* has been cleared off the market and the best offering now heard is 42c. per lb. Manufacturers continue to ask 45c. and upward, but are not placing any actual round lot business at these figures.

WAXES

The demand for the lower grades of *beeswax* was reported much brighter, with the market, steady in all directions. African crude on spot was held at 15@16c. per lb. with shipment goods quoted at 13½@14c. per lb. Brazilian crude closed unchanged at 22@24c. per lb. Pure refined wax on spot held at 36@40c. per lb. Offerings of *candelilla wax* were noted at prices ranging from 24@25c. per lb., depending upon the quantity and seller. The demand was slow and the market barely steady. The call for *carnauba wax* was irregular and an easier feeling prevailed in various directions. Prices, at any rate, showed no important change, with the No. 2 North Country at 24@25c. per lb. and No. 3 North Country at 14½@15c. per lb. Small lots of *Japan wax* on spot brought as high as 26c. per lb. Offerings around the trade were light and sellers' views were quite firm, due to the recent advance in the cost of import. For round lots, the market closed at 24@25c. per lb. The demand for *paraffine wax* has once more fallen off so that refiners appeared quite anxious to meet the views of prospective buyers. Prices varied very little. The adverse exchange restricts any export business, while domestic consumers showed little disposition to buy in any quantity.

The Chicago Market

CHICAGO, Oct. 7, 1921.

Business in the general line of industrial chemicals continues very good and dealers appear well satisfied. While no really large transactions were reported, a very good volume of small orders was noticeable. There were practically no price changes reported and but little evidence of any shading of the present list.

INDUSTRIAL CHEMICALS

A firm tone still ruled in the market for *caustic soda*, although business was quieter. Supplies among second hands are small and 4½c. for the solid 76 per cent and 4¾c. for the ground were the prevailing quotations. *Soda ash* is still very firm and supplies could not be located under \$2.60 per 100 lb. for material in cooperage. *Sal soda* seems to be moving quite well at \$1.65@\$1.70 per 100 lb., although no large orders were reported. *Sal ammoniac* is unchanged as to price and is not moving so well. Prime white material, 98-100 per cent, is available at 7½c. per lb. A fair movement of *carbon bisulphide* was noted in some quarters and supplies were available at 7@7½c. per lb. The *formaldehyde* market is rather featureless, with supplies plentiful at 12c. per lb. *Glycerine* is quiet and firm, the prevailing quotation being 14½c. per lb. for drums. *Litharge* is not so active and the price is unchanged at 7½c. per lb. A fair movement of *lead acetate* was noted and prices are firm at 13@13½c. per lb. for small or medium quantities. *Caustic potash* is firm and unchanged as to price. Small lots are available at 6½c. per lb. for the 88-92 per cent material. *Bichromates* are quiet and supplies are said to be light. The potash salt is available at 13@13½c. and the sodium at 9½c. per lb., single cask lots. *Potassium permanganate* is very quiet and but few sales are noted. The prevailing quotation for spot U.S.P. crystals was 24c. per lb. *Sodium bicarbonate* continues to move in a fair way and the price is unchanged at \$2.60 per 100 lb. The demand for *sodium hyposulphite* has fallen off somewhat, but quotations remain at \$4.05 per 100 lb. for the pea crystal. *Acetate of soda* is meeting with a fair request at 5½@6½c. per lb. *Sodium fluoride* continues active and the price is unchanged at 11@12c. per lb. *Zinc chloride* is moving well at 11½c. for the domestic and 9@9½c. for the imported.

The acids as a rule were quite firm and on some the inquiry was much improved. *Acetic acid* is very firm, with practically all of the second-hand material absorbed. The 28 per cent in barrels is quoted at \$2.65@\$2.75 per 100 lb. and the glacial at \$10.25@\$10.75. A good inquiry for *oxalic acid* is reported and the domestic material is available at 17c. per lb. It appears that about all of the foreign acid has been absorbed. *Sulphuric acid* is moving quite freely and is unchanged in price, makers quoting \$19@\$20 per ton in tank cars, f.o.b. works.

VEGETABLE OILS

Linseed oil is in a weak position, according to a prominent factor, who predicts lower prices in the near future. Several small sales were reported, but the inquiry was light. The boiled oil is quoted today at 81c. per gal. and the raw at 79c.

NAVAL STORES

The naval stores market appears to be quite firm and dealers are reporting a very good volume of business. *Turpentine* is moving in a very fair way at 79c. per gal. drum basis, material in cooperage 5c. higher. *Rosin* is firm and moving very well, the "G" grade being quoted at \$5.35 per 280 lb. in carlots.

The Iron and Steel Market

PITTSBURGH, Oct. 7, 1921.

Viewed as a whole, the steel market is probably improving somewhat in volume of demand, while prices on the whole are not declining and are barely stationary, showing rather a slight stiffening tendency. Nevertheless the situation is not as good as was to be expected for the first week in October.

Consideration of conditions in the different products that make up the steel market as a whole does not enable one to generalize as to the fundamental conditions obtaining in

industry and commerce, but is useful even if it shows a negative result. Easily sheets constitute the most finished steel line. The Steel Corporation's sheet department is this week operating at about 90 per cent, while the independents as a whole are probably averaging 75 per cent or more. This operation, however, is predicated upon the large volume of business booked recently, in anticipation of the price advance that has since been in effect. Tin plate comes next in point of production, with mills operating at between 60 and 70 per cent.

The wire mills are operating at rates from 50 to 65 per cent, but the production is largely seasonal in character, and there is probably some stocking by jobbers and retailers, since orders now being filled were placed before the recent advances in mill prices.

The pipe mills are operating at an average of between 40 and 50 per cent. The demand for standard steel pipe is described as fairly good, not very far from normal, but line pipe and oil country goods generally are in light request and on account of the season of the year there is little prospect of improvement.

Production of steel ingots is scarcely at more than 35 per cent of capacity. The average is held down by light operation of bar, shape, plate and rail mills. The lightness of rail production is easily understood. The railroads bought conservatively for this year and are not taking out all their deliveries, being short of funds. Dullness in plates and shapes is ascribable to there being little construction work involving these materials, though there is much building of garages and dwelling houses. The lightness of demand for bars is not so easily understood, when there is fair demand for pipe, sheets and wire. Buyers of finished steel have been quoted prices averaging not more than about 30 per cent above the average prices of 1913, making an index number of 130 comparing with the Bureau of Labor's index number of all commodities of 152 for August, against 148 for July, so that steel prices have been relatively low.

The recent advances in wire products and sheets involved a sales campaign in which mills were ready to book orders at the old prices, while buyers were convinced that prices were going to advance. The operations were quite successful in placing tonnage on mill books. For several weeks past a number of mills making bars, shapes and plates have been conducting similar campaigns, but the operation has not been signally successful. While buyers may have been willing in most cases to place contracts for the remainder of the year, subject to specification from time to time as needs arose, they evidently have not been in position to put much tonnage on books in actual shipping orders. While the tonnage desired has not accumulated, a mill here and there has been disposed to stiffen in prices nevertheless. All three products can still be bought at 1.60c., but there is more disposition to hold to 1.65c. for bars and 1.65c. or higher for plates and shapes. There are reports that sales have been made at 1.50c. or less, but these are probably incorrect in all cases.

SEMI-FINISHED STEEL

Quite generally the mills are now quoting \$32 on sheet bars, by the so-called "advance" from \$30. Sales had actually been made at less than \$30 and no transactions have definitely shown a price above \$30. Billets are altogether neglected, some mills not having even an asking price. Nominally they are about \$30, with \$32 for small billets.

PIG IRON

The local pig-iron market has been very quiet, but furnaces expect a little buying movement very shortly. This would probably bring in some idle furnaces, so that it is not certain prices would advance. We quote: Bessemer, \$20; basic, \$19.25@ \$20; foundry, \$21, f.o.b. valley furnaces, freight to Pittsburgh being \$1.96. At a recent conference between iron and steel producers and railroad officials the sought-for reductions in ore, coke and limestone rates were denied, the assigned reason being that a general reduction in freight rates may possibly occur early next year.

Connellsville coke shows a stiffer tone and quotations are higher, though advances are not well supported thus far by sales. We quote: Spot furnace, \$2.35@ \$2.50; contract furnace, \$2.50@ \$2.75; spot foundry, \$4.25@ \$4.75.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots		Less Carlots	
Acetic anhydride..... lb.			\$0.40 - \$0.45	
Acetone..... lb.	\$0.12½ -	\$0.12½	.13 -	.13½
Acid, acetic, 28 per cent..... 100 lbs.	2.75 -	3.00	3.25 -	3.50
Acetic, 56 per cent..... 100 lbs.	5.50 -	5.75	6.00 -	6.50
Acetic, glacial, 99½ per cent, carboys, 100 lbs.	10.50 -	11.00	11.25 -	10.50
Boric, crystals..... lb.	.12½ -	.13	.13½ -	.14
Boric, powder..... lb.	.13 -	.13½	.14 -	.14½
Citric..... lb.			.45 -	.47
Hydrochloric..... 100 lb.	1.25 -	1.50	1.60 -	1.75
Hydrofluoric, 52 per cent..... lb.	.12 -	.12½	.12½ -	.13
Lactic, 44 per cent tech..... lb.	.09½ -	.10	.10½ -	.12
Lactic, 22 per cent tech..... lb.	.04½ -	.05½	.06 -	.07
Molybdic, C.P..... lb.	3.25 -	3.50	3.60 -	4.00
Muriatic, 20 deg. (see hydrochloric).....				
Nitric, 40 deg..... lb.	.06½ -	.06½	.06½ -	.07
Nitric, 42 deg..... lb.	.06½ -	.07	.07½ -	.07½
Oxalic, crystals..... lb.	.16 -	.16½	.16½ -	.17½
Phosphoric, 50 per cent solution..... lb.	.13 -	.13½	.14 -	.18
Picric..... lb.	.20 -	.25	.27 -	.35
Pyrogallie, resublimed..... lb.			1.75 -	1.90
Sulphuric, 60 deg., tank cars..... ton			11.00 -	12.00
Sulphuric, 60 deg., drums..... ton			13.00 -	15.00
Sulphuric, 66 deg., tank cars..... ton	17.00 -	18.00		
Sulphuric, 66 deg., drums..... ton	21.00 -	22.00	22.50 -	23.00
Sulphuric, 66 deg., carboys..... ton				
Sulphuric, fuming, 20 per cent (oleum) tank cars..... ton	21.00 -	22.00		
Sulphuric, fuming, 20 per cent (oleum) drums..... ton	23.00 -	23.50	24.00 -	24.50
Sulphuric, fuming, 20 per cent (oleum) carboys..... ton	31.00 -	32.00	33.00 -	34.00
Tannic, U. S. P..... lb.			.75 -	.85
Tannic (tech.)..... lb.	.45 -	.48	.50 -	.55
Tartaric, imported crystals..... lb.			.27 -	.28
Tartaric acid, imported, powdered..... lb.			.27 -	.28
Tartaric acid, domestic..... lb.				.35
Tungstic, per lb. of WO..... lb.			1.10 -	1.20
Alcohol, Ethyl..... gal.			4.65 -	4.90
Alcohol, Methyl (see methanol).....				
Alcohol, denatured, 188 proof..... gal.			.35 -	.36
Alcohol, denatured, 190 proof..... gal.			.37 -	.38
Alum, ammonia, lump..... lb.	.03½ -	.03½	.04 -	.04½
Alum, potash, lump..... lb.	.03½ -	.04	.04½ -	.04½
Alum, chrome lump..... lb.	.10 -	.11	.11½ -	.12½
Aluminum sulphate, commercial..... lb.	.02 -	.02½	.02½ -	.02½
Aluminum sulphate, iron free..... lb.	.03 -	.03½	.03½ -	.04
Aqua ammonia, 26 deg., drums (750 lb.) lb.	.07½ -	.07½	.08 -	.08½
Ammonia, anhydrous, cyl. (100-150 lb.) lb.	.30 -	.32	.33 -	.35
Ammonium carbonate, powder..... lb.	.07 -	.07½	.08 -	.09
Ammonium chloride, granular (white sal ammoniac)..... lb.	.06 -	.06½	.06½ -	.07
Ammonium chloride, granular (gray sal ammoniac)..... lb.	.06½ -	.07	.07½ -	.08
Ammonium nitrate..... lb.	.07½ -	.07½	.07½ -	.08½
Amylacetate..... gal.			3.25 -	3.50
Amylacetate tech..... gal.			2.50 -	3.00
Arsenic oxide, (white arsenic) powdered lb.	.05½ -	.05½	.06 -	.06½
Arsenic, sulphide, powdered (red arsenic) lb.	.11 -	.11½	.12 -	.13
Barium chloride..... ton	44.00 -	45.00	46.00 -	50.00
Barium dioxide (peroxide)..... lb.	.20 -	.21	.22 -	.23
Barium nitrate..... lb.	.07½ -	.08	.08½ -	.09
Barium sulphate (precip.) (blanc fixe) lb.	.04 -	.04½	.04½ -	.05
Bleaching powder (see calc. hypochlorite).....				
Blue vitriol (see copper sulphate).....				
Borax (see sodium borate).....				
Brimstone (see sulphur, roll).....				
Bromine..... lb.	.27 -	.28	.28½ -	.30
Calcium acetate..... 100 lbs.	2.00 -	2.05		
Calcium carbide..... lb.	.04½ -	.04½	.05 -	.05½
Calcium chloride, fused, lump..... ton	23.50 -	24.00	24.50 -	25.50
Calcium chloride, granulated..... lb.	.01½ -	.02	.02½ -	.02½
Calcium hypochloride (bleaching powder) 100 lb.	2.50 -	2.60	2.70 -	3.25
Calcium peroxide..... lb.			1.40 -	1.50
Calcium phosphate, tribasic..... lb.			.15 -	.16
Camphor..... lb.			.70 -	.72
Carbon bisulphide..... lb.	.06½ -	.06½	.07 -	.07½
Carbon tetrachloride, drums..... lb.	.10½ -	.10½	.11 -	.12
Carbonyl chloride, (phosgene)..... lb.			.60 -	.75
Caustic potash (see potassium hydroxide).....				
Caustic soda (see sodium hydroxide).....				
Chlorine, gas, liquid-cylinders (100 lb.) lb.	.08 -	.09	.09½ -	.10
Chloroform..... lb.			.38 -	.43
Cobalt oxide..... lb.			2.00 -	2.10
Copperas (see iron sulphate).....				
Copper carbonate, green precipitate..... lb.	.19 -	.19½	.20 -	.21
Copper cyanide..... lb.			.50 -	.62
Copper sulphate, crystals..... lb.	.05 -	.05½	.05½ -	.06
Cream of tartar (see potassium bitartrate).....				
Epsom salt (see magnesium sulphate).....				
Ethyl Acetate Com. 85%..... gal.			1.00 -	1.10
Ethyl Acetate pure (acetic ether, 98% to 100%)..... lb.			.40 -	.42
Formaldehyde, 40 per cent..... lb.	.11½ -	.12	.12½ -	.13
Fusel oil, ref..... gal.			3.25 -	3.75
Fusel oil, crude..... gal.			1.50 -	1.75
Glauber's salt (see sodium sulphate).....				
Glycerine, C. P. drums extra..... lb.			.14½ -	.15
Iodine, resublimed..... lb.			3.50 -	3.60
Iron oxide, red..... lb.			.10 -	.20
Iron sulphate (copperas)..... ton	18.00 -	19.00	20.00 -	23.00
Lead acetate..... lb.			.10½ -	.12½
Lead arsenate, paste..... lb.	.09 -	.09½	.10 -	.11
Lead nitrate..... lb.			.15 -	.20
Litharge..... lb.	.07½ -	.08	.08½ -	.09
Lithium carbonate..... lb.			1.30 -	1.40
Magnesium carbonate, technical..... lb.	.08 -	.08½	.09 -	.10
Magnesium sulphate, U. S. P..... 100 lb.	2.50 -	2.75		
Magnesium sulphate, technical..... 100 lb.			1.10 -	1.75
Methanol, 95%..... gal.			.66 -	.68
Methanol, 97%..... gal.			.70 -	.72
Nickel Salt, double..... lb.			.12 -	.12½
Nickel salt, single..... lb.			.14 -	.14½
Phosgene (see carbonyl chloride).....				
Phosphorus, red..... lb.	.40 -	.41	.42 -	.45
Phosphorus, yellow..... lb.			.30 -	.35
Potassium bichromate..... lb.	.11 -	.11½	.11½ -	.12

	Carlots	Less Carlots
Potassium bitartrate (cream of tartar) . . . lb.	\$. . . \$. . .	\$0 25 1/2 \$0 28
Potassium bromide, granular . . . lb.		14 20
Potassium carbonate, U. S. P. . . . lb.	20 - 21	22 25
Potassium carbonate, 80-85% . . . lb.	.04 1/2 - .04 1/2	.05 06
Potassium chlorate, crystals . . . lb.	.06 1/2 - .07	.07 1/2 - 10
Potassium cyanide . . . lb.		26 28
Potassium hydroxide (caustic potash) . . . lb.	.05 1/2 - .05 1/2	.05 1/2 - 06
Potassium iodide . . . lb.		2 60 2 75
Potassium nitrate . . . lb.	.09 1/2 - .09 1/2	10 12 1/2
Potassium permanganate . . . lb.	.20 - 21	22 23
Potassium prussiate, red . . . lb.	.28 - 29	29 30
Potassium prussiate, yellow . . . lb.	.20 - 20 1/2	21 22
Rochello salts (see sodium potas tartrate)		
Salammoniac (see ammonium chloride)		
Salt soda (see sodium carbonate)		
Salt cake (bulk) . . . ton		17 00 - 20 00
Silver cyanide . . . oz.		1 35 - 1 38
Silver nitrate . . . oz.		46 47
Soda ash, light . . . 100 lb.	2.10 - 2.15	2 20 - 2 50
Soda ash, dense . . . 100 lb.	2.35 - 2 40	2 45 - 2 70
Sodium acetate . . . lb.	.04 - .04 1/2	.04 1/2 - 05
Sodium bicarbonate . . . 100 lb.	2.00 - 2.25	2 50 - 2 75
Sodium bichromate . . . lb.	.07 1/2 - .07 1/2	.08 - .08 1/2
Sodium bisulphate (nitre cake) . . . ton	5.00 - 5 25	5 50 - 6 50
Sodium bisulphate powdered, U.S.P. . . lb.	.04 1/2 - .05	.05 1/2 - 06
Sodium borate (borax) . . . lb.	.05 1/2 - .06	.06 1/2 - 07
Sodium carbonate (salt soda) . . . 100 lb.	1.75 - 1 90	2 00 - 2 25
Sodium chloride . . . lb.	.07 1/2 - .07 1/2	.08 - .08 1/2
Sodium cyanide . . . lb.	.25 - .26	.27 - 30
Sodium fluoride . . . lb.	.10 1/2 - .11	.11 1/2 - 12
Sodium hydroxide (caustic soda) . . . 100 lb.	4.00 - 4 10	4 15 - 4 75
Sodium hyposulphite . . . lb.		.03 1/2 - .03 1/2
Sodium nitrite . . . lb.	.06 1/2 - .07	.07 1/2 - .07 1/2
Sodium peroxide, powdered . . . lb.	.25 - .26	.27 - 30
Sodium phosphate, dibasic . . . lb.	.04 1/2 - .04 1/2	.04 1/2 - .05 1/2
Sodium potassium tartrate (Rochelle salts) . lb.		.21 - 24
Sodium prussiate, yellow . . . lb.	.13 - .13 1/2	.13 1/2 - .13 1/2
Sodium silicate, solution (40 deg.) . . . 100 lb.	1.00 - 1 15	1 25 - 1 40
Sodium silicate, solution (60 deg.) . . . lb.	.02 1/2 - .03	.03 1/2 - .03 1/2
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	1 50 - 1 75	2 00 - 2 25
Sodium sulphide, fused, 60-62 per cent (conc) . lb.	.04 1/2 - .04 1/2	.05 - .06
Sodium sulphite, crystals . . . lb.	.03 1/2 - .04	.04 1/2 - .04 1/2
Strontium nitrate, powdered . . . lb.	.12 - .13	.13 1/2 - 20
Sulphur chloride, red . . . lb.	.05 - .05 1/2	.05 1/2 - .06 1/2
Sulphur, crude . . . ton	18 00 - 20 00	
Sulphur dioxide, liquid, cylinders ex a . . . lb.	.08 - .08 1/2	.09 - 10
Sulphur (sublimed), flour . . . 100 lb.		2 25 - 3 10
Sulphur, roll (brimstone) . . . 100 lb.		2 00 - 2 75
Tin bichloride, 50 per cent . . . lb.	.18 - .19	
Tin oxide . . . lb.		.38 - 40
Zinc carbonate, precipitate . . . lb.	.16 - .16 1/2	.17 - .17 1/2
Zinc chloride, gran . . . lb.	.09 1/2 - .09 1/2	.10 - 11
Zinc cyanide . . . lb.	.42 - .44	.45 - 47
Zinc dust . . . lb.	.11 1/2 - .11 1/2	.11 1/2 - 12 1/2
Zinc oxide, XX . . . lb.	.07 1/2 - .07 1/2	.08 - .09
Zinc sulphate . . . 100 lb.	3.00 - 3 25	3 30 - 3 50

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude . . . lb.	\$1.15 - \$1.20
Alpha-naphthol, refined . . . lb.	1 30 - 1 35
Alpha-naphthylamine . . . lb.	30 - 35
Aniline oil, drums extra . . . lb.	17 1/2 - 20
Aniline salts . . . lb.	24 - 26
Anthracene, 80% in drums (100 lb.) . . . lb.	75 - 1 00
Benzaldehyde U.S.P. . . . lb.	1 00 - 1 25
Benzidine, base . . . lb.	1 00 - 1 10
Benzidine sulphate . . . lb.	75 - 85
Benzoic acid, U.S.P. . . . lb.	60 - 65
Benzoate of soda, U.S.P. . . . lb.	52 - 55
Benzene, pure, water-white, in drums (100 gal.) . gal.	27 - 32
Benzene, 90%, in drums (100 gal.) . . . gal.	25 - 28
Benzyl chloride, 95-97%, refined . . . lb.	25 - 27
Benzyl chloride, tech . . . lb.	20 - 23
Beta-naphthol benzoate . . . lb.	3 50 - 4 00
Beta-naphthol, sublimed . . . lb.	70 - 75
Beta-naphthol, tech . . . lb.	32 - 35
Beta-naphthylamine, sublimed . . . lb.	1 90 - 2 00
Cresol, U. S. P., in drums (100 lb.) . . . lb.	16 - 17
Ortho-cresol, in drums (100 lb.) . . . lb.	25 - 27
Cresylic acid, 97-99%, straw color, in drums . . . gal.	70 - 75
Cresylic acid, 75-97%, dark, in drums . . . gal.	60 - 65
Cresylic acid, 50%, first quality, drums . . . gal.	45 - 50
Dichlorobenzene . . . lb.	.06 - .09
Diethylaniline . . . lb.	1 00 - 1 15
Dimethylaniline . . . lb.	.42 - .50
Dinitrobenzene . . . lb.	.25 - .28
Dinitrochlorobenzene . . . lb.	.25 - .30
Dinitronaphthalene . . . lb.	.32 - .40
Dinitrophenol . . . lb.	.37 - .40
Dinitrotoluene . . . lb.	.25 - .30
Dip oil, 25%, car lots, in drums . . . gal.	30 - 35
Diphenylamine . . . lb.	.60 - .70
Fluoride . . . lb.	1 10 - 1 20
Meta-phenylenediamine . . . lb.	1 15 - 1 20
Monochlorobenzene . . . lb.	.12 - .14
Monoethylaniline . . . lb.	1 50 - 1 60
Naphthalene crushed, in obls . . . lb.	.05 1/2 - .07 1/2
Naphthalene, flake . . . lb.	.06 1/2 - .08
Naphthalene, balls . . . lb.	.08 - .09 1/2
Naphthionic acid, crude . . . lb.	.70 - .75
Nitrobenzene . . . lb.	.12 - .15
Nitro-naphthalene . . . lb.	.30 - .35
Nitro-toluene . . . lb.	.15 - .17
Ortho-amidophenol . . . lb.	3 00 - 3 10
Ortho-dichlor-benzene . . . lb.	.15 - .20
Ortho-nitro-phenol . . . lb.	.75 - .80
Ortho-nitro-toluene . . . lb.	.15 - .20
Ortho-toluidine . . . lb.	.21 - .25
Para-amidophenol, base . . . lb.	1 40 - 1 45
Para-amidophenol, HCl . . . lb.	1 70 - 1 80
Para-dichlorobenzene . . . lb.	.15 - .20
Paranitroaniline . . . lb.	.79 - .82
Para-nitrotoluene . . . lb.	.80 - .85
Para-phenylenediamine . . . lb.	1 70 - 1 75
Para-toluidine . . . lb.	1 25 - 1 40
Phthalic anhydride . . . lb.	.40 - .50

Phenol, U. S. P., drums . . . lb.	.08 - .10
Pyridine . . . gal.	2 00 - 3 50
Resorcinol, technical . . . lb.	1 50 - 1 60
Resorcinol, pure . . . lb.	2 00 - 2 25
Salicylic acid, tech., in bbls . . . lb.	.18 - .20
Salicylic acid, U. S. P. . . . lb.	.19 - .22
Salol . . . lb.	.60 - .70
Solvent naphtha, water-white, in drums, 100 gal . gal.	.25 - .28
Solvent naphtha, crude, heavy, in drums, 100 gal . gal.	.14 - .16
Sulphanilic acid, crude . . . lb.	.27 - .30
Tolidine . . . lb.	1 30 - 1 35
Toluidine, mixed . . . lb.	.43 - .45
Toluene, in tank cars . . . gal.	.25 - .28
Toluene, in drums . . . gal.	.28 - .31
Xylidines, drums, 100 gal . . . lb.	.40 - .45
Xylene, pure, in drums . . . gal.	.40 - .45
Xylene, pure, in tank cars . . . gal.	.45 - .45
Xylene, commercial, in drums, 100 gal . . . gal.	.33 - .35
Xylene, commercial, in tank cars . . . gal.	.30 - .35

Waxes

Prices based on original packages in large quantities:

Bayberry Wax . . . lb.	\$0 19 - \$0 20
Beeswax, refined, dark . . . lb.	.24 - .25
Beeswax, refined, light . . . lb.	.28 - .30
Beeswax, white pure . . . lb.	.36 - .42
Candelilla wax . . . lb.	.24 - .25
Carnauba, Florida . . . lb.	.48 - .50
Carnauba, No. 2, North Country . . . lb.	.24 - .25
Carnauba, No. 3, North Country . . . lb.	.14 1/2 - .15
Japan . . . lb.	.24 - .26
Montan, crude . . . lb.	.05 - .05 1/2
Paraffine waxes, crude match wax (white) 105-110 m.p. . . lb.	.03 1/2 - .03 1/2
Paraffine waxes, crude, scale 124-126 m.p. . . lb.	.02 - .03
Paraffine waxes, refined, 118-120 m.p. . . lb.	.03 - .03 1/2
Paraffine waxes, refined, 125 m.p. . . lb.	.03 1/2 - .03 1/2
Paraffine waxes, refined, 128-130 m.p. . . lb.	.03 1/2 - .04 1/2
Paraffine waxes, refined, 133-135 m.p. . . lb.	.04 1/2 - .05
Paraffine waxes, refined, 135-137 m.p. . . lb.	.05 1/2 - .06
Stearic acid, single pressed . . . lb.	.09 1/2 - .10
Stearic acid, double pressed . . . lb.	.10 - .11
Stearic acid, triple pressed . . . lb.	.11 - .11 1/2

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl . . . 280 lb.	\$5 55 - \$5 65
Rosin E-I . . . 280 lb.	5 75 - 6 25
Rosin K-N . . . 280 lb.	6 35 - 6 75
Rosin W. G.-W. W . . . 280 lb.	6 90 - 7 40
Wood rosin, bbl . . . 280 lb.	6 25 - .
Spirits of turpentine . . . gal.	.75 1/2 - .
Wood turpentine, steam dist . . . gal.	.73 - .
Wood turpentine, dest. dist . . . gal.	.72 - .
Pine tar pitch, bbl . . . 200 lb.	. - 6 50
Tar, kiln burned, bbl. (500 lb.) . . . bbl.	. - 11 00
Retort tar, bbl . . . 500 lb.	. - 11 00
Rosin oil, first run . . . gal.	.35 - .
Rosin oil, second run . . . gal.	.37 - .
Rosin oil, third run . . . gal.	.44 - .
Pine oil, steam dist., sp.gr. 0.930-0.940 . . . gal.	. - \$1.90
Pine oil, pure, dest. dist . . . gal.	. - 1 50
Pine tar oil, ref., sp.gr. 1.025-1.035 . . . gal.	. - .46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla. . . gal.	. - .35
Pine tar oil, double ref., sp.gr. 0.965-0.990 . . . gal.	. - .75
Pine tar, ref., thin, sp.gr. 1.080-1.060 . . . gal.	. - .35
Turpentine, crude, sp. gr. 0.900-0.970 . . . gal.	. - 1 25
Hardwood oil, f.o.b. Mich., sp.gr. 0.960-0.990 . . . gal.	. - .35
Pinewood creosote, ref . . . gal.	. - .52

Solvents

73-76 deg., steel bbls. (85 lb.) . . . gal.	\$0.37
70-72 deg., steel bbls. (85 lb.) . . . gal.	.35
68-70 deg., steel bbls. (85 lb.) . . . gal.	.34
V. M. and P. naphtha, steel bbls. (85 lb.) . . . gal.	.23

Fertilizers

Ammonium sulphate, bulk and d. bags . . . 100 lb.	\$2 15 - 2 50
Blood, dried, f.o.b., N. Y . . . unit	4 00
Bone, 3 and 50, ground, raw . . . ton	30 00 - 32 00
Cyanamide, f.o.b. works . . . unit	4 50
Fish scrap, dom., dried, f.o.b. works . . . unit	2 90 - 3 00
Nitrate soda . . . 100 lb.	2 25 - 2 30
Tankage, high grade, f.o.b. Chicago . . . unit	3 00 - 3 10
Phosphate rock, f.o.b. mines, Florida pebble, 68-72 p.c . . ton	5 00 - 7 50
Tennessee, 78-80 p.c . . ton	8 00 - 9 00
Potassium muriate, 80 p.c . . ton	38 00 - 40 00
Potassium sulphate . . . unit	1 20 - 1 25

Crude Rubber

Para-Upriver line . . . lb.	\$0 21 - 21 1/2
Upriver coarse . . . lb.	.11 1/2 - .12
Upriver caucho ball . . . lb.	.11 1/2 - .12
Plantation—First latex crepe . . . lb.	.15 1/2 - .15 1/2
Ribbed smoked sheets . . . lb.	.15 1/2 - .15 1/2
Brown crepe, thin, clean . . . lb.	.15 - .15
Amber crepe No. 1 . . . lb.	.17 - .17

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls . . . lb.	\$0 10 - \$0 10 1/2
Castor oil, AA, in bbls . . . lb.	.11 - .11 1/2
China wood oil, in bbls. (f.o.b. Pac. coast) . . . lb.	.14 1/2 - .15
Cocoonut oil, Ceylon grade, in bbls . . . lb.	.09 1/2 - .10
Cocoonut oil, Cochin grade, in bbls . . . lb.	.10 1/2 - .10 1/2
Corn oil, crude, in bbls . . . lb.	.09 - .09 1/2
Cottonseed oil, crude (f. o. b. mill) . . . lb.	.07 1/2 - .08
Cottonseed oil, summer yellow . . . lb.	.09 1/2 - .10
Cottonseed oil, winter yellow . . . lb.	.10 1/2 - .10 1/2

Linseed oil, raw, ear lots (domestic)	gal.	67	—	.68
Linseed oil, raw, tank cars (domestic)	gal.	.62	—	.63
Linseed oil, in 5-bbl lots (domestic)	gal.	.70	—	.71
Olive oil, Denatured	gal.	\$1.10	—	\$1.20
Palm, Lagos	lb.	.07	—	.07 $\frac{1}{2}$
Palm, Niger	lb.	.06	—	.06 $\frac{1}{2}$
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.08	—	.08 $\frac{1}{2}$
Peanut oil, refined, in bbls.	lb.	.11	—	.11 $\frac{1}{2}$
Rapeseed oil, refined in bbls.	gal.	90	—	91
Rapeseed oil, blown, in bbls.	gal.	.92	—	.94
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.08 $\frac{1}{2}$	—	—
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.07 $\frac{1}{2}$	—	—

FISH

Light pressed menhaden	gal.	\$0.40	—	—
Yellow bleached menhaden	gal.	.42	—	—
White bleached menhaden	gal.	.44	—	—
Blown menhaden	gal.	.48	—	—

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	\$24.00	—	30.00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	20.00	—	24.00
Barytes, crude, 88% @ 94% ba., Kings Creek	net ton	10.00	—	12.00
Barytes, floated, f.o.b. St. Louis	net ton	23.00	—	24.00
Barytes, crude, first grade, Missouri	net ton	7.00	—	—
Blanc fixe, dry	lb.	.04	—	.04 $\frac{1}{2}$
Blanc fixe, pulp	net ton	45.00	—	55.00
Casein	lb.	.07	—	.10
Chalk, Precipitated, domestic, extra light	lb.	.04 $\frac{1}{2}$	—	.05
Chalk, Precipitated, domestic, light	lb.	.04	—	.04 $\frac{1}{2}$
Chalk, Precipitated, domestic, heavy	lb.	.03 $\frac{1}{2}$	—	.04
Chalk, Precipitated, English, extra light	lb.	.04	—	.05
Chalk, Precipitated, English, light	lb.	.04 $\frac{1}{2}$	—	.05
Chalk, Precipitated, English, dense	lb.	.04	—	.04 $\frac{1}{2}$
China clay (kaolin) crude, f.o.b. mines, Georgia	net ton	6.50	—	8.50
China clay (kaolin) washed, f.o.b. Georgia	net ton	9.00	—	10.00
China clay (kaolin) powdered, f.o.b. Georgia	net ton	13.00	—	20.00
China clay (kaolin) crude f.o.b. Virginia points	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points	net ton	13.00	—	20.00
China clay (kaolin), imported, lump	net ton	12.00	—	20.00
China clay (kaolin), imported, powdered	net ton	25.00	—	30.00
Feldspar, crude, f.o.b. Maryland and North Carolina points	net ton	5.00	—	7.50
Feldspar, crude, f.o.b. Maine	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore	net ton	27.00	—	30.00
Fullers earth, f.o.b. Mines	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Pa.	net ton	15.00	—	18.00
Fullers earth, powdered, f.o.b. Fla.	net ton	18.00	—	—
Fullers earth, imported, powdered	net ton	24.00	—	27.00
Graphite, Ceylon lump, first quality	lb.	.06	—	.07
Graphite, Ceylon chip	lb.	.04 $\frac{1}{2}$	—	.05
Graphite, high grade amorphous crude	lb.	.00 $\frac{1}{2}$	—	.02 $\frac{1}{2}$
Kieselguhr, f.o.b. mines, Cal.	per ton	40.00	—	—
Kieselguhr, f.o.b. N.Y.	per ton	61.00	—	—
Magnesite, calcined	per ton	66.00	—	70.00
Pumice stone, imported	lb.	.03	—	.40
Pumice stone, domestic, lump	lb.	.05	—	.05 $\frac{1}{2}$
Pumice stone, domestic, ground	lb.	.06	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore	net ton	—	—	10.00
Quartz (acid tower) 1 $\frac{1}{2}$ @2 in., f.o.b. Baltimore	net ton	—	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore	net ton	—	—	17.00
Quartz, lump, f.o.b. North Carolina	net ton	5.00	—	7.50
Shellac, orange fine	lb.	.64	—	.65
Shellac, orange superfine	lb.	.66	—	.68
Shellac, A. C. garnet	lb.	.50	—	.52
Shellac, T. N.	lb.	.56	—	.57
Soapstone	ton	12.00	—	15.00
Sodium chloride	long ton	12.50	—	13.00
Talc, paper-making grades, f.o.b. Vermont	ton	11.00	—	18.00
Talc, roofing grades, f.o.b. Vermont	ton	8.50	—	13.00
Talc, rubber grades, f.o.b. Vermont	ton	11.00	—	18.00
Talc, powdered, Southern, f.o.b. cars	ton	7.50	—	11.00
Talc, imported	ton	30.00	—	40.00
Talc, California talcum powder grade	ton	18.00	—	25.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh	per ton	\$50.00	—	—
Carborundum refractory brick, 9-in.	1,000	1250.00	—	—
Chrome brick, f.o.b. Eastern shipping points	1,000	1100.00	—	—
Chrome cement, 40-45% Cr ₂ O ₃	net ton	52-55	—	—
Chrome cement, 40-45% Cr ₂ O ₃ , sucks, in car lots, f.o.b. Eastern shipping points	net ton	30-32	—	—
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	35-40	—	—
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	30-35	—	—
Magnesite brick, 9-in. straight	net ton	65-70	—	—
Magnesite brick, 9-in. arches, wedges and keys	net ton	77	—	—
Magnesite brick, soaps and splits	net ton	98	—	—
Silica brick, 9-in. sizes, f.o.b. Chicago district	1,000	40-42	—	—
Silica brick, 9-in. sizes, f.o.b. Birmingham district	1,000	42-45	—	—
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.	1,000	35-38	—	—

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	\$200.00	—	\$225.00
Ferrochrome per lb. of Cr. contained, 6-8% carbon, earlots	lb.	11	—	—
Ferrochrome per lb. of Cr. contained, 4-6% carbon, earlots	lb.	.11	—	.12
Ferromanganese, 76-80% Mn, domestic	gross ton	60.00	—	63.00
Ferromanganese, 76-80% Mn, English & German	gross ton	60.00	—	63.00
Spiegelisen, 18-22% Mn	gross ton	25.00	—	27.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo	lb.	2.25	—	—
Ferrosilicon, 10-15%	gross ton	38.00	—	40.00
Ferrosilicon, 50%	gross ton	60.00	—	65.00
Ferrosilicon, 75%	gross ton	130.00	—	135.00
Ferrotungsten, 70-80%, per lb. of contained W	lb.	.40	—	.45
Ferrouranium, 35-50% of U, per lb. of U content	lb.	6.00	—	—
Ferrovanadium, 30-40%, per lb. of contained V	lb.	4.25	—	4.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content	net ton	\$8.00	—	\$10.00
Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃	ton	24.00	—	26.00
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard	ton	24.00	—	26.00
Coke, foundry, f.o.b. ovens	net ton	4.25	—	4.50
Coke, furnace, f.o.b. ovens	net ton	3.25	—	3.50
Coke, petroleum, refinery, Atlantic seaboard	net ton	12.00	—	13.00
Fluorspar, gravel, f.o.b. mines, New Mexico	net ton	15.00	—	—
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	20.00	—	22.00
Ilmenite, 52% TiO ₂ , per lb. ore	lb.	.01 $\frac{1}{2}$	—	.01 $\frac{1}{2}$
Manganese ore, 50% Mn, c.i.f. Atlantic seaport	unit	.20	—	.21
Manganese ore, chemical (MnO ₂)	net ton	50.00	—	55.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.	lb.	.55	—	.60
Monazite, per unit of ThO ₂ , c.i.f., Atlantic seaport	unit	30.00	—	—
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.12	—	.12
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport	unit	.13	—	.13
Pyrites, domestic, fines, f.o.b. mines, Ga.	unit	.11	—	.12
Rutile, 95% TiO ₂ per lb. ore	lb.	.15	—	—
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal)	unit	2.75	—	3.00
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.	unit	3.00	—	3.25
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	1.25	—	1.75
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.25	—	2.50
Vanadium pentoxide, 99%	lb.	12.00	—	14.00
Vanadium ore, per lb. of V ₂ O ₅ contained	lb.	1.00	—	—
Zircon, washed, iron free, f.o.b. Pablo, Florida	lb.	.04 $\frac{1}{2}$	—	.13

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	12.50
Aluminum, 98 to 99 per cent	24.5@25
Antimony, wholesale lots, Chinese and Japanese	4.70@4.80
Nickel, ordinary (ingot)	41.00
Nickel, electrolytic	44.00
Monel metal, sheet and blocks	35.00
Monel metal ingots	38.00
Monel metal, sheet bars	40.00
Tin, 5-ton lots, S. Rai	26.75@27.00
Lead, New York, spot	4.70
Lead, E. St. Louis, spot	4.50
Zinc, spot, New York	5.00@5.05
Zinc, spot, E. St. Louis	4.60

OTHER METALS

Silver (commercial)	oz.	\$0.70 $\frac{1}{2}$
Cadmium	lb.	1.00-1.25
Bismuth (500 lb. lots)	lb.	1.50@1.55
Cobalt	lb.	3.00@3.25
Magnesium (f.o.b. Philadelphia)	lb.	1.25
Platinum	oz.	78.00
Iridium	oz.	150.00-170.00
Palladium	oz.	55.00-60.00
Mercury	75 lb.	38.00-39.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	19.50
Copper bottoms	27.00
Copper rods	18.00@18.75
High brass wire	15.75
High brass rods	13.25
Low brass wire	17.25
Low brass rods	17.25
Brazed brass tubing	25.00
Brazed bronze tubing	29.75
Seamless copper tubing	19.50
Seamless high brass tubing	18.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current	Cleveland	Chicago
Copper, heavy and crucible	9.50@10.00	9.25	9.50
Copper, heavy and wire	9.00@9.25	8.50	8.50
Copper, light and bottoms	7.50@8.00	7.50	7.25
Lead, heavy	3.25@3.50	3.25	3.25
Lead, tea	2.25@2.35	2.25	2.25
Brass, heavy	4.25@4.50	4.50	5.00
Brass, light	3.25@3.50	3.25	3.50
No. 1 yellow brass turnings	4.00@4.25	4.25	4.50
Zinc	2.00@2.25	2.00	2.25

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by $\frac{1}{2}$ in. and larger, and plates $\frac{1}{2}$ in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes	\$2.88	\$2.88	\$2.88
8 ft steel bars	2.78	2.78	2.78
Soft steel bar shapes	2.78	2.78	2.78
Soft steel bands	3.42	3.48	3.48
Plates, $\frac{1}{2}$ to 1 in. thick	2.88	2.88	2.88

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Arkansas

PENTERS BLUFF—The American Manganese Co., 57 East Jackson Boulevard, Chicago, Ill., is reported to have plans under way for the erection of a new reduction plant in the vicinity of Penters Bluff, for the production of pulverized limestone. The plant is estimated to cost in excess of \$500,000. Manganese properties will also be operated in this district.

California

LONG BEACH—The California-Mexican Oil & Refining Co., Los Angeles, Vernon Dumas, head, is considering the construction of a new oil refinery in the vicinity of Long Beach, estimated to cost about \$450,000.

WILMINGTON—The Union Oil Co., Union Oil Bldg., Los Angeles, will break ground at once for the erection of its proposed new 3-story building at Wilmington, Los Angeles harbor. It will be 110 x 144 ft., and is estimated to cost \$250,000. A large laboratory for testing work will be installed. Ralph J. Reed is chief engineer.

Connecticut

WEST HAVEN—The West Haven Oil Co. has plans under way for the erection of new buildings at Elm and Water Sts., for general works service, to include tanks and other accessory equipment. Dwight E. Smith, Liberty Bldg., New Haven, is architect.

Illinois

CHICAGO—The National Rosin, Oil & Size Co., 3001-17 West Forty-seventh St., has filed plans for the extensions and improvements in its plant to cost about \$12,000.

CHICAGO—The Kaestner & Hecht Co., 500 Throop St., is taking bids for the erection of an addition to its foundry at Blackhawk and Cherry Sts., used for machinery and other metal casting production, to cost about \$30,000, including improvements in the present structure. Frank D. Chase, Inc., 645 Michigan Ave., is architect and engineer.

CHICAGO—The Oil & Chemical Corp., 4650 Iowa St., has acquired the entire block of property at Kirkpatrick Ave., Iowa and Walton Sts., totaling 248 x 504 ft. The company is now using a portion of the site and the remainder will be utilized for expansion. The property at one time was occupied by the Reedy Foundry Co. H. T. Dorington is secretary.

Kentucky

COVINGTON—The Michaels' Art Bronze Co., 230 Scott St., will commence the immediate erection of a 4-story and basement addition to its plant, 45 x 65 ft., to cost about \$40,000. F. I. Michaels is president.

Maryland

BALTIMORE—The Barclay Petroleum Co., 35 Wall St., New York, N. Y., is considering plans for the erection of a new oil refinery in the vicinity of Baltimore. The proposed plant will be equipped for operation under a centrifugal system of refining.

BALTIMORE—About \$100,000 will be expended by the Meadowbrook Dye Works, Inc., for machinery for installation at its proposed new plant on O'Donnell St., near Third St., comprising the former property of the Gunther Brewery. The building is 1-story, 96 x 140 ft., located on a site, 200 x 204 ft. The company was organized recently with a capital of \$200,000, and office at 523 Equitable Bldg.

BALTIMORE—The property of the National Vinegar Corp., St. Helena, near Baltimore, has been acquired by Emmet F. Sheridan and associates, who have taken possession. The property consists of a main 4-story building, 60 x 80 ft., with 2-story structure, 80 x 80 ft., and smaller

buildings. The new owners are forming a corporation to operate the plant for the manufacture of vinegar and byproducts. A number of improvements and extensions will be made, with the installation of machinery, estimated to cost about \$100,000. Plans have been filed for the immediate erection of a 2-story addition, to cost \$12,000. The former plant capacity will be doubled.

BALTIMORE—The Red "C" Oil Mfg. Co., Keyser Bldg., has had plans prepared for the erection of a new building at the Key Highway and Lawrence St., for general works service. W. H. Fehsenfeld is president.

Massachusetts

EASTHAMPTON—The Easthampton Foundry Co., Railroad St., has commenced the erection of a new 1-story foundry, 40 x 50 ft., with two wing extensions, 16 x 20 ft. The structure will cost about \$30,000. L. A. Moackel is president.

CHARLESTOWN—The Masury-Young Co., 198 Milk St., Boston, manufacturer of olive oil products, oil compounds, etc., has awarded a contract to the National Engineering Co., Boston, for the erection of a new 3-story plant on Roland St., Charlestown, 34 x 72 ft. A. D. Little, Inc., Cambridge, Mass., is engineer.

CHELSEA—The Revere Rubber Co. has had plans prepared for the erection of an addition to its plant to cost about \$20,000. Lockwood, Greene & Co., 245 State St., Boston, are architects.

Michigan

MANISTEE—Ruggles & Rademaker, 381 River St., have construction under way for a new salt manufacturing plant to cost in excess of \$500,000, with machinery. F. W. Perkins, company address, is architect.

New Jersey

CAMDEN—The Camden Pottery Co., Mt. Vernon and Orchard Sts., manufacturer of sanitary earthenware products, has construction under way on a new 2-story addition, 30 x 72 ft., at Orchard and Chestnut Sts., to cost about \$30,000. T. M. Dobbins is president.

New York

CORNING—The Corning Brick, Terra Cotta & Tile Co. has commenced the rebuilding of its plant, recently destroyed by fire with loss in excess of \$75,000. M. E. Gregory is president.

BUFFALO—The Dunlop Tire Corp., River Road, is planning to inaugurate operations at its new plant, recently completed, early in January, with a working force of about 2,500 men. The plant when entirely completed will represent an investment of close to \$20,000,000. P. D. Saylor is general manager.

BROOKLYN—Simon Garber & Sons, 1876 Pitkin Ave., manufacturer of oil products, have awarded a contract to the Turner Construction Co., 242 Madison Ave., New York, for the erection of a new 1-story building at Junius St. and Sutter Ave., to cost about \$200,000.

Ohio

NEWARK—The Leonard Oil Gas Co. is completing plans for the erection of a new oil refinery on East Street, estimated to cost about \$200,000 with machinery. The Rust Engineering Co., 1901 Fifth Ave., Pittsburgh, Pa., is engineer. J. W. Leonard is president.

CANTON—The Canton Oxygen Co., 1339 Yale Ave., N.W., manufacturer of commercial oxygen products, is having plans prepared for the erection of a new 1-story plant on Louisville Road, 47 x 90 ft. W. L. Stolzenbach is president. M. H. Miller, 319 McKinley Ave., S.W., is engineer.

Oklahoma

HENRYETTA—The Henryetta Glass & Mfg. Co. has awarded a contract for the erection of its proposed new local plant and construction will be commenced at once. A list of equipment to be installed

has been prepared, to include spraying machines, molds, mechanical fans and general manufacturing equipment. The new plant will specialize in the manufacture of chimneys, globes, shades, automobile lens and kindred products. The company was organized recently with a capital of \$50,000. H. L. Chambers is head.

Oregon

PORTLAND—The Columbia Tire Co., 1401 Northwest Bank Bldg., will soon call for bids for the erection of a new 2-story plant, 300 ft. wide, with four wings, extending to the rear, each 90 ft. long. It is estimated to cost about \$100,000. R. A. Wurzburg is head.

Pennsylvania

PHILADELPHIA—F. W. Tunnell & Co., 15 North Fifth St., manufacturer of fertilizer products, has awarded a contract to the Austin Co., Bulletin Bldg., for the erection of a new plant on Wheatshaf Lane, 1-story, 95 x 250 ft., estimated to cost about \$125,000. F. H. Tunnell is president.

EAST STROUDSBURG—The Nitroloid Co. has commenced operations at the former plant of the East Stroudsburg Glassware Co., recently acquired, for the manufacture of sheet celluloid and kindred products.

PHILADELPHIA—The United Chemical & Industrial Corp., Widener Bldg., has acquired a substantial interest in the Salts & Chemicals, Ltd., Kitchener, near Ottawa, Ont. The company will conduct certain operations, and plans to increase the capacity of the plant. Walter Whetstone is treasurer.

PITTSBURGH—The Air Reduction Co., 120 Broadway, New York, N. Y., manufacturer of commercial oxygen, etc., has filed plans for the first unit of its proposed new plant at 1100-16 Ridge Ave., to cost about \$60,000.

Tennessee

CHATTANOOGA—The Signal Mountain Portland Cement Co., James Bldg., will take bids during November for its proposed new local plant, estimated to cost in excess of \$500,000.

Texas

GROESBECK—The Magnolia Petroleum Co., Dallas, is planning for extensions in its plant at Groesbeck to cost in excess of \$500,000. A new pumping plant will be constructed and new tanks installed in the storage department of the works. E. A. Latimer is manager.

HOUSTON—The Ligol Chemical Co. has commenced the erection of a new plant on the Buffalo Bayou for the manufacture of liquid soaps, metal paint and affiliated products. It is proposed to commence operations at an early date. J. W. Crotty is president.

HOUSTON—The Sinclair Refining Co. is planning for the rebuilding of the portion of its plant on the Houston Ship Channel, recently destroyed by fire with loss estimated at about \$50,000.

Virginia

NORTH HOLSTON—The Southern Gypsum Co. is planning for the installation of crushing and other machinery at its plant. The company recently increased its capital to \$750,000 for expansion. Frank A. Wilder is president.

PULASKI—The General Chemical Co., 25 Broad St., New York, N. Y., will resume operations immediately at its local acid plant, placing two units in service, and giving employment to about 50 men. The plant has been shut down since March. It is expected to resume production in other departments at an early date.

West Virginia

PRINCETON—The Princeton Brick Co. is planning for extensions and improvements at its plant to double the present capacity. New machinery will be installed.

Washington

CHESTER—The Standard Stoneware Co. is completing plans for the erection of a new pottery for the manufacture of high-grade ware. It is proposed to break ground in October. Paul Seidel is president.

Wisconsin

MILWAUKEE—The J. Greenebaum Tanning Co., North Milwaukee, will take bids at once for the erection of a new 2-story tannery addition, 45 x 70 ft., estimated to cost about \$30,000.

Capital Increases, Etc.

THE KINGSTON PAPER Co., Little Falls, N. Y., has filed notice of change of name to the Niagara Felt & Paper Co. The latter organization has commenced the erection of a new plant on Sugar St., Niagara Falls, N. Y., to cost about \$300,000.

THE CARTHAGE BOARD & PAPER Co., Carthage, Ind., has filed notice of change of name to the American Paper Products Co.

THE PARAMOUNT RUBBER PRODUCTION Co. of New York, Waterloo, N. Y., has filed notice of dissolution under state laws.

THE HARRIS SOAP Co., 18 Stetson St., Buffalo, N. Y., has filed notice of increase in capital from \$35,000, to \$100,000.

THE PRINCE'S METALLIC PAINT Co., Allentown, Pa., has been adjudged an involuntary bankrupt.

THE MARYLAND VEGETABLE OIL Co., Fifteenth St. and Sixth Ave., Canton, Baltimore, Md., has arranged for a stock issue of \$2,250,000. John F. Nissly is president.

THE BARAHONA SUGAR Co., 129 Front St., New York, N. Y., has filed notice of increase in capital from \$16,000,000 to \$18,300,000.

THE BOONE OIL Co., 11 Broadway, New York, N. Y., has filed notice of increase in capital from \$7,000,000 to \$13,000,000.

A petition in bankruptcy has been filed against the BEVEL GLASS Co., 24 Downing St., New York, N. Y., manufacturer of mirrors, etc.

THE CARTHAGE SULPHITE PULP & PAPER Co., Carthage, N. Y., has arranged for a bond issue of \$600,000, for general operations, improvements, etc.

THE ALUMINUM Co. OF AMERICA, Oliver Bldg., Pittsburgh, Pa., has arranged for a bond issue of \$18,000,000, for general operations, financing, etc.

New Companies

THE DETROIT UNIVERSAL SOLVENT Co., Detroit, Mich., has been incorporated with a capital of \$25,000, to manufacture chemicals, paints, oils, etc. The incorporators are Wallace A. Armstrong, David S. Boyd and Harry W. Summers, 2691 Wreford Ave., Detroit.

THE AMIQUID Co., Boston, Mass., has been incorporated with a capital of \$500,000, to manufacture leather products. Frank A. Kamp is president, and Thomas M. Claffin, Brookline, Mass., treasurer.

THE PARK CHEMICAL Co., Brooklyn, N. Y., has been incorporated with a capital of \$100,000, to manufacture chemicals and chemical byproducts. The incorporators are J. A. and T. F. McGuinn, and J. Amico. The company is represented by E. J. Flanagan, 44 Court St., Brooklyn.

THE BENTON MFG. Co., 2130 West Van Buren St., Chicago, Ill., has been incorporated with a capital of \$5,000, to manufacture chemicals and chemical byproducts. The incorporators are Rupert Perböhner, Sidney Bisco and Solomon P. Roderick.

THE ALPHA PAPER PRODUCTS CORP., Brooklyn, N. Y., has been incorporated with a capital of \$5,000, to manufacture paper goods. The incorporators are W. G. Golden, M. Hoosack and F. D. McGarey, 51 Chambers St., New York.

THE ELECTRIC FOUNDRY & ENGINEERING Co., Wilmington, Del., has been incorporated with a capital of \$100,000, to manufacture steel and other metal castings. The company is represented by the Capital Trust Co. of Delaware, Dover, Del.

THE HERCULES SAPONA Co., INC., Boston, Mass., has been incorporated with a capital of 1,000 shares of stock, no par value, to manufacture chemicals and chemical byproducts. J. Sidney Stone is president; and Herbert P. Mason, Saugus, Mass., treasurer.

E. T. STILLE & Co., INC., 3422 Lincoln Ave., Chicago, Ill., has been incorporated with a capital of \$20,000 to manufacture varnish, shellac, paint, etc. The incorporators are E. T. and D. E. Stille, and W. W. Bennett.

MCCOMB BROS., INC., Scarsdale, N. Y., has been incorporated with a capital of \$25,000 to manufacture chemicals and affiliated products. The incorporators are S. and J. B. McComb, and F. Winters, Scarsdale. The company is represented by Jacob Axelrad, 365 Broadway.

THE TENMESCAL OIL Co., Los Angeles, Cal., has been incorporated with a capital of \$500,000, to manufacture petroleum products. The incorporators are L. K.

Adams, J. C. Gillham and C. C. Rich. The company is represented by Claud B. Andrews, 730 Merchants National Bank Bldg., Los Angeles.

THE BOULEVARD CHEMICAL Co., 381 Forest St., Jersey City, N. J., has filed notice of organization to manufacture chemicals and chemical byproducts. Robert H. Cohen, 42 Clendenny Ave., Jersey City, heads the company.

THE NASHVILLE PULP & PAPER Co., Nashville, Tenn., has been incorporated under Delaware laws with capital of \$1,250,000, to manufacture paper products. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington, Del.

THE JOHNSON HIGH TEST OIL Co., 503 State Bank Bldg., Freeport, Ill., has been incorporated with a capital of \$50,000, to manufacture petroleum products and byproducts. The incorporators are Harold W. Johnson, Edward J. Murray and Charles E. Johnson.

THE PERFEX PACKING FIBRE Box Co., New York, N. Y., has been incorporated with a capital of \$9,000, to manufacture fiber goods. The incorporators are L. Smith, Jr., B. I. Cantor and C. M. Hiesiger. The company is represented by Kleiner, Britwitz & Nadil, 399 Broadway.

THE SOLE WHITE LEATHER Co., Salem, Mass., has been incorporated with a capital of \$50,000, to manufacture leather products. Harold E. Hadley is president; and Thomas A. O'Keefe, 178 Lowell St., Peabody, Mass., treasurer.

THE NEW CORUNNA BRICK Co., Detroit, Mich., has been incorporated with a capital of \$25,000, to manufacture brick and other burned clay products. The incorporators are Henry F. Horn, Howard G. Harris and Christian P. Steinheiser, 1110 East Grand Boulevard, Detroit.

THE EL DORADO OIL REFINING Co., Tulsa, Okla., has been incorporated with a capital of \$500,000, to manufacture refined petroleum products. The incorporators are L. F. Severson, Tulsa; G. W. and L. F. Merrill, both of Texarkana, Tex.

THE ARKANSAS Co., New York, N. Y., has been incorporated with a capital of \$10,000, to manufacture oils, chemicals and kindred products. The incorporators are M. Braham E. F. Katzenhuber and A. A. Kelley. The company is represented by H. H. Neiman, 160 Broadway, New York.

THE KUEHN-CASWELL Co., New York, N. Y., has been incorporated with a capital of \$50,000, to manufacture insulating materials, compounds, etc. The incorporators are W. G. Kuehn, E. T. Caswell and J. E. Finegan, 5 Beckman St., New York.

THE UNITED STATES NON-METALLIC MINERALS CORP., Los Angeles, Cal., has been incorporated with a capital of \$100,000, to manufacture refined mineral products. The incorporators are C. H. Dickinson, S. H. Deyot and H. J. O'Brien, 801 Brent Ave., South Pasadena, Cal.

THE POTASH-MARL Co., INC., Marlton, N. J., has been incorporated with a capital of \$50,000, to manufacture potash products. The incorporators are Harry T. Martin, George F. Pentecost and Stanley Silliman, all of Marlton.

HUNNELL & Co., INC., New York, N. Y., has been incorporated with a capital of \$25,000, to manufacture oils, chemicals, etc. The incorporators are L. C. Hunnell, G. A. and G. W. Heath, 136 Liberty St., New York.

THE WESTERN GYPSUM PRODUCTS Co., Los Angeles, Cal., has filed notice of organization to manufacture gypsum specialties. M. E. Edwards, 3433 Hollenbeck St., Los Angeles, represents the company.

THE COLUMBUS FERTILIZER Co., Columbus, Ga., has been incorporated with a capital of \$15,000, to manufacture commercial fertilizer products. The incorporators are O. C. and Drane Bullock, and C. M. Neal, all of Columbus.

THE C. A. REED Co., Williamsport, Pa., has been incorporated with a capital of \$303,000, to manufacture paper products. Construction of a new plant will be placed under way at once, to be located at Laurel and Willow Sts., and estimated to cost approximately \$100,000. Harry A. Miller is treasurer.

THE KEMOZONE LABORATORIES, INC., Buffalo, N. Y., has been incorporated with a capital of \$50,000, to manufacture chemicals and chemical byproducts. The incorporators are M. J. O., and O. F. Cabana, Buffalo. The company is represented by Norton Bros., Brishane Bldg.

THE W. R. HOLLINGSHEAD CHEMICAL Co., New York, N. Y., has been incorporated under Delaware laws with a capital of \$1,000,000, to manufacture washing com-

pounds and other chemical products. The company is represented by the United States Corporation Co., 65 Cedar St., New York.

THE R. & G. RUBBER Co., New York, N. Y., has been incorporated with a capital of \$5,000, to manufacture rubber products. The incorporators are S. Zimmerman, S. Klein and H. Booke. The company is represented by J. M. Wolf, 2 Rector St., New York.

THE NATIONAL GRAPHITE Co., Kittery, Me., has been incorporated with a capital of \$500,000, to manufacture graphite products. Dexter B. Pattison is president, and Horace Mitchell, treasurer, both of Kittery.

THE WESTMORELAND LIME PRODUCTS Co., Wilmington, Del., has been incorporated under state laws with capital of \$100,000, to manufacture lime and affiliated products. The company is represented by the Delaware Registration Trust Co., 900 Market St., Wilmington.

THE GLOBE FIBRE Co., New York, N. Y., has been incorporated with a capital of \$20,000, to manufacture fiber products. The incorporators are H. Silverman, K. Axelrod and Abraham Grometstein, 41 Park Row.

THE BANGOR PULP WOOD & LUMBER Co., Bangor, Me., has been incorporated with a capital of \$100,000, to manufacture pulp products. Arthur G. Anderson is president and treasurer, and Donald F. Snow, secretary, both of Bangor.

THE CARBONDALE MFG. Co., New York, N. Y., has been incorporated with a capital of \$200,000, to manufacture refined oil products. The incorporators are F. Schaerer, J. F. McDavitt and K. Drinane. The company is represented by Kaye, McDavitt & Scholer, 149 Broadway, New York.

THE STEAM BOILER MATERIAL Co., 718 West 63d St., Chicago, has been incorporated with a capital of \$15,000 to mine, manufacture and deal in products of fire clay, firebrick, furnace linings, etc. The incorporators are Charles A. Miller, Arthur T. Leafy and Charles Vlaricoates.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its seventy-fourth meeting at Toronto, Canada. Dec. 27 to 31, 1921.

AMERICAN CERAMIC SOCIETY will hold its twenty-first annual meeting at St. Louis, Feb. 27 to March 2, 1922.

AMERICAN GAS ASSOCIATION will hold its third annual convention in the Congress and Auditorium Hotels, Chicago, the week of Nov. 7. More than 100 manufacturers will exhibit their latest gas-burning appliances.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its annual winter meeting at Baltimore, Md., Dec. 6 to 9. Headquarters will be at the Southern Hotel and the sessions will be held in the Engineers' Club.

AMERICAN MINING CONGRESS AND NATIONAL EXPOSITION OF MINES AND MINING EQUIPMENT will hold its twenty-fourth annual convention in the Coliseum, Chicago, Oct. 17 to 22.

ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS will hold its thirty-eighth annual convention at the Washington Hotel, Washington, D. C., Oct. 24-26.

INDUSTRIAL COST ASSOCIATION will hold its second national conference at Pittsburgh, Pa., Nov. 2-4, with headquarters at the William Penn Hotel.

INDUSTRIAL RELATIONS ASSOCIATION OF AMERICA will hold its annual convention at the Waldorf-Astoria, New York, Nov. 1-5.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stettens Restaurant, 342 Broad St., Newark, N. J., the second Monday of every month.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

The following meetings are scheduled to be held in Rumford Hall, the Chemists' Club, New York: Oct. 14—Société de Chimie Industrielle, regular meeting; Oct. 21—Society of Chemical Industry, Grasselli Medal; Nov. 11—American Chemical Society (in charge), Society of Chemical Industry, American Electrochemical Society, Société de Chimie Industrielle, joint meeting; Nov. 18—American Electrochemical Society, regular meeting; Dec. 2—Society of Chemical Industry, regular meeting; Dec. 9—American Chemical Society, regular meeting.

CHEMICAL & METALLURGICAL ENGINEERING

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Assistant Editors
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Industrial Editor
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Number 16

Coal, and the Rocky Road To Normalcy

STRIKES at hand and in prospect! Wars and rumors of wars! Peace that Senates will not ratify!

Such is our topsy-turvy world, a psychological maelstrom which keeps nations arming against they know not what, industries filling their stocks to withstand a state of siege, and the individual hoarding necessities against the hour of trouble. Such obstructions beset the return of sanity in us all.

The recent conference on unemployment emphasized how intimately the mental outlook affected everyday affairs. Almost everyone can see that slow trade and few jobs are cause and effect, and effect and cause; but we need to be reminded that the very realization of slow trade and a vision of jobless men intensifies that very condition. "Millions of people out of work! When will it hit me? Guess I'd better go slow!"

So narrow is the ledge which separates prosperity from panic and credit from ruin that it is crossed almost over night by a wave of thought. This doubtless is the reason why men who are really conversant with conditions throughout our country, and even of the world, are very careful against spreading alarming reports unless they are absolutely justified in doing so. And in this very direction lies a great fault in our Hallowe'en boggy, the threatened railroad strike. It is perhaps unreasonable to expect labor unions to give up their most efficient weapon, the strike, but it does seem hasty to brandish tomahawks and beat the tocsin now.

Doubtless many such considerations are the underlying reason why public officials and the press have had so little to say about the coal situation. Or it may be our national business policy not to borrow trouble; not to worry much about what can be foreseen—let it arrive and then make shift. But that is certainly not the way of engineers. In their work they must visualize all probable combinations of circumstances, and provide ways and means of preventing or handling them.

So, looking beyond the present railroad scare, they should be informed that there is unquestionably going to be trouble in the coal fields next spring. Operators have already agreed to arbitrate any question of wages, but the unions in recent convention at Indianapolis stand firm on a wage increase. Undoubtedly, this means no coal next spring, either bituminous or anthracite.

With this in view, managers would be well advised, and engineers would do well in emphasizing the fact, that several months' coal should be stored *now*. Deliveries are now prompt, and will be slow after New Year's. A drop in price sufficient to cover the risk of unpreparedness cannot be expected. Furthermore, generous purchases of coal would do much to relieve one most acute spot on the unemployment map—in the bituminous coal fields.

Do it now, and help over the bumps along the road to normalcy!

Internal Strain Versus Amorphous Metal

BEILBY'S theory of amorphous metal, as later extended by various scientists, has enjoyed such widespread acceptance among American metallurgists and has been put to such good uses that we sometimes forget the fact that a strong contingent of European workers declines to subscribe to the soundness of the idea. A leader of these "dissenters" is Professor E. HEYN. His comments on JEFFRIES and ARCHER'S recent publications on the hardening theory are printed on page 728 of this issue. In order that there may be readily available a statement of what Professor HEYN considers the greatest obstacle to the theory of amorphous metal, his "Theory of Strengthening of Metals by Cold-Work" has been translated and abstracted on page 735. Unfortunately, space limitation has made it necessary that this material be highly compressed. However, a great deal of pains has been taken to avoid distortion of the original meaning, and those who are using metallurgical theory will undoubtedly study HEYN'S ideas with interest.

In denying the amorphous theory, HEYN insists that a theory of latent tensions or of internal strain can be applied directly to a single-phase alloy, a metal wholly crystalline to the smallest particle. It is therefore surprising that he finds it necessary to visualize the mechanism of the imagined actions by the use of a compound substance composed of two such dissimilar materials as steel springs and modeling clay. However, this is a remark in passing and no sound reason for dismissing the theory.

And, without inferring that BAUSCHINGER'S published results have led to incorrect generalizations, it should be stated immediately that the development of optical methods for making a continuous record of a tension or compression test has given the investigator an implement of precision with which to make a searching survey of the field of elasticity. Without waiting for this critical examination it is agreed that when a metal has been loaded beyond its original limit of flow and then unloaded, it retains within it a certain amount of elastic strain and a corresponding stress which is held in equilibrium by some internal force similar to frictional resistance. In other words, when a test-bar is pulled, the crystals deform very slightly in shape and size, acting in an elastic manner up to the limit of flow, when their capacity for further homogeneous distortion is exhausted and further movement takes place by slip of crystalline blocks along their cleavage planes, partly relieving the load, permitting some of the crystalline fragments to return toward their original atomic spacing temporarily. However, the great majority of the crystals continue under distortion which approaches the breaking point.

One does not need to postulate amorphous layers around the crystalline blocks to grant that when the

external load is relieved, the distorted crystals visualized by HEYN as springs must exert a certain amount of pressure against their surroundings before the bar as a whole should contract. Crystal interlocking might be called upon to explain this lag. Entire relief of external loading, in other words, leaves the crystals in possession of a small residual deformation, corresponding to an internal strain similar to that imposed by external tension. By "internal" probably everyone (even Professor HEYN) means "within the test-piece" rather than "within the space lattice," for it is not admitted that physical distortion below the elastic limit can introduce something into the relations *between* atoms which would prevent recovery of normal spacing; strained crystals are due to forces acting somewhere upon their surfaces.

If it be assumed that the residual compressive strains are so arranged that they must be relieved on a second loading before the crystalline blocks take any additional deformation, no extension of the piece will be measured until the external load is sufficient to balance the internal resistance holding the internal stresses in equilibrium. But when that time comes, the crystalline blocks of our conception, or the springs of HEYN'S, are by no means free of stress, as Professor HEYN would have us suppose when he moves the origin of his stress-strain diagram and measures internal stresses from the new position. The elastic portion of the metal retains the residual deformation it possessed before reloading, and consequently the corresponding internal stress, a stress which is in the same sense as that imposed by the second loading in tension. Hence, considering only the distortions in the crystalline blocklets, it is difficult to see how the unit stress at their limit of flow will be in any way different or located on a different abscissa in the stress-strain diagram than on the first loading. Rather it is the compression loading on the surrounding material (likened by HEYN to frictional resistance) which is relieved by the first loads applied, and whose subsequent tension stresses may be measured from the transformed axis. However, Professor HEYN denies the actual existence of any such substance in a single phase metal, although he visualizes it as a thing so non-metallic as clay.

But only for the time being! In order to explain the lowered limit of flow in compression, it is apparently necessary to have the commanding part of the material free of stress at point *D* of his diagram (page 736). Therefore the "plastic mass" which held the "springs" in tension on relief of the first tension loading suddenly transforms itself into "springs" in compression, and this is the stuff which fails first in the subsequent compression test and so extensively as to produce flow at a low load. Howbeit this stuff is non-existent.

At any rate, if Professor HEYN'S views on residual stresses in overstrained metal be accepted, his hypothetical springs in tension be replaced by the actual crystalline blocklets, slightly deformed, and these ideas be then used to explain the higher flow limit on repeated loading and a lower flow limit in opposite loading, one is led to the conclusion that the material surrounding the crystalline fragments and holding them in position must have more influence in shaping the stress-strain curve than the blocklets themselves. This is true, whether we conceive this cementing material to be amorphous metal, or, with HEYN, merely layers of atoms pulled or pushed slightly out of their crystallographic positions and existing in a state of elastic strain.

Act! but

Think First

JUST because we brought out an important issue of this magazine in which we endeavored to point out where the faults lie in various chemical and metallurgical industries, we do not want to become common scolds. We want to take a cheerful view of life. But we think it worth while occasionally to look at the reverse side of some leading examples, and, without criticising the eminent men who have set them, to point out how such examples may be misused.

One of the most frequent references to the late ANDREW CARNEGIE is that he was never afraid to make a big scrap-heap if he had something better to take the place of what was discarded. The idea of that very canny and provident Scotchman, ruthlessly tearing down valuable equipment to throw it away, seems big and strong and mighty. If a thing is no good, get rid of it! Don't be afraid! It sounds fine. But unfortunately it has become the slogan of the wastrel and the man who is lazy in his mind. "Cut it out and call it a loss," we say; and then we smile at ourselves for our courage.

The other day we came across an Indiana farmer who is doing very well. He said when he took the farm over he was short of money to buy the machinery he needed, and among other things he lacked a corn planter. A neighbor had lately bought a new one and discarded his old one—which was laid out in the weather alongside of his new one. "What do you want for the old corn planter?" the young farmer asked. "It's no good," said the neighbor; "it's all used up. It's junk." "But what do you want for it?" he persisted. "I tell you it's all used up; you can have it for a dollar." So he bought it for a dollar, took it home, took it apart, oiled it and got the rust off, used it successfully for two years and then sold it for forty dollars when he needed a larger one.

Often we treat processes and whole industries just as the neighboring farmer did. They don't work and so, being ambitious to be drastic and powerful and resolute, we say: "Cut it out! Send it to the scrap-heap!" What we lack in our head-pieces is patience and persistence along with industry. We pride ourselves on thinking quickly when we don't think at all. We misuse CARNEGIE'S careful study and the superior technical information and advice with which he provided himself abundantly as a cover for our own ignorance and laziness.

These quick decisions to quit early or before a thing is determined by painstaking study and information, which are supposed to represent activity of mind and peculiar resolution but which in fact are nothing more than ignorance and bullying, are the despair of research. If a man speaks short and quick, that is no reason to believe that the activity of his mind is short and quick. He may not think at all. Very often he doesn't. He can dress his words as though he were a captain of dragoons while he uses his mind as though he ran a peanut stand.

The country is full of the corpses of enterprises that might have been going and producing concerns if it hadn't been for this loud-mouthed slap-dash impatience of ignorance. The destroyers are of the kind that declare they have no time for theories; that if you have anything that is all tried out and proved they will give it attention, but they prefer to let some other fellow do any experimenting that may be needed. And where should we all be today if nobody had ever had any use for theories or any willingness to experiment? We should be back in the woods, climbing trees!

Tinkering With Scientific Bureaus

OUR opinion has been requested regarding a scheme for the reorganization of the scientific bureaus of the Government and we cannot refrain from offering a few comments on the nature of that request. We received four closely typed pages across the first of which was written the touching appeal, "Will you please publish this in whole or in part?" while at the bottom of the last page and beneath the signature of our correspondent was the following postscript: "Please write soon to your Senator and Congressman urging this plan." The plan itself is simply this—all of the scientific bureaus of the Government are to be consolidated under one department. This idea, to be sure, is not entirely new, but in other respects the plan is not at all lacking in novelty. The suggestion of creating a new department of science is summarily dismissed, for "already there exists an institution which has great prestige and represents the science of the Government in a general way. It is the Smithsonian Institution." Just why the Institution was chosen is not exactly clear unless it is believed that bureaucratic life is now extinct and the bureaus themselves are ready for the museum!

Our would-be reformer, however, is really serious. He lists in all thirty-two scientific bureaus which, with their personnel and appropriations intact, should be transferred to the Smithsonian Institution. Among these we note the Patent Office, the Bureau of Fisheries, the Library of Congress, and even the Government Hospital for the Insane! Such is the rare combination to be effected in the interests of efficiency.

But we are told that there is appalling duplication in these scientific bureaus. For instance, the Library of the Smithsonian Institution contains 100,000 volumes, twice this many are in the Surgeon General's Office, and each of the other scientific bureaus maintains its own specialized library. Now all these libraries are to be combined under the Smithsonian Institution in order (to use the words of our correspondent) "to reduce expenses by avoiding duplication of books." Imagine the line forming on the right for consulting Vol. III of Thorpe or glancing through the pages of the latest number of CHEM. & MET.

And still there are many other reasons why this super-government control should be vested in Smithsonian. The consolidation "will tend to give more influence and efficiency to science and divorce it from the evils of politics." Furthermore, "many of the bureaus now have little influence and consequently *the scientific workers are paid shameful and minimum salaries.*" The italics are ours, for we feel that here we have struck the real keynote of the proposal. Our conviction is confirmed a little farther down in the brief, where we find the suggestion that "in inviting scientific men to take up *permanent* work with the Government, it is understood that they cannot be removed from their positions without very serious charge. . . . A true scientist in love with his work is more concerned with the permanency of his position and independence in his work than in the salary he obtains" and therefore "is always willing to make some sacrifice if necessary when the good of all Government science is at stake."

We have been asked for our opinion, and we are frank to admit that to us the scheme appears most ridiculous. It is the sort of propaganda that obscures the real issue and contributes nothing toward the solution of one of the most serious problems confronting the Government.

The Congressional Joint Committee on the Reorganization of the Administrative Branch of the Government needs practical, workable suggestions and scientific societies asked to indorse such schemes as this will do well to weigh their recommendations most carefully.

Iron Industry

As a Barometer

LONG ago it was said that "iron is the barometer of trade," but the barometric or prophetic character of iron demand is only partial. It obtains chiefly in connection with construction work. It is characteristic of much investment construction, the kind that looks to a long period of time for returns, a skyscraper office building being a particularly good illustration, that it is undertaken when costs are low—i.e., when general business is relatively inactive. As it requires a long time for the completion of such construction jobs and as periods of inactivity and activity alternate, the jobs undertaken when business is inactive are usually completed when business is active. Among the first contracts let is the contract for the steel, and the letting of the contract is prophetic that later workmen are going to be employed in erecting the buildings and putting on the finishing touches.

Of a totally different character, as to its connection with trade movements, is steel bought by railroads either directly or in the form of equipment. In the past the railroads have not bought much steel until business had improved and their traffic had increased. In the past one would have had to be quite blind to avoid seeing that business had improved until he observed that the railroads were making purchases on a liberal scale. The rule will apply to the immediate future. Until there is a very material increase in freight traffic the railroads will not buy freely.

In still another category is the steel that is bought directly or indirectly by the general public for current consumption, corrugated sheets, wire fence, agricultural implements, etc., by the farmer, tools by the mechanic, household wares by the housewife, and so on. This buying follows rather than precedes an improvement in business.

Some demand for steel precedes, some demand accompanies and some demand follows an improvement in general business. Only part of the steel demand is barometric or prophetic. If one wishes to obtain an indication for the future he should not take the demand for steel as a whole, but should scrutinize the steel market in detail and pick out the particular classes that are indicative along this line. The sales of Fords to farmers are one thing, the fabricated steel lettings, as reported by the Bridge Builders' and Structural Society, are an altogether different thing.

As to the divergence in conclusions reached by observation of the steel market in the recent past, that is due largely to the finished steel business having divided itself into two classes. One class includes sheets, wire products, tin plates and tubular goods. Demand for these has been and is relatively good. The other class includes bars, shapes, plates and rails. Demand for these has been and is very poor. Materials in the first class are widely distributed and the demand for them betokens a very fair degree of common everyday activity. Materials in the second class run more to construction work, investment buying and railroad buying. They make "the tonnage" in steel, and when they are in poor demand the steel output is low.

Readers' Views and Comments

The Slip Interference Theory of the Hardening of Metals

To the Editor of Chemical & Metallurgical Engineering

SIR:—I read with keen interest the important contribution by Dr. Zay Jeffries and R. S. Archer, which sheds light on many dark points, and I am glad to avail myself of this opportunity of recording some comments.

The Amorphous Metal Theory of Beilby. To my regret I am unable to sympathize with this theory, which, as the authors suggest, gives the only completely satisfactory explanation of the phenomena of the strengthening of metals by cold-work. First, I doubt whether the amorphous metal theory might justly be called a "theory" at all. In advancing a theory, a fundamental supposition is made, which by logical reasoning leads to conclusions controllable by observation.

The amorphous metal theory necessitates quite a number of independent suppositions: (1) The existence of the "amorphous" phase. (2) Different assumptions as to the properties of this phase, which is assumed to be hard, of great strength, to have fluid characteristics, to be soft at elevated temperatures and so on. In short, all the properties which can be observed in the metal itself are, as circumstances require, attributed to this hypothetical phase. Now, it is a somewhat unsatisfactory "explanation," to explain the properties of a substance as a whole by attributing the same properties to a hypothetical part of it. The amorphous theory might thus be termed a *pars pro toto* theory.

However this may be, there is a serious objection to this theory. It can explain the fact that a metal which has been stressed in tension beyond its yield point will after unloading and loading anew in tension exhibit a higher yield point, or, in other words, be strengthened. Now it is a known fact, established by the research work of Bauschinger, that a metal which has been stressed in tension beyond its yield point, has its original yield point in compression lowered, and *vice versa*. Cold-work in tension thus can effect strengthening in tension (hardening), but, on the other hand, cold-work in compression causes weakening (softening), when tested in tension. I should like to know how this well-established phenomenon could be explained by the amorphous theory without starting some new assumptions *ad hoc*.

This curious behavior of metals led me to the theory of "latent elastic strains" which is outlined in *Metall und Erz*, 1918, Nos. 22 and 23, and more completely¹ in the *Festschrift der Kaiser Wilhelm Gesellschaft zur Forderung der Wissenschaften*, 1921, p. 121, entitled "A Theory of the Strengthening of Metals by Cold-Work."

As to the boundaries between neighboring crystal grains, I am convinced that in them the arrangement of the particles of the space lattice will be different from the arrangement of the particles in the interior of the

crystal grains. A field of forces will act between the surface layers of contiguous crystals and the particles will take positions along the lines of force. This forced or restrained state of the substance along the boundaries seems to me to have close resemblance to a state of elastic strain. In so far I agree with the authors that these boundaries play an important rôle in the behavior of the metal.

Provided there is no foreign matter inclosed between neighboring grains, I cannot see any necessity to suppose these boundaries to be amorphous, or liquid, or undercooled, and I oppose this view for the same reasons which hinder me from denoting by the word amorphous a crystalline substance which is slightly deformed under elastic strain.

Troostite, Osmondite, Sorbite. The authors join the very generally accepted opinion that these constituents represent nothing more than different degrees of subdivision of the cementite particles in a ferrite-like groundmass. Some years ago I called attention² to the maximum of solubility exhibited by steel hardened and tempered at 400 deg. C. (exhibiting a structure called osmondite) to the maximum of dark coloration on etching and to the greatest carbonaceous residue on dissolving such steel in dilute acids. Prof. Benedicks tried to explain this behavior by drawing analogies with the phenomena observed in colloidal solutions of solid bodies in liquids. But his argument, though ingenious, appeared to me somewhat unconvincing and my doubts have recently been strengthened by the magnetic experiments of Saizo Saito³ which led this author to the conclusion that the transitional constituent "osmondite" in fact contains free carbon.

Martensite Is Alpha Iron. The authors conclude that the magnetism of the martensite suggests the presence of crystalline, magnetic (alpha) iron. Most metallographers are now inclined to believe that there is no difference between alpha and beta iron, but that the critical range A_1 is nothing more than the temperature at which alpha iron loses its magnetism on heating and regains it on cooling, without any change of phase. Now, what would happen, if, by any treatment, it was possible to conserve gamma iron below A_1 ? Could not then the gamma iron have a magnetic transition point of its own, so that the gamma iron could be ferromagnetic below some definite temperature? Indeed, Prof. Honda⁴ found magnetic transformations in carbon steels at temperatures above A_1 —that is, when the iron is undoubtedly in the gamma state.

The results of X-ray spectrometry alluded to by the authors would no doubt give valuable evidence as to this question. I look forward with the greatest interest to the publishing of the details of these experiments.

E. HEYN.

Berlin-Dahlem, Germany.

¹E. Heyn and O. Bauer, "Influence of the Treatment on the Solubility of Steel in Sulphuric Acid," *Iron and Steel Institute*, 1909, vol. 1, p. 109.

²"On the State of Carbide in Carbon Steels Quenched and Tempered," *Science Reports*, Tohoku University, vol. 9, p. 281 (1920).

³"Ueber die Wärmeerscheinungen und Magnetisierungsänderungen ferromagnetischer Körper bei höheren Temperaturen," *Science Reports*, Tohoku University, vol. 2, p. 69.

¹Abstract of the latter article is printed on p. 735 of this issue.

What the X-Ray Spectrometer Tells About the Structure of Solid Solutions

To the Editor of Chemical & Metallurgical Engineering

SIR:—In referring to Haakon Styri's splendid notes¹ on the paper of Jeffries and Archer² on "The Slip Interference Theory of Hardening," it is mainly with the idea of throwing a little light upon the matter of the space-lattice conception of solid solutions. Mr. Styri has struck upon those points in the theory which have formed the basis of most of the criticism that has come to the writer's attention.

It is undoubtedly true that the X-ray spectrometer would fail to find a small amount of cementite even if it were present in austenite as such. Indeed as the writer has shown the pattern is only faint in a white cast iron whose cementite content may be quite high. Furthermore, in examining any crystalline matter composed of iron and carbon the pattern is that of the iron atoms, substantially as if the carbon were empty space. The disparity of atomic weight is responsible for this phenomenon. Nevertheless there is great cause to regard austenite as a solid solution of carbon in gamma or face-centered iron.

Many experiments have shown that when the microscope and the equilibrium diagram indicated that a solute metal exists in solid solution in a solvent metal the X-ray spectrometer shows that the average spacings between the atomic layers have not changed (center to center) from those in the pure solvent and that the solute atoms simply replace atoms in the solvent lattice. The extent of the solubility is indeed in a sense a measure of the similarity in volume and electronic distribution of the two kinds of atoms. Thus the cube edge of the "crystal cell" of copper has not changed by the addition of 30 per cent of zinc. Beyond this amount there seems to be such force distortion in the lattice that further additions of zinc form a different lattice whose interatomic forces are compatible with stability. In different alloys this may or may not represent a compound in which a definite number of each kind of atoms forms the basis of the "crystal cell." As solute is added the volume of the solid solution naturally increases in proportion to the atomic volume of the solvent, multiplied by the number of atoms of solute incorporated.

By analogy, cannot carbon atoms replace iron atoms in austenitic iron? The writer first sought to explain the solution of carbon (regardless of state) in austenite by placing the carbon atoms in the interatomic spaces—the tetrahedra of the face-centered lattice suggesting a stable location for the supposedly tetrahedral carbon atom—but the volume increase forbids consideration of this easy solution. Indeed the suggestion that volume increases with addition of cementite to austenite supports our conception admirably.

So then, if the carbon atom in austenite were compelled to be surrounded by three iron atoms in some manner to constitute Fe_3C (or perhaps Fe_3C_2) we should certainly have a discontinuity in the austenite lattice. In the course of the same investigation in which the writer, under the direction of Dr. Jeffries, showed that manganese steel, nickel-iron and hot iron were all face-centered cubic in character, some information regarding cementite was obtained—namely, that there are spacings in the cementite lattice which could not pass

through the austenite lattice. Hence even a single "crystal cell," even if it were the simplest molecule, could not diffuse through austenite and the carbon atom would have to progress by continuous distortion of the lattice, constantly divorcing its iron partners and setting up new distortion. But even by this process we have been forced to picture carbon atomically dispersed, which seems to be the point which is not looked upon with favor by those who object to the idea that the solution of cementite in iron is a true solid solution. The fact is, we must regard atoms—not molecules—as the basis of crystal structure; the bricks, if you will, that build the walls of the crystal. The bricks are not alike, but fit together to form a stable whole.

In all fairness it should be said that the author finds certain strong lines in his cementite pattern to match lines in austenite. This may indicate that austenite has stability approaching that of the compound, but it does not alter the fact that all specimens of cementite do show the same very complicated pattern with some large spacings. Frankly, the "puzzling out" of the cementite lattice progresses very slowly and is very baffling. A few large crystals of pure cementite suitable for examination by the original Bragg method would greatly facilitate a solution of its structure.

Picturing here and there a carbon atom replacing an iron atom in austenite, quenching merely permits the allotropic change, leaving the carbon atoms *in situ* in martensite. The body-centered iron lattice in martensite, marvellously fine grained, is no doubt subjected to enormous force distortion by the presence of the carbon still atomically dispersed. Carbon then, as far as itself is concerned, is very like a compressed monatomic gas and could very easily, it would seem, form hydrocarbons with the "nascent" hydrogen formed during solution by acid.

The writer does not feel qualified to discuss the other extremely interesting points in Mr. Styri's paper and has in mind merely the idea of adding possibly a few details of the atomic structure phase of the new theory.

Cleveland, Ohio.

E. C. BAIN.

The Use of Inert Gas for the Prevention of Explosions

To the Editor of Chemical & Metallurgical Engineering

SIR:—Referring to the use of inert gas for the prevention of explosions and fires, as described by Edward F. White in the Sept. 14 issue of your journal, may I call attention to the fact that the Lewis Recovery Corporation has United States and foreign patents for the use of flue gas as a carrier for the vapors of volatile solvents used in coating, impregnating or treating fabrics or other materials?

This corporation has had solvent recovery plants embodying this principle in continuous operation for over four years with entire absence of fires and explosions. These plants are recovering solvents such as gasoline and benzene in industries in which fires have been notoriously frequent. Indeed, a fire outside the inclosed solvent-using equipment in one of these plants failed to ignite the flue gas-solvent vapor mixture within, although it destroyed everything outside. No difficulty has been encountered in operating with a maximum oxygen content of 3 per cent. This gives a factor of safety of 4, as 12 per cent oxygen is required for flame propagation in hydrocarbon vapors.

Lewis Recovery Corporation
Cambridge, Mass.

KENNETH E. BELL.

¹CHEM. & MET. ENG., Aug. 24, 1921, vol. 25, No. 8, p. 313.

²CHEM. & MET. ENG., June 15, 1921, vol. 24, No. 24, pp. 1057 to 1067.

Joseph William Richards In Memoriam

DR. JOSEPH WILLIAM RICHARDS, professor of metallurgy at Lehigh University, died at his residence, 231 East Market St., Bethlehem, Pa., on Wednesday, Oct. 12, 1921, at 9 a.m., from heart failure. Impressive funeral services were held on Saturday following at Packer memorial chapel of Lehigh University, where a large number of friends, among whom were the leading chemists and metallurgists of America, gathered in honor of his memory.

J. W. Richards was born in Oldbury, England, fifty-seven years ago, on July 28, 1864, and was brought to this country when very young. He was graduated from the Central High School of Philadelphia, Pa., in 1882 with the degree of Bachelor of Arts (A.B.) and entered Lehigh University in September of that year. He was graduated from Lehigh University in 1886 with the degree of Analytical Chemist, and was awarded the degree of Master of Science (M.S.) in 1891 and that of Doctor of Philosophy (Ph.D.) in 1893. In September, 1887, Dr. Richards was appointed assistant instructor in metallurgy and blowpiping at Lehigh University, and he served continuously at the university from that time to his death in the following positions: Instructor in metallurgy, mineralogy and blowpiping, 1890-1897; assistant professor, 1897-1903; professor of metallurgy, 1903-1921.

Dr. Richards was one of the foremost engineers of the country and had an international reputation in various branches of metallurgical technology. His services were widely sought as legal expert in chemical and metallurgical cases. He was a member of the U. S. Assay Commission, 1897; representative of the Franklin Institute to the International Geological Congress held in Russia in 1897; member of the jury of awards, department of chemistry, of the National Export Exhibition, Philadelphia, in 1899; member of the jury of awards and chairman of the metallurgical sub-jury, Panama Pacific International Exposition, 1915; member of the U. S. Navy Consulting Board, 1915-1918. He was a member of the Franklin Institute, Philadelphia, president of the chemical section 1897, 1899, and professor of electrochemistry of the Institute 1907-1910.

Always of an independent and original turn of mind, it was not surprising to find Richards among the "insurgents" from the American Chemical Society and the American Institute of Electrical Engineers who met

in Philadelphia nearly twenty years ago to form the American Electrochemical Society; indeed, he was the first president. Many of the conservatives decried the movement, on the basis that there were enough national societies already, but the independents persisted. Since the first, the Electrochemical Society has been unique in the hearty friendliness of the gatherings, much in contrast with the habitual secrecy and reserve supposed to permeate the industry. On the other hand, the influence of example has not been without value to the tone and activities of each of the older societies. Dr. Richards' interest has been continuous. President for the first year of its existence, he became secretary in 1907, an office he has filled since that time.

A few months after the electrochemists formed their society, a small group of enthusiasts gathered together in a certain public house in Philadelphia, prominent among

whom were Dr. Richards, W. D. Weaver, then Editor of the *Electrical World*, Carl Hering, and E. F. Roeber. Talk ran upon the need of a publication reflecting the aims of the new society, and it was agreed that such a magazine should be published. Unfortunately, or perhaps fortunately, the new society, numbering only 200 or 300 members, had not the funds for the venture, but Weaver promised to interest Mr. McGraw in the project, if possible. In this he was successful, and the Electrochemical Publishing Co. was formed, with Dr. Richards as president, a company which with Dr. Roeber as editor on Sept. 1, 1902, started publishing *Electrochemical Industry*, the forerunner of CHEMICAL & METALLURGICAL ENGINEERING.

Dr. Richards was no dummy president. His interest in the details of the publication was intense for several years. Further-

more, he was one of the principal editorial contributors in the first volumes, publishing many notable articles on electrometallurgy as practiced both here and abroad. His important work on *Metallurgical Calculations*, which has become standard and has had such a wide circulation in several languages, was published serially in *Electrochemical Industry*.

His other books include a treatise on Aluminum, and several translations, principal among which is "Cementation of Iron and Steel" from the Italian of Federico Giolitti. His contributions to the technical press and many scientific societies are legion.

Dr. Richards was fortunate in selecting teaching as a profession, and his influence on American technology, transmitted through his students, will be unending. They especially will mourn the passing of a helping friend and a true gentleman.



JOSEPH WILLIAM RICHARDS

Studies in Colorado Shale Oils—A

Secondary Oils Obtained From a Representative Colorado Shale Oil by Successive Distillations at Atmospheric Pressure—Character and Composition of These Decomposition Products and of Their Parent Material

By ARTHUR J. FRANKS

IN TWO recent preliminary papers¹ under this title the author presented elementary data on a number of Colorado shale oils and their fractions. The results of this work have shown that the heavy fractions of these oils are unstable and crack easily on distillation at atmospheric pressure. The decomposition is attended by the following very marked phenomena: (1) a lowering in specific gravity; (2) an increase in saturated hydrocarbons; and (3) a considerable loss of nitrogen and sulphur, as well as a decided change in their distribution. The increase in saturation was accounted for by the decomposition of the heavy, unsaturated and unstable compounds containing sulphur and nitrogen, and perhaps oxygen. But since such a phenomenon is not in accord with the theories and results prevalent in petroleum practice and because the evidence already presented was not conclusive, it was decided to extend the scope of these preliminary investigations in order to obtain further data, either in support of or in contradiction to the theories already suggested.

SCOPE OF THE PRESENT INVESTIGATION

The purpose of the present work was to study, by means of careful analyses, the changes produced in the fractions of a representative Colorado shale oil by repeated distillations at atmospheric pressure, to endeavor to verify previous data with the hope of proving conclusively that new saturated hydrocarbons were formed as a large portion of the products of cracking and that their source was the heavy compounds soluble in concentrated sulphuric acid, and, if possible, to throw further light on the general character and composition of these decomposition products and their parent material.

This investigation was conducted along the same general lines as in the previous studies.² Two series of distillations were made. The first involved four successive distillations of a single sample of oil into 10 per cent fractions. The changes in these fractions were determined by the means of measurements of specific gravity, saturation, temperature of distillation and amount of decomposition, and by analyses for sulphur and nitrogen. On the basis of the behavior of the oil, as determined by these changes in the 10 per cent fractions, conclusions are to be drawn as to some of the general characteristics of the oil as well as its probable composition. A second series of distillations and analyses were made on another sample of the same oil to prove definitely that saturated compounds formed a large part of the products from the cracking of some of the heavy, unsaturated and basic fractions, to provide a sufficient amount of cracked distillate for examination and to serve as a general check on the first part of this work.

The oil upon which this investigation was made was chosen because it was regarded as representing a typical product from Colorado shales of the De Beque region. It was made in a Ginnet retort and was obtained through the courtesy of the Monarch Shale Oil Co. A 1-gal. sample was taken from a 10-gal. can of this oil which had been allowed to stand undisturbed in the laboratory for two weeks in order to permit most of the suspended water to settle out. The sample was thoroughly mixed by long shaking and a 4-oz. portion withdrawn for analysis. The results of this analysis are:

Specific gravity.....	0.909	Nitrogen, per cent.....	1.992
Saturation, per cent.....	20.8	Water, per cent.....	0.13
Sulphur, per cent.....	0.72	Initial boiling point, deg. C.....	70

OUTLINE OF THE INVESTIGATION PROCEDURE

All distillations were made in Pyrex distillation flasks at a rate which was maintained constant throughout the progress of the distillation by constant and extremely careful regulation of the gas flames. Naked flames from Meeker burners were used as the source of heat. The sizes of all fractions are expressed on the basis of the original oil volume and not that of the oil distilled. The vapor temperatures were measured by a 400 deg. C. thermometer and are uncorrected for the emergent stem. The same one was used for all distillations in order that the results might be strictly comparative.

All specific gravities are expressed at 25 deg. C. and were obtained from the Baumé values taken with a hydrometer. The conversions were made from standard tables. The same hydrometer was used for all the determinations.

The water, initial boiling point (i.b.p.), saturation, nitrogen and sulphur were determined as described in former papers.³ A modified Kjeldahl method was used in obtaining the nitrogen and a modification of the Parr sodium peroxide fusion method for the sulphur. All analyses of the crude oil and fractions were made in duplicate with extreme care. Where the results failed to check within reasonable limits the analyses were repeated and averages taken as the true values.

METHOD OF PROCEDURE FOR THE FIRST SERIES OF DISTILLATIONS

In the first distillation it was attempted to separate the oil into 10 per cent fractions with as little decomposition as possible without resorting to the use of either a vacuum or steam. A 1,500-c.c. portion of the well-mixed sample was distilled to dryness from a weighed 2-liter distillation flask at a rate of about eight drops a second. When the vapor temperature reached 300 deg. C. hydrogen gas (obtained from a cylinder) was introduced slowly in five fine streams through a perforated tube which extended to the bottom of the flask.

¹CHEM. & MET. ENG., vol. 24, No. 13, March 30, 1921, p. 561 and vol. 25, No. 2, July 13, 1921, p. 49.

²Loc. cit.

³Loc. cit.

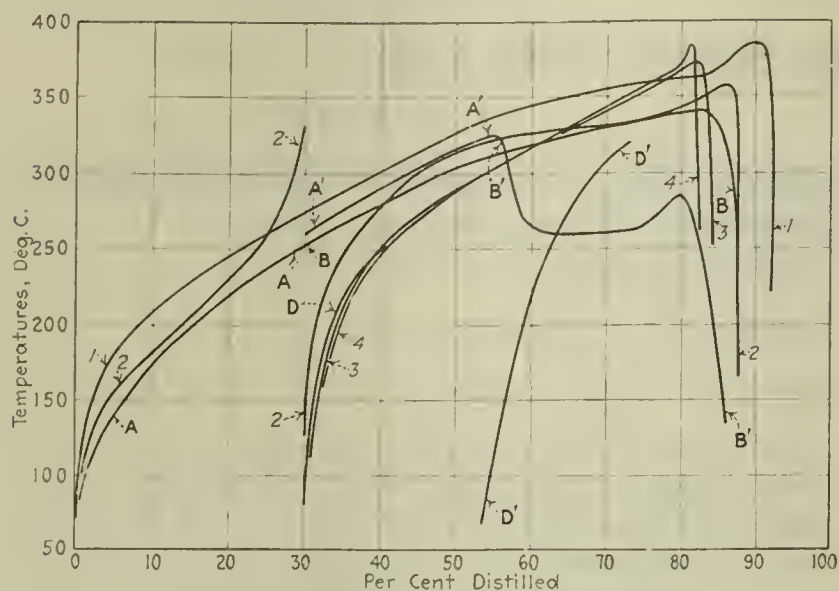


FIG. 1. TEMPERATURE CURVES

As the distillation continued, hydrogen was admitted at an increasing rate, which reached about 25 liters per 100 c.c. of distillate near the end. The rate of heating and the amount of hydrogen used were so controlled that no appreciable amount of vapor issued from the condenser. After the distillation was finished the flask was cooled and weighed. The increase in weight gave the amount of coke produced by decomposition of the oil.

Two composites were then made from two-thirds (100 c.c.) of each of the 10 per cent fractions; one contained the first three and the other the last seven fractions. The remaining portions of each fraction were then analyzed. The results appear under "1" in Table I.

DISTILLATION OF THE COMPOSITES

The two composites were then distilled separately to determine their stabilities. It was also desirable to remove the lighter oils in order that the changes in the heavy oils might be more marked. The result of such procedure will be obvious from a glance at the curves in Figs. 1 to 4.

The 300-c.c. light oil composite was again distilled at a constant rate from a 500-c.c. distillation flask into three 10 per cent fractions of 100 c.c. each. The last fraction contained only 98 c.c., since it was impossible to drive over all of the oil. This introduces no appre-

ciable errors in the analysis, however. The same analyses as before were made on each fraction. The results are given under "2" in Table I. No further distillations of the light oil were made, since changes other than those due to refractionation are not apparent. The remainder of this part of the investigation was conducted on that portion of the oil above and including the 40 per cent fraction.

The heavy oil composite (623 c.c.) of the seven fractions from "1" was distilled from a weighed 1,000-c.c. distillation flask into 10 per cent fractions of 100 c.c. each. The distillation was carried to dryness, at a rate of two drops per second, as described in a former article.⁴ The weight of coke was obtained from the difference in weight of the flask before and after distillation. Three-tenths (by volume) of each of the cuts

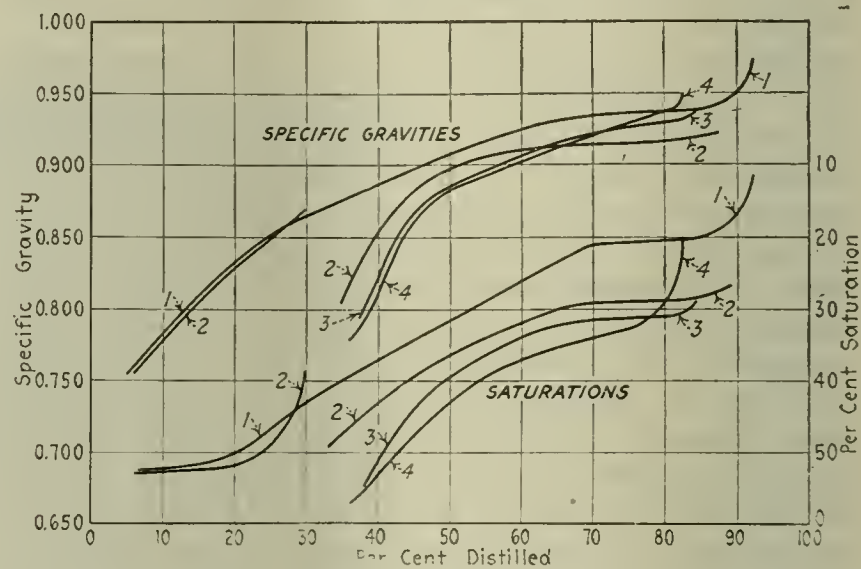


FIG. 2. SPECIFIC GRAVITY AND SATURATION CURVES

were reserved for the usual analysis, the results of which are presented under "2" in Table I.

The remaining seven-tenths of each of the fractions from "2" (405 c.c.) were composited and distilled to dryness from a weighed 1,000-c.c. distillation flask at approximately the same rate and in the same manner as before. Ten per cent fractions (70 c.c.) were again taken and the coke determined. Three-sevenths of each

⁴Loc. cit.

TABLE I. DATA FROM FIRST SERIES OF DISTILLATIONS

Dist. No. Fraction	Analyses for 10 per Cent Fractions				Vapor Temperatures			
	1	2	3	4	1	2	3	4
	—Sp. Gravities (25 Deg. C.)—				Per Cent Saturation			
10	0.782	0.778	.....	.....	52.2	53.4	.....	.....
20	0.831	0.828	.....	.....	50.0	52.0	.....	.....
30	0.864	0.871	.....	.....	43.0	38.8	.....	.....
40	0.887	0.853	0.819	0.810	37.2	43.0	52.2	53.0
50	0.906	0.897	0.884	0.883	31.5	36.4	39.5	43.0
60	0.926	0.911	0.906	0.903	26.3	32.0	33.8	37.0
70	0.935	0.915	0.922	0.921	21.1	29.0	31.4	33.8
80	0.937	0.918	0.930	0.938	20.5	28.8	31.0	29.1
82.6	.....	.....	.....	0.950	.....	.....	19.8	.....
84.3	.....	.....	0.937	.....	.....	.....	28.6	.....
87.9	.....	0.924	.....	.....	.....	26.8	.....	.....
90.0	0.950	.....	.....	.....	17.0	.....	.....	.....
92.3	0.975	.....	.....	.....	11.0	.....	.....	.....
Composite*	0.924	0.903	0.894	0.892	25.1	32.9	36.9	37.3
	—Per Cent Sulphur—				Per Cent Nitrogen			
10	0.75	0.68	.....	.....	0.599	0.528	.....	.....
20	0.79	0.73	.....	.....	0.993	0.930	.....	.....
30	0.77	0.86	.....	.....	1.331	1.450	.....	.....
40	0.75	0.70	0.61	0.60	1.429	1.218	1.071	1.063
50	0.73	0.69	0.65	0.64	1.575	1.506	1.613	1.607
60	0.68	0.64	0.62	0.60	1.712	1.797	1.786	1.785
70	0.67	0.60	0.58	0.58	1.726	1.828	1.878	1.883
80	0.65	0.48	0.55	0.52	1.744	1.849	1.964	1.988
82.6	.....	.....	0.45	0.47	.....	.....	.....	2.169
84.3	.....	.....	.....	.....	.....	.....	1.992	.....
87.9	.....	0.40	.....	.....	.....	2.037	.....	.....
90.0	0.60	.....	.....	.....	1.832	.....	.....	.....
92.3	0.52	.....	.....	.....	2.084	.....	.....	.....
Composite*	0.67	0.59	0.59	0.58	1.688	1.700	1.706	1.707
	Temperature, Deg. C.				Temperature, Deg. C.			
0	70	65	.....	.....	80.0	360	365	370
5	182	158	.....	.....	81.5	.....	.....	385
10	205	179	.....	.....	82.0	.....	370	360
15	.....	204	.....	.....	82.1	.....	.....	.....
20	245	229	.....	.....	82.6	.....	.....	260
25	.....	257	.....	.....	83.6	.....	340	.....
30	276	330	65	65	84.3	.....	250	.....
35	.....	245	207	208	86.5	.....	.....	.....
40	302	278	250	247	87.9	358	.....	.....
50	330	316	289	288	90.0	165	.....	.....
60	344	326	315	317	92.3	220	.....	.....
70	355	332	340	340	.....	.....	.....	.....

* Composite of heavy oils from fractions over 30 per cent.

† First drop in receiver, 135 deg.

§ Initial boiling point.

of these cuts were withdrawn and the same determinations made as for the other fractions. The results of the analysis appear under "3" in Table I.

The four-sevenths of the oil remaining from each of the "3" fractions (217 c.c.) were composited for the last time and distilled into 10 per cent fractions (40 c.c.) from a weighed 500-c.c. distillation flask. The rate of distillation was maintained at about three-fourths of a drop per second. The usual data were obtained on these fractions. The results are given under "4" in Table I.

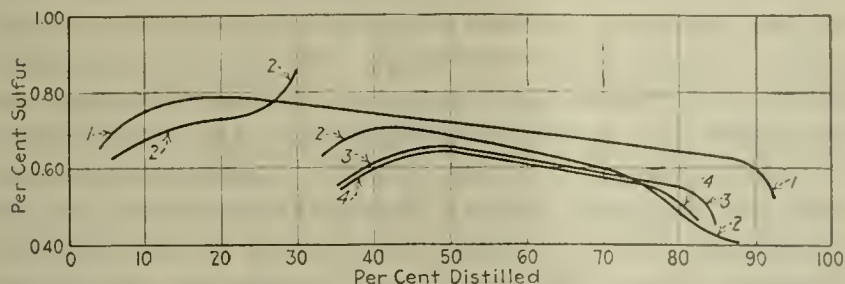


FIG. 3. SULPHUR CURVES

METHOD OF PROCEDURE FOR THE SECOND SERIES OF DISTILLATIONS

The second series of distillations was carried out in a somewhat different manner. A 1,200-c.c. sample of the same oil was distilled from a 2-liter flask at a rate of four drops per second until 30 per cent (360 c.c.) had been condensed. The resulting fraction will be called "A" for the sake of convenience. The distillation was then stopped, the undistilled residue (hereinafter designated as fraction "B") allowed to cool, and a sample then withdrawn for analysis. A 490-c.c. portion of this residue was then distilled to dryness from a weighed 1,000-c.c. flask at a rate of two drops per second. The weight of coke was obtained by weighing and subtracting the weight of the cold flask. Vapor temperatures were read at every 5 per cent fraction, but no cuts were made. The whole distillate (hereinafter designated as "C") was then thoroughly mixed and a sample taken for analysis.

The heavy unstable oils present in B must have decomposed during this distillation, and whatever light oils were thus formed therefrom must have been left in C. Hence, 330 c.c. of C was then distilled from a 1,000-c.c. flask at a rate of two drops per second. As the vapor temperature reached 250 deg. C. the distillation was slightly retarded in order to permit a sharper separation of the oil boiling below 254 deg. C., at which temperature the distillation was discontinued. This distillate will be hereinafter referred to as "D" and the residue as "E." Obviously, D is a new, secondary product formed by the cracking of certain constituents originally present in B.

Determinations for specific gravity, saturation, sulphur and nitrogen were made on A, B, C, D and E. All analyses were made in duplicate. In addition to these analyses, determinations for aromatics and organic bases were made in A and D. The data from these analyses are given in Table II. The temperature curves are presented, together with those from the first series of distillations, in Fig. 1.

The aromatics were determined by the "aniline point" method developed by Tizard and Marshall.⁵ It depends upon the difference between the temperatures of mutual solubility of saturated hydrocarbons containing aromatics, and of those free from such compounds.

TABLE II. DATA FROM SECOND SERIES OF DISTILLATIONS
Analysis of Fractions

Product	Yield, per Cent	Sp. Gr. (25° C.)	Sat., per Cent	Sp. Gr. Sats.	Sulphur, per Cent	Nitrogen, per Cent	Aromatics, per Cent	Bases, per Cent	Unsat. Compd.
A(70-254°)	30	0.824	45.6	0.809	0.72	1.034	4.7	8.0	46.4
B.....	70	0.950	11.5	.....	0.66	2.336	..	..	..
C.....	57.1	0.905	32.5	.....	0.60	1.880	..	..	..
D(75-254°)...	10.8	0.826	49.2	0.791	0.64	1.164	2.8	12.0	38.8
E.....	46.2	0.924	29.0	.....	0.58	2.055	..	..	..

Vapor Temperatures									
Prod-uct	Per Cent Fraction	Temp., Deg. C.	Prod-uct	Per Cent Fraction	Temp., Deg. C.	Prod-uct	Per Cent Fraction	Temp., Deg. C.	Prod-uct
A	5	140	C	35	265	C	80	339	D
	10	172		40	280		82	341	
	15	195		45	292		85	335	
	20	218		50	303		87.1	250	
	25	236		55	312	D	5	218	
	30	254		60	317		9	242	
				65	324		10	250	
				70	330		10.8	254	
				75	335				

It was first necessary to remove from the sample to be analyzed all bases and unsaturated hydrocarbons by means of a thorough treatment in the cold with a liberal amount (about 200 per cent by volume in all) of 95 per cent sulphuric acid. The saturated hydrocarbons were allowed to separate, the tar was drawn off, the hydrocarbons poured into a small clean flask, and then carefully washed with a very small amount of water. Powdered anhydrous sodium carbonate was then thrown in to neutralize any acid remaining in the oil and to take up the water. After standing for about a day the oil should be neutral, clear and dry. An ordinary washing

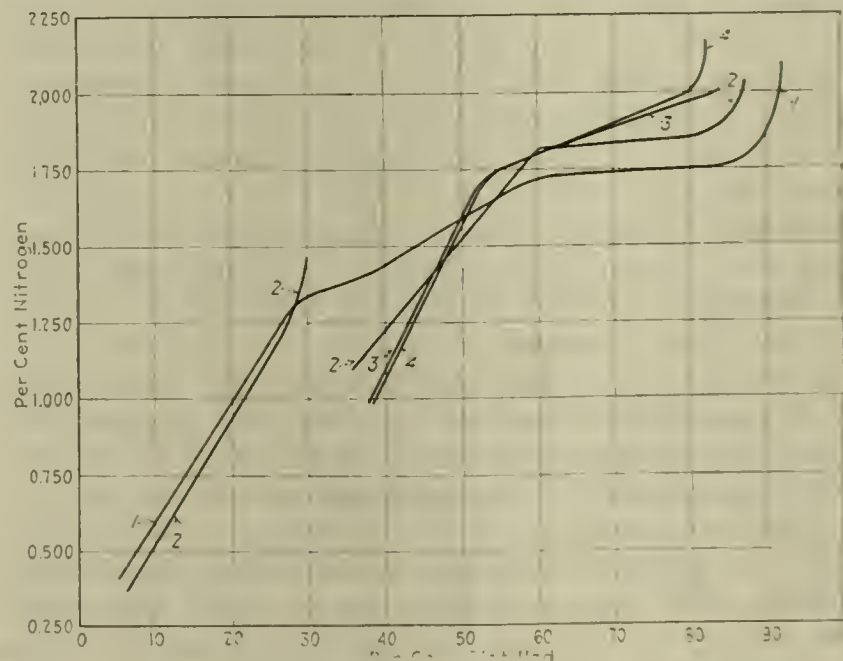


FIG. 4. NITROGEN CURVES

with either water or alkali solution should not be attempted in the case of shale oil distillates, since persistent emulsions are formed which are separable only with great difficulty.

After obtaining the specific gravity, the aniline point was then determined on the saturated hydrocarbons by measuring a 10-c.c. portion into a large test tube from a pipette, adding 10 c.c. of freshly distilled aniline from another pipette, heating and stirring the mixture until complete solubility obtained, then slowly cooling and stirring and determining the temperature at which it became turbid. This temperature is the aniline point.

The remainder of the saturated oil was then sulphonated by shaking in the cold with a liberal amount of 98 per cent sulphuric acid for about 20 to 30 minutes, which treatment removes the aromatics. The hydro-

⁵J. Soc. Chem. Ind., 40, 20T, 1921.

carbons were then separated, washed and dried as before, and the aniline point determined. The percentage of aromatics by weight was obtained from the difference in aniline points by the use of a curve prepared by Tizard and Marshall.⁶ Since the saturation and specific gravity of the oil and the specific gravity of the saturated hydrocarbons were known, the percentage by weight of aromatics in the original sample was easily calculated.

The bases were determined by measuring the absorption of the oil by dilute hydrochloric acid. Ten c.c. of the oil was measured into a graduated 15-c.c. centrifuge tube and 3 c.c. of HCl (1 part conc. acid to 4 parts of water) added. The tube was stoppered, well shaken and centrifuged until separation of the two liquid layers was complete. From the amount of oil absorbed by the acid the volume per cent of bases was calculated.

The unsaturated compounds are expressed in per cent by volume and were calculated as the difference between 100 and the sum of the bases and saturated hydrocarbons.

FACTS DEDUCED FROM THE TABULATED DATA AND GRAPHS

The data presented in the tables and represented graphically by the curves verify the results of previous work, as well as many expectations. In general it may be said that the light oils (boiling below 270 deg. C.) are very stable and suffer no appreciable alterations on distillation other than those due to changes in distribution of some of the compounds obtained by a higher degree of fractionation. The heavy fractions of the crude oil, on the other hand, are not stable, and during a single cracking distillation suffer extensive decomposition. This phenomenon has already been mentioned by the author in the two previous papers mentioned above and by C. W. Botkin.⁷ The very heavy end portions of the crude oils are so unstable that they decompose even when a large quantity of an inert gas (such as hydrogen) is used during the distillation. This is obvious from a comparison of the analysis of the heavy oil composite from the first distillation with the analysis of the undistilled residue *B*. The data in Table III show that, generally speaking, about half of the unstable constituents of the heavy oils are of this type.

After one cracking distillation, however, the oils produced and those escaping decomposition are fairly stable.⁸ Yet further distillations do effect appreciable changes in the oils, as the curves and especially the calculations from the data (Table III) show.⁹ At the end of four distillations the heavy fractions (above 270 deg. C.) of the crude oil, with the exception of saturated hydrocarbons, had decomposed to such a great extent that the resultant distillates seemed to be virtually new oils, composed largely of products from the cracking of those fractions. It will be shown later that this is actually the case.

The temperature curve (Fig. 1) constitutes a valuable index of the general course of the changes produced in the oils by the successive distillations. The temperatures at which 10 per cent cuts were made are plotted as

ordinates and the per cent distilled as abscissas. These and all curves are drawn through the mean values wherever the points fail to strike a smooth curve. In most cases, however, the curves pass through the points determined experimentally. The curve for the first distillation lies above the others because of the great rate at which the liquid was distilled in the attempt to prevent decomposition as far as possible; hence the fractionation was poor. This is verified by curve 2 for the second distillation of the light oil. The curves for the products *A* and *C* are representative of results secured by the standard method⁹ of distillation adopted in this work. Curve 2 for the heavy oils shows that much decomposition and the formation of a large portion of the light oils occurred during the first distillation. Curves 3 and 4 indicate further decomposition and light oil formation, as well as increased stability of the distillates. It is obvious that the 30 to 46 per cent fraction (65 to 276 deg.) from the fourth distillation consists of oils produced by the cracking of unstable constituents of the crude and not present originally therein.

The specific gravity curves (Fig. 2) merely confirm the conclusions drawn from the temperature curves.

The curves in Fig. 2 representing the distribution of saturated hydrocarbons show marked resemblance to the specific gravity and temperature curves. This verifies the qualitative relationship stated by the author⁹—namely, that the percentage saturation of the 10 per cent fractions decreases as their specific gravities and

TABLE III. PERCENTAGE LOSSES AND INCREASES IN SATURATION OF DISTILLATES

Kind of Loss	Distillation				Total 1-4	B-C
	1	2	3	4		
Total weight.....	9 20	5.91	3.97	1.82	20.90	16.3
Coke.....	4 15	3.69	1.40	0.28	9.52	8.5
Gas.....	5 05	2.22	2.57	1.54	11.38	7.8
Sulphur.....	11 6	12.2	3.4	2.0	29.2	25.5
Nitrogen.....	32 8	4.7	3.3	1.4	42.2	32.3
Volume.....	7.7	4.4	3.6	1.7	17.4	12.9
Increase in sat., c.c.....	93 0	34.0	10.0	—4.0	133.0	106.0
Increase in sat., per cent.	44.7	16.1	5.0	—2.0	63.8	51.0

vapor temperatures increase. This relationship is well illustrated, especially by the curves for those fractions near the end of the distillations.

The sulphur curves in Fig. 3, in which the percentages of sulphur are plotted as ordinates and percentage distilled as abscissas, certainly confirm the results of and conclusions drawn from previous work relative to the distribution of sulphur and its relation to various properties of the distillates. They are very similar in form. This is all the more remarkable when it is considered that all of these curves either pass through or strike very close to the points determined by analysis. In no case are the differences greater than possible errors in the analyses themselves. The data and curves confirm the deductions arrived at in the preceding paper—namely, that the cracking causes a considerable loss of sulphur, but only a small lowering of the percentage in the resulting products, and that if most of the cracking is prevented the sulphur decreases regularly in the heavier distillates, as a part of curve 1 shows. Since decomposition began after the 80 per cent fraction, the balance of the curve is forced downward. The small difference between curves “3” and “4” indicate that although most of the cracking had occurred in the first two distillations there is still a little decomposition even

⁶Ibid., 22T.

⁷CHEM. & MET. ENG., vol. 24, No. 20, May 18, 1921, p. 876.

⁸Botkin (CHEM. & MET. ENG., vol. 24, p. 879) states: “Compared with the first distillation, the decomposition during the second and third distillations is very slight, occurring only at higher still temperatures when the distilling flask is nearly dry and probably at a temperature exceeding that indicated by the thermometer. This shows a high stability for the heavy portions of the once-run oils . . .”

⁹CHEM. & MET. ENG., March 30, 1921, p. 561.

after a third distillation. The amount of sulphur lost by the fourth distillation is, however, not great (see Table III), which shows that most of the unstable sulphur compounds had been decomposed in the first distillations and that the new compounds and those remaining are quite stable. The fact that all the sulphur curves turn downward near the end shows that the very heavy, last oils contain a little less sulphur than the less heavy fractions.

The nitrogen curves in Fig. 4, in which the percentages of nitrogen are plotted as ordinates and the percentages distilled as abscissas, are a great aid in following the course of the changes in the oils. Since the amount of nitrogen is relatively high, determinations can be easily and accurately made, and especially because most of the heavy nitrogen compounds seem to be sensitive to heat and easily decomposed. The curves furnish further evidence in support of the conclusions drawn from the data in the preceding paper relative to the distribution of the nitrogen and the forms in which it occurs, and also confirm the deductions from the other curves presented in this communication.

It is rather surprising to find the distribution of the nitrogen so consistent and the changes in distribution so abrupt. The persistence of straight lines which represent uniform increases in nitrogen at four different rates in the distillates cannot be ignored, although their significance is not clear. The curves suggest the presence of four different series, or classes, of nitrogen compounds. No other explanation seems possible for these sharp turning points in the curves and for the uniform rates at which the nitrogen increases in the different fractions. Most of the nitrogen in the fractions boiling up to 300 deg. C. is present in the form of basic compounds, since but little nitrogen is left in these distillates after a treatment with dilute hydrochloric acid. Much basic material is also present in the heavy oils, but a large amount of the nitrogen seems to be present in the form of heavy oils containing sulphur and resembling the heavy fractions of asphaltic petroleum. Some of these nitrogenous, asphaltic oils seem to be quite stable, but the others (which are heavier) are not. This accounts for three main classes of compounds. Since there must be more than one class of nitrogen bases, the presence of a fourth series is almost certain. Many others may be present in such small amounts, or they may be distributed throughout the oil in such a manner as not seriously to effect the general distribution of the nitrogen.

Part B of this article will be published in a subsequent issue.

Cement Industry in the Philippines

The town of Naga, in the Island of Cebu, is now conceded as the best field for a cement industry in the Philippines, according to the Bureau of Science, Manila. Both the chemical and grinding tests on raw cement material produced in the field have been highly successful and point to the feasibility of a cement venture on a large scale.

The field is situated near coal mines from which a suitable supply of fuel may be run to the cement plant by gravity.

The National Cement Co., mostly owned by the Government, will in a short time erect a cement plant in this locality, it is reported.

Strengthening Metals by Cold-Work

BAUSCHINGER'S numerous experiments on cold-worked metals proved that if a test-piece be overstrained in tension beyond the original elastic limit, $+\sigma_e$, it thereby acquires a higher elastic limit in tension, but a lower elastic limit, $-\sigma_s'$, in compression (and *mutatis mutandis*). Thus cold-work in tension strengthens in tension but weakens in compression, and *vice versa*. In general the original properties return after heating beyond a "temperature of restoration," varying with the metal. In tin and lead, for instance, it lies near atmospheric. (Such metals are excluded from consideration in what follows, since working at ordinary temperatures causes no change in properties.)

Prof. E. Heyn attempts to explain the nature of these changes.¹ He says that deformation may be elastic or plastic. Within the limits of elasticity, the outer forces are balanced by those set up by the small displacements of the "smallest particles" (Heyn does not call them atoms or molecules) from their mean positions in the space lattice. Release of stress is accompanied by regeneration of the work of deformation, and the process

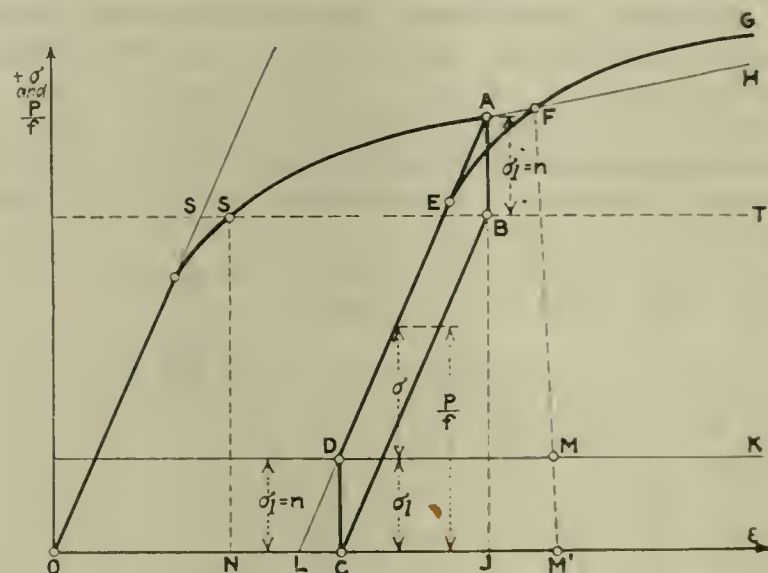


FIG. 1. IDEAL STRESS-STRAIN DIAGRAM ON RELOADING IN TENSION

is reversible. True plastic deformation is visualized by Prof. Heyn thus: Materials stressed beyond the "limit of flow" act like clay, the tiny particles migrate from one position of stability to another, and yet another. Continual flow takes place without increase of stress; increasing the force only increases the rate of flow. Release of force causes no restoration of shape or energy; the process is not reversible.

Under these suppositions an ideal stress-strain diagram should start from the origin and rise straight (by Hooke's law) to the elastic limit, (OS' in Fig. 1) then proceed horizontally along S'T to fracture. However, the actual diagrams are essentially different. The proportional limit is reached before the "limit of flow," and the latter is accompanied by no sharp break in the curve at S, only a very small radius of curvature, except with the iron alloys and a few others. Prof. Heyn says this early deviation from elastic behavior is due to true plastic deformation at defects and minute cavities acting as internal notches. Once the limit of flow is passed, added stress must be imposed to continue the elongation, even up to fracture, as shown by the curve SA, because in metals the deformation is accompanied by rupture of the crystallites into

¹*Metall und Erz*, 1918, Nos. 22 and 23, and *Festschrift der K. Wilhelm Gesellschaft zur Förderung der Wissenschaften*, 1921, p. 121.

smaller blocklets; the body of these still act in an elastic manner, even though they are sliding past each other at their boundaries as in true plastic deformation, therefore added loads must be imposed to overcome the elastic resistance of the blocklets still remaining intact. He insists that such phenomena can occur in a pure metal containing but a single phase.

If a tension test-piece is stressed somewhat beyond the limit of flow, say to point *A* (Fig. 1), and the load removed, a certain amount of contraction *CJ* may be measured, a quantity which varies somewhat with the speed of release and upon aging. The permanent set *OC* determined immediately may therefore consist not exclusively of plastic deformation, but in small part of elastic deformation held latent by internal forces.

Reloading for a second time, it is found that the limit of flow has increased. Yet if the permanent set consists entirely of plastic deformation, it would seem that the smallest particles should have returned on unloading to their original distances between mean positions, and apparently should require the original stress to restart plastic flow, and not resist a somewhat larger one. Hence Heyn returns to the assumption given in the preceding paragraph, that overstrained metal retains in addition to much pure plastic deformation a certain amount of elastic elongation or strain ϵ_l and also a corresponding stress in tension σ_l , which is in equilibrium with some internal force similar to frictional resistance. The imposed load P/f is equal

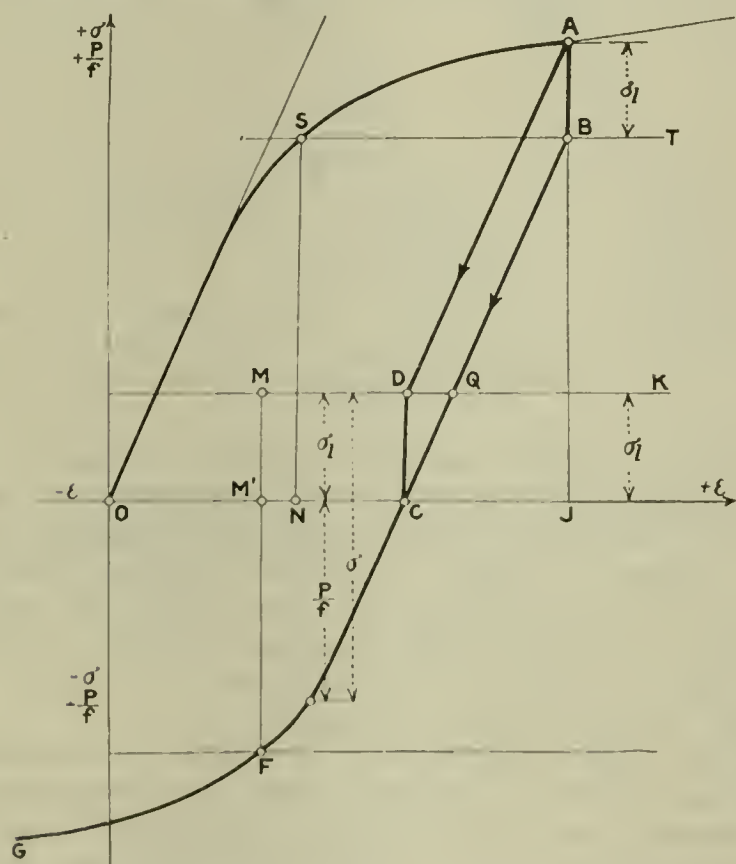


FIG. 2. IDEAL STRESS-STRAIN DIAGRAM ON RELOADING IN COMPRESSION

to the unit stress σ when the unloaded bar is free of original strain, or when release of outer load is accompanied by no latent stress σ_l . He likens the action to that of a rod of purely plastic substance like plasticine in which is embedded a multitude of fine spiral springs, which act in an elastic manner even when the piece is stressed above σ_s , the limit of flow. If this rod is rolled out, the springs attempt to return to their original position but are restrained by their anchorage.

Using these ideas to analyze the action on release of a tension test-piece loaded to a point *A* (Fig. 1), Prof. Heyn notes that at first the internal stress remains

constant at σ_l (and the corresponding deformation at *OJ*) even while the imposed load P/f is decreasing. When $\sigma_A - P/f$ becomes sufficient to overcome the internal resistance w , the test-piece shortens an amount proportional to the further decrease in loading. The curve representing the relation between elongation and external load (the $\epsilon, P/f$ curve) becomes *ABC*; the ϵ, σ curve (or that between elongation and internal stress) for the corresponding time is *AD*, parallel to *BC* and separated by a constant distance, σ_l .

On reloading, the rod does not elongate until the outer force P/f becomes equal to the internal resistance counteracting the latent stress σ_l . After that, Prof. Heyn states, the rod acts exactly as it did on first loading—i.e., the curve *OSA* begins from point *D* as origin and follows *DEG*. In this the $\epsilon, P/f$ curve is *CDEFG*. The ϵ, σ curve is a parallel curve, σ_l below, or what is the same thing, curve *DEFG* with horizontal *DK* for x -axis.

The so-called strengthening, therefore, merely consists of moving the limit of flow from the load *S* to the load *F* (Fig. 1), on the original curve *OSA*. He also believes that this strengthening is fictitious, since he measures the true internal stress σ on reloading from abscissa *DK*, and its real magnitude is the same in the second as in the first reloading. In his words: "The essential point is that the theory of latent stresses explains the loop formed by experimental stress-strain curves on repeated loadings." The form of the loop *ABCD* naturally varies with the circumstances.²

When loading the overstrained bar in compression, certain phenomena occur which may best be visualized by considering the overstrained bar as a complex of springs called α remaining in tension (by latent stress) and others called α' in compression (for equilibrium). Further it is assumed that a stress-strain diagram in compression would be the same shape as in tension, merely rotated 180 deg. about the origin. After release from overstrain springs α are in tension equal to $+\sigma_l$, and springs α' are in compression equal to $-\sigma_l$. As loading progresses the compression on springs α' continually increases and at *F*, the limit of flow, it is equal to $-\sigma_l - P/f$ (the distance *MF*, Fig. 2). In other words, draw a stress-strain curve in compression downward from *Q* as origin, and it will correspond to the curve derived from experiment. Such construction also shows that the hypothesis of latent stress explains why the limit of flow in compression, after an overstraining in tension, lower in numerical value than the original limit of flow in tension.

Recognizing the inconsistency of using a plastic mass to restrain his imagined springs when reloading in tension and replacing this plastic mass by springs in compression when loading in compression, Heyn imagines the latter to be incapable of taking stress except in compression. Thus they would have no influence on a second loading in tension.

Since either tension or compression causes the same kind of failure in crystalline metal—namely, by shear—the resultant deformation on cold-work is always of the same nature. By the theory of elasticity, such deformation is accompanied by an increase in volume; it has been found experimentally that cold-work of any kind is accompanied by a decreased specific gravity, according to theory.

²Bouasse, Abstracts, *Ann. Chim. phys.* (series 7), vol. 29, p. 384 (1903).

Causes of High Top Heat in the Blast Furnace

Charts Recording the Temperature of Waste Gases Are of Value in Controlling Furnace Operations, Indicating Especially Clearly the Exact Time When Charging Is Done and if the Charge Is Alternately Hanging and Slipping

By WALLACE G. IMHOFF

IT IS extremely interesting to study the operation of the blast furnace from the viewpoint of the top heat. This feature is not of minor importance, but really is deserving of careful consideration, for by thoroughly understanding the causes which effect the top heat at least one result will be smoother furnace operation.

In order to control the top heat all the conditions which effect it should be known and thoroughly understood. Some of the most important features and indications of high top heat are listed in the captions below, and discussed in some detail.

HIGH WIND

For a given set of furnace conditions only a certain volume of wind can be blown in order to maintain a state of equilibrium. If the volume of wind is decreased, then the furnace will at once respond by becoming hotter in the bottom, or if the volume of wind is increased, the furnace will at once respond by becoming colder in the bottom. Therefore a very important feature is to know just how much wind to blow into a furnace to give the smoothest operation. All these features seem so simple that they are not even important enough to bear discussion, yet in practice they are not so thoroughly understood.

Suppose, for example, we try to increase our tonnage by increasing the wind. At first perhaps there does not seem to be any appreciable difference in the operation of the furnace, but by and by the reserve heat in the furnace has been exhausted and we note as time goes on that our top heat is gradually beginning to rise.

In a short time the furnace seems to be getting cold in the bottom, although the top heat continues to remain high. As a matter of fact, with the reserve heat gone the bottom is now blown cold and the fusion zone has risen from the hearth to the mantle or higher, thus causing the continued high top heat.

LOW STOVE HEAT (COLD AIR)

One of the commonest causes of a high top heat is the continued use of cold air. At this time we generally have present an extremely hot bottom, or a bottom that is at least hotter than is desired. This would be the time to increase the wind and get more tonnage, but as a matter of fact cold air is generally run in with the stove heat to lower the hearth temperature. The cold air has two effects—it reduces the hearth temperature to such an extent that it throws the silicon into the slag as silica, and thereby frees the sulphur; and second, it raises the top heat.

The first feature may often be desired to obtain better driving, especially if the furnace is hanging, but it is accomplished sometimes only by extreme sacrifice.

With the rise in top heat the furnace often gets in such a condition that it has to be slipped to put in charges. This aggravates conditions already bad and finally the furnace goes off entirely.

Cold air should seldom be used. The logical way to cool the bottom down is to increase the wind a revolution or so, and when the iron desired is made, then cut the wind back to normal. The use of cold air does not seem to be understood from another angle, and that is that it is often left on too long, throwing the furnace violently cold. Great judgment must be exercised in running the stove heat down with cold air that it be shut off before the cooling effect has gone too far.

LETTING THE FURNACE HANG A LONG TIME

It is not a good policy to let a furnace hang longer than thirty-five to forty minutes. There are a number of reasons for this, the most important one being that it precipitates too much cold stock into the hearth and lower part of the furnace at once, and hence makes extremely irregular iron.

The continued hanging of the furnace is indicated by a gradual rise in top heat. This is noted by the saw-toothed top heat curve drawn with regular furnace operation, the rise being made during the intervals of filling, and the fall being caused by the cold charge. With smooth regular driving these saw-teeth on the curve are small and there are a large number of them, for the furnace is filled often and the top heat does not have a chance to rise very high before another cold charge is put in.

The longer a furnace hangs the higher the top heat will rise. This is shown by the very large saw-teeth on the top heat chart. Once the top heat has risen to a high temperature it is often difficult to get it back to normal again. By watching the indications shown on the top heat chart under various conditions the state of the furnace can be immediately seen. For example, suppose it hangs for an hour, slips 12 ft., and then starts to hang again. The top heat chart shows a smooth continued rise in temperature, then a gradual dropping off for an hour in steps represented by the lowering of the big bell to drop in a new charge. With each charge there is a step down. Finally the furnace is filled and when the filling ceases, the top heat curve again ascends in a smooth, rising, straight line.

A COLD BOTTOM

High sulphur may be caused by a shortage of lime, but another cause of more importance is a cold bottom. The hearth temperature is the indicator of the condition of the sulphur, and, *vice versa*, the sulphur is the indicator of the hearth temperature.

The top heat chart may show a very low top heat with a cold bottom, or it may be very high. In the first

instance the stack is cold all the way up and down and therefore a top heat of 200 to 250 deg. may be expected. On the other hand, a cold bottom may be due to a high fusion zone, in which case a high top heat will be recorded. For example, suppose we show an actual case of this type. At 5:45 a.m. the bottom was cold, as shown by the analysis of the iron, 0.64 silicon and 0.078 sulphur. Thirty-two extra coke were put in at 7:50 a.m. Before the coke went in the top heat was 350 deg. By 7:40 p.m. the top heat showed 650 deg., and the bottom was still cold due to the fact that cold air was run in to counteract the effect of the coke.

As a matter of fact, the coke burned in the middle of the furnace and the bottom remained cold. By examining the iron it will be seen that when the effect of the coke disappeared the furnace was in as bad a condition as before. The complete analyses are given below:

Time	Silicon	Sulphur	
5:45 a.m.	0.64	0.078	Cold
10:50 a.m.	0.80	0.057	
3:55 p.m.	1.13	0.042	Greatest effect of coke
8:35 p.m.	1.15	0.062	
1:00 a.m.	0.80	0.052	Cold

32 extra coke put in at 7:50 a.m.
Top heat at 5:45 a.m., 350 deg.
Top heat at 7:40 p.m., 650 deg.

This example shows clearly why the lining in some furnaces is so badly cut out above the mantle. The high fusion zone is indicated clearly by the high top heat and cold bottom. The use of cold air is one of the quickest and surest ways of raising the fusion zone.

HIGH SULPHUR

As stated above, high sulphur is caused by a cold bottom. By continually observing the top heat chart other features of interest are also to be seen at this time. In addition to the high top heat and high sulphur, generally there is a high blast pressure, sticking and hanging, and slow furnace driving.

The addition of a large amount of extra coke often raises the sulphur. This is shown by an example when thirty extra coke were put in at one time. The top heat curve showed very high peaks and the iron at cast time analyzed 0.54 silicon and 0.072 sulphur. Another example is of interest, as it shows the effect very strongly in the iron and also in the extreme rise and fall of the top heat curve. At 2:30 p.m. thirty-two extra coke were put in. The complete analyses of the iron show the effect of the coke:

Time	Silicon	Sulphur	
5:45 p.m.	0.54	0.060	Cold
10:30 p.m.	1.38	0.034	Coke
2:55 a.m.	1.53	0.244	Coke
7:50 a.m.	0.37	0.207	Cold

High-sulphur iron is often made on a hot lean furnace. This also is accompanied with a high top heat. An example of such a furnace is given below. The top heat was from 400 to 650 deg. all the time:

Iron		Slag		
Silicon	Sulphur	Silica	Alumina	Bases
1.83	0.038	.....	.....	.....
1.70	0.047	.....	.....	.....
1.72	0.053	35.86	13.68	48.21
2.31	0.053	.....	.....	.....
2.22	0.067	.....	.....	.....

The silica in the slag should be about 33.00 for 13.68 alumina and 48.21 bases.

Hanging and extra coke go hand in hand. On some

furnaces it is a normal thing to put two extra coke in after every slip. It is interesting to look at the effect of slipping with extra coke as seen by the top heat chart. The condition of a furnace was such that it was slipped at 5:10, 6:05, 6:10, 6:20, 7:30. Eight extra coke were put in at 8:25 a.m., eight at 12:10 p.m., sixteen at 3 p.m. and eight at 6:30 p.m. The top heat had been running along at about 350 deg. Just as soon as the extra coke took effect it raised to 400 and then to 550 deg.

Another example showing the relation of the top heat to slipping and extra coke is shown when the furnace was slipped at 12:45 a.m., 1:45 a.m., 2:30 a.m., 3:20 a.m., 3:45 a.m. and 4:35 a.m. Four extra coke were put in at 12:20, and twelve extra coke at 4 a.m. The top heat had been running uniformly around 350 deg. When the coke came down the top heat chart showed 350, 350, 400 and 500 deg. respectively.

These examples are sufficient to show that continued slipping with extra coke will raise the top heat. With furnaces in extremely bad shape the top heat has been seen at 1,250 deg. and from 80 to 120 extra skips of coke were put in to bring the furnace around. It is needless to say such cases are seldom encountered.

TOO MUCH ORE FOR STONE

A number of cases have come to notice where a high top heat may be caused by having too much ore on the burden for the amount of stone that is carried. Whether there is or should be any relation between the top heat and the amount of stone carried is a question, yet at times when a high top heat was observed it was noticed that the furnace needed more stone.

LIGHT CHARGES

The various methods of charging a furnace, the size of the charge and the method of filling are a broad subject in themselves. A feature of particular interest at this time is the fact that a high top heat was repeatedly observed with light charges. It seems that when a heavy charge is used the ore and the stone have a blanket effect of holding down the top heat, while with small light charges the stock becomes intimately or haphazardly mixed and the coke burns up through the charges above.

It is readily seen how a large heavy blanket of ore would tend to lower the top heat. In some instances the charge is four coke, four ore and two stone, while in others it is two coke, two ore and one stone. By the first method there is just twice as much material in each charge as in the second method. Still another instance is known where the charge was made up of but one coke, one ore and one stone. In order to show clearly how charging the furnace affects the top heat and furnace operation a number of examples used on different furnaces will be given.

In No. 1, the full charge is lowered at once, the stock being put on the big bell in the order of coke, ore and stone. In No. 2, four skips of coke are put on the bell and it is then lowered, then four skips of ore and the bell lowered, and then two skips of stone and the bell lowered. In this method each material is dropped into the furnace separately. In No. 3, the big bell is lowered six times to the round, or after two coke, after one stone, after two ore, after two coke, after one stone and after two ore have been put in. In No. 4, the big bell is lowered four times, once after two coke, once after

DIFFERENT METHODS OF CHARGING THE FURNACE

		Lb.	
1.	4 Coke 4 Ore 2 Stone	3,000 5,700 3,650	Lower big bell once
2.	4 Coke 4 Ore 2 Stone	2,460 5,100 3,030	Lower big bell three times
3.	2 Coke 1 Stone 2 Ore	2,580 2,700 5,400	Lower big bell six times
4.	2 Coke 2 Stone 2 Coke 4 Ore	3,060 3,180 3,060 5,400	Lower big bell four times
5.	2 Ore 1 Stone 2 Coke	5,100 2,880 2,940	Lower big bell twice
6.	2 Coke 2 Ore 1 Stone	5,680 8,000 3,000	Lower big bell once
7.	2 Coke 1 Ore 1 Stone	5,680 4,000 3,000	Lower big bell once
8.	1 Coke 1 Ore 1 Stone	2,840 3,500 3,300	Lower big bell once

two stone, once after two coke and once after four ore. In No. 5, the big bell is lowered only twice, once after two ore, one stone and two coke have been put in and again after two more ore, one stone and two coke have been put in. In No. 6, the big bell is only lowered once, when two coke, two ore and one stone are put in. In No. 7, the big bell is lowered only once after two coke, one ore and one stone have been put in. In No. 8, the big bell is lowered only once, after one coke, one ore and one stone have been put in.

The point to be brought out clearly here is that when the amount of ore and stone is light in proportion to the amount of coke then the top heat is likely to be high, or in other words, when there is a surplus of fuel present.

LETTING THE FURNACE GO DOWN

Smoothest furnace operation is always obtained when the filling is even and regular. It is of vital importance that the stock is not let go down, for this means starting irregular driving. If the furnace is not charged for long intervals of time, this is immediately shown on the top heat chart. The curve will keep on rising until cold stock is put in, when it will show exactly the time recharging began by the fall in the curve. The furnace should be filled as soon as there is room for a charge to be put in. This assures regular driving and heats the charge long before it gets down in the furnace. In addition it keeps the top heat down.

An example of particular interest which illustrates the value of filling the furnace regularly and keeping it full is shown in the following incident. It was in the winter time when about 6 in. of snow was on the ground. The furnace was tested with the gage rod, which registered full. It was tested again some time later, and the rod again registered full. Although there was no evidence of hanging, still after two hours the rod showed the furnace to be full. At the end of four hours suspicion pointed to the gage rod, and it was found that it would go down just so far and then stick.

The furnace had gone down 30 ft. Filling was kept up all night to get it full again. At 4 o'clock in the morning it started to hang. Then the pressure started to rise. Every effort was made to make it take stock,

but the cold stock had come down from above and the furnace went violently cold. At 3:10 in the afternoon the stock came down with a terrific explosion tearing the bottom out of the dust catchers and covering the ground with ore, coke and limestone. It was weeks before it ran smoothly again. This shows the effect of cold stock coming down quickly into the hearth. When the furnace is kept full, the stock is heated gradually all the way down. The top heat chart shows how long the furnace has been let go down, or the interval between filling.

WHITE SMOKE FROM THE STOVE STACKS

White smoke from the stove stacks is an indication of a hot furnace. The top heat may or may not be high at this time, but such a condition is very often accompanied by a high top heat. For instance, a top heat of 870 deg. was shown on a furnace when extremely heavy white smoke could be seen at the stoves and boilers. As the fumes or smoke decreased in volume the top heat went down to 740, then 620, and then to 580.

SLIPS

Slips are shown on the top heat chart by an immediate rise in top heat. The stock having dropped down in the furnace, the loosened charge allows the hot gases to come clear to the top of the furnace. Just as soon as filling starts the cold charges going in have the effect of lowering the temperature. This is seen by the falling step-like top heat curve, which shows a step down when each new charge is dropped in.

SLOW DRIVING

It is natural to expect a rise in the top heat when the furnace drives slow and a fall in the top heat when the furnace drives fast. The explanation is simple, so it will not be discussed. A typical example of extremely high top heat is shown on a heavily limed furnace which only took thirty-eight charges during the day. The top heat was around 875 deg. and all during the day there were explosions on top due to the high heat. The stock was heavily watered and as a radical resort even full skips of water were run into the furnace before the top heat was finally brought under control. This is an example of slow driving.

The same furnace, which normally took forty charges to the shift, showed a top heat of 520 deg. on fast driving lean furnace when forty-five charges were put in. At another time a top heat of 500 deg. was registered when forty-six charges were put in. It might be stated the normal top heat of this furnace was 400 to 500 deg.

As stated before, the position of the fusion zone has a decided influence on the top heat. This same furnace showed a top heat of 600 to 670 deg. when forty-eight charges were put in, but the fusion zone was high. One of the quickest ways to raise the fusion zone is by putting a large extra coke blank or by running in cold air over a considerable length of time.

It must be remembered that furnace conditions are very flexible and the examples cited are the general behavior under certain definite operation. For example, a furnace on lake ores was cold on top and hot in the bottom and took only twenty-two charges, which was extremely slow driving. The top heat registered only 350 deg. The filling report shows the furnace to be hanging all day and twenty extra skips of coke were

put in. Thus it is seen that there are exceptions to the rule.

On the other hand, often ideal examples occur. Such an illustration showed that the top heat curve ran all day long and all night evenly recording 400 deg. top heat. The top heat curve was an even saw-toothed curve all the way around, with no large peaks or any irregularities of any kind. The stove heat was 950 deg. all day, the blast pressure ran smoothly all day long at 9.5 lb., and driving was smooth, quiet, even and regular. These conditions were ideal furnace conditions and therefore as the result an ideal top heat curve was recorded.

OTHER FEATURES AND INDICATIONS OF HIGH TOP HEAT

The stove changes not only affect the stove charts but often, especially when making a radical change in the stove heat, say from 700 to 1,000 deg., the increase in temperature is also noted with a corresponding small increase in top heat.

During a shut-down to change a tuyere, cooler, water block, etc., there is a rise in temperature of the top heat, which is indicated by the rise on the chart during the shut-down interval. This is easily explained as due to the decrease or entire slowing down of the

velocity of the gases. They are not carried off so rapidly and hence are much hotter.

It is interesting to compare the top heat charts of a skip-filled and a hand-filled furnace. The peaks or teeth of the former are regularly larger than the fine, small, band-saw teeth of the hand-filled furnace. A hand-filled furnace is seldom full and the filling is therefore continuous, while with a skip-filled furnace the stack is filled in from twenty to twenty-five minutes and then allowed to drive for about the same interval of time.

Brief mention has previously been made of the influence of extra coke on the top heat. It is naturally to be expected that a rise will be shown in the top heat after a large extra coke blank. A furnace running on lake ores which showed a top heat around 350 deg. showed a top heat of from 650 to 700 deg. after eighty skips of extra coke had been put in. Another instance was seen when the top heat ran around 1,000 deg. when sixty extra coke were put in every day for a week.

The top heat curve falls off to nothing when the furnace is banked. This is gradual and is registered as an even falling curve on the top heat chart.

Pittsburgh, Pa.

Determination of Available Lime in Quicklime and Hydrated Lime

BY ALICE I. WHITSON

FOR most chemical purposes free or uncombined calcium oxide is the valuable constituent of lime, and in practice limes are bought and sold on this basis. Notwithstanding this fact, there is no generally accepted method for obtaining this value, and there has been for some time a demand from various industries for a practical and reliable method.

At the request of the Interdepartmental Conference on Chemical Lime, a series of comparative analyses was made by the Geological Survey, the Bureau of Chemistry and the Bureau of Standards, each using duplicate samples of high-calcium and high-magnesium quick and hydrated limes representing the four types of lime in use. Complete gravimetric analyses were first made for comparison purposes and calcium oxide determinations were then made by the seven methods for the determination of free lime given in detail by R. K. Meade in *Concrete*, vol. 10 (1917), Cement Mili Section, p. 25.

The results obtained by the Scaife method were most promising and further investigation of this method at the Bureau of Standards led to the following modified procedure:

Place 1.4 g. of the carefully prepared and finely ground (passing 100 mesh) lime in a 400-c.c. beaker, add 200 c.c. of hot water, cover, heat carefully and then boil for three minutes.

Cool, wash down cover, add two drops of phenolphthalein and titrate with N hydrochloric acid, adding the acid dropwise as rapidly as possible and stirring vigorously to avoid local excess of acid. When the pink color disappears in streaks, retard the rate of addition of acid somewhat, but continue until the pink color disappears entirely and does not reappear for 1 or 2 seconds. Note the reading and ignore the return of color.

Repeat the experiment, substituting for the 400-c.c. beaker a 1-liter graduated flask carrying a one-hole stopper fitted with a short glass tube drawn out to a point. Cool and add dropwise and with vigorous stirring 5 c.c. less acid than before. Call the number of c.c. used A. Grind up any small lumps with a glass rod flattened at one end, dilute to the mark with freshly boiled distilled water, close the flask with a solid stopper, mix thoroughly for 4 or 5 minutes and let settle for half an hour.

Pipette a 200-c.c. portion, add phenolphthalein, and titrate slowly with 0.5 N hydrochloric acid until the solution remains colorless on standing 1 minute. Call this additional number of c.c. B. Then the percentage of available CaO = $2A + 5B$.

Table I presents determinations which were made by the modified method.

TABLE I. DETERMINATIONS OF AVAILABLE LIME BY MODIFIED SCAIFE METHOD

Sample	Uncombined CaO Present (Calculated From Complete Analysis)	Available Lime Found	
		Operator A	Operator B
Calcium quicklime.....	93.4	93.4	93.4
		93.5	93.3
Calcium hydrate.....	87.3	85.0	85.0
		85.0	84.3
High-magnesium quicklime	58.0	57.9	58.0
		58.0	58.1
High-magnesium hydrate...	50.0	50.3	50.0
		50.0	50.1
MgO and CaO, (0.7 g. each)	49.0	49.3	....
		48.8	....
CaO (precipitated).....		100.0	....

All figures are based on the lime ignited at red heat, as prescribed in A.S.T.M. specifications for hydrated lime¹, and the hydrochloric acid was standardized by means of Bureau of Standards benzoic acid No. 48-a, through a sodium hydroxide solution.

It is apparent that the determinations on duplicate samples by the modified method agree within reasonable limits and closely approximate the calculated values. The modified Scaife method is approved by the Interdepartmental Conference on Chemical Lime, and is now being tested in Government and works laboratories.

¹Published by permission of the Director, Bureau of Standards.

¹Proc. A.S.T.M., 1920, p. 629.

Elements of the Superconcentration of Nitric Acid

Application of Distillation Studies of $\text{HNO}_3:\text{H}_2\text{SO}_4:\text{H}_2\text{O}$ Mixtures to the Economical Production of Highly Concentrated Nitric Acid From Weak Acid—Preconcentration by Distillation Should Precede Superconcentration With Sulphuric Acid—Effect of Hydrochloric Acid and Nitrogen Tetroxide

BY ERNST GALLE

IF WE follow the history of the technology of nitric acid, we can differentiate two great periods. In the first, nitric acid was manufactured from Chilean saltpeter; in the second, from atmospheric nitrogen by means of the electric arc or from ammonia. Both periods have this in common, that the acid is not obtained in concentrated form and must first be concentrated or superconcentrated.¹ It is easy to appreciate, therefore, that from early times the study of nitric acid-water mixtures has attracted the interest of the chemist, resulting in the publication of a series of articles whose findings will be briefly summarized in the following.

PROPERTIES OF AQUEOUS NITRIC ACID SOLUTIONS

Dalton found (*Ann. Phil.*, vol. 9, p. 186, vol. 10, pp. 38 and 83) that in the distillation of an acid whose density is less than 1.40 at first a weaker acid comes over, until the constant distilling residue has a density of 1.42; this residue boils at 120 deg. C. According to Mitscherlich it boils at 120 to 121 deg. C.; according to Millon at 125 to 128 deg. C.; according to Smith at 121 deg. C. At ordinary atmospheric pressure, after sufficiently long boiling of nitric acid of any concentration between 70 per cent and 65 per cent, there is finally obtained a residue of constant composition containing 68 per cent HNO_3 , whose boiling point at 735 mm. mercury is 120.5 deg. and whose density is 1.414. If the distillation is carried out at 70 mm. pressure the residue contains 66.7 per cent HNO_3 and boils under this pressure at 65 to 70 deg. C. At 150 mm. the HNO_3 content is 67.6 per cent, at 1,220 mm. 68.6 per cent—i.e., 0.6 per cent higher than at ordinary pressure.

If, by the passage of dry air, one-third, one-half or three-fourths of the acid is evaporated, the residue shows a composition dependent upon the temperature but independent of the composition of the acid used, and contains at 13 deg. C. 64 per cent, at 60 deg. C. 64.5 per cent, at 100 deg. C. 66.2 per cent HNO_3 (Roscoe, *Ann. Phil.*, 203, 1860).

The peculiar discontinuity of the properties of aqueous nitric acid solutions led to the assumption of the presence of various hydrates, which were first reduced by Küster & Koomann² [*Z. anorg. Chem.*, vol. 41, p. 1 (1905)] to $\text{HNO}_3 \cdot 3\text{H}_2\text{O}$ and $\text{HNO}_3 \cdot \text{H}_2\text{O}$ and isolated by Pickering [*J. Chem. Soc.*, vol. 63, p. 436 (1893)]. More complete summaries, which will not be taken up as beyond the scope of this article, are found in Abegg, "Handbuch der anorganischen Chemie," vol. III, part

3, p. 158, and Spiegel, "Der Stickstoff und seine wichtigsten Verbindungen," p. 204.

If the two curves in Fig. 1 are examined, of which the first gives the boiling points of nitric acid solutions of various concentrations and the second the boiling points of sulphuric acid solutions of various concentrations, it can readily be seen that aqueous nitric acid can be separated by simple distillation only to an acid

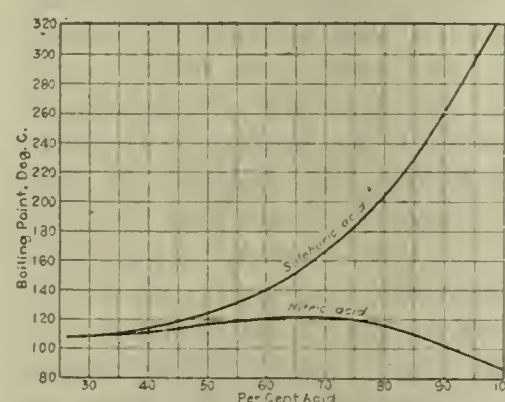


FIG. 1. BOILING POINTS OF SULPHURIC AND NITRIC ACIDS

The curves in the original article were not copied, but for sulphuric acid the figures of the Manufacturing Chemists' Association were used and for nitric acid those of Creighton and Githens.

of 68 per cent strength, while aqueous sulphuric acid yields an acid of 98.3 per cent strength. Consequently, in order to obtain a highly concentrated nitric acid, two separate phases must be considered:

a concentration to 68 per cent and a superconcentration to 98 per cent, which latter must principally be carried out with other means

than is the case with sulphuric acid. Experiments by Guido Pauling give the results shown in Fig. 2, when distilling acid below 68 per cent strength.

Concerning the distillation of acids stronger than 68 per cent, experiments have yielded the following:

Nitric acid having a density of 1.503, freed from N_2O_4 by blowing warm

air through it, showed boiling points rising from +88 deg. to +121 deg. C., leaving behind at the latter temperature a residue containing 77.1 per cent HNO_3 . The portion boiling between 88 deg. and 93 deg. is strongly colored red; when bleached, this acid has a density of 1.516 and a boiling point of 84.4 to 86.7 deg.; when redistilled it yields an acid of 1.517 density with a boiling point of 84.4 deg. C. (Smith, *Pharm. Centralbl.*, vol. 19, p. 203).

Acid of a density of 1.55 when distilled first yields an acid of 1.62 density (containing N_2O_4), then of 1.53; the residue shows a density of 1.49 (Proust). More lately Creighton and Githens [*J. Franklin Inst.*, vol. 179, p. 161; abstr. in *Z. angew. Chem.*, vol. 2, p. 208

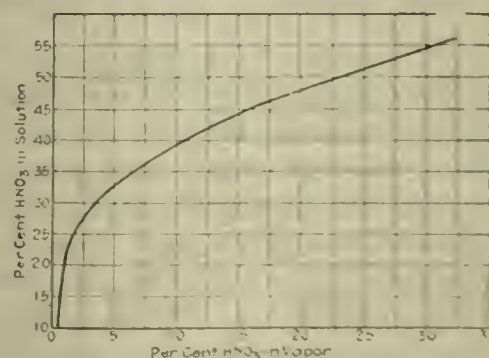


FIG. 2. RELATION BETWEEN BOILING NITRIC ACID SOLUTIONS AND THEIR VAPORS

Translated from *Z. angew. Chem.*, 1921, vol. 34, pp. 168-170, 173-175, by F. C. Zeisberg, Chemical Department, E. I. du Pont de Nemours & Co.

¹There is no English equivalent of the German "Hoehkonzentration," used both as noun and verb. The word "superconcentration" has hence been coined, to be applied when the resulting product, particularly nitric acid, is concentrated to a high degree (above 90 per cent in the case of nitric acid). F.C.Z.

²Undoubtedly an error for "Kremann." F.C.Z.

(1916)] have determined the boiling points and vapor pressures of aqueous nitric acid solutions by the dynamic method. From the locations of the maxima of the boiling point curves the variation of the composition of the mixtures of maximum boiling point with the pressure is established.

Interesting results were also obtained by Konrad Schaefer [*Z. angew. Chem.*, vol. 2, p. 56 (1916)] from the absorption spectra of gaseous nitric acid. The NO_2 group exists in two constitutionally different modifications: a selective absorbing form in inorganic nitrates and dilute aqueous nitric acid, and an end absorbing form in alkyl nitrates, in concentrated nitric acid solutions and also in gaseous nitric acid.

DEVELOPMENT OF NITRIC ACID TECHNOLOGY

Let us now examine the period during which nitric acid was made from Chilean saltpeter and sulphuric acid. In his "Handbook of Sulphuric Acid Manufacture" Lunge pictures the development of this industry from its first beginning up to the present. From the statements therein we see the efforts made to recover as high a concentration as possible of nitric acid, through changes in the apparatus and by means of various devices. By means of the processes of Guttman and the Chemische Fabrik, Griesheim (Ger. Pat. 59,099), Uebel's three retort system (Ger. Pat. 106,962) and Valentiner's vacuum distillation process (Ger. Pat. 63,207) this aim was achieved.

By this time the processes for making nitric acid from atmospheric nitrogen were already figuring in the technique. In their book "The Technical Utilization of Atmospheric Nitrogen" Donath and Frenzel give a collected review of the work in this field. "The Oxidation of Ammonia to Nitric Acid" has been treated by Donath and Indra in a monograph whose basic contents have been included by Lunge in the fourth edition of his handbook of the sulphuric acid industry. From all these processes only weak nitric acid results, which in the best cases contains 50 per cent HNO_3 . If this is not directly worked up into ammonium, potassium, sodium or barium nitrate, but is destined for the explosives industry, then a further concentration is unconditionally necessary.

THE IMPROVED PAULING CONCENTRATION PROCESS

The process of Pauling, already used successfully on the large scale before the war, has, after many improvements by Dr. A. Hoenig, which among others included raising the capacity from a steam consumption of 1,500 kg. per 24 hours to 19,000 kg., proved very good. The original Pauling process showed a great many disadvantages. Above all, in case of stoppage from mud, it was impossible to remove the Steuler filling material. It was necessary to wash for a long time with water to set the tower in order again. In washing, acid losses naturally occur, while on the other hand both the lining and the packing are likely to crack from local overheating. In order to avoid these disadvantages the manhole 1, as shown in Fig. 3, was devised by Dr. Hoenig.

The Steuler packing, of the size of a man's fist, necessitated a low rate of acid feed and a correspondingly low steam consumption. By filling the tower with Raschig rings the water evaporating capacity was increased twelvefold. Moreover, stoppages from mud were observed much more infrequently. The rings, also, have proved very resistant; after 1,000 hours'

operation the decrease in weight was hardly worth mentioning (0.21 per cent).

The final form of Dr. Hoenig's improved Pauling tower is best described by means of the diagrammatic sketch in Fig. 3. This consists of a column A, of about 8 m. height, of cast-iron sections. The lower section (base section *a*) carried the manhole 1, the steam jet *F*, and the exit pipe 2, for the denitrated, dilute sulphuric acid. Between the bottom section *a* and the second section *b* a silicon iron grating *G* is inserted, which carries the packing (Raschig rings). The top section *g* is not packed. It contains the acid distributor *H*, and carries the gas exit pipe 3, which leads to the condenser, the three inlet pipes for dilute nitric acid 4, concentrated sulphuric acid 5 and waste acid 6, as well as a thermometer 7. The column is lined with acid-resisting masonry.

The condenser *B* is a silicon iron coil cooled by a water spray. The 49 deg. acid condensing here runs off through the pipe 8 to earthenware pots, from which the acid can be filled into traveling pots or carboys. In

addition, the condenser is connected, through pipe 9, with a stoneware exhaustor, which blows the gases uncondensed in *B* into absorption towers, in which the last portions of nitrous oxides are absorbed. The weak acid resulting therefrom is returned to the process. The weak denitrated acid running off at a strength of 57 deg. Bé. enters the cooler *D* and from here goes to the sulphuric acid concentrating plant.

At *E* is the acid distribution. From reservoirs set higher the dilute nitric acid flows through the glass vessels 11 and 12; the concentrated sulphuric acid and the waste acid flow to the tower. The amount of acid added can be roughly regulated by varying the cross-section of the siphon, the finer regulation being obtained by using the adjustable level 11. For handling all the

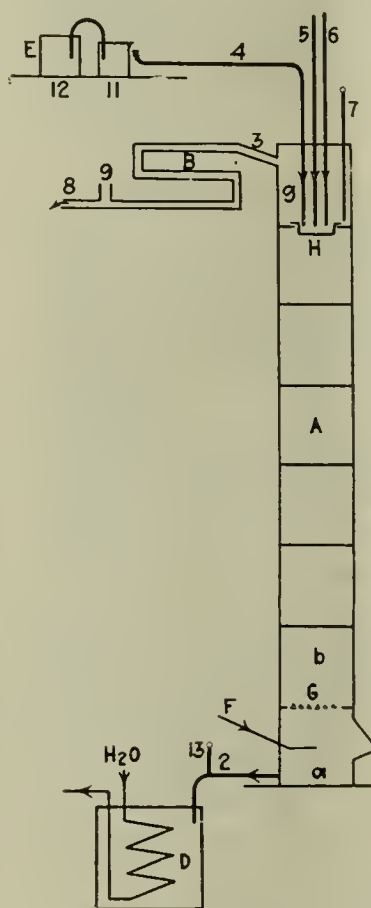


FIG. 3. IMPROVED PAULING PROCESS.

acid, silicon iron pumps (Patscher construction) and pumps of acid-proof castings with chromium steel shafts made by Eichler in Wesseling have proved excellent. Before operating, the tower must first be heated to a certain high temperature. To do this, concentrated 66 deg. sulphuric acid is allowed to run slowly into the tower through pipe 5 for about 48 hours. At the same time, steam is admitted carefully through *F* with a pressure of two atmospheres. Both the acid and the steam are gradually increased until after 48 hours the thermometer 7 reads 130 deg. Then, through 4, dilute 30 deg. Bé. nitric acid is allowed to run in and the sulphuric acid and the steam are so regulated that a nitric acid of 49 deg. flows off through 8 and the residual sulphuric acid is free from nitric acid. With normal operation the thermometer 7 stands at about 112 deg. C., thermometer 13 at about 167 deg. C., and the residual sulphuric acid has a strength of about 57 deg. Bé. (73 per cent H_2SO_4).

According to Pauling's original statements 5 parts of concentrated sulphuric acid should be used to concentrate 1 part of nitric acid. As an experiment, waste acid (75 per cent H_2SO_4 , 12 per cent HNO_3 , 13 per cent H_2O) was allowed to flow in through 6; it developed that the tower would completely denitrate this acid, and in addition that concentrated sulphuric acid equivalent to the sulphuric acid content of the waste acid could be saved. The partial reduction of nitric acid to nitrous acid brought about by the nitro-body content of the waste acid was neutralized by increasing the size of the condenser. Let us now examine in the following table of operating results, and the data calculated therefrom, the nitric acid-sulphuric acid ratios on the one hand and the water-sulphuric acid ratios on the other, obtained with the tower operating full capacity (10,000 kg. 99 per cent HNO_3 in 24 hours) and with different strengths of weak nitric acid fed to the tower.

The operation of the tower for 24 hours then gives:

	H_2SO_4 , kg.	HNO_3 , kg.	H_2O , kg.
H_2SO_4 (66 deg.)	43,000		6,970
HNO_3 (33 deg.)		11,280	13,620
Steam			1,390
	43,000	11,280	21,980

SULPHURIC ACID CONSUMPTION INCREASED WITH DILUTE NITRIC ACID

If waste acid is added, the addition of concentrated sulphuric acid is reduced correspondingly, without, however, causing any change in the remaining ratios. Much more sulphuric acid is, however, necessary with dilute nitric acid. Care must hence be taken, by adding various stronger acids, not to allow the concentration to drop below 30 deg. On the contrary, if the acid is stronger, then not only is the production of highly concentrated acid in unit time greater but the sulphuric acid consumption drops appreciably. (See Table I.)

Now, there was not only pure atmospheric nitric acid available for superconcentration, but also various dilute nitric acids containing hydrochloric acid. With these latter the sulphuric acid consumption increases considerably, as compared with the consumption for pure acids of like concentration; the explanation for this

TABLE I. OPERATING RESULTS WITH DIFFERENT STRENGTHS OF WEAK NITRIC ACID

Strength of Weak Nitric Deg. Bé.	Per Cent	$\text{HNO}_3 : \text{H}_2\text{SO}_4$	$\text{H}_2\text{O} : \text{H}_2\text{SO}_4$	Remarks
27	36.5	0.143	0.253	
30	41.3	0.196	0.323	
31	43.0	0.204	0.455	
32	44.7	0.250	0.475	
33	46.5	0.263	0.500	
30	....	0.143	0.250	Weak acid with 2 per cent HCl

is given in experiments to be described later. Above, the corresponding figures obtained in actual operation are given.

BEHAVIOR OF NITRIC ACID-SULPHURIC ACID MIXTURES

Experience shows, therefore, that in superconcentrating very dilute acids or acids containing hydrochloric acid the sulphuric acid consumption increases, with an appreciable decrease in the production. The following experiments were hence carried out to study the causes of this phenomenon, in order, so far as possible, to avoid them. Very few references are available in the literature with respect to the behavior of nitric acid-sulphuric acid mixtures. The only known work is the study of A. Saposchnikow, appearing in the *J. Russ. Phys. Chem. Soc.*, and mentioned in the *Chem. Zen-*

tralbl. (1904, p. 395; 1905, pp. 381, 1152)¹. Saposchnikow investigated the partial pressure of nitric acid mixed with increasing amounts of sulphuric acid, the composition of the vapor carried out of these mixtures by the air stream at 25 deg. C., the vapor density of these mixtures and their electrical conductivity. The picture of the reaction, given in the form of curves, is veiled by the nitrogen oxide content of the nitric acid used. Further, he found the vapor pressure of an acid of 1.478 sp.gr. to be much lower than that of an acid of 1.52 sp.gr.—viz., 16.64 mm. By the addition of H_2SO_4 , it increases noticeably, reaching a maximum in mixtures with 35 per cent H_2SO_4 . Numerous systematic experiments on the nitrating action of nitric acid-sulphuric acid mixtures on cellulose are mentioned. Besides, he concludes from his experiments on the vapor pressures at 25 deg. C. that the water contained in concentrated nitric acid (42 deg. Bé.) is completely removed by the sulphuric acid, which circumstance explains the applicability of such mixtures to the manufacture of nitrocellulose. From the partial pressure curves it is to be seen that very small amounts of water reduce the partial pressure of nitric acid very considerably, which explains why even the strongest nitric acid, without sulphuric acid, is not suitable for the manufacture of nitrocellulose. In further experiments he studied the nitrating action of sulphuric acid mixtures with dilute nitric acid and found that the water-abstracting sulphuric acid increased the number of free molecules of nitric acid.

More lately Creighton and Githens (*J. Frank. Inst.*, vol. 180, p. 703) investigated the influence of sulphuric acid on aqueous nitric acid at atmospheric and reduced pressures, and found that at 760 mm. nitric acid of maximum boiling point contains 68.18 per cent HNO_3 , without sulphuric acid, 64.5 per cent in the presence of 10 per cent H_2SO_4 , and 59.2 per cent in the presence of 20 per cent H_2SO_4 .

Konrad Schaefer (*Z. angew. Chem.*, 1917, p. 56) made optical experiments in this domain and found that dehydration of nitric acid results in a constitutional change in the NO_2 group. Very likely those nitric acid molecules which contain the end absorbing form of NO_2 group largely, or perhaps wholly, react during nitration. These, to my knowledge, are the only researches in this field.

DISTILLATION PHENOMENA WITH WEAK NITRIC ACID

In the following are given the experiments carried out by the author on the superconcentration of nitric acid and their results. As raw material for the following first series of experiments a nitric acid of 25 deg. Bé. was used, obtained by the oxidation of ammonia by the Ostwald process. Analysis showed: Sp.gr. 1.210, HNO_3 33.48 per cent, HNO_2 0.14 per cent.

Of this acid 500 c.c. (corresponding to 167.4 g. monohydrate) was distilled in a distilling flask fitted with a Liebig condenser. Between 102 and 106 deg. 256 c.c. passed over; in the flask 244 c.c. remained. The distillate tested 2.1 deg. Bé. and analyzed, sp.gr. 1.015, HNO_3 2.90 per cent, HNO_2 0.29 per cent. The residue tested 41.2 deg. Bé. and analyzed, sp.gr. 1.400, HNO_3 65.56 per cent, HNO_2 0.00 per cent.

¹Galle is evidently unfamiliar with the work of Pascal. See Pascal, *Compt. rend.*, vol. 165, pp. 589-91 (1917), and C. de la Condamine, *Ind. Chim.*, No. 54, pp. 153-5, 187-9 (1918), for partial pressures of mixed acid solutions at boiling temperatures, and their boiling points; Pascal and Garnier, *Bull. Soc. Chim.*, vol. 27, p. 18 (1920) for specific heats of mixed acid solutions and *Bull. Soc. Chim.*, vol. 25, p. 145 (1919), for sp.gr. of mixed acid solutions at various temperatures.

In order to study the relations more closely another 500 c.c. was distilled and the distillate was caught in 25 c.c. lots and titrated with N/2 NaOH and methyl orange. From a series of experiments, which agreed well among themselves, the average figures shown in Table II were obtained.

Besides, it was observed that already at 90 deg. vapors of NO_2 appeared which dissolved partially, with the development of a blue color, in the first portions of the distillate and partially escaped into the air. A peculiar smell was also observed, reminiscent of ozone,

TABLE II. DISTILLATION OF 500 C.C., 25 DEG. BÉ. NITRIC ACID

No.	C.C.	C.C. N/2 NaOH	Per Cent HNO_3	Per Cent HNO_2	Boiling Point, Deg. C.
1	25	26 40	1 36	1.46	102
2	25	11 40	1 44	....	103
3	25	12 30	1 55	....	104
4	25	13 90	1 75	....	104
5	25	16 40	2 07	....	105
6	25	19 50	2 46	....	105
7	25	24 60	3 10	....	106
8	25	26 20	3 30	....	106
9	25	38 50	4 85	....	106
10	25	50 00	6 30	....	106
Total distillate, 250		239 20	2 82	0 15	104 7

The residue tested 40.8 deg. Bé. and analyzed, 1.395 sp.gr., 64.22 per cent HNO_3 , 0.00 per cent HNO_2 .

but which could not be chemically proved to be this substance. Graphically expressed, the strength of the resulting acid is given in Fig. 4.

PRECONCENTRATION OF WEAK NITRIC ACID

Next, an attempt was made to see whether it was possible to obtain a distillate wholly free from HNO_2 , in order to investigate the possibility of preconcentrating the weak acid commercially and thus to avoid the irksome necessity of returning the dilute 3 per cent distillate to the nitric acid absorption towers of the ammonia oxidation plant. After many experiments an apparatus of the following design (see Fig. 5) was finally constructed by a glass blower, and insulated with asbestos paper. The flask A had a volume of about 1 liter; the column B, filled with glass beads, was 40 cm. long and 4 cm. in diameter, and contained at the top a thermometer

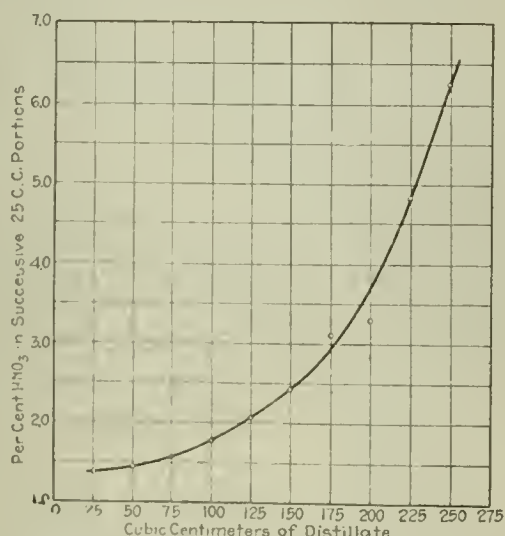
FIG. 4. STRENGTH OF DISTILLATE WHEN DISTILLING 500 C.C. 33.5 PER CENT HNO_3

TABLE III. PRECONCENTRATION OF WEAK NITRIC ACID

No.	C.C.	C.C. N/2 NaOH	Per Cent HNO_3	Per Cent N_2O_4	Boiling Point, Deg. C.
1	25	2 30	0 04	0 18	99
2	25	0 35	0 04	....	99
3	25	0 55	0 07	....	99
4	25	0 40	0 05	....	99
5	25	0 35	0 04	....	99
6	25	0 30	0 04	....	99
7	25	0 25	0 03	....	99
8	25	0 25	0 03	....	98.5
9	25	0 30	0 04	....	98.0
10	25	0 50	0 06	....	99.0
Total distillate, 250		5 55	0 044	0 018	100 25
11	25	129 00	16 24	....	117
12	25	140 00	17 60	....	118

well b, which was fused in. In order to facilitate charging with weak acid, the opening C was provided.

Again, 500 c.c. of dilute nitric acid was subjected to distillation. The thermometer rose to 99 deg. C. and 225 c.c. distillate passed over. Then the distillation began to lag. By adding a second burner it became more lively, but the temperature also rose. Table III again gives the average of a series of distillations.

The residue of 250 c.c. showed a sp.gr. of 1.40 and contained 64.14 per cent HNO_3 . From these experiments it is clearly evident that it is possible with suitable apparatus to preconcentrate nitric acid to about 65 per cent without the addition of a water-binding material; a further concentration is, of course, out of the question.

SUPERCONCENTRATION OF PRECONCENTRATED ACID

Experiments were then made to superconcentrate the acid of 41 to 42 deg. Bé. thus obtained, by the addition of sulphuric acid. An acid of sp.gr. 1.410, containing 67.10 per cent HNO_3 and 0.02 N_2O_4 , served as a

TABLE IV. DISTILLATION OF HNO_3 (1.410) + H_2SO_4 (1.84)

$\text{HNO}_3 : \text{H}_2\text{SO}_4$	$\text{H}_2\text{O} : \text{H}_2\text{SO}_4$	Boiling Point, Deg. C.	Per Cent HNO_3 in Dist.
5 00	2 40	118.8	74 66
2 42	1 20	117 6	79 72
1 61	0 81	113 8	84 55
1 18	0 59	110 0	90 75
1 00	0 50	101 2	96 80
0 67	0 33	95 8	96 69
0 50	0 25	93 0	96 72
0 40	0 20	88 6	96 74

starting point. This was mixed in the distilling flask with sulphuric acid of 66 deg. and distilled. From a series of experiments in which 25 c.c. portions of the distillate were again collected, the results shown in Table IV were obtained.

From this it is evident that it is possible, by the addition of concentrated sulphuric acid, to obtain highly concentrated nitric acid from an acid of 1.41 sp.gr. An acid of 96.8 per cent HNO_3 (on the large scale, continuously, 99 per cent HNO_3) is obtained in the laboratory even when the water:sulphuric acid ratio is 0.5—i.e., when the water contained in the 1.41 acid has the ratio 1:2 to the sulphuric acid monohydrate. A further addition of sulphuric acid, it is true, raises the vapor pressure of the nitric acid-sulphuric acid-water mixture, and as a result thereof lowers the boiling point,

but this is without significance in the industrial process. If hydrochloric acid is added to the nitric acid (2 per cent of the monohydrate content), a raising of the boiling point to 113 deg. C. resulted with the $\text{H}_2\text{O}:\text{H}_2\text{SO}_4 = 1:2$ ratio, and an acid of 90.18 per cent HNO_3 distilled over, which, however, contained 0.41 per cent NOCl . This result corroborates the operating fact that a larger amount of sulphuric acid is necessary to superconcentrate nitric acid which contains hydrochloric acid. The hydrochloric acid content raises the boiling point, the vapor pressure is lowered as a result of the

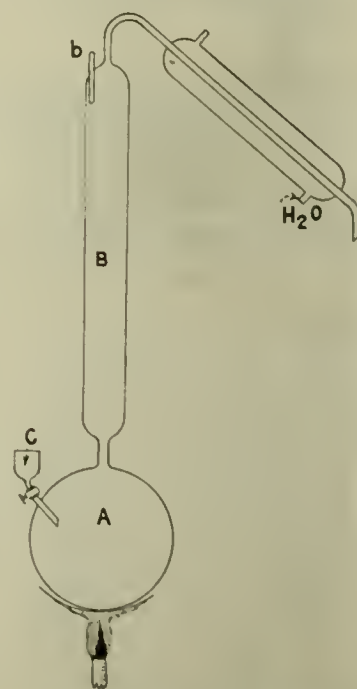


FIG. 5. PRECONCENTRATION APPARATUS

formation of nitrosyl chloride, and this latter must be broken down by an excess of sulphuric acid in order to make possible a normal operation.

SUPERCONCENTRATION WITHOUT PRECONCENTRATION

Next, experiments were carried out to learn how the dilute acid direct from the oxidation process, without any preconcentration, behaved when subjected direct to superconcentration with sulphuric acid. First, an acid obtained from the oxidation of ammonia (by the Ost-

TABLE V. DISTILLATION OF HNO_3 (1.21) + H_2SO_4 (1.84)

$\text{HNO}_3 : \text{H}_2\text{SO}_4$	$\text{H}_2\text{O} : \text{H}_2\text{SO}_4$	Boiling Point, Deg. C.	Per Cent HNO_3 in Dist.
1.00	2.00	110	18.80
0.25	0.5	117.6	65.00
0.17	0.33	118.3	80.69
0.13	0.25	115	89.76
0.10	0.20	110	99.11
0.08	0.16	109	93.38

wald process) and having a sp.gr. of 1.21 (33.48 per cent HNO_3) was mixed with sulphuric acid and distilled. The averages of a series of runs are shown in Table V.

Next, an arc process acid (Pauling system) of 1.295 sp.gr. (46.65 per cent HNO_3) was treated in the same

TABLE VI. DISTILLATION OF HNO_3 (1.295) + H_2SO_4 (1.84)

$\text{HNO}_3 : \text{H}_2\text{SO}_4$	$\text{H}_2\text{O} : \text{H}_2\text{SO}_4$	Boiling Point, Deg. C.	Per Cent HNO_3 in Dist.
1.72	2.0	116	42.95
0.87	1.0	118.3	69.36
0.50	0.5	116.3	80.07
0.20	0.33	110.6	92.44
0.25	0.25	109.0	95.54
0.18	0.20	103.3	96.45

way. In Table VI the average figures from a series of experiments are given.

If the figures given in Tables IV, V and VI are now plotted on co-ordinate paper, the results shown in Fig. 6 are obtained. The abscissas represent the $\text{H}_2\text{O}:\text{H}_2\text{SO}_4$ ratio and the ordinates of the upper set of curves boiling points. The ordinates of the lower set of curves represent strength of distillate.

DIRECT SUPERCONCENTRATION OF WEAK ACID UNECONOMICAL

From these diagrams it is evident that the more concentrated the nitric acid is which is to be distilled the less sulphuric acid is necessary to superconcentrate it. With increased addition of sulphuric acid the vapor pressure is raised and the boiling point approaches that of pure nitric acid. With the decrease in boiling point the concentration of the distillate simultaneously increases. The use of nitric acid containing hydrochloric acid is, so far as possible, to be avoided in the concentrating operation.

On the manufacturing scale it is hence evident that the use of an acid weaker than 40 deg. Bé. is without question to be avoided. Care must be taken to preconcentrate to 40 deg. and then first to employ the resulting acid for superconcentration. An example will be given: If acid of 30 deg. is subjected to superconcentration, then roughly five times the weight of the nitric acid monohydrate of sulphuric acid will be necessary—viz., in 24 hours 10,000 kg. of HNO_3 (99 per cent) requires 50,000 kg. of H_2SO_4 (66 deg.). If this 30 deg. acid is replaced, through preconcentration, with acid of 40 to 42 deg. Bé., then for the same daily production of nitric acid 20,000 kg. of sulphuric acid suffices, 40 per cent of that necessary in the first case. No cog-

nizance has been taken of the fact, either, that as a result of the discharge of stronger acids the capacity of the tower is appreciably increased in the second case. Since in practice, however, the capacity of a concentrating plant is usually dependent upon that of the sulphuric acid concentrating apparatus, it is self-evident that, presupposing the necessary spares for superconcentration, the output of a superconcentration plant can be about trebled by preconcentration.

AVOIDING LOSSES DUE TO NITROGEN TETROXIDE

Since it is often the case that weak nitric acid from denitrating operations is sent to the superconcentrating plant, or, to save sulphuric acid, so-called waste acids

are run into the concentrating tower, the behavior of the nitrogen tetroxide contained in these acids was investigated. First, a waste acid from a nitro-cotton factory, of the following composition, was distilled: Sp.gr. 1.710, H_2SO_4 70.00 per cent, HNO_3 6.74 per cent, N_2O_4 2.86 per cent, H_2O 20.40 per cent; color yellow green. There first condensed a yellow green liquid, which later became underlain with a brown colored layer; some uncondensed nitrogen tetroxide escaped. Because of

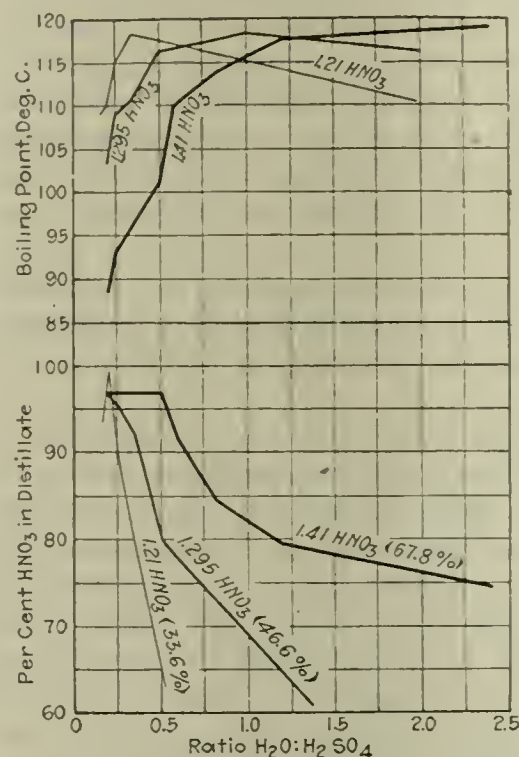


FIG. 6. EFFECT OF $\text{H}_2\text{O}:\text{H}_2\text{SO}_4$ RATIO ON CONCENTRATION OF NITRIC ACID

the great volatility of the condensed substances (on sucking them into a pipette they vaporized), these could be regarded as nitrous acid (Fritsche, *J. prakt. Chem.*, vol. 19, p. 179) and nitrogen tetroxide (Dulong, *Ann. chem. phys.*, vol. 2, p. 317).

When the distillate was absorbed in potassium hydroxide solution, crystals of potassium nitrate separated in the course of the distillation, while the mother liquor contained potassium nitrite. If nitric acid of high N_2O_4 content is mixed with sulphuric acid and distilled, then only 50 per cent of the N_2O_4 given off is found in the distillate as such. The other half has been oxidized to nitric acid. On this basis half the N_2O_4 contained in highly concentrated nitric acid may be reckoned as nitric acid, since in nitrations it reacts as nitric acid.

In working up nitric acids rich in N_2O_4 it is well, therefore, also to provide an alkaline absorption following the water absorption, to avoid nitric acid losses; the nitrite solution obtained is worked up into nitrate.

SUMMARY

Summarizing this work, the following rules for the superconcentration of nitric acid are indicated:

1. The weak nitric acid must be preconcentrated, without the addition of sulphuric acid, to 42 deg. Bé.
2. The 42 deg. nitric acid is superconcentrated with sulphuric acid, using twice as much sulphuric acid as the water contained in the nitric acid.
3. If the dilute nitric acid contains HCl , then the

H₂SO₄ necessary for superconcentration is increased, with 42 deg. Bé. acid as well as with weaker ones.

4. The N₂O₄ contained in the weak nitric acid is converted into nitric acid to the extent of 50 per cent, in the superconcentration of nitric acids containing it. Equally, 50 per cent of the nitrogen tetroxide in highly concentrated nitric acid reacts as nitric acid in the mixed acid made therefrom.

Progressive and Compartment Dry Kilns for Timber Compared*

The dry kiln becomes yearly of increasing importance to technically-controlled processes, and the findings in each particular instance of operation are valuable for application to conditions in other lines. This may be true of recent work with kilns used in drying lumber.

All lumber dry kilns now on the market are either progressive or compartment kilns. In the progressive type the drying conditions increase in severity from one end of the kiln to the other, the material being moved into severer conditions as it dries. In the compartment type the same temperature and humidity prevail throughout the kiln at any one time, beginning with mild conditions and increasing in severity as the material becomes dry.

The progressive type of kiln requires less skill in the operator. It consumes less heat per pound of water evaporated from the wood, but the saving of steam possible should not be considered so important as the question of ability to perform the work required with the best results. The progressive kiln reaches its greatest heat efficiency in drying from the green state and is most useful in circumstances which permit of

its being supplied continuously with green lumber of one thickness and class. It is, however, impracticable with this type of kiln to give individual attention to special loads of lumber.

The compartment type of kiln is more flexible and affords greater control over the drying conditions, permitting less change in temperature, humidity and circulation in the kiln with variations in the wind and weather. It is better adapted to meet the varying requirements of different kinds of material and is most useful where exact and careful drying is required.

A Convenient Humidity Table for the Wet and Dry Bulb Thermometer

Users of wet and dry bulb thermometers will find the following table, compiled at the Forest Products Laboratory, Madison, Wis., very useful for quickly determining relative humidity values from wet and dry bulb thermometer readings. To use the table, read the temperatures and subtract the wet bulb readings from the dry. Locate the vertical column of figures headed by the appropriate difference between wet and dry bulb readings, and the horizontal row of figures beginning at the extreme left with the observed dry bulb reading. The figure marking the intersection of these rows is the relative humidity value expressed in per cent.

Take the following as an example: wet bulb temperature, 132 deg. F.; dry bulb temperature, 140 deg.; difference, 8 deg. The figure marking the intersection of the vertical column for 8 deg. difference with the horizontal row beginning with 140 at the extreme left is 79, which is the correct relative humidity for the given thermometer readings.

*From U. S. Forest Products Laboratory Technical Notes.

RELATIVE HUMIDITY TABLE
Difference Between Wet and Dry Bulb Thermometers—in Degrees Fahrenheit

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	
60	94	89	83	78	73	68	63	58	53	48	44	39	34	30																											
70	95	90	85	81	76	72	68	64	59	56	51	47	43	40	37	33	29																								
80	95	91	87	83	79	75	71	68	64	61	57	54	50	47	44	41	38	35	32	29																					
90	96	92	88	85	81	77	74	71	67	65	61	58	55	52	49	47	44	41	39	36	34	31	29	26	25																
100	96	93	89	86	83	79	76	73	70	68	64	62	59	57	54	51	48	46	44	42	39	37	35	33	31	29	27														
102	96	93	89	86	83	80	77	74	71	69	65	62	59	57	54	52	49	47	45	43	40	38	36	34	32	30	28														
104	96	93	90	86	83	80	77	74	71	69	65	63	60	58	55	52	50	48	46	43	41	39	37	35	33	31	29	27													
106	96	93	90	87	83	80	77	74	72	69	66	63	60	58	56	53	51	48	46	44	42	40	38	36	34	32	30	28													
108	96	93	90	87	84	81	78	75	72	70	66	64	61	59	56	54	51	49	47	45	43	41	39	37	35	33	31	29	28												
110	96	93	90	87	84	81	78	75	72	70	67	64	62	60	57	55	52	50	48	46	44	41	39	37	36	34	32	30	28	27											
112	96	93	90	87	84	81	78	75	73	70	67	65	62	60	57	55	53	51	49	47	44	42	40	38	37	35	33	31	29	28											
114	97	93	90	87	84	81	78	75	73	71	68	65	63	61	58	56	53	51	49	47	45	43	41	39	37	35	34	32	30	28	27										
116	97	93	90	88	84	82	79	76	74	71	68	66	63	61	59	56	54	52	50	48	46	44	42	40	38	36	34	33	31	29	28										
118	97	93	91	88	85	82	79	76	74	71	68	66	64	62	59	57	54	53	51	49	46	44	42	41	39	37	35	34	32	30	29	27									
120	97	94	91	88	85	82	79	77	74	72	69	66	64	62	60	57	55	53	51	49	47	45	43	41	40	38	36	34	33	31	30	28	27								
122	97	94	91	88	85	82	79	77	75	72	69	67	65	63	60	58	56	54	52	50	48	46	44	42	40	38	37	35	33	32	30	29	27								
124	97	94	91	88	85	83	80	77	75	72	70	67	65	63	61	58	56	54	52	51	48	46	44	43	41	39	37	36	34	33	31	29	28	27							
126	97	94	91	88	86	83	80	78	75	73	70	68	65	64	61	59	57	55	53	51	49	47	45	43	42	40	38	37	35	33	32	30	29	28							
128	97	94	91	89	86	83	80	78	76	73	71	68	66	64	61	59	57	55	53	52	49	47	46	44	42	40	39	37	36	34	33	31	30	28	27						
130	97	94	91	89	86	83	80	78	76	73	71	68	66	64	62	60	58	56	54	52	50	48	46	44	43	41	40	38	36	35	33	32	30	29	28						
132	97	94	92	89	86	83	81	78	76	74	71	69	67	65	62	60	58	56	54	53	50	49	47	45	43	42	40	39	37	35	34	32	31	30	29	27					
134	97	94	92	89	86	84	81	79	76	74	71	69	67	65	63	61	59	57	55	53	51	49	47	46	44	42	41	39	38	36	35	33	31	30	29	28					
136	97	94	92	89	86	84	81	79	77	74	72	69	67	65	63	61	59	57	55	53	51	50	48	46	45	43	41	40	38	37	35	34	32	31	30	28	27				
138	97	94	92	89	86	84	81	79	77	74	72	70	68	66	63	62	60	58	56	54	52	50	48	47	45	43	42	40	39	37	36	35	33	32	31	30	29	28	27		
140	97	94	92	89	87	84	81	79	77	75	72	70	68	66	64	62	60	58	56	54	52	51	49	47	46	44	42	41	39	38	36	35	34	33	31	30	29	28	27		
142	97	94	92	89	87	84	82	80	77	75	73	70	68	66	64	62	60	58	57	55	53	51	49	48	46	44	43	42	40	39	37	36	34	33	32	30	29	28	27		
144	97	95	92	89	87	84	82	80	78	75	73	71	69	67	65	63	61	59	57	55	53	52	50	48	47	45	44	42	41	39	38	36	35	34	33	32	31	30	29	28	27
146	97	95	92	90	87	85	82	80	78	75	73	71	69	67	65	63	61	59	57	56	54	52	50	49	47	45	44	43	41	40	38	37	36	35	33	32	31	30	29	28	27
148	97	95	92	90	87	85	82	80	78	76	73	71	69	67	65	63	61	60	58	56	54	53	51	49	48	46	45	43	42	40	39	38	36	35	34	32	31	30	29	28	27
150	98	95	92	90	87	85	82	80	78	76	74	72	70	68	66	64	62	60	58	57	55	53	51	49	48	46	45	43	42	41	39	38	37	36	35	34	32	31	30	29	28
152	98	95	93	90	88	85	83	81	79	76	74	72	70	68	66	64	62	60	59	57	55	53	52	50	48	47	46	44	42	41	40	39	37	36	35	33	32	31	30	29	28
154	98	95	93	90	88	85	83	81	79	77	74	72	70	68	66	65	63	61	59	57	56	54	52	50	49	47	46	44	43	42	40	39	38	37	35	34	33	32	30	29	28
156	98	95	93	90	88	85	83	81	79	77	74	72	71	69	67	65	63	61	59	58	56	54	53	51	49	48	46	45	43	42	41	40	39	38	37	36	34	33	32	31	30
158	98	95	93	90	88	86	83	81	79	77	75	73	71	69	67	65	63	61	60	58	56	55	53	51	50	48	47	45	44	43	41	40	39	38	37	36	34	33	32	31	30
160	98	95	93	90	88	86	83	81	79	77	75	73	71	69	67	65	64	62	60	58	57	55	53	52	50	49	47	46	44	43	42	41	39	38	37	36	35	34	33	32	31
162	98	95	93	90	88	86	84	82	80	77	75	73	71	69	68	66	64	62	60	59	57	55	54	52	51	49	47	46	45	44	42	41	40	39	37	36	35	34	33	32	31
164	98	95	93	91	88	86	84	82	80	78	75	73	72	70	68	66	64	62	61	59	58	56	54	52	51	49	48	47	45	44	43	41	40	39	37	36	35	34	32	31	30
166	98	95	93	91	88	86	84	82	80	78	76	74	72	70	68	66	65	63	61	59	58	56	54	53	51	50	48	47	46	44	43	42	41	39	38	37	36	35	33	32	31
168	98	95	93	91	88	86	84	82	80	78	76	74	72	70	68	67	65	63	61	60	58	56	55	53	52	50	49	47	46	45	43	42	41	39	38	37	36	35	33	32	31
170	98	95	93	91	89	86	84	82	80	78	76	74	72	70	69	67	65	63	62	60	59	57	55	53	52	51	49	48	47	45	44	43	41	40	39	37	36	35	34	33	32
172	98	95																																							

Hammer-Welding Plant of the Blaw-Knox Co.

New Plant and Process for Making Large Seamless Tanks and Sheet-Steel Vessels
Described by Tracing the Course of an 8-Ft. Boiler Shell
of $\frac{7}{8}$ -In. Plate Through Its Manufacture

BY ERNEST EDGAR THUM

IN A FOREGOING article¹, entitled "Welding, Particularly Hammer Welding," a general survey was given of the various methods now in common use for joining metals into a continuous substance. It was noted that all the new methods extended the use of welding to joints which would not be attempted by the blacksmith.

Hammer welding is an adaption of the methods of the smith to quantity production and to pieces so large that they are entirely unmanageable without adequate mechanical handling. Consideration of the fundamentals indicated that a mechanical welding operation, simulating hand-forging, must heat the pieces rapidly to the correct temperature without oxidation, and quickly hammer the hot metal together, continuing the work to recalescence. Transfer of tools or heated metal must be very rapid. The work must be firmly held. Finally the completed article must be bodily put into an annealing furnace, to relieve internal strains and refine the grain.

Such operations must remove as many as possible of those empirical conditions which are so difficult to control in handwork and which make it remarkable that so many welds are good, not that a few are very bad.

While any forge shop which has applied the principles of modern metallurgical control to welding under the steam or drop hammer may justly claim to practice hammer welding, and while a brief description of the Navy's excellent plant for making anchor chain was included in the former article, it would be better at this time to restrict the term to the welding of long seams in plate work. The advantages of "seamless" containers for volatile gases and fluids are obvious. Equally apparent must be the utility of welded vessels which must withstand wide variations in temperature and pressure. Welded pipe should be an attractive material for lines offering a minimum frictional resistance to flow of liquid.

Perhaps half a dozen concerns in the United States are now equipped to turn out this material. However, information regarding their equipment and the process has been closely held. Considerable credit, therefore, is due to the officials of the Blaw-Knox Co. and the National Tube Co. for their broad-mindedness in opening their plants for inspection.

What follows is a description of the operating technique of the Blaw-Knox Co. Thanks are due to Messrs. Lehman and Leitelt, vice-president and engineer respectively of that concern, for their helpful co-operation.

BLAW-KNOX PLANT

Briefly, the method for hammer-welding seams in use in the Blaw-Knox Co. is as follows: The various plates, bent or pressed to shape, are assembled with lap joints, and stitched together here and there by a short torch

weld on the edge. The assembly is then placed on a carriage, joint up. A pair of gas flames are held one above the seam and the other directly below. When that region has been brought to a proper heat, the upper and lower torches are quickly replaced by an air hammer and anvil respectively, and the hot spot welded and worked down flat. This cycle is repeated until the seam is welded continuously from end to end. When all the seams are finished, the whole article is annealed; all fixtures applied, and if it is a pressure vessel, it is subjected to hydraulic test.

A plant for negotiating such heavy work naturally has many machine tools and handling devices for storing, shaping, assembling and testing. While interesting, such equipment can hardly be regarded as a part of the welding machinery, and it will be passed with brief mention.

Material is stored at one end. The yard is covered by a 70-ft. span crane of 10-ton capacity. The main shop itself is divided into two aisles, one 70 ft. wide and the other 40 ft. Most of the latter is occupied by the welding machinery, but some is partitioned off for a power house and tool room. In this space are located a motor generator set and switchboard, an air compressor, a high-pressure pump and accumulator for the hydraulic system and a repair shop holding a carefully selected group of machine tools.

Plates measuring more than 1-in. thick are not welded without scarfing, and a modern edge planer with a 20-ft. throat is installed for this purpose. Near by is a very powerful bending roll. It is four-roll set with ability to bend cold plates 20 ft. wide by $\frac{3}{4}$ in. thick, and hot plates $1\frac{1}{2}$ in. thick. These rolls are driven by a 100-hp. electric motor. The center roll of the lower three is supported by hydraulic rams so as to give the proper "squeeze" to the plates in bending. This machine is not only used in forming plates prior to welding but also for re-rolling afterward in order to give a true cylindrical shape to circular work, especially at the seam. For this purpose the end housing is hinged to the foundation, so that an open-ended shell can be slipped under the top roll.

Dished ends, flanged plates and domes are cut to correct shape and pressed, either hot or cold, in another department, well equipped with heating furnaces, flanging rolls and hydraulic presses for this kind of work. Such operations are a common feature of all boiler work, and no special notice need be given them here.

WELDING OPERATION

An operation may perhaps best be described by tracing the course of a boiler shell, say 8 ft. in diameter by 15 ft. long.

A square plate of appropriate size is selected, and the

¹CHEM. & MET. ENG., vol. 25, No. 12, Sept. 21, 1921, p. 553.

edges brushed vigorously with a wire brush to remove any dirt or loose rust. (It is not necessary to have the metal bright before welding, since some oxide is reduced during heating, and the rest melted or fluxed. It is largely ejected during the first hammer blows, but extreme care is necessary to eliminate it substantially from the finished joint.) The plate is then rolled into a cylindrical tube of correct diameter, and so that the edges overlap a distance about the thickness of the plate. On completion of this cold work, the end roll housing drops, and the plate is removed by one of the 10-ton overhead cranes commanding the building.

It is apparent that an exact closure at a long seam made in the rolls is impossible, owing to the fact that there will be a narrow strip of straight, unbent plate along each edge. The plates therefore lap over each other in a blunt angle. Such a seam may often be welded immediately, especially if the bent plate is stiff enough so that there is little tendency for the two edges to spring apart when they are hammered. Shorter seams, heads and smaller fixtures are attached by screw clamps,

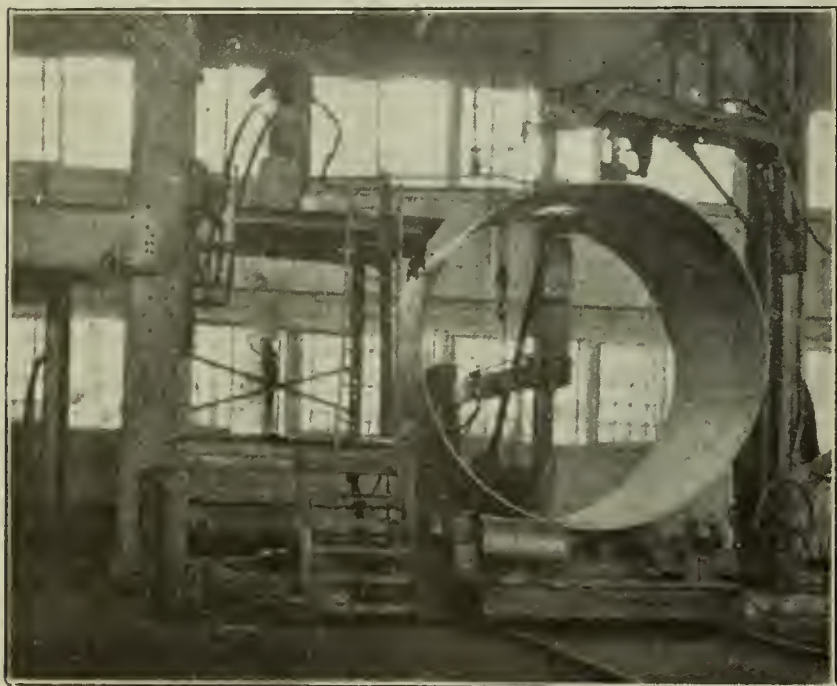


FIG. 1. CARRIAGE FOR HANDLING WORK

and "tacked" on by a workman with an oxyacetylene flame. He builds up short fillet welds at intervals of 3 or 4 ft. Then the joint is ready for the welder.

As noted above, in welding work as bulky and heavy as this, it is necessary to bring the fire to the work rather than *vice versa*. This does not obviate the necessity of closely controlled manipulation of the work, however. Blaw-Knox engineers have therefore designed several different carriages for this purpose, one of the simple ones being shown in Fig. 1. There have been electrical controllers installed on the pulpit at the left whereby the carriage is moved bodily forward or back, the cradle may be lifted, or moved to either side; and finally the rollers cradling the work may be rotated without changing their position in space. Thus the operator has three motions of translation and one of rotation at his command, which allows him quickly and surely to adjust the work so that it may rest at exactly the proper angle on the anvil and a blow may be struck in exactly the proper direction.

As may be seen from Figs. 1 and 2, the heating and hammering machine consists essentially of two pivoted arms carrying burners, another with an anvil; a fourth may carry the air hammer, although in the views shown it is held by a jib crane. With the pipe

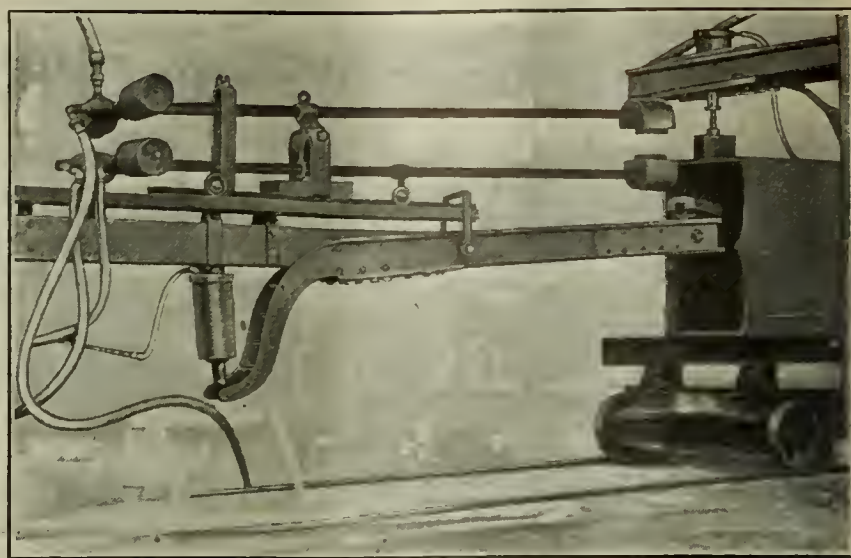


FIG. 2. HEATING AND HAMMERING MACHINE

properly placed on the carriage, the two burners are swung into position, one just above and one just below the spot where welding is to begin. Fig. 3 is a sketch of these burners, which consists of a box where the gas and air is properly mixed, and a firebrick tuyere, luted in place with refractory clay. The two heavy pipes carrying gas and air serve as supporting arms. In place, the foreman signals an assistant at the rear end of the machine, the gas valve is opened, and the fuel ignited by a small pilot flame. Almost immediately the air valve is opened, quickly reaching the correct amount, when the flame "pops" back to the tuyere, burning in a short, non-luminous roaring flame, completely filling the space between burner and plate, and flaring out along the steel for 6 in. or more on all sides (Fig. 1).

About five minutes is required to reach a welding heat on a 12-in. seam in $\frac{3}{8}$ -in. plate. Temperatures here might readily and advantageously be read by optical pyrometer. Fine sand or borax may be used as a flux,

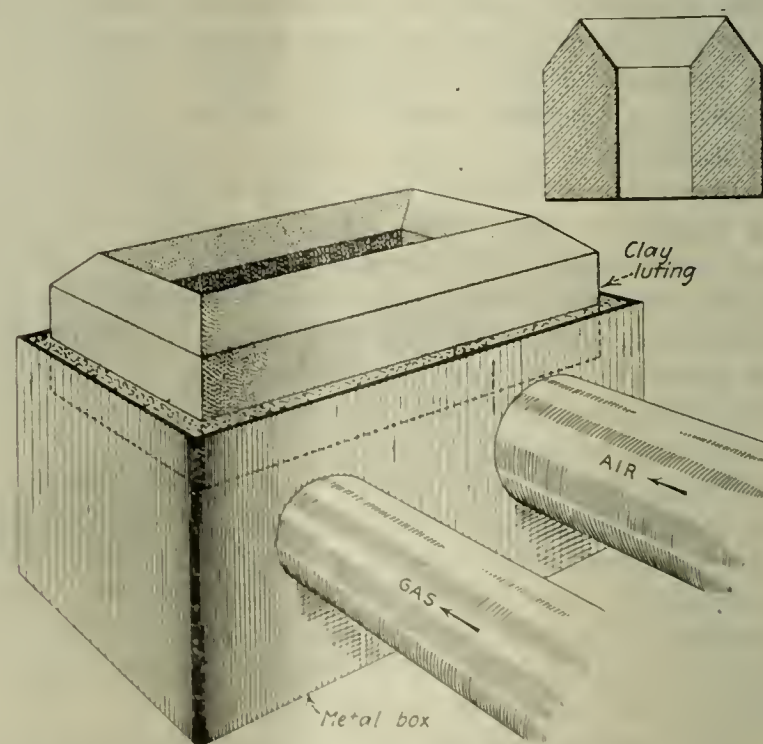


FIG. 3. SKETCH OF BURNER, WITH BRICK TUYERE IN PLACE

but if the flame is held with a slight deficiency of air, little trouble from slag or oxide is to be expected in low-carbon metal. As the welding heat is approached, molten slag will drip from the metal—in fact the plate itself will be slightly fused at projecting corners. The burners, which are nicely pivoted and balanced, are then swung to one side, the gas and air turned off, and their place immediately taken by the anvil or "horn"

beneath and the hammer above. Inspection of Figs. 1 and 2 will show that both of these fixtures are held on very stout, stiff arms, properly pivoted and actuated by air cylinders so that they can be jammed into place with great dispatch and accuracy. It is necessary that the anvil reach its exact position in bearing over the whole hot spot, especially when welding around blunt corners, else the hammer will merely beat the metal out of shape without effecting a weld. It is understood of course that corner work requires special anvils—the anvil used is in all cases shaped to the contour of the inner surface of the object.

First light blows of the hammer are directed at the corner of the sheet, gradually working across the weld; ejecting any molten material in a sheet of white hot sparks. High-speed blows at full air pressure are continued until the temperature has fallen to a faint red, when the force of the blow is lightened, but continued down through the recalcrescence temperature to a



FIG. 4. DEPHLEGMATOR MADE BY HAMMER WELDING

black heat. The hammer itself is swung so it is moved back and forth by the foreman during this operation; the pipe meanwhile resting solidly on the horn, inertia in the hammer cylinder and arm absorbing the reaction from the blow. Air at 100-lb. per sq.in. is the motive power; the cylinder is 5 in. in diameter, the stroke is 11 in., and a blow is struck 160 times per minute.

About half the length heated is welded in this operation, but in thick plate the region must be reheated and hammered twice more before the combined sheets are worked down to the thickness of the rest of the shell. This produces a lap joint which is at least 3 in. long in any sheet thicker than $\frac{3}{8}$ in. Flux is more liberally used in the second and third heatings. When this spot is finally joined to the foreman's satisfaction, the carriage is shifted and the same cycle of operations repeated on the continuation of the seam.

Thus a cylinder is welded from end to end. As a final operation, it is replaced in the bending rolls, they are adjusted to give the exact curvature required, and the seam rolled back and forth several times to bring this portion to correct shape.

If one end is to be closed, as in Fig. 4, the dished and flanged end sheet² is tacked in correct position by

five or six short fillet welds, the work then placed on the carriage so that the burner and anvil arms reach into the pipe through the open end. One portion of a circular seam is then welded in the regular way; the pipe rotated on its cradle and a diametrically opposite portion finished. Intervening sections are then closed and welded. Large stills such as shown in Fig. 5 can be made, the bottom entirely solid, and the top having a manway not less than 18 in. in diameter, the minimum opening necessary for burner and anvil. Small openings and fixtures such as brackets are often welded in place by an oxyacetylene flame.

FUEL GAS

Water gas is used for the burners at the Blaw-Knox plant. Other gases have been tried elsewhere, but often with indifferent success. While water gas (approximately 46 per cent H₂ and 43 per cent CO) produces a relatively low amount of heat on perfect combustion, it requires but a small amount of air with a corresponding small proportion of nitrogen and consequently gives a very hot flame, as shown in Table I.³

TABLE I. CHARACTERISTICS OF GASEOUS FUELS

Gas	Calorific Power Calories per Cu.M.	Volumes of Air for Combustion	Temperature of Flame, Deg. C.
Natural gas (Pittsburgh).....	8,423	9 35	1,852
Oil gas.....	7,350	7 74	1,915
Coal gas (illuminating).....	5,550	5 79	1,896
Coke-oven gas.....	5,159	5 36	1,892
Carburetted water gas.....	5,008	5 02	1,914
Water gas.....	2 590	2 24	1,924
Ordinary producer gas.....	1,300	1 13	1,555

The small amount of air required for combustion is of greater advantage in another way—it is much easier to get a quick and intimate mixture of gas with, say, two volumes of air than with nine or ten volumes, as would be required for natural gas. Unless the gases are correctly mixed, certain portions of the flame would have a great excess of oxygen, with fatal results to a welded joint. In fact, one of the chief excellences of a



FIG. 5. SEAMLESS STILL FOR CRACKING GASOLINE

smith's fire is the fact that his thick bed of incandescent charcoal effectually prevents the passage of any air until its oxygen has combined at least to carbon dioxide.

Gas is generated in two units built by the United Gas Improvement Co. of Philadelphia, using coke as a fuel. It is not necessary to devote space for an exposition of

²Flanging is arranged so that the ends fit over the sides; heating and hammering operations are then conducted so as to close the flange in to correct diameter, avoiding any expansion of the shell.

³From Richards' "Metallurgical Calculations," vol. 1, p. 190.

the gas manufacture. In practice, the producer is run about one minute on air blast, heating the coke, and wasting the products of combustion. Then a series of valves are changed, requiring about fifteen seconds, and steam is blown through the hot column of fuel, decomposing it into H_2 and CO , the fuel gas. In about three minutes the coke has been so cooled by the reaction that another heating period is necessary. Fig. 6 shows a plan of a typical water-gas generating plant, which corresponds closely to the layout at Blaw-Knox, except that the "blow-up" gases are wasted rather than passing through waste-heat boilers as shown, steam being available elsewhere.

Coarse dust is removed by passing the gas through a water-sealed cyclone dust catcher, and then scrubbed

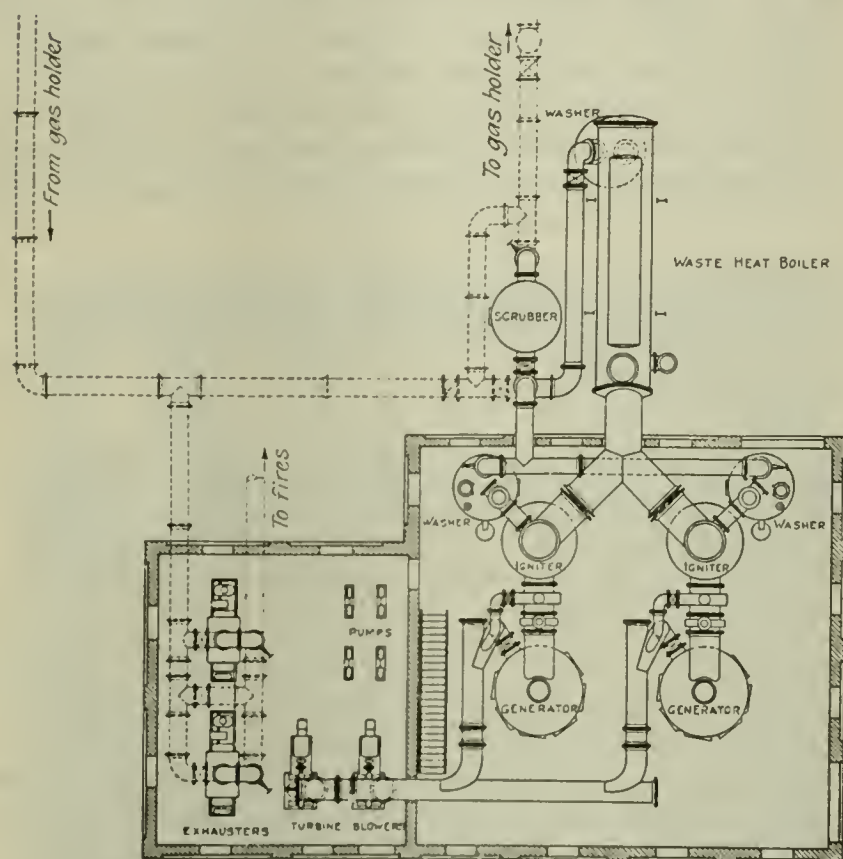


FIG. 6. WATER GAS GENERATING PLANT

free of finer particles and cooled in a column filled with trays over which water is sprayed. A final purifier filled with wood shavings and rusty iron turnings removes any sulphur compounds. A gas holder of 30,000-cu. ft. capacity acts as a reservoir, from which gas is drawn by an impeller blower, and delivered through a 12-in. main at 1.5-lb. pressure, controlled automatically. Air for combustion is also pumped through a 12-in. main by a similar Roots blower, at 1.5 lb. per sq.in.

After a pipe or tank—in fact any pressure vessel or article to work under anything greater than nominal load—has been completely welded, it is heat-treated. An annealing furnace (Fig. 7) large enough to receive work 6 x 9 ft. in size and 20 ft. long was furnished by Tate, Jones & Co., Inc., for this purpose. It is equipped with ten main and ten auxiliary burners, arranged for either oil or natural gas. Variation in temperature in the furnace is held to within 30 deg., as registered by pyrometers installed at eight dif-

ferent points in the furnace. A unique feature of the installation is a door which when opening sinks into a pit so as not to interfere with the crane when handling large circular work in and out of the furnace.

Welded articles are heated gradually to about 75 deg. above their upper critical, thus relieving working stresses and refining the grain. Considerable variation in the relation between strength, hardness and ductility is possible, as is well known, by proper control of heating times, temperatures, and cooling rates. It is unnecessary to expand on this point, important though it be, for the principles of heat-treating low-carbon steel articles are the same, whether the piece be hammer welded or merely forged.

TESTS ON WELDS

The excellence of well-made seams joined in this manner is becoming generally acknowledged. Numerous tests of hammer-welded joints have been made, and seldom show an efficiency less than 90 per cent of the strength of the material. It is reasonable to expect high strength from such joints, since the method used evidently does much to remove those three chief causes of defects in forge-work—viz., insufficient care and labor by the smith, poor control of the heating flame and temperature of the work, and lack of accurate heat-treatment of the finished piece.

Blaw-Knox Co. in its boiler shop has a test pit and high-pressure pumps for testing closed tanks, and in addition the hammer-welding department contains a long testing press for proving open-ended pipes up to 6 ft. in diameter and 40 ft. long at any pressure under 1,500 lb. per sq.in. After a pressure of 50 to 100 per cent in excess of the working load has been applied, the seam is struck vigorously several times with a 10-lb. sledge. This would not only lay bare many a defect which would not be detected by a static load, but actually subjects the whole structure to a considerable impact, as is evident by the pressure gage jumping about 100 lb. at each blow. It is important to note that such testing should never strain the vessel much more than 80 per cent of the proportional limit of the material, otherwise the metal will become somewhat brittle due to cold work.

Fig. 8 shows a pot for annealing wire which after

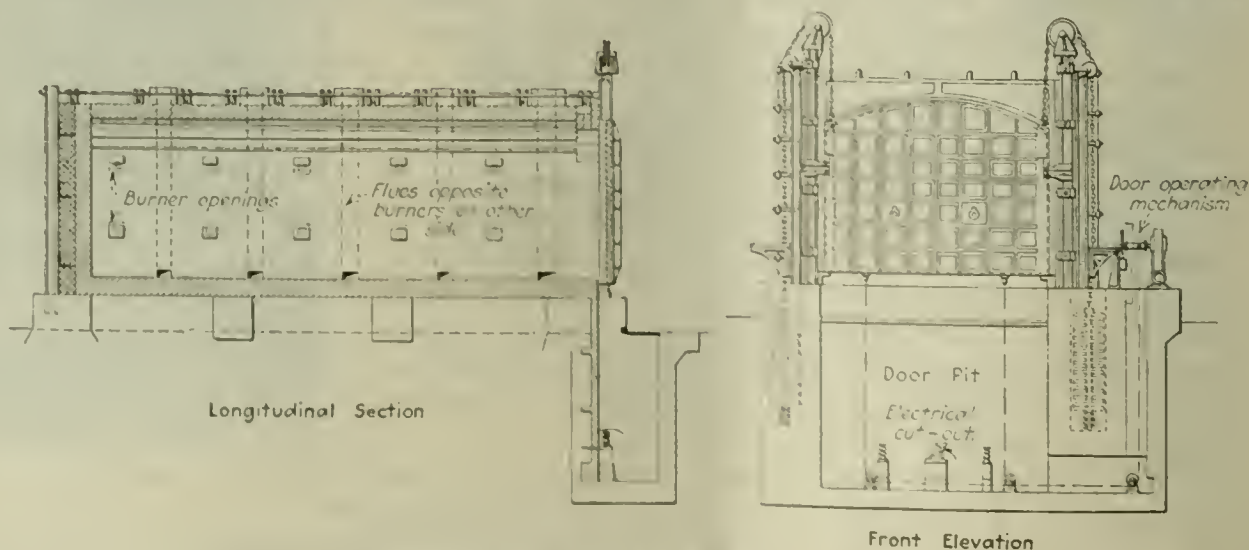


FIG. 7. ANNEALING FURNACE FOR LARGE TANKS

completion was tested somewhat above its elastic limit. Well-marked Lüder's lines were then found to cover the entire surface, passing through the longitudinal and circumferential welds (whose general position is shown by the arrows) without appreciable distortion. This is a very elegant demonstration of the homogeneity of



FIG. 9. LUDER'S LINES CROSSING WELD ON POT OVER STRAINED IN TESTING

weld and body plate. Another evidence of quality in the weld is the fact that many annealing pots similar to this have been made of straight pipes, the double bell at the top having been expanded without injury or extra stretch at the weld.

WELDED ARTICLES

Modern industry requires vessels which withstand considerable temperature or mechanical strains and yet remain impervious to penetration by contained fluids or surrounding gases. Blaw-Knox Co. specializes in the manufacture of such articles.

Thin wire and sheet must be annealed during and after manufacture. A small amount of surface oxidation would be fatal, especially as the gage becomes finer and finer. Cast-iron annealing pots, with a carefully sealed lid, have been the standard utensil for guarding against this danger, but they warp badly on many reheatings, finally becoming impossible to seal effectively. Furthermore they are very heavy. Consequently hammer-welded annealing pots are gaining favor rapidly.

Riveted stills and tanks for volatile and light oils have given much trouble. No matter how carefully riveted and calked, the continual "weaving" of plate on plate caused by temperature variation in a setting, or by the jars incident to transportation, is almost certain to cause leakage, especially of the lighter fractions which penetrate almost microscopic openings. Such leaks have caused disastrous explosions or great losses in transit, and can be entirely overcome by hammer-welding.

Other heating vessels should be close to size and seamless in order that the heat conduction should be uniform throughout, or that there may be close clearance between walls and stirring or other mechanism. Cast vessels are thick, brittle and unsafe under any but moderate pressures, and hammer-welding is undoubtedly able to produce containers which will allow the designer of digesters and similar apparatus a much greater leeway.

Canadian Soap Industry in 1918

According to a report that has been issued recently by the Dominion Bureau of Statistics, Canada produced 108,316,748 lb. of soap in 1918, practically the whole of which was consumed in the dominion, only a little more than 1,000,000 lb. being exported. The dominion produced practically all its own requirements, only a trifle more than 5,000,000 lb. being imported.

The Pyrolysis of Some Hydrocarbons

BY FRED DENIG

THE purpose of this investigation was to determine the decomposition and vapor pressures of hexane, gasoline, kerosene and vaseline.

Vapor pressure data are of immense value to the refinery engineer in the design of pressure stills, cracking apparatus, etc. Such data are also of use to the internal combustion engineer who is interested in the history of the hydrocarbon during compression just before combustion. Roy Cross¹ published some curves several years ago showing the relation between pressure and temperature of several hydrocarbon mixtures when subjected to heat. These curves are about the only ones published and available to the average engineer interested in petroleum. It was thought desirable to recheck his values and to cite the distillation curve of the gasoline studied, which he failed to do. The curve for hexane has been determined, since engineers are prone to use this compound in many calculations involving gasoline. Vaseline was studied in order to determine whether it would decompose into fixed gases or into gasoline- and kerosene-like substances.

The bomb used in the investigation was furnished by H. L. Doherty & Co. through the active interest of D. G. Brandt. It consists of a cylinder 17 in. long, 4

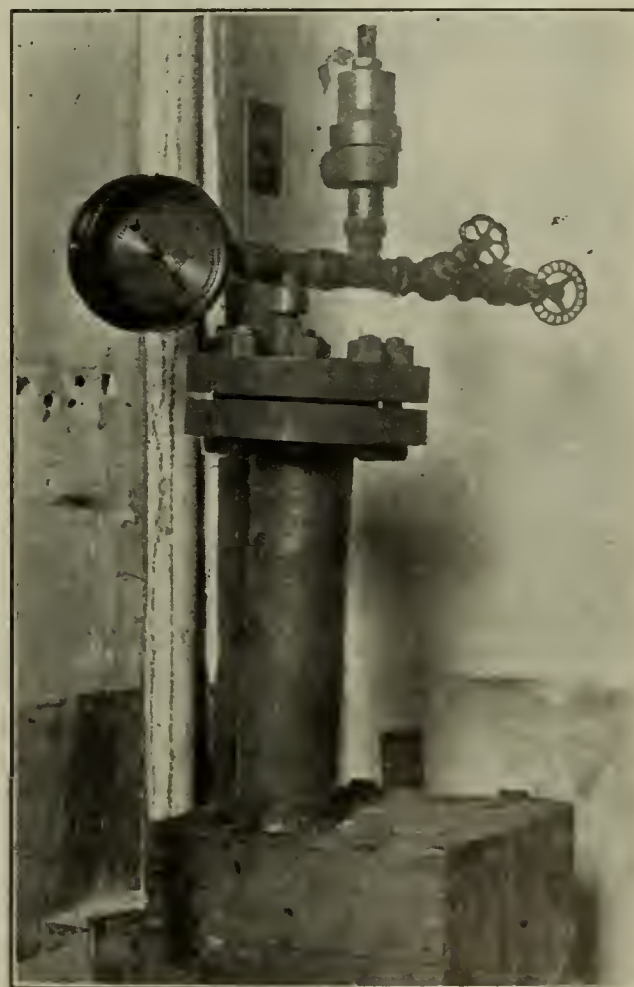


FIG. 1. EXPERIMENTAL BOMB

in. outer diameter and 3½ in. inner diameter. Fitted to the cylinder was a collar 1½ in. thick. A head plate served as a cover, having a groove cut into it to fit the cylinder. A ring of soft copper was fitted into the groove. The collar and head were drawn together by means of eight ½-in. bolts. The approximate volume of the bomb was 2 liters. The bomb was made of shell steel and had been tested out to 7,000 lb. per sq.in.

¹"The Cracking of Petroleum in the Liquid Phase," MET. & CHEM. ENG., vol. 16, 1917, p. 643. See also Kansas City Test. Lab. Bull. 15, p. 226.

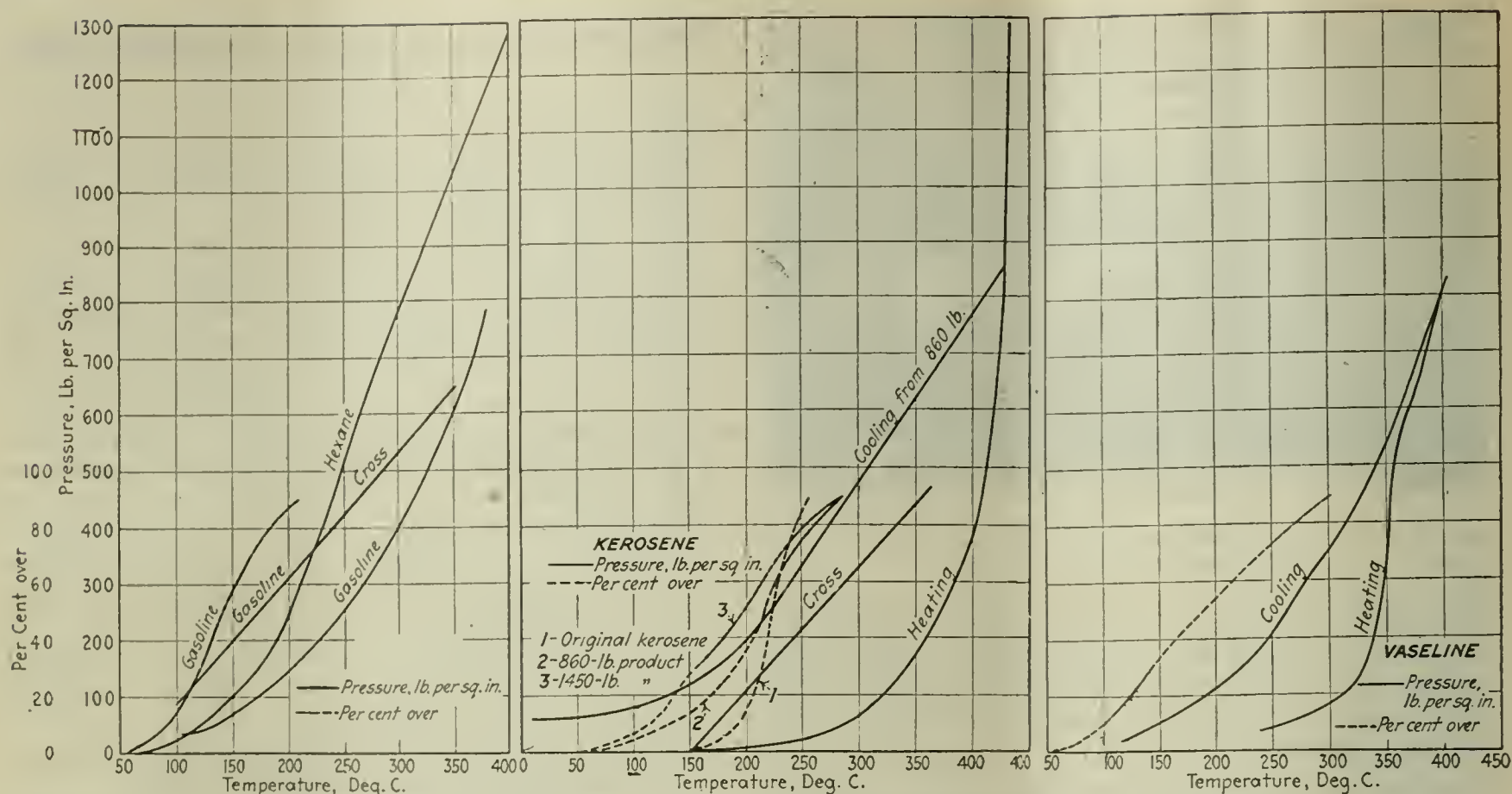


FIG. 2. VAPOR PRESSURE OF HEXANE, GASOLINE, KEROSENE AND VASELINE

TABLE I. VAPOR PRESSURE OF HEXANE

Time	Temp., Deg. C.	Pressure Corr., Lb. Sq. In.
12:45	Start	...
1:15	145	85
1:21	180	165
1:26	200	255
1:30	210	305
1:35	230	400
1:40	243	485
1:45	255	565
1:50	275	665
1:55	293	775
2:00	315	870
2:05	335	970
2:10	347	1,025
2:15	365	1,100
2:20	375	1,160
2:25	390	1,215
2:30	400	1,280
2:55	360	1,080
3:10	310	870
3:25	280	685
3:35	255	590
3:48	235	435
4:10	200	305
5:15	125	95

No residual gas pressure.

The bomb was charged with 500 c.c. of hexane. The hexane was Kahlbaum's hexane (normal), redistilled, and the fraction taken that distilled within a range of ± 2 deg. C. of 69 deg. C. It is to be noted that the hexane was not absolutely pure, but the best that could be obtained under the circumstances. Indeed it was the same hexane that Ipatiev used in his studies on the decomposition of hexane.

TABLE II. VAPOR PRESSURE OF GASOLINE.

Time	Temp., Deg. C.	Pressure Corr., Lb. Sq. In.
1:15	Start	...
1:45	105	35
1:50	140	55
1:55	165	90
2:00	190	130
2:05	210	170
2:10	230	205
2:15	245	245
2:20	255	275
2:25	265	300
2:30	280	345
2:35	290	370
2:40	300	400
2:45	310	435
2:50	320	470
2:55	327	505
3:00	335	535
3:05	340	565
3:10	350	610
3:15	360	645
3:20	365	685
3:25	370	715
3:30	375	755
3:35	380	790

No residual gas pressure.

Distillation curve of final product exactly the same as the original. Specific gravity of gasoline used 0.7457 at 23 deg. C. Distillation gave (See Fig. 2):

Deg. C.	Per Cent Over	Deg. C.	Per Cent Over
60	5	133	40
80	5	143	50
94	10	155	60
106	15	170	70
109	20	184	80
120	30	210	90

TABLE III. VAPOR PRESSURE OF KEROSENE

Time	Temp., Deg. C.	Pressure Corr., Lb. Sq. In.
8:00	Start	...
9:00	270	35
9:10	295	65
9:20	300	75
9:40	320	110
9:50	335	145
10:00	340	175
10:10	365	215
10:20	375	255
10:30	387	290
10:40	395	325
10:50	400	365
11:00	405	400
11:10	410	460
11:20	415	545
11:30	425	625
11:35	426	680
11:40	427	755
11:45	430	850
11:50	432	950
11:55	435	1030
12:00	435	1140
12:10	435	Shutdown 1440

500 c.c. was heated to 860 lb. pressure and the mass cooled, several points were taken on the cooling curve and are plotted as dotted line on the kerosene curve.

4:05	430	860
6:00	210	215
7:00	90	75
Next day	20	60

The original kerosene has a sp.gr. of 0.800 at 24 deg. C. Distillation gave (see Fig. 3):

Original, Deg. C.	Per Cent Over	After Heating to 860 lb., Deg. C.	After Heating to 1,450 lb., Deg. C.
150	5	60	50
196	10	111	100
204	20	133	136
214	30	169	136
218	40	192	156
224	50	208	180
229	60	217	198
235	70	227	215
243	80	240	232
257	90	258	254
		285	285

Analysis of gas from the heats.

	After Heating to 860 lb., per Cent	After Heating to 1,450 lb., per Cent
Hydrogen	25.0	64.0
Methane	48.0	33.5
Ethylene	27.0	2.5

TABLE IV. VAPOR PRESSURE OF VASELINE

Time	Temp., Deg. C.	Pressure Corr., Lb. Sq. In.
7:30	Start	...
8:30	190	...
8:42	237	35
8:59	260	45
9:00	285	70
9:05	310	95
9:10	327	135
9:15	335	180
9:20	343	260
9:25	350	335
9:30	353	425
9:35	360	515
9:40	367	580
9:45	375	625
9:50	380	650
9:55	382	670
10:00	387	700
10:05	392	735
10:10	395	760
10:15	400	800
10:20	405	815
10:50	355	565
11:02	320	425
11:10	300	355
11:20	270	275
11:30	250	215
11:45	230	150
12:00	190	100
12:15	170	75
1:15	115	15

Analysis of fluid mass in bomb after heat to 860 lb. distillation gave (see Fig. 4):

Deg. C.	Per Cent Over	420 c.c. of liquid recovered, sp.gr. > 0.830 at 25 deg. C.
54	...	The fraction distilling below 300 deg. C. contained 8.8 per cent by volume of olefins and 20 per cent by volume of aromatics.
100	10	
115	20	
145	30	
165	40	
185	50	
210	60	
240	70	
268	80	
+300	90	

Four liters of gas was obtained, with the following analysis:

	Per Cent
Hydrogen	67.0
Ethylene	8.7
Methane	25.0

Weight of free carbon deposited, 22g. The bomb was charged with 454 g (1 lb.) of vaseline. The vaseline had a specific gravity of 0.876 at 22 deg. C.

hydraulic pressure by the makers. The head plate contained an opening for a bull nipple for the pyrometer couple and another opening for a $\frac{3}{4}$ -in. nipple that connected to the fittings. As shown in Fig. 1, this nipple is connected to a tee, which in turn was connected to a pressure gage on one side and a pressure release valve and valves on the other side.

When cold no trouble was experienced in making the bomb tight and able to resist high pressures. However, when heated all joints were found to leak. Various expedients were tried to relieve the trouble. Finally we welded the bull nipple and the $\frac{3}{4}$ -in. nipple to the head of the bomb. For the leaks in all other connections we applied thin rings of soft copper. From

that time on we had no further trouble with leaks.

The bomb was placed in a Case gas muffle furnace. The upper limit of temperature was 425 deg. C., due to

the large amount of radiation from the walls of the furnace and the head of the bomb which protruded from the furnace.

To measure temperature a thermo-element of constantin-iron was used. The pyrometer was carefully calibrated before and after the experiments.

An American steam gage recording up to 3,000 lb. was used throughout the experiments. The gage was calibrated before and after the experiments, and a correction curve drawn. The corrections on this curve were the mean of the corrections as determined by the two calibrations.

METHOD OF PROCEDURE

A sample of the hydrocarbon was placed in the bomb and heated. Pressure and temperature observations were made at frequent intervals, and both heating and cooling curves obtained. The volume of gas formed was noted and the gas analyzed, and the liquid remaining was distilled and the fractions corresponding to the gasoline and kerosene cuts were treated for unsaturated compounds by the sulphuric acid² test and for aromatics.³ The tests applied were empirical in nature and serve only to give a general idea as to the constitution of the substances obtained.

All experimental values are tabulated on the accompanying tables, and curves showing the P - T relations are drawn for each substance. The curves for gasoline and hexane are shown on the same plot in order to show the marked difference in vapor pressures.

HEXANE

The curve for the vapor pressure of hexane has been determined experimentally up to 400 deg. C. (See Table I and Fig. 2.) Ipatiev³ heated hexane in a bomb quite similar to the one used in this experiment and states that at 510 deg. C. the hexane decomposes with explosive violence. In this paper he did not give the pressure-temperature data that he usually gave when he worked on the pyrolysis of different substances. For this reason it was determined in this experiment. Due to the large size of the bomb 425 deg. C. was the limit of temperature obtainable in the furnace used.

GASOLINE AND KEROSENE

In examining the P - T curve for gasoline (see Table II and Fig. 2), it is to be noted:

1. No decomposition took place throughout the range that the gasoline was heated, the product obtained after heating having exactly the same distillation curve as the substance placed in the bomb, and the cooling curve being exactly the same as the heating curve. Had the gasoline "cracked" the cooling curve (P - T) would lie above the heating curve.

2. The curve obtained is not a straight line, or in other words gasoline vapor does not follow Boyle's law. This fact is mentioned because Cross⁴ apparently obtained a straight line relation. He does not state whether he obtained his curve by experiment or by calculation.

Examination of the kerosene vapor pressure curve (see Table III and Fig. 2) shows a sharp bend upward. This sudden change in direction of the curve indicates decomposition. Analysis of the product after heating

shows the same fact. The decomposition point of kerosene is very close to its boiling point, so naturally decomposition is expected. It is interesting to note that Cross also obtained a straight line as he did in the case of gasoline.

VASELINE

Vaseline was studied in order to determine whether it would break down into a large amount of fixed gases or whether it would form a large amount of light products and a relatively small amount of fixed gases. (See Table IV and Fig. 2.)

The vaseline broke down almost completely to gasoline and kerosene, 81 per cent by volume being recovered. Of this fluid mass found in the bomb 34 per cent distilled off within the gasoline range—i.e., below 150 deg. C.—and 54 per cent distilled within the kerosene range—i.e., between 150 and 300 deg. C. The combined gasoline and kerosene fractions contained by volume 20 per cent of aromatics and about 9 per cent olefins. This may be explained by the work of Ipatiev, who heated ethylene under pressure and found that the gas polymerized at a temperature range of 350 to 400 deg. C., producing paraffins such as hexane, heptane octane, higher olefins and cycloparaffins, together with high-boiling products of an unsaturated character. Probably what happens can be best explained by simply assuming that the vaseline breaks down into the lower hydrocarbons, principally ethylene and hydrogen. The ethylene immediately polymerizes into cyclic and aromatic compounds, as well as into the paraffins.

POLYMERIZATION

There is much that remains to be studied about polymerization and it deserves much more intensive study than has been given to it. It will probably explain as much as our present-day theory of "cracking." Pressure is probably the greatest factor in influencing polymerization. For instance, when kerosene was heated to 860 lb. pressure, the gas contained 27 per cent olefin, the fluid 14 per cent gasoline, while when the pressure was allowed to rise to 1,450 lb. and at practically the same temperature, the gas contained 2.5 per cent olefin and the liquid 25 per cent gasoline; the theory being, of course, that at the increased pressure the olefins rapidly polymerized into gasoline-like substances.

New Method for Drying Clay

Pottery plants at Devon and Cornwall, England, are now using a new method for drying clays, in which two metal drums are employed, one inclosed in the other. The inner drum is driven by mechanical means, and while revolving, steam enters it at a few degrees above the temperature of boiling water. The clay is passed into the outer drum and comes into contact with the inner drum as it revolves, filled with steam. The water in the clay is evaporated and the clay dried quickly, the process being one measured in minutes. The waste steam, with temperature lowered through operation, is passed back to the boiler and utilized again under increased temperature. The labor saving in the new method, it is said, is considerable. The clay is fed into the drum automatically. The space requirements are only about one-eighth or one-tenth of the regular demands, and 1 ton of coal will dry about 45 tons of clay under the mechanical system described, as compared with about 8 to 10 tons by the customary method.

²Kansas City Test. Lab. Bull. 15, pp. 335, 336.

³Ipatiev, *Ber. Deutsch. chem. Gesell.*, vol. 44, pp. 2978 and 2987 (1911).

⁴MET. & CHEM. ENG., vol. 16 (1917), p. 643.

Electrolysis vs. Retort Smelting for Zinc*

BY FREDERICK LAIST

IT MAY be stated that the electrolytic zinc process is applicable to a great variety of ores and concentrates. Almost any ore containing zinc can be treated, although, of course, it does not necessarily follow that the operation of extracting the zinc will be profitable.

When we first undertook the development of the electrolytic process at Anaconda for the beneficiation of our complex zinc-lead-copper-silver ores and the utilization of our surplus water power, I had very little idea that such a process could be applied commercially except when the concentrates were low grade and water power was obtainable at low cost. Later we found that we could purchase high-grade concentrates originating in the West in competition with retort plants; in fact, it is probably not too much to say that the future of the zinc business in the West is going to depend to a considerable extent on the development of electrolytic zinc.

FUTURE OF ELECTROLYTIC ZINC

With the development of the process and the extension of our operations, my optimism as to the future of electrolytic zinc has steadily grown, until now I am not sure that we will not yet see electrolytic plants operating on high-grade concentrates and actually producing their power by the combustion of coal or oil or gas.

This statement may seem somewhat extreme, but it is based on the following general premises:

1. The fuel required for distillation and reduction of a ton of zinc in a modern retort plant will, when burned in an efficient modern power plant, generate sufficient electric energy to deposit a ton of zinc from sulphate solution.

2. The labor required for producing a ton of zinc electrolytically from a given concentrate will be no more than one-third the labor required by the furnace method.

3. The total investment required to produce a ton of zinc electrolytically will, in general, be little, if any, greater than by distillation—it being assumed, of course, that both plants are constructed with a view to permanence.

4. The great purity of electrolytic zinc and the desirable qualities which it possesses by reason of its purity will, as they become better known, give electrolytic zinc a distinct advantage on the market to the detriment of less pure grades of zinc.

While the correctness of the above premises has not been absolutely proved, I have from time to time come into possession of data which lead me to believe that in the main they are not far off. An accurate comparison can, of course, be made only where all local conditions are known, such as character of ore to be treated, cost and kind of fuel, unit construction costs, etc.

ADVANTAGE OF THE PROCESS OVER RETORT PROCESS

A very important advantage of the electrolytic zinc process over the retort process, and which I have purposely not included in the above, as I wish to speak of it more at length, is better recovery. There has been a good deal of misunderstanding as to the recovery realized in existing electrolytic plants and a certain amount

of disappointment has been manifested at the apparently low recovery being made. At Great Falls, for example, the recovery is approximately 80 per cent; at Trail it is lower than this. This 80 per cent average recovery is, however, made up of recoveries of about 75 per cent on low-grade concentrates containing 30 per cent to 35 per cent zinc on the one hand and 85 per cent to 90 per cent on high-grade concentrates containing 50 to 55 per cent zinc on the other. In other words, the possible recovery depends entirely on the grade and composition of the concentrates undergoing treatment, and the actual recovery depends as well on the design of the leaching equipment and the facilities for washing. I have not the slightest hesitation in saying that on pure, high-grade Joplin concentrates a well designed roasting and leaching plant can make a recovery of 92 to 95 per cent of the zinc content, and that in general on any given grade of concentrate a better recovery can be made than is commercially possible by distillation.

It goes without saying that a lower grade concentrate can be successfully treated, since the operating costs of the electrolytic process are more nearly proportional to zinc content than those of the distillation process and the presence of lead and iron is much less detrimental.

EXPERIMENTAL WORK CARRIED ON

The recovery of zinc from low-grade, and to a lesser extent, from high-grade concentrates is one of the things which is receiving considerable attention at the present time, and the future will see great improvement in this direction. Experimental work is being carried on along two lines:

1. To cut down losses of insoluble zinc by more careful control of roasting, and to improve extraction and washing by better design of leaching plant equipment and flowsheet.

2. By subjecting residues to additional treatment for recovery of both soluble and insoluble zinc.

The latter development is particularly important where the residues are to go to the lead smelter, as the presence of zinc in such residues, apart from representing an economic loss in itself, is highly detrimental to the subsequent smelting operation. Its removal and recovery would, therefore, be a very decided step in advance. Experimental work at Anaconda and Great Falls indicates that a recovery of 75 per cent of the zinc in the residue may be expected, which would bring the over all recovery on even a low-grade (30 to 35) concentrate between 92 and 94 per cent.

ABILITY TO TREAT FINES

Another important advantage of the electrolytic process is its ability to treat fines. Whether we like it or not, the flotation process is bound to be resorted to more and more for the production of zinc concentrates, and these are necessarily very fine. So far from being a detriment as in the firing process, this condition is a positive advantage to the new process, so that at Great Falls we have in the past actually limited our purchases of outside material to flotation concentrates.

Where acid is to be manufactured, the less complete roast required for the wet process may present certain advantages and might under favorable conditions make unnecessary the use of muffle furnaces. Obviously, from the standpoint of recovery the presence of sulphur in the form of SO₂ is not detrimental. The only possible disadvantage from too much sulphate in the

*Extracts from an address given before the meeting of the American Zinc Institute, May 10, 1921.

calcine is the building up of acid in the solution system to the point where a discard of cell acid must be made. This actually happens at Great Falls and results in the loss of a small percentage of zinc. Both the acid and the zinc could be saved by evaporation of a small portion of the cell solution each day, and this will probably be done.

From what has been said, you can see that electrolytic zinc has made quite remarkable progress in the six years that have elapsed since the commencement of the experimental work on which the existing plants are based. From a war baby it has grown into an industrial process which has demonstrated its ability to produce zinc in competition with older processes and has unquestionably come to stay.

Technically, both metallurgically and mechanically, the existing plants are far from perfect, and much remains to be done. In all departments improvements can be made which will result in better recovery, better current efficiency and lower operating and plant costs. Such improvements are not problematical, but certain, and in many instances already roughed out.

A British View on Steel Foundry Furnaces

A CONTRIBUTION to *The Engineer*, Aug. 5, 1921, says that the starting of a foundry for the production of small steel castings presents many difficulties by reason of the many different factors in the problem which have to be taken into consideration. For example, electric steel, by virtue of its freedom from gases and great purity, together with its high pouring temperature, seems well suited for the making of very thin and light castings, especially so if the steel is run directly from the furnace spout to the molds. Furnaces of 1-ton capacity are possibly the most suitable size. Compare this proposal with the crucible process, which is also suitable for the purpose in view. The pots are usually of about 90-lb. capacity—larger pots have generally been abandoned. The steel can be obtained exceedingly hot, fluid, and free from gas, and if a proper selection of the raw metals is made the resultant steel is as free from impurities as electric steel. The making of very thin section castings presents no difficulty.

A very small electric furnace would be necessary were it desired to pour the whole contents economically with the furnace at its highest temperature. To transfer the whole charge to one large ladle and from it to fill the molds would be less satisfactory owing to the steel chilling, and the steel would tend to set before the whole charge was cast. On the other hand, the crucibles can be taken straight from the crucible holes, at their highest temperature, just when wanted.

Furthermore, several small electric furnaces, say of 1-ton capacity, would be necessary to obtain a large output of exclusively small castings, and the cost of operating small electric furnaces is relatively high. In the crucible process, on the other hand, the weight of metal per pot is standard, and the cost is not affected by the size. Hence a comparison of the two methods may result in favor of the crucible, but there are, nevertheless, particular cases in which the electric furnace has the advantage.

The bessemer system, with converters up to 1 or 2 tons capacity, also has its advocates, who claim many

advantages over the two previous processes for the production of small steel castings, particularly when side-blown converters are used. The total tonnage may be kept down to 1 ton, and the temperature may be made very high if necessary by the addition of high grade silicon after the initial heat from the original charge has been attained. Small converters, as compared with electric furnaces of similar capacity, could deliver over five times the tonnage in an equal time, and the quality may be as high. The success of the converter primarily depends upon the operator. A skilled blower can be relied upon to put charge after charge into the foundry well up to the schedule. With low sulphur and phosphorus in the charged materials, these objectionable elements need not be high enough to influence the quality unduly. Abnormally low sulphur and phosphorus can, of course, be obtained in the electric furnace, but it is only rarely that such extreme purity is required, and at a cost which purchasers will pay only in exceptional circumstances.

The usual bottom-blown bessemer and side-blown converter produce similar qualities of steel. Generally the side-blown converter produces the more fluid steel for small work, but the refining losses are from 5 to 10 per cent greater than in the bottom-blown converter. It is generally supposed that the "blown" process always absorbs unlimited quantities of oxides. This may occur with overblown charges, but rarely happens when the process is in the hands of skilled operators. As a matter of fact, with weighed additions of ferrosilicon and manganese, etc., the attainment of specified physical tests and analyses to specifications presents no difficulty.

THE OPEN-HEARTH FURNACE

The usual open-hearth furnace is not so successful for small castings. The extremely high temperature required cannot be obtained consistently without destroying the refractories and generally shortening the life of the furnace. The most successful type of open-hearth for small work is the Siemens special rapid, with a capacity of 1 ton. The producers are built on to the end of the furnace—the flame describing a horseshoe bend before passing back through the same end on the way to the regenerators. The ferro-silicon and manganese are allowed to melt on the banks and run down into the bath. The carbon is somewhat high—from 0.60 to 0.80 per cent, and occasionally up to 1 per cent. The steel is poured directly from the furnace. The furnace is tapped—great care being taken to keep the tap hole and the flow of metal not too large.

The furnace tap hole may be opened and closed many times in the course of a heat, the steel being kept hot in the furnace in the meantime. The refining losses are small, but high carbon, instead of higher temperature and lower carbon, condemns this process for many classes of small castings. This type of furnace, however, has been used extensively with great success for the production of colliery castings. The steel with low carbon is too sluggish and cold for casting small work, but with the addition of manganese excellent manganese steel can be obtained.

The basic bessemer and basic open-hearth furnaces are not a success for the production of small castings.

That the old method of crucible steel making can still more than hold its position against modern methods has been clearly proved, and there are large buyers of small castings who have tried all processes, but

return to their former founders—the crucible steel maker. The quality of crucible steel may be due to the protection of the molten steel from oxidizing gases, which is usually exhausted by charcoal addition, and also by the protection afforded the metal by the slag which may be in contact with a neutral atmosphere.

The price of small steel castings is generally governed by the amount of core making, molding, size and the difficulty in running, etc. Providing the castings are clean and of ample strength for their proposed use, analysis is rarely called for. Special prices are paid for alloys and special carbon castings, but there is only a very small demand for these things.

Generally speaking, the very costly and expensively operated plants cannot insure any higher price for their products on the recommendation of slightly lower sulphur and phosphorus. Specialists can obtain high prices, but steel founders are not all specialists. They have to consider their various inquiries carefully in view of their own risks and their competitors' prices.

Instrument to Measure Elongation of Broken Tensile Specimens

BY R. W. WOODWARD*

ANYONE who has made a large number of tensile tests of metals is well aware of the awkwardness and other difficulties encountered in the usual method of measuring the elongation of a broken tensile specimen. This method generally consists of holding the matched ends of the specimens in the hands or laying them on a bench, setting a pair of dividers to the distance between previously punched gage marks inclosing the fracture, and measuring the distance apart of the divider points by a scale graduated in hundredths of an inch. Obviously by this procedure the fractured ends are not held together as tightly as possible and the measured elongation is somewhat too large. Furthermore the reading of the setting of the dividers from the graduated scale is attended with some difficulties, and blunders are often made. Also the simple operation of dividing the measured elongation by the gage length to obtain the percentage elongation is susceptible of mistakes and in checking computations is quite often found to be wrongly performed.

To overcome the first-named source of error many laboratories use a clamping device to hold the broken specimens, but still measure the elongation by means of dividers and scale. The instrument described in this paper was designed to eliminate as far as possible all the above sources of error and is a direct-reading instrument for obtaining the percentage elongation of a fractured specimen.

It consists of a bed plate upon which are mounted a fixed head stock with a movable center and an adjustable tail stock, as shown in Fig. 1. By this means specimens up to a total length of 9 in. can be rigidly held together, eliminating all gap at the fracture. Above the specimen is a slide carrying two index points. One of these indices is fixed to the slide, while the other is movable on the slide. The movable index carries a pinion which engages a rack on the slide. Fastened to the pinion shaft is a pointer which moves over the scale graduated into fifty divisions. The rack and pinion are such that one revolution of the pinion advances the index exactly 1 in. The pointer is set

at zero when the indices are exactly 2 in. apart; one revolution of the pointer then corresponds to a movement of 1 in., or for a 2-in. gage length, to 50 per cent elongation.

In operation the slide is moved until the fixed index is set into one gage mark. (There are light springs on the indices to keep them normally above the specimen.) The movable index is then slid along the rod until it fits into the other gage mark. The reading of the pointer then gives directly the percentage elongation. The elongation may be readily determined with an accuracy of ± 0.1 per cent, while with the ordinary method the best that can be obtained is ± 0.5 per cent.

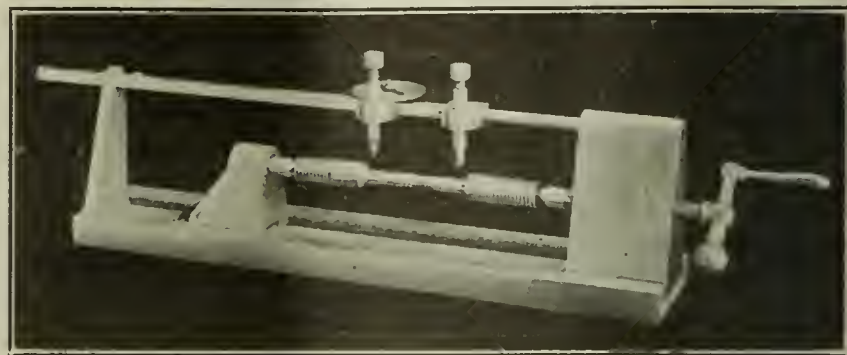


FIG. 1. MACHINE FOR MEASURING ELONGATIONS

The following table shows the applicability of the instrument and represents elongation values obtained by the methods noted on ten specimens taken at random from a large number of the type shown in Fig. 1.

Specimen	Per Cent Elongation Measured by		
	Special In trument	Dividers, Specimen Held in Hands	Dividers, Specimen Held in Clamp
Q6A.....	21.7	22.5	21.5
Q8A.....	22.4	23.0	23.5
M8.....	22.1	23.0	22.5
V8A.....	25.2	25.0	25.0
R6C.....	24.4	24.5	24.0
Q9C.....	19.1	19.5	19.0
A1A2.....	6.0	6.5	6.0
P4A.....	25.8	26.0	25.5
R2C.....	19.8	20.0	19.5
R8C.....	21.7	21.5	22.0
Average.....	20.82	21.15	20.85

These readings were all taken independently without a knowledge of the values obtained by the other methods. They show that high values for elongation are obtained unless the specimen is held in some form of a clamp. Incidentally in this short series of measurements the value for the elongation of Q8A for the method given last in the table was first read off the scale as 0.42 in. instead of 0.47 in., as later inspection of the results show it should have been. This is an inexcusable blunder, but one that is certainly bound to occur at times.

The time taken to obtain the above measurements was also observed, but was found to be practically the same for all methods—namely, six to seven minutes. However, if the elongation is measured on opposite sides of the specimens, a gain in time as well as in accuracy will be noted.

The advantages claimed for this instrument are:

1. Elimination of sources of errors and blunders.
2. Greater sensitivity in the measurement of elongation.
3. Greater reliance can be placed upon the results.
4. A saving in time.

While the instrument described here¹ is designed to take 2-in. gage length specimens, by a simple change of dials it can be adapted to other gage lengths.

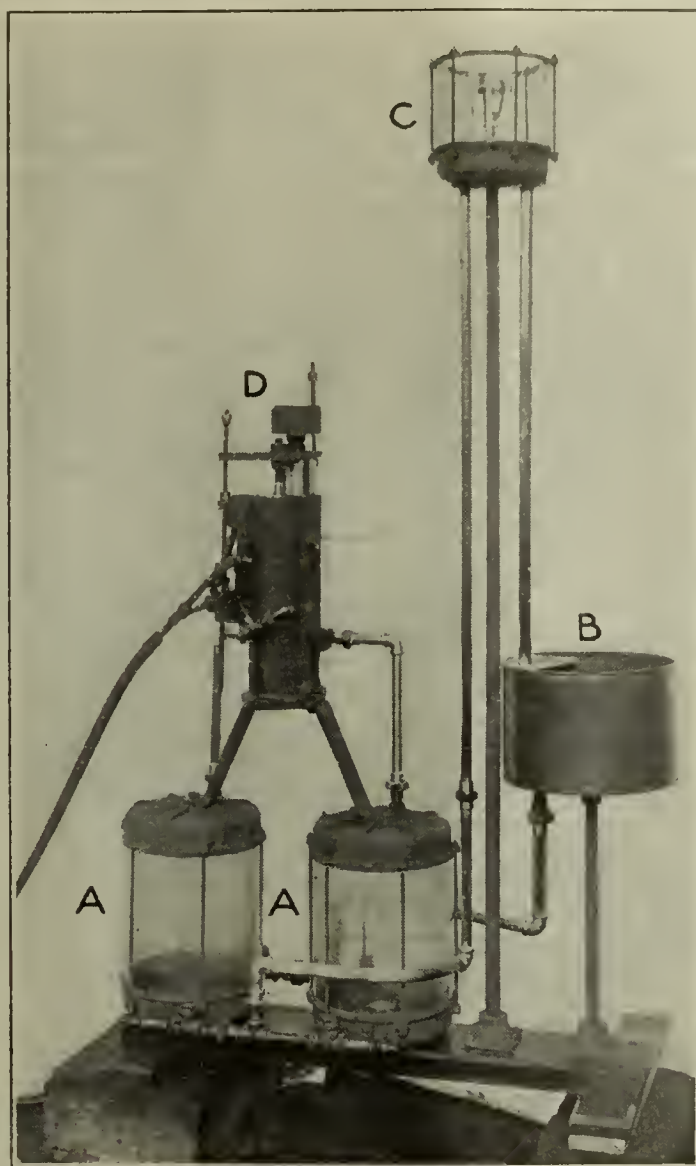
¹Arrangements have been made whereby this instrument will be placed on the market by the Tinius Olsen Testing Machine Co. of Philadelphia.

*Physicist, U. S. Bureau of Standards.

Displacement Pump for Elevating Acid by Compressed Air

ORDINARY simple or even compound air lifts have their limitations for handling acids and other chemical solutions owing to the low factor of submergence frequently encountered. The saturation of the air by the acid has also resulted in undesirable fumes and in losses due to precipitation at the point of discharge.

These difficulties are avoided in the Sullivan displacement pump, a small demonstration model of which is shown in the accompanying figure. The pump consists



DISPLACEMENT PUMP FOR ACID

of two cylinders or tanks, A, A, with a common inlet and a common discharge opening, each provided with check valves. The tanks fill by gravity from the source of supply, B, and are alternately emptied of their contents by direct air pressure which carries the liquid being pumped to the desired elevation, C. The filling and emptying of the tanks is controlled by the Sullivan automatic switch, which is placed above the level of the acid and operated by air from a line independent of that which supplies the tanks. The operation of the switch, by alternately admitting compressed air to each tank, secures a continuous discharge of acid into the storage tank or basin.

The characteristics of this new pump are:

The liquid to be pumped does not come in contact with any moving parts, such as floats, except the inlet and discharge check valves.

Clearance losses are avoided, since the automatic switch leads the expanded air from the empty tank into the full cylinder before admitting live air to the latter, thus filling the lines and clearance spaces.

Power and time losses in overcoming inertia are obviated by this method of reusing the exhaust air, thus starting the acid before live air is admitted.

The speed of switching is governed effectively by an accessible valve, without other adjustment.

The air pressure to the switching apparatus is regulated by an independent diaphragm reducing valve, securing positive and equal timing of the switch movement, regardless of the pressure in the air receiver.

There is no precipitation loss or emulsification of the acid being pumped. The compressed air does not mingle with the liquid, but merely exerts direct pressure upon its surface.

The pump and exposed parts may be made up of steel, cast iron, bronze or other materials designed to resist the chemical action of the acid to be handled.

Pumps may be supplied for any capacity and lift, and for liquid of any specific gravity, within a wide range.

New Brown Cold Junction Compensated Pyrometer

THE Brown Instrument Co., Philadelphia, Pa., is placing on the market a new thermo-electric pyrometer, which is automatically compensated in the instrument for changes in cold junction temperatures and which includes means of setting the pointer of the instrument to zero in the usual manner.

This is an improvement on the method of cold junction compensation developed by Darling in England in 1909, and an improvement on a few subsequent developments for automatic cold junction compensation brought out since that time. These former methods afforded no means of setting the instrument to zero. It is customary on all electrical instruments, including millivoltmeters and pyrometers, to supply a zero adjuster to enable the user to set the instrument to zero, provided the zero has shifted, due to jars in transportation or with continual service.

Darling used what is called a Briguet spiral, a compound strip of two metals of different coefficient of expansion. The Briguet spiral was used to move the scale dependent on the change in atmospheric temperature surrounding the instrument, or as an alternative this Briguet spiral was mounted to act on the springs controlling the moving element of the galvanometer. Darling's device was never used to any extent, because it was evident that unless an instrument had a means of setting to zero, serious errors might result in the use of the instrument. Suppose, for example, the instrument pointer was standing at 110 deg. F., was the pointer standing at this position on the scale because the temperature surrounding the instrument was 110 deg. F., or was the temperature surrounding the instrument only 90 deg. F. and had the zero shifted 20 deg.? Naturally, no accurate temperature instruments could be obtained with this element of doubt.

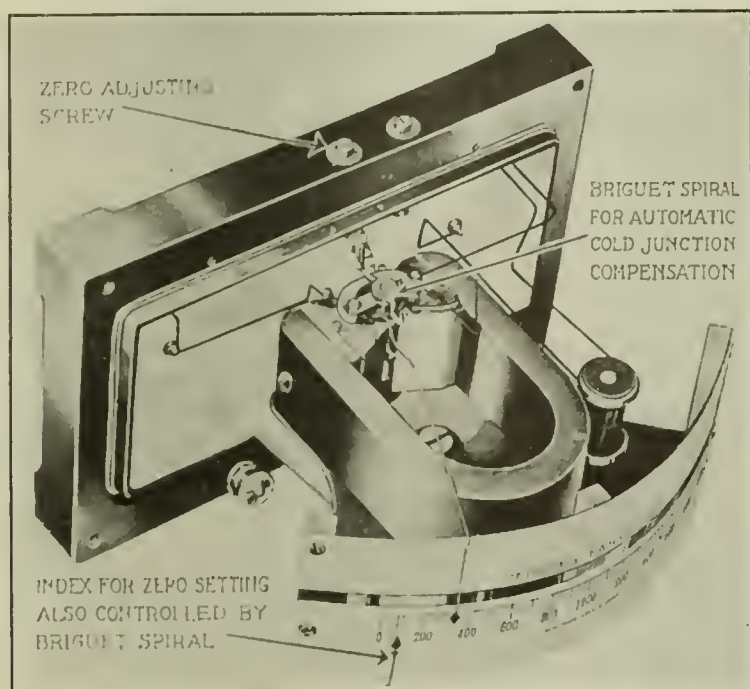
The new Brown construction patented Dec. 28, 1920, includes a means of setting the instrument to its proper zero. This is clearly set out, for example, in claim 1, as follows: "In an electrical instrument, a pointer, a scale operatively arranged with respect to said pointer, means to automatically compensate said scale for changes in temperature surrounding said instrument and means for establishing a normal zero, whereby said pointer can be set to zero."

It is generally understood by all users of thermo-

electric pyrometers that the millivoltage or emf. developed by a thermocouple is dependent on the difference in temperature between the hot and cold ends of a thermocouple. To get accurate measurements of temperature, it is therefore necessary that the cold end of the thermocouple be maintained at a constant temperature or the instrument must be compensated for the changes in temperature at the cold junction of the thermocouple.

It is common practice to use what are known as extension or compensating leads, formed of material similar to the thermocouple, which will transfer the cold junction from the binding posts of the thermocouple to a distant point. Heretofore it has been necessary to locate the cold junction at the end of the extension or compensating leads in a cold well in the ground or in a compensating box, where the temperature can be maintained constant.

If the new Brown pyrometer, compensated for changes in temperature of the cold junction, is used,



INTERIOR VIEW OF BROWN COMPENSATED PYROMETER

the extension or compensating leads are brought to the meter. Changes in temperature at the end of the extension or compensating leads also take place in the meter itself, which can be compensated for this change in temperature.

There are two methods by which this compensation can be easily obtained. A portion of the scale of the instrument may be mounted on thermostatic material and moved, dependent on the change in temperature of the meter, and in this way automatic compensation may be had. Only a portion of the scale is moved and an index on the other portion of the scale denotes the normal zero of the instrument.

A Briguet spiral similar to that used by Darling may be mounted in the instrument, controlling the springs and moving element directly, and a second index controlled by thermostatic metal may be mounted on the scale. This index works with change in temperature exactly in relation to the movement of the pointer controlled by the Briguet spiral attached to the moving element.

In using the new Brown pyrometer, it is only necessary to bring the compensating or extension leads from the thermocouple to the instrument. After mounting the instrument, the instrument pointer is set by the zero

adjuster to correspond with the index on the scale. If the values for a thermocouple have been determined, based on a cold junction of 75 deg. F., the index will indicate 75 deg. F., provided the instrument is subject to this surrounding temperature. If the instrument pointer does not correspond with this index, it is set accordingly. When the temperature surrounding the instrument and the cold junction of the end of the compensating leads at the instrument rises to 90 deg. F., the index automatically rises to 90 deg. F., and the Briguet spiral attached to the instrument pointer causes it to move up to 90 deg. F., automatically adjusting for the temperature of the cold junction of the thermocouple.

It will be understood that any number of thermocouples with their extension or compensating leads can be brought to the one instrument having this automatic compensation. Likewise, recording instruments can be equipped with this automatic compensation and means for setting the pointer to zero.

Census Report on Phosphate Rock, 1919

Phosphate rock to the value of \$10,300,198 was produced in the United States in 1919, according to figures just made public by the Bureau of the Census. Sixty-five per cent of the total production came from Florida. Thirty per cent of the total production was mined in Tennessee. The remaining 15 per cent was produced in South Carolina, Idaho, Kentucky and Utah. The detailed figures, as given out by the Census Bureau, are:

Number of enterprises.....	48
Number of mines.....	69
Number of enterprises operating beneficiating plants in connection with mines.....	20
Mineral lands operated, total (acres).....	160,447
Persons engaged in industry, total.....	4,761
Proprietors and firm members.....	14
Salaried employees.....	374
Wage earners (average number).....	4,373
Wage earners Dec. 15 or nearest representative day:	
Above ground.....	5,764
Below ground.....	149
Power used (horsepower).....	49,639
Capital.....	\$72,733,956
Principal expenses:	
Salaries.....	761,423
Wages.....	3,900,966
Contract work.....	163,696
Supplies and materials.....	2,161,501
Fuel.....	1,739,833
Power.....	79,468
Royalties and rents.....	209,687
Taxes.....	347,580
Expenditures for development (included in the above items).....	353,237
Products, total value ¹	\$10,300,198
Phosphate rock:	
Quantity (tons, 2,240 lb.).....	1,988,975
Value at mine.....	\$10,292,990

Selected Bibliography on Oil Shale

A "Selected Bibliography on Oil Shale," compiled by E. H. Borroughs, bibliographer, and M. J. Gavin, oil shale technologist, has just been issued by the United States Bureau of Mines. The bibliography, which is designated as Serial 2,277, refers to about 300 articles, papers, reports and treatises bearing on the technology of oil shale, and selected chiefly from the literature of the years 1915-20. The references cited cover the oil shales of the entire world, and relate to the history of the industry; the geographic occurrence and geology of shale deposits; methods of mining, retorting, refining and utilization; the properties of shale and their determination; statistics of the industry; legislation and legal regulations; and economics. Copies of Serial 2,277 may be obtained free by addressing the Director of the Bureau of Mines, Washington, D. C.

¹ Includes value of other minerals produced and the amount received for miscellaneous work, services and power furnished other enterprises.

Current Events

in the Chemical and Metallurgical Industries

Dinner to Delegates From American Engineering Societies to Great Britain and France

The homecoming of the delegates from the American Engineering Societies who went to Great Britain and France to present the John Fritz medal to Sir Robert Hadfield and to Eugène Schneider was celebrated by nearly two hundred engineers at a dinner Monday evening, Oct. 10, at the Hotel Pennsylvania, New York City. Representatives of the British and French governments and of foreign engineering societies gave the event an international aspect unique in gatherings of engineers.

J. Vipond Davies, president of the United Engineering Society, acted as toastmaster. Messages were received from Herbert Hoover, Sir Robert Hadfield, Eugène Schneider, the Institution of Civil Engineers, the Institution of Mining and Metallurgy and Mining Engineers, Captain Riall E. Sankey, president of the Institution of Mechanical Engineers; Magnus Howett, secretary of the Institution of Mechanical Engineers; the British Iron and Steel Institute, Engineers Club of London, Faraday Society, Viscount James Bryce, Arthur Neal, Member of Parliament from Sheffield; Jesse Merrick Smith, and A. E. Kennelly, exchange professor to France. The speakers were Ambrose Swasey, Charles F. Rand, F. B. Jewett, A. S. Dwight, John R. Freeman, all members of the deputation; Captain G. H. Armstrong, British Consul General; Gaston Liebert, French Consul General; G. C. Clapperton, representing the British Institution of Electrical Engineers, and Prof. Jacques Cavalier, spokesman for the French universities. The closing feature of the evening was the presentation by Gaston Liebert, the French Consul General at New York, of medals struck by the French Government in commemoration of the entente cordiale between the engineering societies of both countries to the following engineers: George S. Webster, Philadelphia, president of the American Society of Civil Engineers; Edwin Ludlow, New York, president of the American Institute of Mining and Metallurgical Engineers; Edwin S. Carman, Cleveland, president of the American Society of Mechanical Engineers; W. McClellan, Philadelphia, president of the American Institute of Electrical Engineers; Charles T. Main, Boston, chairman of the A.S.C.E. delegation; A. S. Dwight, New York, chairman of the A.I.M.E. delegation; Ira N. Hollis, Worcester, Mass., chairman of the A.S.M.E. delegation; F. B. Jewett, New York, chairman of the A.I.E.E. delegation, and Ambrose Swasey, Cleveland, general chairman of the deputation.

Protest Distilled Spirits Tax

Drug, industrial alcohol, flavoring extracts and confectionery interests have joined in a protest to the Finance Committee of the Senate against the proposal of the majority members of the committee to levy a flat tax of \$6.40 a proof gallon on distilled spirits, with a rebate of \$4.20 a proof gallon where it is shown that the spirits are to be used for non-beverage purposes. It was stated that such a proposal is not acceptable to the industries requiring pure ethyl alcohol in the manufacture of its products for the following reasons:

1. The House bill did not increase the tax on alcohol from \$2.20 per proof gallon, but provided for an additional tax of \$4.20 on each proof gallon to be paid by the person responsible for diversion of the spirits to beverage purposes. This, substantially, is as it should be, and legitimate manufacturers are not concerned in such penalty, regardless of the amount thereof. The proposal of the majority members of your honorable committee, however, would make law-abiding citizens criminals until they proved themselves innocent.

2. Said proposal would tie up for an interminable

period vast capital—as an illustration, approximately \$1,500,000 annually in the case of Parke Davis & Co., Detroit, alone—without ultimately adding one penny to the Treasury of the United States or aiding in the enforcement of prohibition and without recompense to lawful business for interest, additional clerical help and counsel fees incidental to keeping accounts and prosecuting claims for rebate; and in this connection consideration should also be given to the inevitable increased cost to the ultimate consumer of medicines, food products and other necessities of life in the manufacture of which alcohol is an essential factor.

3. Said proposal would unquestionably put out of business innumerable small merchants and manufacturers doing a reputable business but not possessing or able to borrow the necessary additional capital to finance themselves pending uncertain adjustments of alcohol rebate accounts.

4. As taxes on distilled spirits under existing law are payable by the distiller or proprietor of the bonded warehouse on withdrawal from bond and are sold to the trades tax-paid, said proposal if otherwise practicable, leaves open the question of how and by whom the \$4.20 is to be legally claimed by way of rebate.

5. Generally speaking, said proposal is based upon the theory that if all distilled spirits are lawfully used, the Government will receive only the present rate of \$2.20 per proof gallon, and that any additional revenue will come from those who violate the Eighteenth Amendment to the Constitution and the national prohibition act; therefore, from a national standpoint, what is gained by penalizing legitimate industry and making more expensive indispensable articles of commerce, especially when the integrity and lawful operations of manufacturers using alcohol in their processes are investigated before the federal prohibition commissioner issues to them the basic permit to obtain and use alcohol and exacts bond (obtainable only at exorbitant rates of premium) in a penal sum practically double the non-beverage alcohol tax involved and conditioned upon their lawful use of the chemical?

6. Said proposal is a prohibition measure pure and simple and will neither produce additional revenue nor add a tithe of discouragement to bootleggers, who could not obtain a drop of alcohol if the prohibition unit of the Internal Revenue Bureau administered effectively the national prohibition act, the purposes of which are well stated in its very title—viz: "An act to prohibit intoxicating beverages, and to regulate the manufacture, production, use, and sale of high-proof spirits for other than beverage purposes, and to insure an ample supply of alcohol and promote its use in scientific research and in the development of fuel, dye, and other lawful industries."

7. In the final analysis, why not encourage industry in the lawful use of a chemical raw material of paramount importance which is already taxed many hundred per cent above its cost of production and thereby materially increase the revenue?

The protest is signed by the American Drug Manufacturers' Association, the American Pharmaceutical Manufacturers' Association, the National Wholesale Druggists' Association, the National Association of Retail Druggists, the Manufacturing Perfumers' Association, the Proprietary Association, the Flavoring Extracts Manufacturers' Association, the National Confectioners' Association and the Industrial Alcohol Manufacturers.

Copper Shingle Production

The Anaconda Copper Mining Co. has established a department at its Washoe plant at Anaconda, Mont., for the manufacture of copper shingles, copper-zinc shingle nails and affiliated specialties, in an effort to broaden the market for copper products. The present production for the most part is of purely experimental character.

Further Data on the Oppau Disaster

According to a statement made by the Badische Anilin und Sodafabrik, in another warehouse at Oppau no less than 7,000 tons of sulphonitrate of ammonium (the compound which caused the damage in the recent explosion) remained absolutely intact, although the walls of the building were blown in and glowing fragments fell right into the contents.

A witness affirms that on the day of the catastrophe preparations had been made for splitting up a block of the compound by means of explosives. On the other hand, the double explosion leads experts to think that possibly the first explosion outside the warehouse, presumably in the neighboring sulphonitrate of ammonium factory, was the result of completely unknown causes, and that the principal explosion was brought about by fragments scattered by the first explosion.

As to the practice of blasting the hardened masses of the product, it is said that this operation had been carried out about 20,000 times at the Badische works and elsewhere and had been performed only the day before in the very warehouse in which the explosion occurred.

La Liberté of Paris learns from a highly qualified chemist who visited the works at Oppau two days after the catastrophe that it is a mistake to suppose that the explosion will have any notable effect on the German output of fertilizers and dyes. In the first place, the dye works, which are situated at a distance of 2 kilometers from the site of the explosion, suffered little damage and work was scarcely interrupted. Within a radius of 250 meters nearly all buildings were completely destroyed; from 250 to 500 meters serious damage was caused; beyond 500 meters nothing but reparable damage occurred. It is reckoned that in three months' time the production of ammonia and the manufacture of fertilizers can be resumed as previously.

As for the cause of the disaster, the French chemist said that he could offer no explanation. The salt in question, he was informed, was manufactured at the works before 1914 and numerous experiments had been made in order to test its non-explosiveness; it had been placed in barrels and set on fire, for instance, or an electric spark had been passed through it, but no sign was ever detected of any danger of explosion.

Recent Advances in Plant Chemistry

About one hundred members of the Rochester Section of the American Chemical Society met at Hobart College, Geneva, N. Y., Oct. 1. Prof. J. E. Lansing, director of the department of chemistry, discussed in a very interesting way the teaching of chemistry at Hobart College from 1822 to the present day, and Dr. Thatcher spoke on "Recent Advances in Plant Chemistry," in part as follows:

Undoubtedly the most serious handicap which biochemists have had in the attempts to study or duplicate the chemical processes which take place in cell protoplasm lies in the fact that we have thus far been compelled to work with mixtures of reagents in solution, contained in beakers, test tubes, etc., in which ionization and diffusion make a uniform chemical change throughout the entire reacting mass practically unavoidable. Recent advances in our knowledge of the colloidal condition make it plain, however, that even in so small a mass as the protoplasmic contents of a single cell there are thousands, if not millions, of colloidal compartments, separated from one another by membranes of variable and perhaps constantly varying permeability, in which a great variety of chemical changes may go on independently of each other.

It would seem to me, therefore, that the first requisite for up-to-date study of the chemistry of living things is a recognition of the structure of the cell as an essential factor in its synthetic operations, and that the first advancement toward an understanding of and possible duplication of the cell synthesis will require the successful reproduction of a colloidal mass having similar structure to that of cell protoplasm.

I believe that a proper mental picture of the organization and activity of a plant cell is suggested by the figure of a well-organized chemical factory, with the different trans-

formations which are involved in the whole process going on in different parts of rooms of the factory, with the raw materials systematically transported from one room to another as they are needed to keep each step in the whole process going at the proper rate, and with all the different parts of the whole factory working in smooth co-ordination with one another.

The raw materials for this factory are the mineral matter and water coming from the soil and the gases of the atmosphere; the intermediates are the simple carbohydrates and amino-acids; and the finished products comprise all of the varied compounds which are the results of cell protoplasmic activity and which are used by the plant for its nutrition, growth or reproduction.

The researches of botanists and chemists in the past have dealt with the nature of the compounds and the chemical changes which are involved in each separate process of the factory's operation. The principal problem now is to learn the nature and method of superintendence of the factory, whereby its operations are automatically regulated and altered so as to provide the proper output of all the varying products of the factory to meet the needs of the whole plant. We are as yet almost wholly in the dark concerning the regulatory agencies which control the rate and character of the synthetic processes of cell operation. We call these regulatory agents "catalyst," or "enzymes"; but as to what they are and how they act we know very little.

Furthermore, we have absolutely no idea, as yet, of the methods of intercommunication and of recognition of supplies and needs of raw materials or finished products whereby the factory output is varied in kind or quantity.

A further aspect of plant chemistry, the significance of which is easily apparent from the simile of the factory, is that chemical changes which are almost the exact antithesis of each other are going on simultaneously in every active plant organism, if not indeed in each individual plant cell. The synthetic production of complex organic compounds and the destructive oxidation of previously produced synergic foods to furnish energy for the synthetic processes go on simultaneously; just as, in any factory, there is consumption of fuel, wearing out of equipment, etc., during the process of manufacture of the factory output. This phenomenon, too, is readily understood on the basis of colloidal structure and emphasizes again the importance of recognition of this condition of matter as a necessary step in studies of protoplasmic activities.

New Jersey Chemists Meet

About 150 members attended the first regular meeting of the New Jersey Chemical Society at Newark on Oct. 10. Dr. H. E. Howe, chairman of research extension division of the National Research Council, talked on the history, organization and functions of the Council. Chemists individually and as members of the different scientific societies were urged to co-operate with the Council in its efforts to visualize to the manufacturer the importance of industrial research. Prof. Arthur W. Thomas followed with some instructive remarks and a general review of recent developments in colloidal chemistry. Dr. Thomas exhibited a number of interesting colloids and by the use of an ultra-microscope demonstrated some of their unusual properties.

Invitation to Engineers to Visit Liège, Belgium, in 1922

The Association of Engineers graduated from the technical faculties of the University of Liège will celebrate next year the seventy-fifth anniversary of its founding. On this occasion there will be scientific ceremonials and social gatherings, to which will be invited the engineers of the great Belgian schools and of allied and friendly countries. The most important events will be a scientific congress and a technical exposition, June 11 to July 14, 1922.

The congress will include sections on mines, metallurgy, mechanics, electricity, chemical industries, geology and public works. The technical exposition will have for its aim the showing of the important rôle played by engineers in works of the profession and in industry.

Contract for German Potash Signed

Six large manufacturers of fertilizer, according to information reaching the United States Potash Producers' Association, have closed a contract for 80 per cent of their potash requirements for the next season with the German syndicate. The price is understood to be very close to the pre-war level. The closing of this contract, it was stated, leaves comparatively little business to be divided between the French and American producers. No American producer of potash is able to compete with the German product at the price offered. It was stated that they would not attempt to enter the market at the present price level.

The delay in the passage of the tariff bill is blamed by the domestic producers for this large contract going to Germany. They contend that they would have been able to meet the price of the German potash had the duty carried in the tariff bill been in effect.

Data Wanted on Industrial and Technical Photography

A survey of industrial and technical photography is being prepared by John H. Graff, industrial photographer and photomicroscopist, Brown Co., Berlin, N. H. In order to supplement his own wide experience with that of others in this field, Mr. Graff requests those using photography in their plants or organizations to assist him with samples of different types of photographs used; a short statement of how and why photography is being used, as in field, office, plant or research; information as to how far an outside photographer is employed, or, if the users have photographic departments of their own, a history of the development of the same. Methods of mounting, filing and reference are important; also statements of the costs and upkeep of the departments and the value and importance of them.

All these data and information will be compiled to make a complete history of the development and uses of industrial photography.

Bureau of Mines Co-Operative Agreements

As co-operative agreements between the U. S. Bureau of Mines and outside agencies are terminated automatically at the end of each fiscal year, it is necessary to renew the agreements that are to be continued. Those thus far signed for the current fiscal year add more than \$250,000 to the bureau's appropriations for research work. Of more importance, however, than the actual money made available are the contributions of services of technical men, of laboratories and other equipment. The co-operative agreements of direct interest to the chemical industries are:

University of Alabama—To study the problems peculiar to the mineral industry in the Southern States, particularly those relating to non-metallic minerals and their by-products, steel, coal and coke.

University of Arizona—To study problems connected with the mining and smelting of low-grade copper ores of the Southwest, with particular attention being paid to sulphur dioxide leaching and the precipitation of copper from sulphate solutions.

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University of California—To study problems including

the purification of copper sulphate solutions, the fundamental chemistry of chloride volatilization and reduction of iron oxides with gases. The chemical service laboratory handles the chemical end of the work at the mining experiment stations located at Reno, Seattle and Salt Lake City.

State of Colorado—To make investigations and to secure data regarding the production of oil from oil shales.

Cornell University—To study alloys, principally those of the non-ferrous type, and electric furnaces.

Ohio State University—To study means of increasing efficiency in the utilization of the mineral substances necessary to the ceramic industry, and to study means of substituting ceramic products of American manufacture for those now imported.

University of Utah—To study the volatilization process as applied to low-grade lead and zinc ores in Utah and as applied to the reduction of lead fume and to the recovery of silver, lead and copper.

University of Washington—To study, among other things, the use of Northwestern clays for ceramic purposes and the electrometallurgical problems of the Pacific Northwest.

Arizona Copper Co.—To study problems relating to the leaching of partly oxidized copper ores.

Central of Georgia Railway Co.—To conduct investigation of Georgia kaolins, to determine their suitability for pottery and other ceramic purposes; to conduct investigations concerning the suitability of bauxite clays and bauxites for refractory or other purposes.

Davison Chemical Co.—To investigate the possibilities of obtaining more complete recoveries of light oil from coke-oven gas for the production of motor fuels.

Combustion Engineering Corporation, New York—To study the combustion of powdered fuels.

Morris P. Kirk, Harbor City, Cal.—To study volatilization of silver and lead from ores, and the reduction of volatilized fume into metallic bullion.

Vanadium Corporation of America, New York—To investigate molybdenum steel.

The Welsbach Co., Gloucester City, N. J.—To investigate cerium alloys.

University of Montana—To study the industrial use of picric acid.

Fire Changes Paper Company's Water-Power Plans

On Saturday, Oct. 8, a fire of unknown origin destroyed the sawmill of I. M. Pierce & Co. at Orono, Me. Because of the distance the logs are now being driven, the mill will not be rebuilt near the present site. The sawmill, a very old one, became the property of the International Paper Co. a few years ago, as it desired to control the water at the mouth of the Stillwater River where it flows into the Penobscot. Arrangements were then made for the continuance of the sawmill, using steam and electric power, and the mill has been a busy place even during the recent depression.

The International Paper Co. uses the water for its Webster mill on the one bank of the river and for its mechanical pulp and hydro-electric plant on the other bank. With the elimination of the sawmill, it is now probable that the old log dam, which was already partly replaced by a higher concrete one at the flume intakes, will be extended across the river, allowing greater water storage and additional installation of pulp grinders and hydro-electric equipment.

The paper company began to operate one of the paper machines recently after being closed down since last spring by a strike. With the many men from the sawmill out of employment, it can be expected that many men from the paper mill, still on strike, will go back.

To Oppose Pollution Bill

Representatives of chemical industries will appear before the Committee on Rivers and Harbors of the House of Representatives on Oct. 25 to oppose a bill by Representative Appleby which, if passed, will make it illegal for manufacturing plants or ships to discharge oil and other refuse matter into any navigable waters of the United States. The passage of this bill, it is declared, would work the greatest hardship on a large number of chemical plants.

Civil Service Examination

Open competitive examinations are announced by the United States Civil Service Commission for the following positions: Metallurgist, \$4,000 to \$4,800 a year; associate metallurgist, \$3,000 to \$3,800; assistant metallurgist, \$2,000 to \$2,800; junior metallurgist, \$1,500 to \$1,800.

Applications on Form 2118 will be received until further notice. Papers will be rated beginning Nov. 1, and thereafter every two weeks until the close of the examinations.

Personal

HAROLD W. ABBOTT has resigned as technical supervisor at the Messina plant of the Aluminum Co. of America, to accept a similar position with the Stackpole Carbon Co., St. Marys, Pa.

JOHN BORG has been elected president of the Big Ledge Copper Co., New York, N. Y., and NELSON GRAY, vice-president and treasurer.

MIERS BUSCH, Philadelphia, Pa., a member of the firm of Shoemaker & Busch, has been elected a director of the Pennsylvania Salt Manufacturing Co., Philadelphia.

CHARLES E. CARPENTER, president of E. F. Houghton & Co., Philadelphia, Pa., addressed the Pittsburgh (Pa.) chapter of the American Society for Steel Treating at the Chatham Hotel, Pittsburgh, on Tuesday evening, Oct. 4.

E. M. A. CHANDLER, formerly with the Industrial Chemical Laboratories, Inc., of Hammond, Ind., has accepted a position on plant research work at the new North Chicago plant of the Abbott Laboratories.

DR. G. G. COLE, head of the chemistry department at Lynchburg College, Lynchburg, Va., has been elected a fellow of the American Association for the Advancement of Science. The honor has been accorded as the result of his extensive research work. He has been a member of the association for fourteen years.

DR. F. G. COTTRELL, head of the chemical activities of the National Research Council, sailed from France on Oct. 11. Dr. Cottrell has spent the summer studying various phases of the chemical industry in Europe.

OTTO EISENSCHIML, president of the Chicago Chemists Club, has just returned from an extended trip in Europe.

E. T. MARCEAU, chemical director of the N. K. Fairbank Co., has transferred his headquarters from Chicago to the New York office.

DR. JOHN MARTIN THOMAS was inaugurated president of the Pennsylvania State College, Oct. 14, at State College, Pa.

H. S. WITMER, who has been for several years in the chemical department of the N. K. Fairbank Co., in Chicago, has been given charge of the St. Louis branch factory.

The University of Maine, Orono, Me., has had the following recent changes in the chemistry departments: George Mervil Seeley, instructor, replacing L. J. Waldbauer, who has gone to McGill; Milton Roland Louria, instructor, replacing Norman F. Eberman, who has gone to Johns Hopkins; John Newell Crombie, instructor, replacing V. L. Kemmerer, who has gone to Thiel College.

Obituary

S. C. LINBARGER, for the past six years ceramic engineer of the Carborundum Co., Niagara Falls, N. Y., died at his home in that city on Saturday, Sept. 3, at the age of twenty-nine years. Mr. Linbarger was a very active member of the American Ceramic Society, at the time of his death being chairman of the committee on sections and divisions and president of the New York branch of the society. He was an authority in the field of refractories and abrasives, having developed the crucibles of graphite, clay and silicon carbide, carborundum saggers and made a number of other important discoveries.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, OCT. 17, 1921.

Trading in the chemical market during the past week has been somewhat spotty with intermittent periods of activity and dullness. There were few important developments uncovered, although the continued inquiry for miscellaneous products gave an encouraging aspect to the situation. Export shipments during the past few months on leading basic chemicals have shown a decided expansion and domestic buying has been well distributed among the various principal consumers.

CHEMICALS

Producers of *nitrate of potash* have reduced prices on the domestic refined material and are asking 7½¢@8¢. per lb. on the granular according to quantity. Prices on *bichromate of soda* showed a little firmer tendency and the market closed at 7¼¢@8¢. per lb. for small quantities. There were a few sales recorded by second hands at 7¼¢. per lb. The demand has shown a fair improvement during the past week and offerings have not been plentiful. Most dealers of *caustic potash* were asking 5¼¢. per lb. for the 88-92 per cent imported material, although some sales were transacted down to 5¢. per lb. While activity is not so general, as buyers have not been desirous to follow the advance, the market seems to be holding its own around recent advances. Most of the imported material recently shipped is reported sold on contract to large consuming interests. Sales of *solid caustic soda* were reported at \$4 per 100 lb., while some odd lot business has gone through at \$4.05@ \$4.15 per 100 lb. Inquiries are quite numerous in the market and the tone is holding quite firm. The export demand from South America has been very good and large tonnage sales were reported by several dealers. A good domestic demand is also recorded from leading consuming interests. At the works 3¼¢. per lb., basis 60 per cent, is quoted for prompt shipment. Dealers of *nitrite of soda* are shading prices slightly in various quarters and small quantity business is reported at 6½¢. per lb., ex-store. In most directions 6¼¢@7¢. was the prevailing quotation. The demand has not been active of late and this condition has stimulated competition among holders.

Manufacturers of *bleaching powder* continue to quote 2¼¢. per lb. f.o.b. works for large drums in carload lots and report conditions extremely favorable. A few producers report production sold up for the next few weeks, while others are barely able to meet the daily requirements. Imported material is quoted at \$1.90 per 100 lb. c.i.f. New York. Sales of *light soda ash* in single bags are being made at \$2.10@ \$2.15 per 100 lb. Barrels are moving at \$2.45@ \$2.50 per 100 lb. A good inquiry is noted around the trade and the market is holding quite firm at the above figures. Ash at the works was quoted at \$1.60 per 100 lb., basis 48 per cent, in carload lots. Prices on spot *oxalic acid* are heard from 15½¢@16¢. per lb. Sales were reported f.o.b. works at 15¢@15½¢. per lb., depending upon the brand and quantity. Inquiries are reaching the market in moderate volume, but seem to be only for small-sized lots. Sales of carload quantities of *silicate of soda* are reported by producers at \$2.90 per 100 lb., f.o.b. New York, for the 60 deg. Bé. The 40 deg. in drums is moving on the basis of 1¢. per lb. in carload lots and up to 1¼¢. in smaller quantities. Imported *sulphide of soda*, 60-62 per cent, has sold at 4½¢. per lb. during the week. The broken material was quoted at 4¾¢. per lb. Domestic producers quote the fused at 5¢@5¼¢. and the broken at 5¼¢@5½¢. per lb., according to quantity. Crystals, 30 per cent, are quoted at 3¼¢. per lb. for domestic material, while numerous lots of imported material for shipment have reached the market at 2½¢. per lb. c.i.f. New York. Leading producers of *borax* are making sales at 5½¢. per lb. for carload lots and 5¾¢@6¢. for smaller quantities, depending upon the brand

and seller. Producers of *Glaubers salt* report sales at 1½c. per lb. in bags and \$1.65 per 100 lb. in barrels for large quantities. Sales of smaller lots in bags are reported at \$1.75 per 100 lb. and \$1.90 for barrels. Manufacturers of *zinc carbonate* are placing business at 16@18c. per lb., according to quantity. The inquiry is moderate, although a fair volume of small lot business is being recorded. The demand for *camphor* has shown improvement during the past week and the spot market has responded readily to the increased buying power. At the close prominent importers reported sales at 76c. per lb. for the Japanese gum and up to 77c. for odd lots.

COAL-TAR PRODUCTS

Sales during the week in the coal-tar products industry have shown considerable improvement. Intermediates have been a shade better, but there still lacks the real snap to buying. Most consumers are merely covering current necessities and are operating in a conservative manner. Heavy resale stocks of naphthalene, phenol, beta-naphthol and aniline oil continue to depress any possible hope for recovery. The majority of the products tend more toward stabilization, although prices are not advancing. Competition still remains quite keen among second hands and manufacturers and quoted prices are seldom adhered to when firm orders are in the market. There are reports around the trade that slightly increased production of *benzene* will soon be available through the opening of a few more coke ovens. Production at present is far from normal and this slight addition will be welcome news to many consumers who are anxiously awaiting supplies. Inquiries from rubber and paint makers are quite numerous for benzene. Refiners are offering only for future delivery at 27@33c. per gal. Resale stocks are very difficult to locate and generally sell at 38@40c. per gal. Resellers of *phenol* have placed business at 8¼@8½c. per lb., but the general quotation heard is 9c. per lb. Government resellers still quote 12c. per lb. The demand for export is decidedly brighter. Stocks among second hands are large and considerable buying will have to be done before the market assumes a normal basis. Makers of *paranitraniline* are quoting 80c. per lb., although there are some who intimate that as low as 77c. per lb. would not be turned down on firm business. Resellers ask 77c., with sales at slightly lower levels recorded. Producers of *dimethylaniline* ask 45c. per lb., but sales among resellers have been made down to 41c. Inquiries seem to be more numerous than formerly and more active interest has taken place in the past few days. Sellers of *betanaphthol* show no disposition to quote below 31c. per lb., except on real round lot business. The demand shows signs of improvement and some fair selling was done during the week. The scarcity of benzene has forced some manufacturers to stop their production of *aniline oil* and the market has strengthened to some extent. Resale stocks, however, are quite heavy and considerable purchasing must be done before the market will show signs of any real strength. The general asking price is 18c. per lb., but there are confirmed reports of actual sales somewhat below this level. First hands quote *H acid* at \$1.10 @ \$1.15 per lb., but some selling is said to have been done under the inside figure. The demand has shown a slight improvement and some fair selling was done during the week.

VEGETABLE OILS

With the market for castor seed firm, crushers of oil were holding out for 11c. per lb. on the U.S.P. quality in barrels and 10c. for the No. 3 technical grade. Offerings of *chinawood oil* on spot were scanty and prices at best were merely nominal, ranging from 15@16c. per lb. The inquiry on spot was confined to small quantity lots only. Futures closed firmer, importers asking as high as 14c. per lb. for November-December shipments from the Orient, c.i.f. New York in hardwood barrels. The market for *coconut oil* underwent practically little change. Ceylon style oil in New York was available at 8½c. per lb. in sellers' tanks, nearby positions, while on the coast 8½c. represented the market on November forward business. Manila oil in bulk closed at 7½c. per lb. asked, coast basis, November-

December shipment, with little interest shown by buyers at this figure. Ceylon style oil in barrels was generally quoted at 10c. per lb. spot New York, with Cochin style oil held at 10½@11c. per lb.

The St. Louis Market

ST. LOUIS, Oct. 14, 1921.

There has been quite an improvement in the drug and chemical market during the past two weeks and from all indications this should continue. While orders are still small, they are more numerous. However, a slight increase in volume is perceptible.

Prices on a whole are firm and the general opinion is that they have now reached a level where they are no longer consistent with manufacturing costs and the tendency will be to advance rather than make reductions for the future.

ALKALIS

Caustic soda remains in good demand, the price of \$4 per 100 lb., basis 73 to 75 per cent solid, f.o.b. point of production. There has been no change in this item. *Soda ash* demand is still only fair, with manufacturers' market prevailing. *Bicarbonate of soda* and *sal soda* are moving slowly but with the *bicarbonate* the more active at \$2.60 per 100 lb. in less than carlots.

CHEMICALS, DRUGS AND PHARMACEUTICALS

The second-hand market an *acetphenetidin* seems to have cleared and a fair volume of business is being transacted. *Ammonia water*, 26 deg., continues to move in a regular way. A heavy demand for *sulphate ammonium*, *pure granular*, is now being experienced and large stocks should be carried. *Benzene* is in sold up condition, with producers accepting business for only small quantities. No futures—ruling price 35c. to 40c. per gal. *Bismuth salts* are moving beyond manufacturers' expectations. The *bromide* situation is none the worse and prices are firm. *Caffeine* is beginning to open, but competition still remains keen. *Carbon bisulphide* demand very strong, with prices ranging from 8@10½c. per lb., depending upon quantities. *Carbon tetrachloride* demand is good owing to the substitution of this material for carbon bisulphide, with price remaining at 12c. During the past few weeks there has been a substantial increase in the demand for *ethers*. *Formaldehyde* is moving very well. There is quite a movement of *glycerophosphates*. *Hypo* is moving in a routine way. *Hypophosphites* are beginning to move quite freely, due to the approach of the fall season and the heavy demand for tonics in which these commodities are used. *Iodides* are in good demand, especially the *potash salts*, for which there is a very heavy demand, undoubtedly due to the fact that Government surplus stocks are now exhausted. *Saccharine* is moving pretty well. *Salicylates* have shown an increase lately. *Sulphur* remains in easy demand and firm price due to high freight rates. *Zinc oxide*, *lead free*, is selling at 8c., with demand light.

ACIDS

The heavy mineral acids are now moving in large volume owing to the fact that many steel mills are again in operation and in all probability this demand will increase. A fair amount of business is being transacted in *phosphoric acid*. *Pyrogallie acid* remains in good demand. A small increase in *tannic acid* inquiries is reported. *Acid tartaric* remains the same.

VEGETABLE OILS AND NAVAL STORES

Castor oil continues in good demand with price firm at 11½c. in drums for No. 1 U.S.P. *Linseed oil* has declined to 73c., basis raw oil, ex-warehouse. The demand is for spot oil and in small quantities. *Turpentine* demand is routine, with prices fluctuating from 75@79c., ex-warehouse.

PAINT MATERIALS

The *lithopone* market is showing signs of life. Manufacturers are quoting 6½c. in carlots and 6½c. in less than carlots at St. Louis. The recent drop in the price of floated *barytes* has stimulated the demand, which is now very strong. Price \$23 per ton continues strong. *Red oxide* and *whiting* moving slowly, with nominal price prevailing.

The Iron and Steel Market

PITTSBURGH, OCT. 14, 1921.

A bit of a chill has crept over the iron and steel and allied industries in the past week or two. There is nothing to indicate that conditions have grown worse in any respect, or to make it propable either that prices are going to decline or production decrease. The new appraisal of the situation must be due to disappointment over expected further improvement not materializing.

From the monthly report of the American Iron and Steel Institute, giving the steel ingot production of thirty companies, it can be computed that production in September was at about 32 per cent of capacity, against about 30 per cent for August and 21 per cent for July. At the middle of July production must have been at about 19 per cent. The increase to an average of 30 per cent for August was quite satisfactory. Apparently it was dangerously encouraging, since September, following the midsummer period, could be expected to show a greater broadening in steel demand. September, however, has shown an operation, in steel production, at only about 32 per cent, while the rate now can scarcely be estimated at over 35 per cent.

STEEL PRICES

Superficially viewed, steel prices show distinct vagaries. Bars, shapes and plates show a firming up. Since the beginning of August it has not been particularly difficult to place an attractive order at about 1.60c.

Last month there were definite advances in both sheets and wire products, \$5 a ton on all descriptions of sheets, \$2 a ton on plain wire and \$3 a ton on barb wire and nails. Each line shows a new development this week. In sheets the independents are announcing another advance, \$5 a ton, effective not later than tomorrow. In wire products it develops that attractive orders can again be placed at the old prices ruling prior to Sept 12.

These movements seem rather confusing, but steel prices do not always move in direct harmony with the relation between the demand and the capacity to supply the demand. In bars, shapes and plates the demand has been light and is light. Mills allowed prices to go below cost of production, hoping to broaden the demand. Buyers have not responded, and now they are trying to get cost out of the little business that is available. In wire products specifications against the contracts booked prior to the advance are presumably somewhat unsatisfactory, hence some sellers are willing to make sales afresh at the old prices. In sheets the business booked before the advance of three or four weeks ago was in actual shipping orders, which are beginning to play out, and it may be inferred that the mills are trying the experiment of another advance, to encourage orders at present prices. As the sheet mills have been losing money, it is quite possible they will adhere to the advance now promised, and their allowing the market to get down to its low point last August, when their costs were somewhat higher than at present, may be explained away or left without explanation. Prices upon which the advance is to be predicated are 2.50c. for blue annealed sheets, 3c. for black and 4c for galvanized.

Demand for oil country goods has increased somewhat, this being attributed to recent advances in oil prices causing oil interests to plan some winter drilling, for which the material must be delivered in the next few weeks.

Railroads have announced reduction of 28 per cent in iron ore freight rates, effective Oct. 20, approximately equaling the 40 per cent advances of Aug. 26, 1920. As the furnaces have large piles of ore, the reduction does not involve an early reduction in the cost of producing pig iron. The railroads had their eyes on the fact that there is approximately 10,000,000 tons of ore on Lake Erie docks. Furnacemen feel that in the circumstances they have no occasion to reduce pig iron prices. They would welcome reductions in rates on coke and limestone, on which they are paying freight bills every day. Consumers of pig iron would welcome reductions in rates on pig iron, which is sold them f.o.b. furnace. Naturally the buying of pig iron is not stimulated, and the market is very quiet. The valley market is unchanged at \$20 for bessemer, \$19.25 to \$20 for basic and \$21 for foundry.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots	Less Carlots
Acetic anhydride.....lb.	—	\$0.40 - \$0.45
Acetone.....lb.	\$0.12½ - \$0.12½	.13 - .13½
Acid, acetic, 28 per cent.....100 lbs.	2.75 - 3.00	3.25 - 3.50
Acetic, 56 per cent.....100 lbs.	5.50 - 5.75	6.00 - 6.50
Acetic, glacial, 99½ per cent, carboys, 100 lbs.	10.50 - 11.00	11.25 - 10.50
Boric, crystals.....lb.	12½ - 13	.13½ - .14
Boric, powder.....lb.	13 - 13½	.14 - .14½
Citric.....lb.	—	.45 - .47
Hydrochloric.....100 lb.	1.25 - 1.50	1.60 - 1.75
Hydrofluoric, 52 per cent.....lb.	12 - 12½	.12½ - .13
Lactic, 44 per cent tech.....lb.	.09½ - .10	.10½ - .12
Lactic, 22 per cent tech.....lb.	.04½ - .05½	.06 - .07
Molybdic, C.P.....lb.	3.25 - 3.50	3.60 - 4.00
Muriatic, 20 deg. (see hydrochloric).....lb.	—	—
Nitric, 40 deg.....lb.	.06½ - .06½	.06½ - .07
Nitric, 42 deg.....lb.	.06½ - .07	.07½ - .07½
Oxalic, crystals.....lb.	.15½ - .16	.16½ - .17
Phosphoric, 50 per cent solution.....lb.	.13 - .13½	.14 - .18
Picric.....lb.	.20 - .25	.27 - .35
Pyrogallol, resublimed.....lb.	—	1.75 - 1.90
Sulphuric, 60 deg., tank cars.....ton	—	11.00 - 12.00
Sulphuric, 60 deg., drums.....ton	—	13.00 - 15.00
Sulphuric, 66 deg., tank cars.....ton	17.00 - 18.00	—
Sulphuric, 66 deg., drums.....ton	21.00 - 22.00	22.50 - 23.00
Sulphuric, 66 deg., carboys.....ton	—	—
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	21.00 - 22.00	—
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	23.00 - 23.50	24.00 - 24.50
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	31.00 - 32.00	33.00 - 34.00
Tannic, U. S. P.....lb.	—	.75 - .85
Tannic (tech.).....lb.	.45 - .48	.50 - .55
Tartaric, imported crystals.....lb.	—	.26 - .27
Tartaric acid, imported, powdered.....lb.	—	.27½ - .28½
Tartaric acid, domestic.....lb.	—	—
Tungstic, per lb. of WO.....lb.	—	1.10 - 1.20
Alcohol, Ethyl.....gal.	—	4.65 - 4.90
Alcohol, Methyl (see methanol).....gal.	—	—
Alcohol, denatured, 188 proof.....gal.	—	.35 - .36
Alcohol, denatured, 190 proof.....gal.	—	.37 - .38
Alum, ammonia, lump.....lb.	.03½ - .03½	.04 - .04½
Alum, potash, lump.....lb.	.03½ - .04	.04½ - .04½
Alum, chrome lump.....lb.	.10 - .11	.11½ - .12½
Aluminum sulphate, commercial.....lb.	.01 - .02	.02½ - .02½
Aluminum sulphate, iron free.....lb.	.02½ - .02½	.03 - .03½
Aqua ammonia, 26 deg., drums (750 lb.) lb.	.07½ - .07½	.08 - .08½
Ammonia, anhydrous, cyl. (100-150 lb.) lb.	.30 - .32	.33 - .35
Ammonium carbonate, powder.....lb.	.07 - .07½	.08 - .09
Ammonium chloride, granular (white sal ammoniac).....lb.	.06 - .06½	.06½ - .07
Ammonium chloride, granular (gray sal ammoniac).....lb.	.06½ - .07	.07½ - .08
Ammonium nitrate.....lb.	.07½ - .07½	.07½ - .08½
Amylacetate.....gal.	—	3.25 - 3.50
Amylacetate tech.....gal.	—	2.50 - 3.00
Arsenic oxide, (white arsenic) powdered lb.	.05 - .06	.06½ - .06½
Arsenic, sulphide, powdered (red arsenic) lb.	.11 - .11½	.12 - .13
Barium chloride.....ton	44.00 - 45.00	46.00 - 50.00
Barium dioxide (peroxide).....ton	.20 - .21	.22 - .23
Barium nitrate.....lb.	.07½ - .08	.08½ - .09
Barium sulphate (precip.) (blanc fixe) lb.	.04 - .04½	.04½ - .05
Bleaching powder (see calc. hypochlorite).....lb.	—	—
Blue vitriol (see copper sulphate).....lb.	—	—
Borax (see sodium borate).....lb.	—	—
Brimstone (see sulphur, roll).....lb.	—	—
Bromine.....lb.	.27 - .28	.28½ - .30
Calcium acetate.....100 lbs.	2.00 - 2.05	—
Calcium carbide.....lb.	.04½ - .04½	.05 - .05½
Calcium chloride, fused, lump.....ton	23.50 - 24.00	24.50 - 25.50
Calcium chloride, granulated.....lb.	.01½ - .02	.02½ - .02½
Calcium hypochloride (bleach'g powder) 100 lb.	2.50 - 2.60	2.70 - 3.25
Calcium peroxide.....lb.	—	1.40 - 1.50
Calcium phosphate, tribasic.....lb.	—	.15 - .16
Camphor.....lb.	—	.76 - .77
Carbon bisulphide.....lb.	.06½ - .06½	.07 - .07½
Carbon tetrachloride, drums.....lb.	.10½ - .10½	.11 - .12
Carbonyl chloride, (phosgene).....lb.	—	.60 - .75
Caustic potash (see potassium hydroxide).....lb.	—	—
Caustic soda (see sodium hydroxide).....lb.	—	—
Chlorine, gas, liquid-cylinders (100 lb.) lb.	.08 - .09	.09½ - .10
Chloroform.....lb.	—	.40 - .43
Cobalt oxide.....lb.	—	2.00 - 2.10
Copperas (see iron sulphate).....lb.	—	—
Copper carbonate, green precipitate.....lb.	.19 - .19½	.20 - .21
Copper cyanide.....lb.	—	.50 - .62
Copper sulphate, crystals.....lb.	.05 - .05½	.05½ - .06
Cream of tartar (see potassium bitartrate).....lb.	—	—
Epsom salt (see magnesium sulphate).....lb.	—	—
Ethyl Acetate Com. 85%.....gal.	—	1.00 - 1.10
Ethyl Acetate pure (acetic ether, 98% to 100%).....lb.	—	.40 - .42
Formaldehyde, 40 per cent.....lb.	.11½ - .12	.12½ - .13
Fusel oil, ref.....gal.	—	3.25 - 3.75
Fusel oil, crude.....gal.	—	1.75 - 2.00
Glauber's salt (see sodium sulphate).....lb.	—	—
Glycerine, C. P. drums extra.....lb.	—	.14 - .15
Iodine, resublimed.....lb.	—	3.50 - 3.60
Iron oxide, red.....lb.	—	.10 - .20
Iron sulphate (copperas).....ton	18.00 - 19.00	20.00 - 23.00
Lead acetate.....lb.	—	.10½ - .12½
Lead arsenate, paste.....lb.	.09 - .09½	.10 - .11
Lead nitrate.....lb.	—	.15 - .20
Litharge.....lb.	.07½ - .08	.08½ - .09
Lithium carbonate.....lb.	—	1.30 - 1.40
Magnesium carbonate, technical.....lb.	.08 - .08½	.09 - .10
Magnesium sulphate, U. S. P. 100 lb.	2.50 - 2.75	—
Magnesium sulphate, technical, 100 lb.	—	1.10 - 1.75
Methanol, 95%.....gal.	—	.66 - .68
Methanol, 97%.....gal.	—	.70 - .72
Nickel Salt, double.....lb.	—	.12 - .12½
Nickel salt, single.....lb.	—	.14 - .14½
Phosgene (see carbonyl chloride).....lb.	—	—
Phosphorus, red.....lb.	.40 - .41	.42 - .45
Phosphorus, yellow.....lb.	—	.30 - .35
Potassium bichromate.....lb.	.11 - .11½	.11½ - .12

	Carlots	Less Carlots
Potassium bitartrate (cream of tartar)..... lb.	\$.20 — .21	\$0.25 — \$0.28
Potassium bromide, granular..... lb.	.20 — .21	.14 — .20
Potassium carbonate, U. S. P..... lb.	.04 — .04	.22 — .25
Potassium carbonate, 80-85%..... lb.	.04 — .04	.05 — .06
Potassium chlorate, crystals..... lb.	.06 — .07	.07 — .10
Potassium cyanide..... lb.	.05 — .05	.26 — .28
Potassium hydroxide (caustic potash)..... lb.	.05 — .05	.05 — .06
Potassium iodide..... lb.	.07 — .07	2.60 — 2.75
Potassium nitrate..... lb.	.07 — .07	.08 — .09
Potassium permanganate..... lb.	.20 — .21	.22 — .23
Potassium prussiate, red..... lb.	.28 — .29	.29 — .30
Potassium prussiate, yellow..... lb.	.20 — .20	.21 — .22
Rochelle salts (see sodium potas. tartrate).....		
Salammoniac (see ammonium chloride).....		
Sal soda (see sodium carbonate).....		
Salt cake (bulk)..... ton		17.00 — 20.00
Silver cyanide..... oz.		1.35 — 1.38
Silver nitrate..... oz.		.46 — .47
Soda ash, light..... 100 lb.	2.10 — 2.15	2.20 — 2.50
Soda ash, dense..... 100 lb.	2.35 — 2.40	2.45 — 2.70
Sodium acetate..... lb.	.04 — .04	.04 — .05
Sodium bicarbonate..... 100 lb.	2.00 — 2.25	2.50 — 2.75
Sodium bichromate..... lb.	.07 — .08	.08 — .08
Sodium bisulphate (nitric cake)..... ton	5.00 — 5.25	5.50 — 6.50
Sodium bisulphate powdered, U.S.P..... lb.	.04 — .05	.05 — .06
Sodium borate (borax)..... lb.	.05 — .06	.06 — .07
Sodium carbonate (sal soda)..... 100 lb.	1.75 — 1.90	2.00 — 2.25
Sodium chloride..... lb.	.07 — .07	.08 — .08
Sodium cyanide..... lb.	.25 — .26	.27 — .30
Sodium fluoride..... lb.	.10 — .11	.11 — .12
Sodium hydroxide (caustic soda)..... 100 lb.	4.05 — 4.15	4.20 — 4.75
Sodium hyposulphite..... lb.	.06 — .06	.03 — .03
Sodium nitrite..... lb.	.06 — .06	.07 — .07
Sodium peroxide, powdered..... lb.	.25 — .26	.27 — .30
Sodium phosphate, dibasic..... lb.	.04 — .04	.04 — .05
Sodium potassium tartrate (Rochelle salts) lb.	.13 — .13	.13 — .13
Sodium prussiate, yellow..... lb.	.13 — .13	.13 — .13
Sodium silicate, solution (40 deg.)..... 100 lb.	1.00 — 1.15	1.25 — 1.40
Sodium silicate, solution (60 deg.)..... lb.	.02 — .03	.03 — .03
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	1.50 — 1.75	2.00 — 2.25
Sodium sulphide, fused, 60-62 per cent (conc.) lb.	.04 — .04	.05 — .06
Sodium sulphite, crystals..... lb.	.03 — .03	.03 — .04
Strontium nitrate, powdered..... lb.	.12 — .13	.13 — .20
Sulphur chloride, red..... lb.	.05 — .05	.05 — .06
Sulphur, crude..... ton	18.00 — 20.00	
Sulphur dioxide, liquid, cylinders extra..... lb.	.08 — .08	.09 — .10
Sulphur (sublimed), flour..... 100 lb.		2.25 — 3.10
Sulphur, roll (brimstone)..... 100 lb.		2.00 — 2.75
Tin bichloride, 50 per cent..... lb.	.18 — .19	
Tin oxide..... lb.		.38 — .40
Zinc carbonate, precipitate..... lb.	.16 — .16	.17 — .17
Zinc chloride, gran..... lb.	.09 — .09	.10 — .11
Zinc cyanide..... lb.	.42 — .44	.45 — .47
Zinc dust..... lb.	.11 — .11	.11 — .12
Zinc oxide, XX..... lb.	.07 — .07	.08 — .09
Zinc sulphate..... 100 lb.	3.00 — 3.25	3.30 — 3.50

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude..... lb.	\$1.15 — \$1.20
Alpha-naphthol, refined..... lb.	1.25 — 1.30
Alpha-naphthylamine..... lb.	.27 — .30
Aniline oil, drums extra..... lb.	.17 — .20
Aniline salts..... lb.	.24 — .25
Anthracene, 80% in drums (100 lb.)..... lb.	.75 — 1.00
Benzaldehyde U.S.P..... lb.	1.25 — 1.35
Benzidine, base..... lb.	.90 — 1.00
Benzidine sulphate..... lb.	.75 — .85
Benzoic acid, U.S.P..... lb.	.60 — .65
Benzoate of soda, U.S.P..... lb.	.52 — .55
Benzene, pure, water-white, in drums (100 gal.)..... gal.	.27 — .32
Benzene, 90%, in drums (100 gal.)..... gal.	.25 — .28
Benzyl chloride, 95-97%, refined..... lb.	.25 — .27
Benzyl chloride, tech..... lb.	.20 — .23
Beta-naphthol benzoate..... lb.	3.50 — 4.00
Beta-naphthol, sublimed..... lb.	.70 — .75
Beta-naphthol, tech..... lb.	.31 — .34
Beta-naphthylamine, sublimed..... lb.	1.75 — 1.85
Cresol, U. S. P., in drums (100 lb.)..... lb.	.16 — .17
Ortho-cresol, in drums (100 lb.)..... lb.	.25 — .27
Cresylic acid, 97-99%, straw color, in drums..... gal.	.70 — .80
Cresylic acid, 95-97%, dark, in drums..... gal.	.65 — .70
Cresylic acid, 50%, first quality, drums..... gal.	.45 — .50
Dichlorobenzene..... lb.	.06 — .09
Diethylaniline..... lb.	1.00 — 1.15
Dimethylaniline..... lb.	.41 — .50
Dinitrobenzene..... lb.	.23 — .27
Dinitrochlorobenzene..... lb.	.23 — .25
Dinitronaphthalene..... lb.	.30 — .35
Dinitrophenol..... lb.	.35 — .40
Dinitrotoluene..... lb.	.25 — .30
Dip oil, 25%, car lots, in drums..... gal.	.30 — .35
Diphenylamine..... lb.	.60 — .70
H-acid..... lb.	1.10 — 1.20
Meta-phenylenediamine..... lb.	1.15 — 1.20
Monochlorobenzene..... lb.	.12 — .14
Monoethylaniline..... lb.	1.60 — 1.70
Naphthalene crushed, in obls..... lb.	.05 — .07
Naphthalene, flake..... lb.	.06 — .08
Naphthalene, balls..... lb.	.08 — .09
Naphthionic acid, crude..... lb.	.70 — .75
Nitrobenzene..... lb.	.12 — .15
Nitro-naphthalene..... lb.	.30 — .35
Nitro-toluene..... lb.	.15 — .17
Ortho-amidophenol..... lb.	3.00 — 3.10
Ortho-dichlor-benzene..... lb.	.15 — .20
Ortho-nitro-phenol..... lb.	.75 — .80
Ortho-nitro-toluene..... lb.	.15 — .20
Ortho-toluidine..... lb.	.20 — .25
Para-amidophenol, base..... lb.	1.40 — 1.45
Para-amidophenol, HCl..... lb.	1.70 — 1.80
Para-dichlorobenzene..... lb.	.12 — .15
Paranitroaniline..... lb.	.77 — .80
Para-nitrotoluene..... lb.	.80 — .85
Para-phenylenediamine..... lb.	1.70 — 1.75
Para-toluidine..... lb.	1.25 — 1.40
Phthalic anhydride..... lb.	.40 — .50

Phenol, U. S. P., drums..... lb.	.08 — .10
Pyridine..... gal.	2.00 — 3.50
Resorcinol, technical..... lb.	1.50 — 1.60
Resorcinol, pure..... lb.	2.00 — 2.25
Salicylic acid, tech., in bbls..... lb.	.18 — .20
Salicylic acid, U. S. P..... lb.	.19 — .22
Salol..... lb.	.60 — .70
Solvent naphtha, water-white, in drums, 100 gal..... gal.	.25 — .28
Solvent naphtha, crude, heavy, in drums, 100 gal..... gal.	.14 — .16
Sulphanilic acid, crude..... lb.	.27 — .30
Tolidine..... lb.	1.30 — 1.35
Toluidine, mixed..... lb.	.43 — .45
Toluene, in tank cars..... gal.	.25 — .28
Toluene, in drums..... gal.	.28 — .31
Xylidines, drums, 100 gal..... lb.	.40 — .45
Xylene, pure, in drums..... gal.	.40 — .45
Xylene, pure, in tank cars..... gal.	.45 — .45
Xylene, commercial, in drums, 100 gal..... gal.	.33 — .35
Xylene, commercial, in tank cars..... gal.	.30 — .30

Waxes

Prices based on original packages in large quantities.

Bayberry Wax..... lb.	\$0.19 — \$0.20
Beeswax, refined, dark..... lb.	.24 — .25
Beeswax, refined, light..... lb.	.28 — .30
Beeswax, white pure..... lb.	.36 — .42
Candellilla wax..... lb.	.24 — .25
Carnauba, No. 1..... lb.	.46 — .47
Carnauba, No. 2, North Country..... lb.	.24 — .25
Carnauba, No. 3, North Country..... lb.	.14 — .15
Japan..... lb.	.22 — .23
Montan, crude..... lb.	.05 — .05
Paraffine waxes, crude match wax (white) 105-110 m.p..... lb.	.03 — .03
Paraffine waxes, crude, scale 124-126 m.p..... lb.	.02 — .03
Paraffine waxes, refined, 118-120 m.p..... lb.	.03 — .03
Paraffine waxes, refined, 125 m.p..... lb.	.03 — .03
Paraffine waxes, refined, 128-130 m.p..... lb.	.03 — .04
Paraffine waxes, refined, 133-135 m.p..... lb.	.04 — .05
Paraffine waxes, refined, 135-137 m.p..... lb.	.05 — .06
Stearic acid, single pressed..... lb.	.09 — .09
Stearic acid, double pressed..... lb.	.10 — .10
Stearic acid, triple pressed..... lb.	.11 — .11

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl..... 280 lb.	\$5.55 — 5.65
Rosin E-I..... 280 lb.	5.75 — 6.25
Rosin K-N..... 280 lb.	6.35 — 6.75
Rosin W. G. W. W..... 280 lb.	6.90 — 7.40
Wood rosin, bbl..... 280 lb.	6.25 — .
Spirits of turpentine..... gal.	.75 — .
Wood turpentine, steam dist..... gal.	.73 — .
Wood turpentine, dest. dist..... gal.	.72 — .
Pine tar pitch, bbl..... 200 lb.	6.50 — .
Tar, kila burned, bbl. (500 lb.)..... bbl.	11.00 — .
Retort tar, bbl..... 500 lb.	11.00 — .
Rosin oil, first run..... gal.	.35 — .
Rosin oil, second run..... gal.	.37 — .
Rosin oil, third run..... gal.	.44 — .
Pine oil, steam dist., sp.gr. 0.930-0.940..... gal.	1.90 — .
Pine oil, pure, dest. dist..... gal.	1.50 — .
Pine tar oil, ref., sp.gr. 1.025-1.035..... gal.	.46 — .
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla..... gal.	.35 — .
Pine tar oil, double ref., sp.gr. 0.965-0.990..... gal.	.75 — .
Pine tar, ref., thin, sp.gr. 1.080-1.060..... gal.	.35 — .
Turpentine, crude, sp. gr. 0.900-0.970..... gal.	1.25 — .
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990..... gal.	.35 — .
Pinewood creosote, ref..... gal.	.52 — .

Solvents

73-76 deg., steel bbls. (85 lb.)..... gal.	\$0.37 — .
70-72 deg., steel bbls. (85 lb.)..... gal.	.35 — .
68-70 deg., steel bbls. (85 lb.)..... gal.	.34 — .
V. M. and P. naphtha, steel bbls. (85 lb.)..... gal.	.23 — .

Fertilizers

Ammonium sulphate, bulk and d. bags..... 100 lb.	\$2.15 — 2.50
Blood, dried, f.o.b., N. Y..... unit	4.00 — .
Bone, 3 and 50, ground, raw..... ton	30.00 — 32.00
Cyanamide, f.o.b. works..... unit	4.50 — .
Fish scrap, dom., dried, f.o.b. works..... unit	2.90 — 3.00
Nitrate soda..... 100 lb.	2.25 — 2.30
Tankage, high grade, f.o.b. Chicago..... unit	3.00 — 3.10
Phosphate rock, f.o.b. mines, Florida pebble, 68-72 p.c..... ton	5.00 — 7.50
Tennessee, 78-80 p.c..... ton	8.00 — 9.00
Potassium muriate, 80 p.c..... ton	38.00 — 40.00
Potassium sulphate..... unit	1.20 — 1.25

Crude Rubber

Para-Upriver fine..... lb.	\$0.21 — .21
Upriver coarse..... lb.	.11 — .12
Upriver caueho ball..... lb.	.11 — .12
Plantation—First latex crepe..... lb.	.15 — .15
• Ribbed smoked sheets..... lb.	.15 — .15
Brown crepe, thin, clean..... lb.	.15 — .
Amber crepe No. 1..... lb.	.17 — .

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls..... lb.	\$0.10 — \$0.10
Castor oil, AA, in bbls..... lb.	.11 — .11
China wood oil, in bbls. (f.o.b. Pac. coast)..... lb.	.14 — .15
Cocanut oil, Ceylon grade, in bbls..... lb.	.10 — .10
Cocanut oil, Cochin grade, in bbls..... lb.	.10 — .11
Corn oil, crude, in bbls..... lb.	.09 — .09
Cottonseed oil, crude (f. o. b. mill)..... lb.	.07 — .07
Cottonseed oil, summer yellow..... lb.	.09 — .09
Cottonseed oil, winter yellow..... lb.	.09 — .10

Linseed oil, raw, ear lots (domestic).....	gal.	.68	—	.69
Linseed oil, raw, tank cars (domestic).....	gal.	.63	—	.64
Linseed oil, in 5-bbl lots (domestic).....	gal.	.71	—	.72
Olive oil, Denatured.....	gal.	\$1.15	—	\$1.20
Palm, Lagos.....	lb.	.07	—	.07 $\frac{1}{2}$
Palm, Niger.....	lb.	.06 $\frac{1}{2}$	—	.06 $\frac{1}{2}$
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.08	—	.09
Peanut oil, refined, in bbls.....	lb.	.11	—	.11 $\frac{1}{4}$
Rapeseed oil, refined, in bbls.....	gal.	.90	—	.91
Rapeseed oil, blown, in bbls.....	gal.	.92	—	.94
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.08 $\frac{1}{2}$	—	—
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.07 $\frac{1}{2}$	—	—

FISH

Light pressed menhaden.....	gal.	\$0.40	—	—
Yellow bleached menhaden.....	gal.	.42	—	—
White bleached menhaden.....	gal.	.44	—	—
Blown menhaden.....	gal.	.48	—	—

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$24.00	—	30.00
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	20.00	—	24.00
Barytes, crude, 88% @ 94% ba., Kings Creek.....	net ton	10.00	—	12.00
Barytes, floated, f.o.b. St. Louis.....	net ton	23.00	—	24.00
Barytes, crude, first grade, Missouri.....	net ton	7.00	—	—
Blanc fixe, dry.....	lb.	.04	—	.04 $\frac{1}{2}$
Blanc fixe, pulp.....	net ton	45.00	—	55.00
Casein.....	lb.	.07	—	.10
Chalk, Precipitated, domestic, extra light.....	lb.	.04 $\frac{1}{2}$	—	.05
Chalk, Precipitated, domestic, light.....	lb.	.04	—	.04 $\frac{1}{2}$
Chalk, Precipitated, domestic, heavy.....	lb.	.03 $\frac{1}{2}$	—	.04
Chalk, Precipitated, English, extra light.....	lb.	.04	—	.05
Chalk, Precipitated, English, light.....	lb.	.04 $\frac{1}{2}$	—	.05
Chalk, Precipitated, English, dense.....	lb.	.04	—	.04 $\frac{1}{2}$
China clay (kaolin) crude, f.o.b. mines, Georgia.....	net ton	6.50	—	8.50
China clay (kaolin) washed, f.o.b. Georgia.....	net ton	9.00	—	10.00
China clay (kaolin) powdered, f.o.b. Georgia.....	net ton	13.00	—	20.00
China clay (kaolin) crude f.o.b. Virginia points.....	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points.....	net ton	13.00	—	20.00
China clay (kaolin), imported, lump.....	net ton	12.00	—	20.00
China clay (kaolin), imported, powdered.....	net ton	25.00	—	30.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	net ton	5.00	—	7.50
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27.00	—	30.00
Fullers earth, f.o.b. Mines.....	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Pa.....	net ton	15.00	—	18.00
Fullers earth, powdered, f.o.b. Fla.....	net ton	18.00	—	—
Fullers earth, imported, powdered.....	net ton	24.00	—	27.00
Graphite, Ceylon lump, first quality.....	lb.	.06	—	.07
Graphite, Ceylon chip.....	lb.	.04 $\frac{1}{2}$	—	.05
Graphite, high grade amorphous crude.....	lb.	.00 $\frac{1}{2}$	—	.02 $\frac{1}{2}$
Kieselguhr, f.o.b. mines, Cal.....	per ton	40.00	—	—
Kieselguhr, f.o.b. N.Y.....	per ton	61.00	—	—
Magnesite, calcined.....	per ton	66.00	—	70.00
Pumice stone, imported.....	lb.	.03	—	.40
Pumice stone, domestic, lump.....	lb.	.05	—	.05 $\frac{1}{2}$
Pumice stone, domestic, ground.....	lb.	.06	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore.....	net ton	—	—	10.00
Quartz (acid tower) 1 $\frac{1}{2}$ @2 in., f.o.b. Baltimore.....	net ton	—	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	—	—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange fine.....	lb.	.66	—	.68
Shellac, orange superline.....	lb.	.70	—	.72
Shellac, A. C. garnet.....	lb.	.53	—	.55
Shellac, T. N.....	lb.	.59	—	.61
Soapstone.....	ton	12.00	—	15.00
Sodium chloride.....	long ton	12.50	—	13.00
Talc, paper-making grades, f.o.b. Vermont.....	ton	11.00	—	18.00
Talc, roofing grades, f.o.b. Vermont.....	ton	8.50	—	13.00
Talc, rubber grades, f.o.b. Vermont.....	ton	11.00	—	18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	7.50	—	11.00
Talc, imported.....	ton	30.00	—	40.00
Talc, California talcum powder grade.....	ton	18.00	—	25.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	per ton	\$50.00	—	—
Carborundum refractory brick, 9-in. { less than earlot	1,000	1250.00	—	—
Carborundum refractory brick, 9-in. { carload lots	1,000	1100.00	—	—
Chrome brick, f.o.b. Eastern shipping points.....	net ton	52- 55	—	—
Chrome cement, 40-45% Cr ₂ O ₃	net ton	30- 32	—	—
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in ear lots, f.o.b. Eastern shipping points.....	net ton	33- 35	—	—
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	35- 40	—	—
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	30- 35	—	—
Magnesite brick, 9-in. straight.....	net ton	65- 70	—	—
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	77	—	—
Magnesite brick, soaps and splits.....	net ton	98	—	—
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	40- 42	—	—
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	42- 45	—	—
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	35- 38	—	—

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00	—	\$225.00
Ferrochrome per lb. of Cr. contained, 6-8% carbon, earlots.....	lb.	.11	—	—
Ferrochrome per lb. of Cr. contained, 4-6% carbon, earlots.....	lb.	.11	—	.12
Ferromanganese, 76-80% Mn, domestic.....	gross ton	60.00	—	63.00
Ferromanganese, 76-80% Mn, English & German.....	gross ton	59.00	—	60.00
Spiegelisen, 18-22% Mn.....	gross ton	25.00	—	27.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.25	—	—
Ferrosilicon, 10-15%.....	gross ton	38.00	—	40.00
Ferrosilicon, 50%.....	gross ton	60.00	—	65.00
Ferrosilicon, 75%.....	gross ton	130.00	—	135.00
Ferrotungsten, 70-80%, per lb. of contained W.....	lb.	.40	—	.45
Ferroumium, 35-50% of U, per lb. of U content.....	lb.	6.00	—	—
Ferrovandium, 30-40% per lb. of contained V.....	lb.	4.25	—	4.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content.....	net ton	\$8.00	—	\$10.00
Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃	ton	24.00	—	26.00
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard.....	ton	24.00	—	26.00
Coke, foundry, f.o.b. ovens.....	net ton	4.25	—	4.50
Coke, furnace, f.o.b. ovens.....	net ton	3.25	—	3.50
Coke, petroleum, refinery, Atlantic seaboard.....	net ton	12.00	—	13.00
Fluorspar, gravel, f.o.b. mines, New Mexico.....	net ton	15.00	—	—
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	20.00	—	22.00
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01 $\frac{1}{2}$	—	.01 $\frac{1}{2}$
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	.20	—	.21
Manganese ore, chemical (MnO ₂).....	net ton	50.00	—	55.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.55	—	.60
Monazite, per unit of ThO ₂ , c.i.f., Atlantic seaport.....	unit	30.00	—	—
Pyrites, Spanish, fines, c.i.f., Atlantic seaport.....	unit	.12	—	.12
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.13	—	.13
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.11	—	.12
Rutile, 95% TiO ₂ per lb. ore.....	lb.	.15	—	—
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	2.75	—	3.00
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	3.00	—	3.25
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	1.25	—	1.75
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.25	—	2.50
Vanadium pentoxide, 99%.....	lb.	12.00	—	14.00
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1.00	—	—
Zircon, washed, iron free, f.o.b. Pablo, Florida.....	lb.	.04 $\frac{1}{2}$	—	.13

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic.....	13.00
Aluminum, 98 to 99 per cent.....	24.50@25.00
Antimony, wholesale lots, Chinese and Japanese.....	5.00@5.25
Nickel, ordinary (ingot).....	41.00
Nickel, electrolytic.....	44.00
Monel metal, shot and blocks.....	35.00
Monel metal ingots.....	38.00
Monel metal, sheet bars.....	40.00
Tin, 5-ton lots, Straits.....	27.25
Lead, New York, spot.....	4.70@4.75
Lead, E. St. Louis, spot.....	4.45@4.50
Zinc, spot, New York.....	5.05@5.10
Zinc, spot, E. St. Louis.....	4.65

OTHER METALS

Silver (commercial).....	oz.	\$0.72 $\frac{3}{4}$
Cadmium.....	lb.	1.00-1.25
Bismuth (500 lb. lots).....	lb.	1.50@1.55
Cobalt.....	lb.	3.00@3.25
Magnesium (f.o.b. Philadelphia).....	lb.	1.25
Platinum.....	oz.	80.00
Iridium.....	oz.	150.00@170.00
Palladium.....	oz.	55.00-60.00
Mercury.....	75 lb.	38.00-39.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled.....	20.50
Copper bottoms.....	28.00
Copper rods.....	19.00@19.75
High brass wire.....	15.75
High brass rods.....	13.25
Low brass wire.....	17.25
Low brass rods.....	17.25
Brazed brass tubing.....	25.00
Brazed bronze tubing.....	29.75
Seamless copper tubing.....	19.50
Seamless high brass tubing.....	18.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current	Cleveland	Chicago
Copper, heavy and crucible.....	9.50@10.00	9.25	9.50
Copper, heavy and wire.....	9.00@9.25	8.50	8.50
Copper, light and bottoms.....	7.50@8.00	7.50	7.25
Lead, heavy.....	3.25@3.50	3.25	3.25
Lead, tea.....	2.25@2.35	2.25	2.25
Brass, heavy.....	4.25@4.50	4.50	5.00
Brass, light.....	3.25@3.50	3.25	3.50
No. 1 yellow brass turnings.....	4.00@4.25	4.25	4.50
Zinc.....	2.00@2.25	2.00	2.25

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by $\frac{1}{2}$ in. and larger, and plates $\frac{1}{2}$ in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes.....	\$2.88	\$2.88	\$2.88
Soft steel bars.....	2.78	2.78	2.78
Soft steel bar shapes.....	2.78	2.78	2.78
Soft steel bands.....	3.42	3.48	3.48
Plates, $\frac{1}{2}$ to 1 in. thick.....	2.88	2.83	2.88

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Arkansas

CAMDEN—The Camden Oil & Refining Co., recently organized, is perfecting plans for the construction of a new oil refinery in the vicinity of Pine Bluff, Ark., with initial daily output of about 500 bbl. It is estimated to cost about \$40,000. H. M. Jones is president.

California

LOS ANGELES—The Bradley-Wise Paint Co., 650 Santa Fe Ave., manufacturer of paints, varnishes, etc., has awarded a contract to Gordon La Barr, 2000 East Vernon Ave., for the erection of its proposed new plant at 49th St. and the Pacific Blvd., Vernon, estimated to cost in excess of \$50,000.

SAN FRANCISCO—The United States Metal Products Co., 330 Tenth St., manufacturer of metal specialties, has preliminary plans under way for the erection of a new 2- or 4-story plant, exact size still to be determined. It will be located on a site adjoining the present works.

Connecticut

WINDSOR LOCKS—C. H. Dexter & Sons, Inc., manufacturers of paper products, have taken bids for the erection of a new 1-story building at their plant, 21 x 140 ft. Greenwood & Noerr, 847 Main St., Hartford, Conn., are engineers.

Delaware

WILMINGTON—The Ricard-Brewster Oil Co. is completing the removal of its plant from Front and Orange Sts., to its new works at Fifteenth and Walnut Sts., where facilities for increased production will be provided. A 2-story brick addition has been constructed to the factory at the new location.

Florida

JACKSONVILLE—The American Collapsible Box Co., High Point, N. C. A. Vanden Boom, manager, is perfecting plans for the erection of its proposed new plant at Jacksonville, for the manufacture of corrugated boxes and containers. The machinery installation will cost about \$75,000.

CANAL POINT—The Florida Sugar & Food Products Co. will soon commence the construction of its proposed new sugar mill, to be 100 x 200 ft., to be equipped for a daily production of about 400 tons of cane sugar. N. K. Williams is construction engineer in charge.

Louisiana

SHREVEPORT—The United States Window Glass Co., Morgantown, W. Va., has construction under way on the superstructure for its new local plant, estimated to cost in excess of \$500,000, and plans to have the works ready for operation early in March, 1922.

MONROE—The McNichol Pottery & Crockery Co., Memphis, Tenn., J. M. Goff, representative, is considering the erection of a new plant in the vicinity of Monroe, estimated to cost in excess of \$150,000 with machinery.

Maryland

HAGERSTOWN—The Vicama Mica Co., 3 Hamilton Row, recently incorporated, is planning for the installation of new equipment at its properties in Virginia, comprising quarrying machinery, pulverizing equipment and kindred apparatus for mica production.

Michigan

MARYSVILLE—The Transue Williams Steel Forge Corp. will defer the erection of its proposed new local plant, plans for which are nearing completion, until early in the coming year. The works are estimated to cost about \$40,000. O. F. Transue, 562 West Ely St., is president and general manager.

DETROIT—The Solvay Process Co., Solvay, N. Y., is considering plans for the

early reopening of its local plant. It is said that about 1,500 operatives will be employed at the start.

DETROIT—The Champion Porcelain Co., recently organized with a capital of \$750,000 by officials of the Champion Spark Plug Co., as a subsidiary company, has acquired the plant and property of the Jeffrey-Dewitt Co., Detroit, manufacturer of porcelain specialties for spark plugs and other products. J. A. Jeffrey is president of the new company, and M. C. Dewitt, vice-president.

Missouri

KANSAS CITY—The Ferro Enamel Supply Co., 1101 Swetland Bldg., Cleveland, O., is considering preliminary plans for the erection of a new branch plant at Kansas City. R. A. Weaver is president.

ST. LOUIS—Fire, Oct. 5, damaged a portion of the building occupied by the Cole Chemical Co., on Laclede Ave. An official estimate of loss has not been made.

New Jersey

NEWARK—The United Butchers' Stock Rendering Co., 392 Jackson Ave., Jersey City, N. J., will take bids during the present month for the erection of its proposed new plant on property recently acquired at Newark, for the manufacture of soap, fertilizer and kindred products. It will be 2-story, 40 x 60 ft., and is estimated to cost about \$50,000 with equipment. David M. Ach, 1 Madison Ave., New York, is architect.

NEWARK—The United Color & Pigment Co., McClellan St. and Evergreen Ave., has filed plans for improvements and alterations in its plant, used for the manufacture of paints, dry colors, etc., estimated to cost about \$10,000.

New York

MECHANICSVILLE—The Duffney Brick Co., is having plans prepared for the erection of a new plant, with main building 2-story, brick and steel, to replace its works recently destroyed by fire, with loss reported at about \$200,000. Bayard & Massey, 75½ North Main St., are architects.

SYRACUSE—The Solvay Process Co., Solvay, has adopted 24-hour operating basis at its local works, with total production said to be in excess of that during the war period.

BINGHAMTON—The Achilles Tire & Rubber Co., Floral Ave., has awarded a contract to S. B. Price for improvements in its plant, replacing a recent fire loss, estimated to cost about \$15,000.

NEW YORK—The Fleischmann Co., 701 Washington St., manufacturer of yeast, will make extensions and improvements in its local plant, including laboratory, estimated to cost about \$35,000. C. Aubrey Jackson, company address, is architect.

Ohio

ELYRIA—The Waukon Rubber Co. is completing plans and will take bids at an early date for the erection of a new 2-story and basement plant for the manufacture of rubber goods, estimated to cost about \$75,000. The Akron Engineering Co., 92 East Mill St., Akron, O., is engineer. W. R. Huntington is president.

ZANESVILLE—The Studebaker-Wulff Co. is negotiating with the stockholders of the Rotary Tire & Rubber Co., now in receivership, for the purchase of the plant and property of the company.

Oklahoma

ARDMORE—The Magnolia Petroleum Co., Dallas, Tex., is planning for the erection of a new casinghead gasoline plant at Ardmore, to be of five-unit type, with power house, air compressors, pumping equipment, etc.

Pennsylvania

WILLIAMSPORT—Dittmar Bros., 618 Day St., manufacturers of composition tiles and kindred products, have broken ground for the erection of a new 2-story plant, 57 x 184 ft., at the foot of Susquehanna St., estimated to cost about \$45,000. William Dittmar is head.

PHILADELPHIA—Fire, Sept. 30, destroyed a portion of the plant of the Publicker Commercial Alcohol Co., Swanson & Snyder Sts. An official estimate of loss has not been made.

South Carolina

CHARLESTON—Fire, Sept. 27, destroyed a portion of the local plant of the Virginia-Carolina Chemical Co., with loss estimated at about \$27,000.

Tennessee

KNOXVILLE—The Knoxville Paper Box Co. has awarded a contract to Warsham Bros., Knoxville, for the erection of a new 1-story plant, 50 x 125 ft., for the manufacture of paper boxes and containers, estimated to cost about \$35,000.

MEMPHIS—Fire, Oct. 4, destroyed a portion of the potash manufacturing plant of G. N. Shepardson, North Seventh St., with loss estimated at close to \$25,000.

KNOXVILLE—The Knoxville Fertilizer Co. is perfecting plans for the erection of a new plant in the Vestal section, to be 154 x 350 ft., and equipped for an initial capacity of about 125 tons. Manley & Young, 814 West Hill Ave., are architects and engineers. James W. Dean is secretary and treasurer.

BROWNSVILLE—The Brownsville Cotton Oil Co. is planning for the rebuilding of the portion of its plant, recently destroyed by fire with loss estimated at about \$22,000. R. N. Bond is manager.

Texas

DALLAS—The Trinity Oil Corp. will commence work at once for the conversion of the skimming plant of the Eastland Oil & Refining Co., into a complete oil refinery and purposes to have the plant ready for operation early in the coming year, with capacity of about 4,000 bbl. a day. The Eastland properties were recently acquired by the Trinity Company.

HOUSTON—The Sinclair Refining Co. is planning for the construction of a new battery of high-pressure oil stills and auxiliary operating equipment on the Houston Ship Channel.

BURKBURNETT—The Texas Oil Refining Co. is planning for the rebuilding of the portion of its local plant, destroyed by fire, Sept. 17, with loss approximating \$30,000.

Virginia

NORFOLK—The Tidewater Glass Mfg. Co. has arranged for the immediate erection of a new 1-story plant, 50 x 200 ft., for the manufacture of glass bottles, and will take bids until Nov. 1 for the installation of equipment, including blowing machines, air compressor, motors and other manufacturing and operating machinery. T. C. Williams is vice-president and architect in charge. J. L. Welton is president.

West Virginia

WHEELING—The Bonita Art Glass Co. is completing plans for the erection of its proposed new plant, comprising two 1-story buildings, 60 x 80 ft., estimated to cost about \$35,000. George E. House is president.

New Companies

E. L. & J. F. DENNEBY, INC., Brockton, Mass., has been incorporated with a capital of \$25,000, to manufacture polishes for leather of all kinds, and kindred specialties. Edward L. Denneby is president, and James F. Denneby, 98 Warren St., treasurer.

THE LAKANTYAS OIL CO., Room 800, 108 South La Salle St., Chicago, Ill., has been incorporated with a capital of \$1,500,000, to manufacture petroleum products. The incorporators are Paul N. Dale, C. C. Taylor and Eric L. Anderson.

THE STENNO CARBON PAPER CO., Salem, Ore., has been incorporated with a capital of \$150,000, to manufacture carbon and waxed papers and kindred products. The incorporators are F. E. Thompson, C. K. Bland and F. H. Drake, all of Portland, Ore.

THE MARYLAND SOAP CO., INC., Baltimore, Md., has been incorporated under Delaware laws with capital of \$500,000, to manufacture soaps, soap powders, etc. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington, Del.

THE ROCHESTER PETROLEUM PRODUCTS, INC., Rochester, N. Y., has been incorporated with a capital of \$50,000, to manufacture oil products of various kinds. The incorporators are T. M. Jameson, C. H. Miller and H. G. Freeman, Rochester. The

company is represented by Theodore Jameson, Wilder Bldg.

THE RHODE ISLAND CRUCIBLE STEEL CO., Providence, R. I., has been incorporated with a capital of \$100,000, to manufacture steel products, castings, etc. The incorporators are George C. Hagstrom, Albert B. Benson and Carl A. Hagstrom, 185 Oakhill Ave., Pawtucket, R. I.

THE FIBRE TIRE & RUBBER CORP., New York, N. Y., has been incorporated under Delaware laws with capital of \$3,000,000, to manufacture rubber products, fiber specialties, etc. The company is represented by Arthur W. Britton, 65 Cedar St., New York.

THE MINERAL CARBONIC GAS CO., Jersey City, N. J., has been incorporated with a capital of \$200,000, to manufacture carbonic gas and affiliated products. The incorporators are H. W. F. Lorenz, Alexander Hynd and William Hall, 164 Broadway, Jersey City.

THE ATLAS CLAY PRODUCTS CO., INC., Atlas (Genesee Co.), Mich., has been incorporated with a capital of \$30,000, to manufacture burned clay products. The incorporators are W. T. Shonk, Redford, Mich.; and M. B. Goodrich, 1090 Sheridan Ave., Detroit, Mich.

THE WATERPROOFING CO. OF AMERICA, INC., 80 East Jackson Blvd., Chicago, Ill., has been incorporated with a capital of \$25,000, to manufacture waterproofing compounds and kindred specialties. The incorporators are A. N. Lustig, M. M. Rappaport and Fred Sprinkman, Jr.

McLANE BROS., MCCARTHY & SHEEHAN, INC., Whitman, Mass., has been incorporated with a capital of \$60,000, to manufacture leather products. The incorporators are William T. McLane, James J. Sheehan and Philip M. McLane, Abington, Mass.

THE LUSTRE ART GLASS CO., New York, N. Y., has been incorporated with a capital of \$50,000, to manufacture glass products. The incorporators are P. Frank, C. Vahlsing and W. S. Overend, 34 Nassau St.

THE FENG LABORATORIES, INC., New York, N. Y., has been incorporated with a capital of \$5,000, to manufacture chemical specialties. The incorporators are A. Lapidus, L. Weinstein and M. Lindeman. The company is represented by Fowler & Hoerner, 27 Cedar St.

THE PHILADELPHIA VINEGAR CO., Philadelphia, Pa., has been incorporated with a capital of 2,000 shares of stock, no par value, to manufacture vinegar and affiliated products. The company is represented by the New Jersey Corp., Guarantee & Trust Co., 419 Market St., Camden, N. J.

THE CHERRY RIDGE BRICK CORP., New York, N. Y., has been incorporated with a capital of \$25,000, to manufacture brick and other burned clay products. The incorporators are G. Stewart, J. W. Collopy, Jr., and A. R. Prendergast. The company is represented by John Ingle, Jr., 2 Rector St.

THE FRENCH-WITTUSEN CO., INC., Utica, N. Y., has been incorporated with a capital of \$25,000, to manufacture glassware products. The incorporators are W. S. G. B., and M. M. French, Utica. The company is represented by Colegrove & Baker, attorneys, Utica.

THE ANTI-GLARE ACCESSORIES CO., Indianapolis, Ind., has been incorporated with a capital of \$20,000, to manufacture light diffusers, glass specialties, etc. The incorporators are F. G. Phillips, M. D. Moore and W. E. Miller, all of Indianapolis.

THE CYL-LAP PRODUCTS CO., Baltimore, Md., has been incorporated with a capital of \$1,500,000, to manufacture abrasive products. The incorporators are Michael S. Coan, David L. Schiller and Robert F. Leach, Jr., Central Savings Bank Bldg.

THE PAN-AMERICAN CANADIAN LEATHER PRODUCTS CORP., Rochester, N. Y., has been incorporated with a capital of \$1,500,000, to manufacture leather products. D. Colbert, 51 Vick Park, Rochester, is the principal incorporator.

THE STATE OIL PRODUCING CO., Boston, Mass., has been incorporated under Delaware laws with a capital of \$300,000, to manufacture oil products. The incorporators are Willard Wayne, M. A. Colter and Henry C. DeWolf, Boston. The company is represented by the Delaware Trust Co., 900 Market St., Wilmington, Del.

THE NORTH AMERICAN POLISH CO., Los Angeles, Cal., has been incorporated with a nominal capital of \$5,000, to manufacture polishes, chemical products and kindred specialties. The incorporators are S. P. and B. B. Dorsey, and W. B. French, Pasadena, Cal. The company is represented by Ticknor, Carter & Webster, 304 Citizens Savings Bank Bldg., Pasadena.

Manufacturers' Catalogs

THE YOUNGSTOWN BOILER & TANK CO., Youngstown, O., calls attention to a well-illustrated bulletin, No. 400, printed in colors, which contains storage tank information, tables, designs and capacities.

THE NORTON CO., Worcester, Mass., has issued a 32-page booklet on Norton grinding machines. A general description is given, together with photographs of the different types.

THE CHAMPION ENGINEERING CO., Kenton, O., in a recent bulletin illustrates and describes its cranes, suitable for installation in foundries, fertilizer plants, tin plate mills, chemical plants, rubber and tire plants, sugar cane mills, copper smelting plants, etc. Mechanical data are given, together with photographs of cranes in operation in different industries and dimensions of the different types.

THE KING KNIGHT CO., San Francisco, Cal., calls attention to its publication "Oil Flow in Pipe Lines," by R. S. Danforth. This book comprises charts showing the pressure loss in different sized pipe lines, the conversion of viscosimeter readings, and the horsepower required for pumping. Price \$3.

BAKER & CO., INC., Newark, N. J., has issued the fourteenth edition of a booklet, Data Concerning Platinum, containing new tables, illustrations and matter descriptive of various appliances made of platinum.

THE M. W. KELLOGG CO., New York, N. Y., has issued an attractive booklet on Corrosion Tests, Grey Cast Iron and Chemi-Steel. Fifteen tests are described, together with a story on forge-welded chemi-steel and its industrial applications.

E. C. CODD CO., Baltimore, Md., in a new booklet describes chain furnace screens for furnaces and ovens. These screens consist of a multitude of individual strands of steel chain, which cuts off most of the heat rays but which does not interfere with the passage of the charge, nor the tools necessary for manipulation of the same.

THE HARDINGE CO., New York, N. Y., has issued Catalog 9, on "Pulverized Fuels." This bulletin is divided into three main sections—viz., the application of pulverized fuel to various burning problems, the principle of operation of the Hardinge mill and a discussion of the application of the Hardinge system for pulverizing fuels. This bulletin should be of interest to those who have problems pertaining to the generation large quantities of heat.

THE KINITE CO., Milwaukee, Wis., in a 24-page booklet describes and illustrates the use of Kinite for shear blades, re-drawing tools, blanking dies, draw dies, embossing and forming dies, broaches, etc. Kinite is explained to be a steel alloy having great resistance to wear, dense structure and close grain, air-hardening quality, freedom from distortion when hardening, and ability to take high polish.

THE LAKEWOOD ENGINEERING CO., Cleveland, O., in Bulletin 39 illustrates and describes Lakewood Model 701, storage battery tractor.

THE POWER SPECIALTY CO., New York, has just published a 32-page catalog on Superheated Steam and the Foster Superheater. In the fore part of this bulletin there is a discussion of the advantages of using superheated steam. This covers the benefits and savings to be expected with superheated steam on reciprocating engines and steam turbines. The Foster patented superheater construction is also fully explained and pictures and drawings are shown of modern installations of this superheater in all well-known types and makes of boilers. This same bulletin also introduces a new type of superheater which utilizes radiant heat from the combustion chamber of the boiler. A new special armored surface has made it possible to apply superheating elements of this kind to any type of water-tube boiler. The construction and advantages of this type are fully covered in the new bulletin No. 300.

THE PHILADELPHIA DRYING MACHINERY CO., Philadelphia, Pa., has just issued a new folder, which briefly illustrates and describes all the different types of ceramic and chemical driers this company builds.

THE DANIEL M. LUEHRS CO., engineer, Cleveland, O., has issued a bulletin on the Luehrs System of Liquid Heat Transmission. The system applies best in the form of circulating oil, heated electrically, where temperatures higher than steam are needed and where the application of direct heat would injure the product or be dangerous to apply. Automatic temperature control is provided. Another bulletin describes the system applied to oil roasting of food products, etc.

Capital Increases, Etc.

THE SUPERIOR ALUM WORKS, INC., Joliet, Ill., has filed notice of change of name to the Superior Chemical Co.

THE MERIDAN OIL CO., Indianapolis, Ind., has filed notice of dissolution under state laws.

THE BEAVER TILE & SPECIALTY CO., 442 West 42d St., New York, N. Y., is arranging for an increase in capital from \$45,000 to \$200,000. George B. Staples is president.

THE L. P. C. CHEMICAL CORP., a Delaware corporation, has filed notice to operate in New York, with capital of \$500,000, for the manufacture of chemical products. F. S. Mardon, 416 East 57th St., New York, is representative.

Involuntary bankruptcy proceedings have been instituted against the VALLEY FORGE MAGNESIA CO., Port Kennedy, Pa., manufacturer of magnesia products.

THE NAVAJO OIL CORP., Kansas City, Mo., has filed notice of change of name to the Interstate Refineries, Inc.

THE ZENITH FOUNDRY CO., Detroit, Mich., has filed notice of increase in capital from \$125,000 to \$200,000.

THE SCOVILL MFG. CO., Waterbury, Conn., manufacturer of brass products, has arranged for an increase in capital from \$5,000,000 to \$20,000,000.

THE AMERICAN AMMONIA CO., Boston, Mass., a Delaware corporation, has filed notice of increase in capital from \$950,000 to \$1,200,000.

Paul S. Ache, Erie Pa., has been appointed receiver for the CHIPPEWA OIL & REFINING CO., Beaver, Pa., in bond of \$50,000. The company's refinery will be continued in operation.

THE AMERICAN CORK SPECIALTY CO. and the COMPRESSED CORK CO., 461 Eighth Ave., New York, N. Y., have been merged with L. Mundet & Son, same address, manufacturer of kindred cork products.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its seventy-fourth meeting at Toronto, Canada, Dec. 27 to 31, 1921.

AMERICAN CERAMIC SOCIETY will hold its twenty-first annual meeting at St. Louis, Feb. 27 to March 2, 1922.

AMERICAN GAS ASSOCIATION will hold its third annual convention in the Congress and Auditorium Hotels, Chicago, the week of Nov. 7. More than 100 manufacturers will exhibit their latest gas-burning appliances.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its annual winter meeting at Baltimore, Md., Dec. 6 to 9. Headquarters will be at the Southern Hotel and the sessions will be held in the Engineers' Club.

AMERICAN MINING CONGRESS AND NATIONAL EXPOSITION OF MINES AND MINING EQUIPMENT is holding its twenty-fourth annual convention in the Coliseum, Chicago, Oct. 17 to 22.

ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS will hold its thirty-eighth annual convention at the Washington Hotel, Washington, D. C., Oct. 24-26.

INDUSTRIAL COST ASSOCIATION will hold its second national conference at Pittsburgh, Pa., Nov. 2-4, with headquarters at the William Penn Hotel.

INDUSTRIAL RELATIONS ASSOCIATION OF AMERICA will hold its annual convention at the Waldorf-Astoria, New York, Nov. 1-5.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

The following meetings are scheduled to be held in Rumford Hall, the Chemists' Club, New York: Oct. 21—Society of Chemical Industry, Grasselli Medal; Nov. 11—American Chemical Society (in charge), Society of Chemical Industry, American Electrochemical Society, Société de Chimie Industrielle joint meeting; Nov. 18—American Electrochemical Society, regular meeting; Dec. 2—Society of Chemical Industry, regular meeting; Dec. 9—American Chemical Society, regular meeting.

CHEMICAL & METALLURGICAL ENGINEERING

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Assistant Editors
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Industrial Editor
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Managing Editor

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The Threatened Railroad Strike

SOBER opinion in well-informed circles is to the effect that the railroad strike will not occur. We make no prophecy, but merely record the belief of those who have knowledge of facts on which they base their opinion. But even the layman without inside knowledge finds it difficult to imagine that the great railroad labor leaders can be so heedless of public opinion or blind to the consequences of their folly as to permit the threatened strike to be consummated. The issue is clear cut and thoroughly understood by the people and they will have none of it. They will show no sympathy for men who, at a time when industry is characterized by unemployment, would force millions of men into the ranks of the idle and paralyze the transportation system of a great nation. Fortunately it looks as though the Government is not to be cowed with threats, nor coerced or intimidated into a surrender. The threatened strike is plainly a revolt against the carefully considered decision of a Government agency. It is not the outgrowth of a controversy between employees and employers. It is a flat refusal to accept a reduction of wage ordered by the same board which a year ago granted an increase in wage. It is a plain refusal to play the game fairly and squarely. We have yet to see the first expression of public sentiment favorable to this attitude on the part of the unions, and while there may be some doubt as to whether the strike will eventuate or not, there is not the slightest question as to the outcome in case it occurs. Unionism will have dealt itself a blow from which it will not soon recover. The strike has been conceived in selfishness on the part of a small group of citizens and its success would be a crime against a nation that has been patient and long suffering with railroad workers.

Nobody To Blame

"**N**OBODY to blame." This, briefly, is the remarkable verdict of the Coroner's jury published after investigating the disaster to the ZR-2, which fell a blazing mass of junk into the River Humber a few weeks ago, burning out all but five of the fifty gallant lives aboard. "Nobody to blame." This is to say, the holocaust was either an accident not to be foreseen and guarded against, or an act of GOD. Surely such a verdict is the epitome of human stupidity or blasphemy!

In appraising this disaster engineers should remember several things: First, that the facts regarding this and similar occurrences are buried in governmental archives or known by uncommunicative officers. Second, that the first rigid balloon was built only fifteen years ago, and since then very few have been made alike; consequently accurate information about operating loads and stresses of necessity is lacking. Third, that the metallic portions of such machines are made of new alloys, about

whose manufacture and properties much yet remains to be known.

Our consideration should therefore be focused on two phases of the subject: First, Was the design adequate? Second, Were the materials trustworthy? Grave doubts exist on both these questions; an answer of "No" in either case would be fatal. Put bluntly, they were pitting unknown metal against uncertain loads. Is this an "act of God"?

As is perhaps common knowledge, the main skeleton of a modern airship consists of a series of giant bicycle wheels, wired to the center, and set at 15- to 20-ft. intervals. Longitudinal members hold them apart, and each rectangular side panel is wired on its diagonals. Inclosed are the gas bags, to the end are fixed the rudders and below are hung engines and cabins.

Now, from a design standpoint, a main structure can be so arranged as to be determinate to a definite assumed loading—i.e., all the stresses can be figured in the various properly disposed members when forces in definite amount are applied at definite points and in definite directions. Such forces would of course be chosen to represent what is thought to be the most severe operating conditions. Then all the parts can be designed to be safe against these stresses. Of course, one may assume a number of other loadings for other conditions of operation and figure the resulting stresses. Consequently a great many possible loadings would be analyzed in the design, and the final structure would provide for the heaviest combination.

Those who have wrestled with loads and deformations of continuous bridges or gas holders will realize that the problem of airship design is far from simple. The reactions to shifting loads depend upon the elasticity of the structure. When an airship is flying, various combinations of loads are present whether or not they have been so assumed in the preliminary calculations, and they shift themselves in amount and direction automatically with great rapidity, without asking leave of the designer. As our British contemporary *The Engineer* observes, even on the simplest assumptions "airship loadings are diabolically complex, and there is an amazing difference in principal shearing stresses between the inflated and empty condition." Imagine, therefore, what would happen in the members of a huge, fragile craft when buffeted by cyclonic gusts, or if a gas bag should burst when turning at high speed, thereby developing tremendous loads due to inertia. Still, "No one is to blame"!

The Engineer notes as matters of history that it is remarkable that airships have been consistently destroyed; approximately 100 have been constructed in the last fifteen years, the latest costing \$2,500,000, yet there are not a dozen fit to fly today. Forty of them were shot down during the war. While as naval scouts they have gathered valuable information, they are practically worthless in action when opposed by airplanes.

Twenty-six built between 1905 and 1914 came to grief, usually not while flying, but by storm or fire, occurrences which were also frequent during the war. Ten years ago British Naval Airship No. 1 broke amidships with the greatest ease while being taken out of the erecting shed. Yet now "Nobody is to blame"!

Enough for the features of pure design. We do not wish to accuse the designers of failing to act according to their best lights; but it will be evident from the history of airships that many elements of uncertainty surpass the assumptions made by the constructors. It is easily possible that a perfectly built structure would have failed because of excessive and unexpected forces. But what of the materials of construction?

In airships the members are built of $1\frac{1}{4} \times 1\frac{1}{4} \times \frac{1}{16}$ -in. duralumin angles. Duralumin is a peculiar alloy of aluminum and copper, with a little magnesium and manganese. It is "hardened" aluminum. It was discovered by WILM less than twenty years ago, and was in production in Germany before a list of its physical properties was published. That was in 1911, and for several years it was regarded as a metallurgical mystery—its behavior contradicted all expectations. It has the peculiar property of aging: after a proper quenching it increases in hardness and strength at room temperature, rapidly during the first few hours, but progressing at a slower rate for days. Such metal appeared to shock conservative metallurgists, who unconsciously judge the soundness and quality in metal by the degree of permanence of its properties.

In the last four or five years much scientific work has been done on such aluminum alloys, and much of it is published, so that the aging action is no longer so surprisingly bizarre. In fact, its various changes, with changes in composition and heat-treatment, have been co-ordinated with like facts known for many other common alloys, and duralumin has found its place in metallurgical theory without disrupting any of our fundamental conceptions. In fact the broad theory is being used daily to predict the expected action of this new alloy under untried circumstances.

So now it is known to the testing engineer that light aluminum alloys when rolled into thin sections "tear" very easily, making it essential that the metal's outer surface and inner texture be absolutely free of even microscopic notches, where concentrated stresses build up and all manner of evil results. Many American foundrymen have been driven near distraction when trying to make thin aluminum castings which didn't look like old-fashioned cast steel—an accumulation of bubbles held together by films of metal. They can appreciate the skill and sound technique required to cast thoroughly sound ingots, free from surface defects, and then roll these ingots into small shapes of really smooth surface and undamaged edges.

When we entered the war, our Government received and handed over to certain producing companies all that was then known in England and France regarding the manufacture and properties of these airship alloys; yet we are able to state advisedly that constant and intensive investigations directed by American metallurgists, second to none in the world, have only now enabled the production of duralumin of quality without a prohibitive number of rejections and the development of puzzling defects shortly after fabricating. A thoroughly dependable metal can be produced when its vagaries have been studied and mastered, but is it safe to assume that the metal entering into the construction of the ZR-2, cast

and rolled about three years ago, was any better or more dependable than our own technicians would have then produced?

Yet "Nobody was to blame"! Such a verdict is merely stupid. It must have been the refuge of a group of men, ignorant of engineering, and uninformed. But there must have been men present at the inquest who know more about the points at issue than the writer of these lines. Why did they sit silent? Perhaps the new legal philosophy of America has already entered their hearts: "I refuse to answer, by advice of counsel, on the ground that it might tend to incriminate me."

Signs of Promise

TWO events of the past week are calculated to hearten those who sit in the watch towers of chemistry and look for signs of promise. One was the dedication of the new chemical laboratory at Cornell University and the other the inauguration of a new course in chemical engineering in Sheffield Scientific School of Yale University. Each represents an influence set in motion, whose ultimate effects on science and industry cannot be foretold.

Unusual importance attaches to the new laboratory at Cornell because its donor is a New York banker, GEORGE F. BAKER, chairman of the board of directors of the First National Bank of that city. His identity was not made known until the building was dedicated and he himself laid the cornerstone with a silver trowel. Mr. BAKER has taken advantage of an unusual opportunity to contribute to the welfare of his generation, and not of his generation alone, but of his country for generations to come. No one can estimate the beneficence of such a gift to a science the application of which is daily proving itself to be the greatest single factor in our national welfare, whether for peace or war. His example may well be emulated by others with philanthropic ambitions; nor need the exhortation be limited to bankers alone. Beneficiaries of chemistry there are who can pay no better tribute to the industry in which they made their success than to endow instruction in chemistry. The example of Mr. EASTMAN and his gifts to "Tech" are still fresh in the memory.

Of chemical engineering at Yale much can be expected when the course becomes well established and facilities in the way of buildings, equipment and endowment funds are more generously provided. But what the institution may now lack in physical equipment it possesses in personnel and policies. Firm in their belief that instruction in chemical engineering should be directed mainly to the fundamentals of science and mathematics, with intelligent perception of their industrial applications, the faculty has adopted a policy that will do much to offset any lack in buildings or equipment. It is true that the course inaugurated is only of four years duration, but when it is remembered that until last year "Sheff" had only three-year courses in engineering, it will be seen that chemical engineering starts on advanced ground. Nevertheless we express the hope that the course may yet be extended to five or six years, or lacking this, that the students may be prevailed upon to return for post-graduate courses. We congratulate the institution on the inauguration of this department and express the hope that progress will always be evident in the development of the curriculum.

Development Of Transportation

WHAT is to be the greatest industrial work in the United States in the next decade? Prophecy is always hazardous at best, but a general survey seems to suggest that the greatest work will be the development, in the broad sense, of transportation.

There are various ways of guessing what men will do. One is to consider what they have opportunity to do, another what they need to do. Taking the latter tack, some data can readily be collected. The fact has been emphasized of late that normally there are about 2,000,000 persons engaged and drawing pay, if not actually at work during all of the Adamson eight-hour period, in rail transportation. That seems like a very large number out of a total of about 45,000,000 persons, including clergymen, public servants, teachers, office boys and others, engaged in gainful occupations according to Census Bureau showings, particularly when it is considered that there is a great deal of transportation besides rail transportation. It looks as if some improvement could be effected, releasing men for other work.

Then we have had a good bit of information about the freight cost of certain commodities, not many, but some, being more than half the total cost. That looks bad, although sometimes there are extenuating circumstances. Remembering that we are considering transportation in the broad sense, we have had many illustrations of the great difference between the value of food on the farm and on the table. Transportation and distribution are linked together—that is, they ought to be.

We have had preaching for many years about the great value of our natural waterways and of artificial waterways, with much citation of facts to show the economy. Apparently we need to utilize these advantages. One may ask why, if this needs to be done now, it did not need to be done just as much years ago. The fact is that a great change has occurred. Railroading is less than a century old. The greatest mileage of railroad constructed in a year was in 1887, only a third of a century ago. Once built, a railroad needed traffic. There was a very heavy overhead. It is only in quite recent years that the major portion of the railroad mileage has had to work at anything like capacity. There was no economic advantage in relieving a railroad of traffic it needed and could well handle, any more than there would be economic advantage in maintaining two parallel railroads when one could perform all the service desired.

Considering transportation in the broader sense, we have the obvious need of transporting power. We transport much coal at great expense, and use it inefficiently in small power units, when we need to consume the coal economically in large units at the mine and transport the power over a little copper wire, easily maintained.

From the other viewpoint that may be taken in attempting to guess what men will do in the next decade, that of what men have opportunity to do, we see the opportunity of operating railroads more economically, by better administration of freight cars so that they shall carry goods more miles per day per car, by electrification, by block signaling and by other improvements. We see the motor truck developed beyond a parity with the roads on which it should travel, so we have opportunity to build more and better roads.

We see waterways ready to be used, requiring only the building of boats and the installation of terminals. We see canal-building machinery and appliances that will produce given results with much less expenditure of man power than a quarter of a century ago.

We shall always be a restless nation, requiring much transportation of ourselves and our goods, so the market for transportation will always be a broad one. It is the very fact that transportation has been so urgently demanded in rapidly increasing quantities that transportation is not as efficient as it might be. If a commodity will be bought only if the price is low, efficiency makes the price low, but if it will sell anyhow, efficiency may be neglected. That has been the case with transportation.

Russian Chemists Sorely Need Help

SINCE printing an editorial on "Russian Chemists and Organic Chemistry" in our issue for Sept. 14, 1921, several letters have been received from their exiled brothers giving fragmentary information, often contradictory on account of incorrect rumors or tardy post. It appears that Dr. C. N. IPATIEFF served with the Russian Army during the great war, attaining the rank of General. Such duties of course prevented any scientific studies, and it has doubtless been difficult to continue them of recent years, lacking the necessary reagents and apparatus, which must be missing in a country whose very hospitals are stripped of bare necessities. A letter from London contains the sad news of his sickness and death, but another report through German channels speaks of him as still being well. Likewise, two reports have been received concerning Professor OSTROMISLENSKY, one saying that he is alive, but a clipping from a German paper states that he was killed at Moscow. We have also been given the shocking news that Professors KONOVALOV and ZELINSKY died of starvation and exposure as late as last year. Whether the Soviet rulers realize it or not, the loss of such human material is a serious handicap in the advancement of the "proletariat."

The proposal to send out a search party to find some of the survivors was not a flippant phrase, but a serious recommendation. Since HOOVER's relief forces have penetrated Russia, it has probably dawned upon the official mind that every philanthropic effort is not propaganda or an attempted economic penetration of Russia. Could not the American Chemical Society charge a committee with the duty of communicating with prominent members of the once-influential Russian Chemical Society, with the idea of discovering their necessities and formulating some plan of relief? It may be that many other brilliant chemists are approaching the fate of KONOVALOV and ZELINSKY.

Food supplies can now be forwarded to designated individuals through HOOVER's relief. Or it may be found that the greatest lack is equipment and scientific literature; in fact GORKY has been reported as saying that the greatest difficulty now existing for successful work in the arts and sciences is the absolute intellectual isolation of Russia. Public prints now assure us that the economic blockade has been lifted by all outside governments; international communications, though bad, should now allow the passage of necessary shipments, which doubtless would be forthcoming by generous donation if the facts were known.

Who will lend a helping hand?

Readers' Views and Comments

Sound Ingots and Rails as a Matter of Course

To the Editor of Chemical & Metallurgical Engineering

SIR:—I have recently reverted to the valuable articles by Dr. G. K. Burgess, of the Bureau of Standards, Washington, D. C., and the editorial comment relating thereto appearing in the issues of CHEMICAL & METALLURGICAL ENGINEERING for Nov. 10, 17 and 24, 1920. These articles refer to the hundred tons of ingots the writer's firm sent over to America in 1913, made by what is termed the "Hadfield sound steel method." As Dr. Burgess' report showed, these rails were found to be of excellent quality and particularly free from defects.

There is no doubt that the system could be satisfactorily applied to the production of rails on a large scale. It may be added that there have been attempts to follow or copy my system, but unfortunately those doing so have generally left out some particular portion of the *modus operandi* recommended and practiced by my firm, the result being that the system has not had a full and proper chance of being investigated and tested on a large scale.

In view of the difficulties met with in the present type of rails used in roadbed construction, it seems regrettable that the important advantages of manufacture of this system, to which reference is now made, have not been fully and properly tested.

Notwithstanding the efforts adopted by the railroad company to inspect closely the "permanent way," as we call it over here (in your country "roadbed"), which

of course includes the rails, serious breakages of rails are constantly occurring. Besides, the heavy expense required to watch over the roadbed closely enough to prevent accidents is a matter of serious moment. Much of this inspection of steel rails would be unnecessary if steel sound and free from defects, as is quite possible, were used.

The increasing severity of the stresses and abrasion upon steel rails is brought home to the mind when one reads about the American coal train of such extraordinary length pulled by a Mallet engine and representing a string of no less than one hundred 120-ton cars of coal, which ran over the Virginian R.R. on Wednesday, May 25, from Princeton, W. Va., to Sewall's Point. The total trainload aggregated no less than 16,000 gross tons, and the length would probably be not far short of one mile.

In view of the fact that many rails are practically of tool steel temper—that is, as hard as is used for drills, chisels and other similar products—it will be understood that hard steel, which usually means brittle steel, is being severely stressed. In my opinion unless properly made and treated these will be liable to failure under these heavy loads and severe conditions.

At our recent conference at the Institution of Civil Engineers in London, several interesting papers on railroad matters were read, and discussion took place regarding rail failures. It was clearly proved that the microscopic cracks, from which most of these troubles originate, occur from want of care in the production of



FIG. 1. HADFIELD-JACK METHOD (PATENTED) APPLIED TO SHELL MANUFACTURE

From left to right is shown the special billet as cast; one of them sectioned longitudinally; a billet parted ready for breaking; the two portions ready for the press; after pressing, and then

two finished shells. It will be noticed that the forged blanks are somewhat longer than when finished, to furnish material for physical tests.

the original steel in the ingots from which the rails are rolled.

While it is not desirable to exaggerate the situation as some may have done, an improvement is certainly demanded. The following may seem a bold statement to make, but it can readily be proved to be true—namely, that given suitable plant and properly trained superintendents, it is possible to insure that only sound ingots would be passed to the rolling mill, also that every ton of ingots could be produced absolutely sound and from which nothing but sound rails would result. To put the matter in another way, it could be made quite practicable to accept a contract for 10,000 tons or, for the matter of that, hundreds of thousands of tons, of ingots, all of which would be sound and from which all the rails produced would be sound and free from defects.

The great point I wish to make is that under this system not a single ingot could get through which was not inherently sound and that this could be known before the ingot went into the rolling mill itself, whereas now the ingots vary in a very wide and dangerous degree in this respect and it is not known whether they are sound or not. Even if through any untoward accident of carelessness in the heats, some ingots were produced which would not meet the requirements, my point is that these would be known and detected before they reached the rolling mill. It will therefore be seen that the statement that if, say, a million tons of ingots was produced, every one of them would be sound and free from the troubles so frequently met at the present time, is, as shown in my various papers on this special subject, based not on imagination but on statements of fact and actual practice already carried out.

To deal with this rail problem adequately it is necessary to begin by inspection of the ingots—that is, this would not, as at present, be left until the rails themselves were produced, in most of which it is not possible to detect the flaws and imperfections, though they are there, as these cannot be seen.

The reply may be made, "Yes, but at what cost can this be done?" The answer to this is that with a properly systematized plant and operators, the extra cost involved would be comparatively slight. Besides, and in the end, with better methods such extra expense pays, as it is always economical to make and use good products. If some enterprising railroad would say, "We will try five or ten thousand tons of rails made in this manner," then the reply would be, "It can have sound rails, though naturally for small lots there would be, until manufacture was systematized on a large scale, some extra charge necessarily involved."

As further evidence of sound material, if such be needed, the attached Fig. 1 may be of interest to your readers. It shows the application of the Hadfield system to the casting of high explosive shell, of which my firm made hundreds of thousands during the war. It will be noticed that the blank in this particular photograph was not for one shell only, but for producing *two* in one blank, which greatly reduced the cost and time. Excellent results were obtained in making hundreds of thousands of these double blanks; notwithstanding the rapid production, there was practically an entire absence of waster shell from any cause, whether unsoundness, machining quality, mechanical properties or firing tests. As I claim in the case of ingots for rail making, an unsound blank is readily detected before any forging, pressing or other work is put on it.

Other photographs could be reproduced to show the application of the Hadfield system to 12-in., 15-in. and even larger shell cast in single blanks. Similar success to that mentioned above as regards 9.2-in. attended the production of these larger calibers.

In all these cases, especially as regards the larger shell, where the machining surface was so considerable, I do not remember my firm having a single rejection for unsoundness. In these larger calibers it was possible, as with the smaller ones, to determine quickly whether the blanks were in proper sound condition before putting a single minute of work on to them.

I claim that rails can be made in the same way just as sound as high explosive shell. Such rails would be quite sound, also free from segregation and other defects.

ROBERT S. HADFIELD.

Hadfield, Ltd.,
Sheffield, England.

Credulochemistry

To the Editor of Chemical & Metallurgical Engineering

SIR:—Apropos of your recent editorial on "Credulochemistry," I would call your attention to the occurrence of this new science even in such an orthodox place as the Chemical Exposition. The following extracts from circulars which I received at a booth there illustrate some of the modern views of the adherents of this new science:

"There are, practically speaking, but two kinds of floor hardeners: One made of magnesium silicate, the other sodium silicate. Magnesium silicate is obtained from mica, hence cannot be any harder than mica, its base. While it acts very readily on the free lime in the cement, its hardening qualities are limited to the hardness of mica.

"Sodium silicate, which is used in — Floor Hardener with various other chemicals and gums, is spar. The purest form of spar known is red granite, which in turn is four times as hard as mica. In acting on the free lime in the concrete sodium silicate renders it four times as hard as when magnesium silicate is used.

"The hydrofluorine formed by the chemicals used in — Floor Hardener reacts powerfully on concrete and makes sand soluble and forms it into a mass as hard as flint."

The same "chemical" (?) company has made important discoveries in the organic branch of Credulochemistry, one of the most interesting of them being a linseed oil substitute, described in another circular, from which I quote a few sentences:

"The most general characteristic of — Oil is its property of depositing a thin but strong waterproof and porous-proof film; resisting weak acids, strong acids and full-strength acids, even if in solution form. It is high-resisting, non-explosive and less harmful (?) than linseed oil. It is a chemical and mineral oil, called a chemical and mineral oil because of its chemical properties [*sic!*] and purely mineral bases, and is superior in every way to linseed oil or any other paint oil made."

While it may be too much to expect the management of the Chemical Exposition to censor all of the printed matter distributed by exhibitors, yet there would not be much difficulty in general in picking out those who, from the nature of their business, would be most likely to perpetrate such atrocities in the name of chemistry, and keeping a watchful eye on their activities.

Oakmont, Pa.

FRANCIS C. FRARY.

Edward R. Weidlein, New Director of Mellon Institute

ANNOUNCEMENT has been made by the board of trustees of the University of Pittsburgh of the appointment of Edward Ray Weidlein as director of the Mellon Institute of Industrial Research. Mr. Weidlein has been acting director since the recent resignation of Dr. Raymond Foss Bacon, and prior to that time, since 1916, he served as associate director. Dr. Bacon, who left to engage in consulting chemical practice in New York, became director at the time of the death, in 1914, of Dr. Robert Kennedy Duncan, the first director of Mellon Institute and formulator of the Institute's successful system of establishing practical co-operation between science and the chemical industry.

Mr. Weidlein was a student of Dr. Duncan and later became an Industrial Fellow of the Mellon Institute. He has been associated intimately with the industrial fellowship system since 1909, and since 1916 has been a member of the administrative staff of the Mellon Institute. He has had a rich experience in the supervision of industrial research and enjoys a high national reputation as a specialist in the systematic investigation of the problems of chemical and physical technology. In addition, he brings to his new post of responsibility a boundless enthusiasm which has resulted from his studied devotion to the ideals of the industrial fellowship system of the Institute and from his naturally vigorous optimism.

Commenting on Mr. Weidlein's appointment, an officer of the University of Pittsburgh said: "His broadly sympathetic and luminous mind moves on a plane so near to that of Dr. Duncan, the founder of the Mellon Institute's system of research, that he knows this grand scheme of thought as it was developed; he brings to this important position and to the interpretation and diffusion of the Institute's industrial fellowship system such a happy combination of qualities as one very rarely meets with."

Edward Ray Weidlein was born at Augusta, Kan., on July 14, 1887. He was graduated at the University of Kansas, Lawrence, Kan., with the degree of Bachelor of Arts in the year of 1909; in 1910 he received the degree of Master of Arts. From Dec. 1, 1909, to March 1, 1910, he was engaged in a study of camphor, under the direction of the late Dr. Robert Kennedy Duncan. From March 1, 1910, to Oct. 1, 1912, he carried out a comprehensive study of the ductless glands, during the course of which he investigated epinephrin

from the whale. From Oct. 1, 1912, to Oct. 1, 1916, Mr. Weidlein was a Senior Fellow in the Mellon Institute of Industrial Research, having supervisory charge of all of the Institute's investigations on the metallurgy and hydrometallurgy of copper and having direction of the experimental plant at Thompson, Nev. In connection with this investigatory work Mr. Weidlein developed a process for the use of sulphur dioxide in hydrometallurgy which has aroused wide interest because of its economic importance.

On July 10, 1916, Mr. Weidlein came to the Mellon Institute at Pittsburgh as assistant director; on Oct. 1, 1916, he was appointed associate director and he became acting director in 1918, during the leave of absence of Colonel Raymond F. Bacon as Chief of the Technical Division of the Chemical Warfare Service, A.E.F. On March 12, 1918, Mr. Weidlein was appointed chemical expert for the War Industries Board. His activities on this board received the highest official commendation.

The forty-eight Industrial Fellowships or scientific investigations of important problems of manufacturing in operation at the Mellon Institute cover a wide range of problems in chemical and mechanical technology. Mr. Weidlein maintains a constantly active supervision over these researches. He has had this intimate relationship with the industrial fellowship system since its formulation by Dr. Duncan in 1917.

The following are some of the important journal contributions of Mr. Weidlein:

"Jamaica Camphor" (with H. W. Emerson), *Journal of Industrial and Engineering Chemistry*, vol. 4, pp. 33 to 36.

"Epinephrin From the Whale," *Journal of Industrial and Engineering Chemistry*, vol. 4, pp. 636 to 645.

"Recent Developments in Connection With the Use of Sulfur Dioxide in Hydrometallurgy," *Journal of Industrial and Engineering Chemistry*, vol. 9, pp. 1057 to 1058.

"Conservation of Heat in Power and Heating Systems," *CHEMICAL & METALLURGICAL ENGINEERING*, vol. 24, pp. 295 to 300.

"Science and Industry," *Textile World Journal*, vol. 53, No. 44, pp. 186 to 191.

"The Industrial Fellowships of the Mellon Institute," *Science*, N. S., vol. 47, No. 1219.

Mr. Weidlein's inventions in the field of the hydrometallurgy of copper are claimed in U. S. Patents 1,089,096 and 1,201,899; in Canadian Patent 173,040, of Nov. 7, 1916, and in British Patent 10,500, of April 28, 1914.



EDWARD RAY WEIDLEIN

Mixed Orientation Developed in Crystals of Ductile Metals by Plastic Deformation

The Hull Method of X-Ray Crystal Analysis Answers This Contentious Question in a Positive Manner—Cold-Work Produces Change in Orientation Within the Original Grains

BY EDGAR C. BAIN AND ZAY JEFFRIES

IN EXPLAINING the mechanism of slip by which plastic deformation of a metal proceeds, Tammann¹ offers only two modes of motion, translation and twinning. Lehman² has pointed out that movement is possible by fluid flow in crystals, but metallographists and physicists are in general agreement that plastic deformation in metals results from some form of block movement of crystal fragments along slip planes. Since the mechanical twin bears certain fixed relations to the parent crystal, it cannot be said to give any evidence of general rotation or change in orientation. In terms of our modern conception of atomic structure, these earlier assumptions mean that in general parallel atomic planes of atoms during deformation remain constantly parallel to the positions in which they were in the original grain. As regards the geometry of even quite drastic deformation this is theoretically quite possible. Howe³ aptly

ing pits even after severe deformation. Howe³ to a great extent seems to corroborate this impression. "The regularity of the etching pits in each grain even after extreme plastic deformation and the sharp change in their direction from grain to grain are very cogent evidence of the retention of substantial uniformity of orientation during deformation."

One of the present authors,⁴ however, while granting the general truth of the regularity of etching pits in cold-worked metals, believes that the methods of determination of the regularity of direction in etching pits are not sufficiently accurate to warrant more than a qualified statement of the tendency and points out that the pits are usually examined in sections which are most likely to show minimum alteration of orientation. Yet cold-worked metals recrystallize on proper annealing, and "no explanation of the recrystallization of cold deformed metals on annealing has been forthcoming which did not assume a change in orientation within the initial grains due to the deformation."

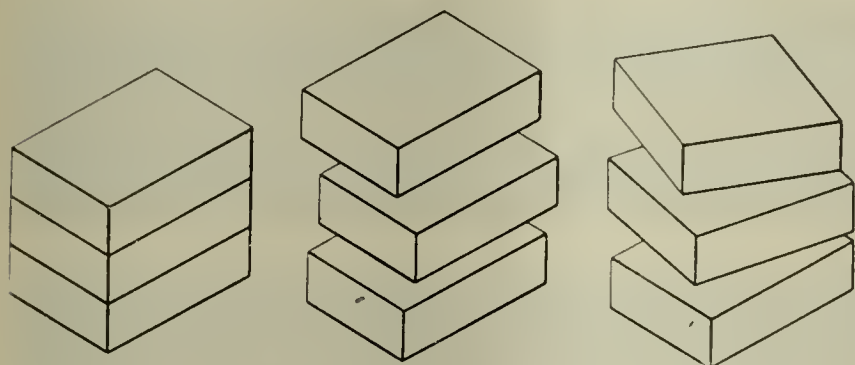


FIG. 1. DIAGRAM OF SLIP IN CRYSTAL BLOCKS BY TRANSLATION AND ROTATION

likens this sort of plastic deformation to the motion of the compass needle in the skater's pocket, which is vectorial or translatory, even though the skater's gyrations are rotary. Fig. 1 diagrams a few crystal blocks slipped by translation and by rotation.

Matthewson and Phillips⁴ criticise this view of Tammann and fail to understand a rearrangement and reorganization of a deformed grain after annealing unless its fragments, enveloped by amorphous layers, have been differently oriented. They maintain that if Tammann's opinion were correct, then annealing would simply stabilize the grain in its altered position. Carpenter and Elam⁵ are inclined to hold to the view that no new orientations are produced in a grain during deformation. To quote: "There is no evidence known to the authors that after deformation the orientation of a crystal differs in any way throughout its extent." They base their conclusion upon the regularity of etch-

¹Trans., Am. Inst. Min. Eng., 1917, p. 2117.

²Jeffries, Trans., Am. Inst. Min. Eng., 1917, p. 2071.



FIG. 2. VERTICAL SECTION OF TYPICAL INGOT FROM WHICH THE COARSE-GRAINED SPECIMENS WERE CUT. ACTUAL SIZE

³Lehrbuch der Metallographie, Gustav Tammann, p. 56.

⁴Zeit. für Met., vol. 13, Nos. 3, 4 and 5.

⁵The Metallography of Steel and Cast Iron, Howe, p. 295.

⁶Trans., Am. Inst. of Min. Eng., 1916, p. 1.

⁷"Crystal Growth and Recrystallization in Metals," J. Inst. Met., No. 2, 1920, p. 112. CHEM & MET. ENG., vol. 24, p. 224 (Jan. 2, 1921).

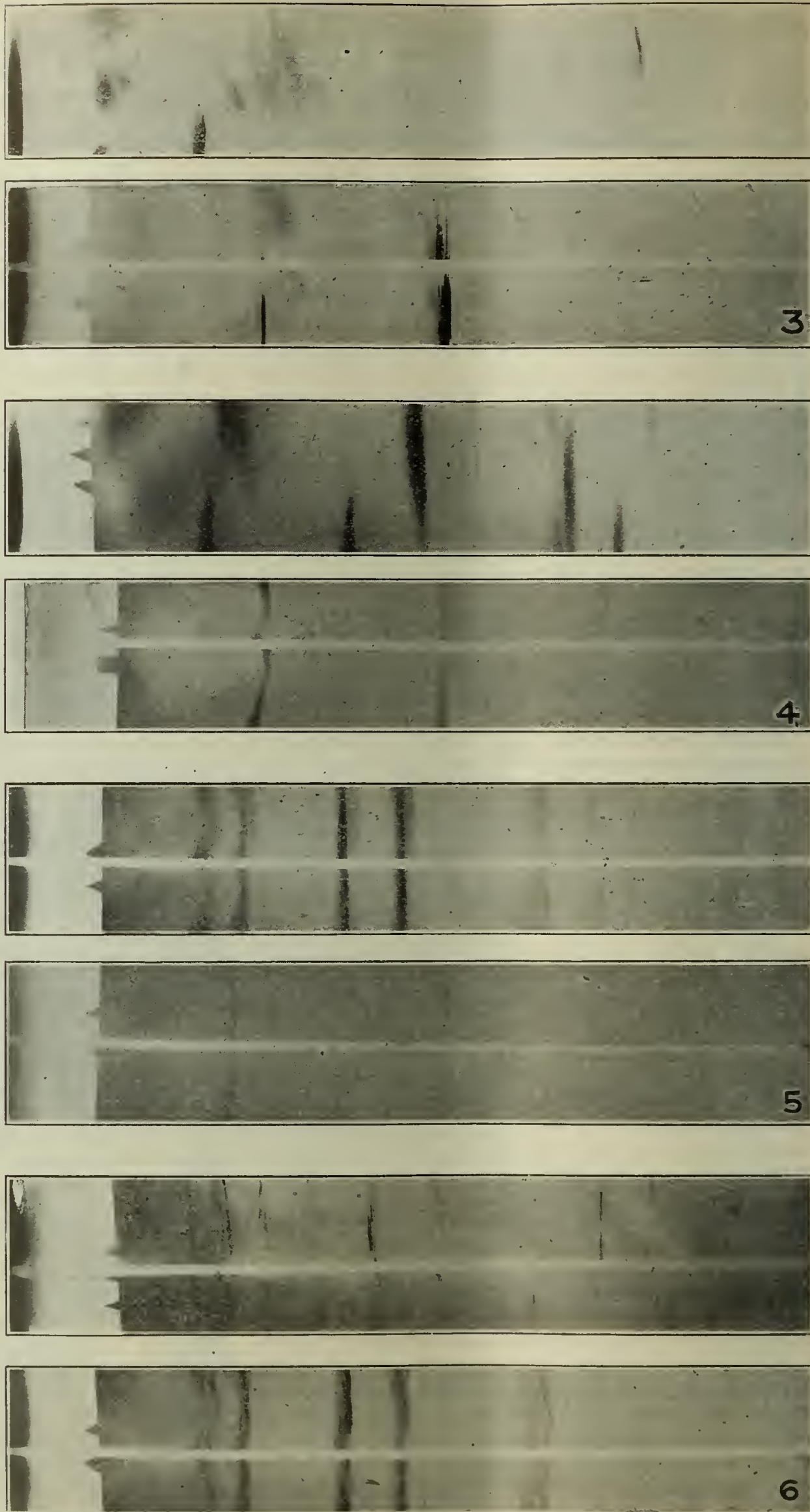
To sum up then, there is a disagreement as to whether or not deformation is accompanied by rotation and production of new orientations.

The authors have employed a new method of examination which offers a complete answer to the question of rotation during deformation. *If a very coarse grained specimen of metal containing only a few grains develops a complete assortment of orientations upon deformation by rolling alone, it would be positive proof of rotation of crystal fragments during deformation. This the authors have demonstrated conclusively.*

It was pointed out by Bain⁸ that the Hull pattern produced by the X-ray spectrometer was quite distinctive for different orders of grain size. A very coarse-grained specimen may show only one or two broad dashes on the film—indeed conceivably none at all—while with refinement of grain size the dashes decrease in size and increase in number. With very fine grain size the general pattern is produced on the film with smooth bands having even gradations on the edges.

For these experiments very coarse grained ingots of copper and aluminum were used. Fig. 2 shows a typical vertical section through the cast metal. This grain structure was developed by slow cooling. Specimens about $\frac{3}{8} \times \frac{1}{8} \times 1\frac{1}{2}$ in. were cut from the large ingots by a milling cutter. Great care was used to prevent deep strains. The specimens were polished and etched twice to remove superficial distorted metal from the surfaces. The separate grains were easily traced through the specimen, and usually numbered three or four. Such was the starting material.

Specimens thus prepared gave films of which Fig. 3 is typical. The film corroborates our idea of few orientations. Next, moderate cold-work was done upon the



FIGS. 3 TO 6. SPECTOGRAMS OF ALUMINUM (ABOVE) AND COPPER

Fig. 3. Coarse grained as cast.

Fig. 4. Moderately worked.

Fig. 5. Severely worked.

Fig. 6. Severely worked and annealed.

⁸CHEM. & MET. ENG., vol. 25, No. 14, p. 657 (Oct. 5, 1921).

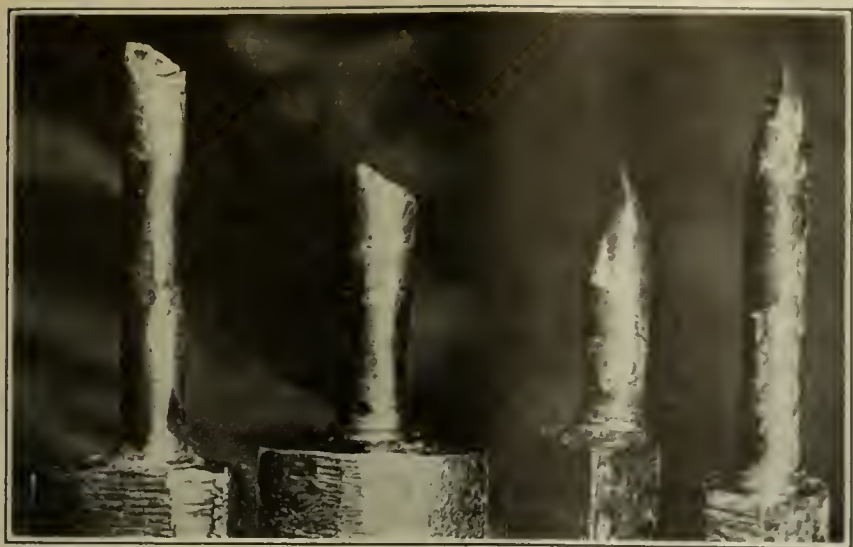


FIG. 7. WEDGE-SHAPED TENSILE RUPTURE CHARACTERISTIC OF SINGLE-GRAIN SECTIONS OF DUCTILE METALS

specimens by rolling to one-fourth or one-fifth their original thickness, and the original grains, much elongated, were revealed by etching. Spectrograms of this rolled metal were similar to Fig. 4, indicating some new orientations, even though the rays struck only about one-fifth the former area. (The beam of X-rays strikes upon the same surface area of the metal after elongation as before deformation. Hence the opportunity for encountering different orientations is only a fraction as great as in the cast specimen.)

But when reduced to one-eighth original thickness, in the case of aluminum, and one-fifteenth, in the case of copper, the full patterns shown in Fig. 5 were yielded by the X-ray spectrometer. These patterns are characteristic of an extremely fine grained metal, with a very complete assortment of orientations at random, such as obtained from the finest powders.⁹

These cold-worked specimens were annealed to produce recrystallization and again placed in the spectrometers. The resulting films shown in Fig. 6 are characteristic of a material whose grains are perhaps 0.005 or 0.010 in. in diameter. There are not sufficient grains in the orientations for reflection to give continuous bands, and we may infer that there is a great reduction in number of orientations by the annealing.

The directional properties of single grains were strongly brought out in observations incidental to these experiments. Sykes¹⁰ observed single grain sections of

⁹It is true that one line of the face-centered patterns is virtually absent from these films, but it is a very weak one at best and offers no ground for denying chaotic orientation in the specimen.

molybdenum wire to give wedge-shaped rupture ends in tensile strength above 300 deg. C. This has been found true for both copper and aluminum at ordinary temperature. Two views of a broken test-piece of copper are shown in Fig. 7. The single grains may be seen faintly etched on the specimen. During the test each grain deformed in its own particular manner; some were much more depressed than others, the boundary offering greatest resistance to deformation.

In rolling such material, however, the directional tendencies of the grains were most clearly seen. Some shifted to the right, some to the left; some elongated, some widened. This led the authors to press a specimen of large grains between lead plates. The different grains were thrown into bold relief but the boundaries seemed always to resist compression most strongly.

After observing the directions of favored slip in a grain the question naturally arises, "Along what atomic planes does slip preferably take place?" If it be the planes of widest separation, then for copper and aluminum it will occur along the planes designated 1-1-1 by Miller indices, of which there are four systems in any grain. For iron the greatest spacing is between successive 1-1-0 planes, of which there are six in any grain. This inference seems to be correct, judging from X-ray spectrometry, although Howe mentions the 2-1-1 planes in this connection. Experiments are under way in the authors' laboratory to show these favored slip planes conclusively.

A striking evidence of the development of mixed orientations by cold-work is seen in Fig. 8, in which is shown at 300 diameters a unicast tungsten wire twisted cold several turns. The specimen, prepared and photographed by P. P. Tarasov, Cleveland Wire Division, National Lamp Works, was polished and etched along a longitudinal section through the axis. According to Howe, etching is most vigorous when progressing normal to the 1-1-1 plane. In this case we seem to have a change of orientation every 90 deg. of turn.

The continuity of deformation is clearly seen here. The steps by which slip takes place must be quite small, and, most important, fairly regular. The lighter-etched areas the authors believe are the cube faces (1-0-0 planes). Such a specimen as this would in all probability give an X-ray film showing all orientations present. In fact the method described above has been applied to coarse-grained tungsten ingot and wire produced from it, with the same results.

¹⁰Trans. Am. Inst. Min. and Met. Eng., January, 1921.

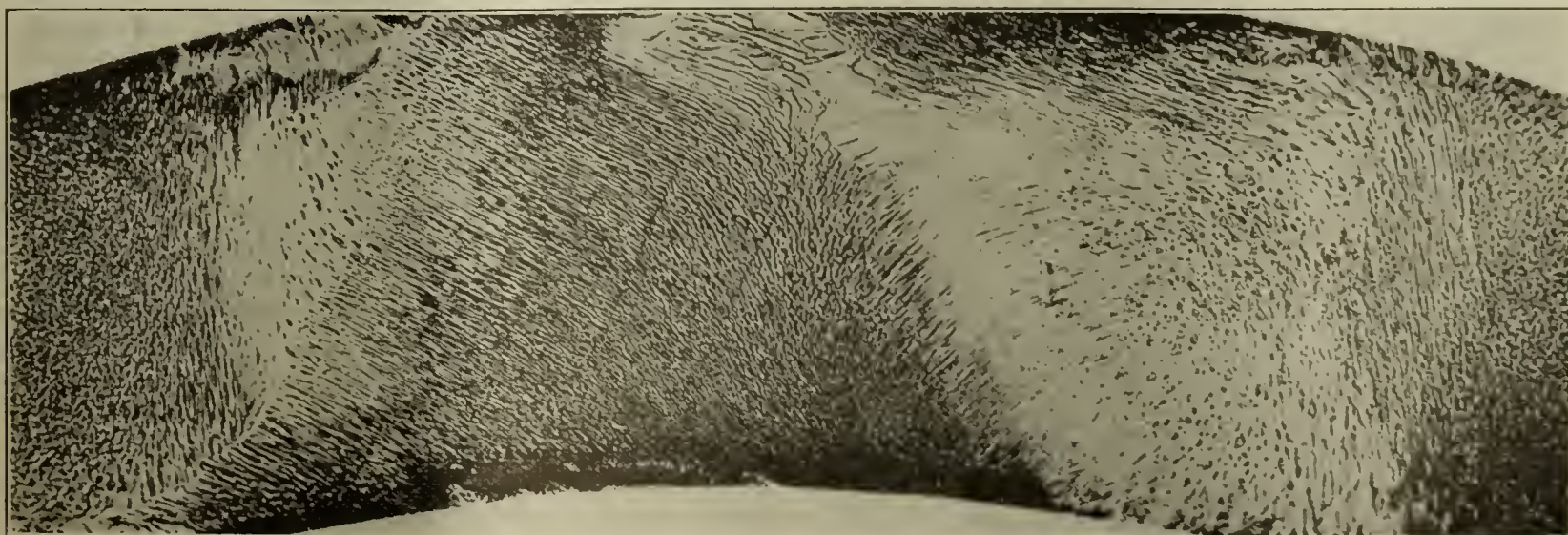


FIG. 8. SINGLE GRAIN IN TUNGSTEN WIRE, TWISTED COLD, POLISHED AND ETCHED. 300 X. CONTINUOUS CHANGE IN ORIENTATION BY ROTATION OF CRYSTAL BLOCKS

Studies in Colorado Shale Oils—B*

Secondary Oils Obtained From a Representative Colorado Shale Oil by Successive Distillations at Atmospheric Pressure—Character and Composition of These Decomposition Products and of Their Parent Material

By ARTHUR J. FRANKS

ALTHOUGH the work done thus far on the study of Colorado shale oils, as described by the author in this magazine,¹⁰ is of a preliminary character and cannot be expected to yield information that is entirely specific nor data which are in themselves sufficient for the deduction of many very definite conclusions, it does bring to light a number of prominent phenomena which are of considerable interest as well as importance. One cannot study the curves (Figs. 1 to 4, pp. 732-733) as a whole without observing certain persistent relationships and drawing therefrom a number of conclusions, some of which may be vague and merely suggestive, while others are quite definite.

The outstanding combination of phenomena met thus far is that of an increase in saturation, lowering of vapor temperature and specific gravity, loss of nitrogen and sulphur and the formation of coke and gas that accompanies a cracking distillation of the crude oil and its heavy distillates. The various losses as well as saturation increases are presented in Table III (p. 734). All calculations are based on a 1,000-c.c. sample of the original crude oil. The coke and gas losses are

total increase in saturation, and total losses of nitrogen and sulphur during the four distillations is well illustrated by the curves in Fig. 5.

LOSS IN SULPHUR AND NITROGEN DURING SUCCESSIVE DISTILLATIONS

From the calculations in Table III and the curves it is evident that most of the decomposition, loss of sulphur and nitrogen and increase in saturation occurs in the first two distillations. More than three-fourths of the nitrogen loss but only about 40 per cent of the sulphur loss occurs in the first distillation. In the second distillation only about 11 per cent of the total nitrogen loss but about 25 per cent of the sulphur loss occurred. Hence there does not seem to be any constant relationship between the amounts of sulphur and nitrogen lost during the decomposition of the more unstable material. Consequently the results indicate that the nitrogen and sulphur in these very unstable oils are present in more than one class of compound. The character of the losses suggests that this easily decomposed unsaturated material is probably made up of very heavy nitrogen compounds, sulphur compounds and those containing both nitrogen and sulphur.

The nitrogen and sulphur losses in the third distillation are small and practically the same. This suggests that the more stable, heavy oils that decompose contain both nitrogen and sulphur. However, it is practically impossible to obtain any definite information from the behavior of the oils on distillation and the losses, because there is now no doubt that there is a recombination of these elements, as the analyses of the new oils show. Hence the actual amount of decomposition cannot be exactly measured. The losses are merely a measure of the difference between the total amounts recovered and those originally present. Therefore but little further information is available through a continuation of the present methods of investigation.

The losses of sulphur and nitrogen in the fourth distillation are less than those found in previous ones. They tell nothing more than that the sulphur and nitrogen compounds present in the distillates after four distillations are very stable. Continued distillations under the same conditions would probably effect neither greater nor less decomposition of these substances than that observed in the last distillation. A study of all other losses during the four distillations shows that what is true of the nitrogen and sulphur compounds is true of any other unstable constituents present in the oil.

INCREASE IN SATURATION OF DISTILLATES DURING SUCCESSIVE DISTILLATIONS

The calculations for increase in saturation must dispel any doubts as to whether new saturated hydrocarbons are formed by the cracking of unstable material

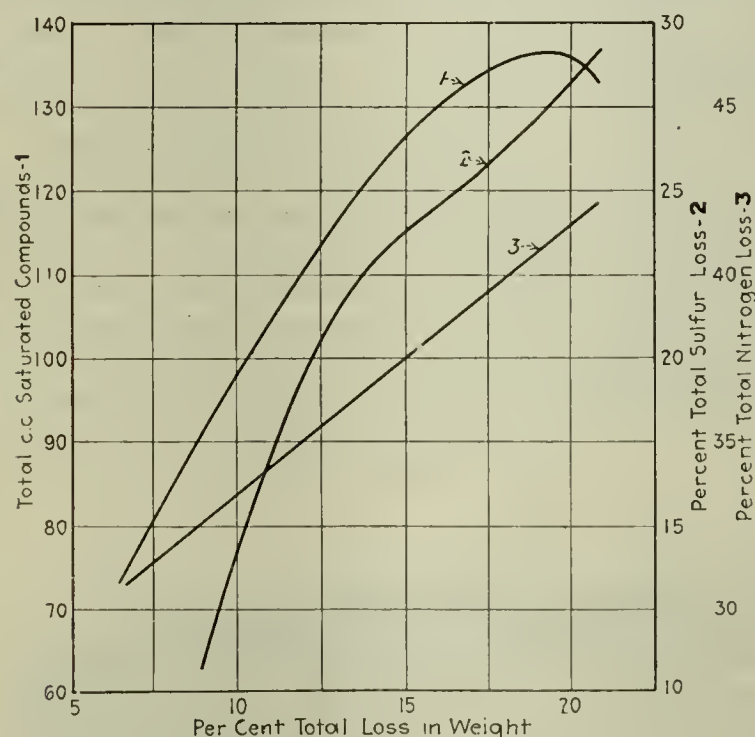


FIG. 5. RELATION BETWEEN LOSS IN WEIGHT, INCREASE IN SATURATION AND LOSSES OF NITROGEN AND SULPHUR

expressed in percentages by weight of the crude. The sulphur and nitrogen losses are given in percentages of their respective total weights present in the crude oil. The loss in volume is expressed in percentages of that of the original oil. The increase in saturation is given in cubic centimeters in one case and in percentages by volume of the original saturation in the other. The relationship between the total loss in weight and the

*For Part A of this article see CHEM. & MET. ENG., vol. 25, No. 16, 1921, p. 731.

¹⁰CHEM. & MET. ENG., March 30, July 13 and Oct. 19, 1921.

in the heavy oils and prove that the increase is not merely due to a loss of unsaturated substances which would, of course, tend to produce the same result. For this reason the difference between the percentage saturation of the crude oil and that of the distillate is not a true measure of the saturated compounds formed during the distillation. Hence the actual volume of new saturated hydrocarbons was calculated in c.c., and is the sum of 100 times the products of percentage saturation and volume of each fraction. About 70 per cent of the total new saturated compounds formed were produced during the first distillation, and at the expense of only 44 per cent the total loss in weight and volume. In the second distillation only about 25 per cent were produced at the expense of about 28 per cent of the weight loss and 25 per cent of the volume loss. In the third distillation but 7.5 per cent were formed at the expense of 19 per cent of the weight loss and 20.7 per cent of the volume loss. In the fourth distillation there was no longer an increase but a loss of 3 per cent of the total saturated compounds formed, at the expense of 8.7 per cent of the weight loss and 9.8 per cent of the volume loss. Hence there is no constant ratio between the loss in weight and the increase in saturation.

There is a definite relationship, however, in which the total amount of saturated compounds formed varies with the loss in weight of oil according to a constantly decreasing ratio. This relationship is well illustrated by the curve in Fig. 5, in which the total increase of saturated compounds (in c.c.) is plotted against the total percentage loss in weight of oil. The maximum saturation is shown very clearly, as well as the fact that further distillations would result in a marked decomposition of the saturated compounds. It is very important to know that the saturation cannot be increased indefinitely by distillations at atmospheric pressure and that the limit is reached after the third distillation. Since the first of these distillations was made with the aid of hydrogen, it is very probable that the limit would be reached practically by two ordinary, destructive distillations.

FORMATION OF SECONDARY PRODUCTS DURING DISTILLATION

In order to secure more information as to the extent of decomposition and light oil formation and the general character of the cracked oils, the data in Table II (p. 733) were obtained. Since there can no longer be any question that *D* is a secondary product not present in the crude oil and that it is a part of the distillate formed during the cracking of the heavy residue *B*, all the compounds present in *D* must also have been thus produced.

The analysis of *D* brings to light some rather surprising facts. It contains 49.2 per cent of saturated hydrocarbons, 2.8 per cent of aromatics, 12 per cent of organic bases and 38.8 per cent of unsaturated compounds, most of which are olefines, because the other unsaturated compounds seldom amount to more than 1 or 2 per cent. Hence this secondary oil contains more saturated hydrocarbons and less olefines than *A*, a primary distillate that boils within the same temperature range and has practically the same specific gravity. The saturated portion of *D* contains 6.0 per cent of aromatics. The remainder must be composed almost entirely of paraffins, because its aniline point is

over 70 deg. C. The only other saturated hydrocarbons which could be present are alicyclics, or naphthenes. They cannot have been present in very great amount; otherwise the aniline point could not have been so high as the one determined. Chavanne and Simon¹¹ have shown that paraffins may be differentiated from naphthenes by the temperature above which they are completely miscible with aniline. This temperature is about 70 deg. C. for paraffins and about 30 to 50 deg. C. for naphthenes. Hence the above conclusion is the only logical one.

PERCENTAGE OF DECOMPOSITION DURING SUCCESSIVE DISTILLATIONS

The lighter secondary oil (*D*) contains about 50 per cent of saturated hydrocarbons and about 50 per cent of other compounds. It is also known that *D* amounts to 10.8 per cent of the original oil, or 17.4 per cent of the oils in *B* that are not saturated, and that *D* was formed at the expense of 20.8 per cent of the volume of this material. This accounts for a decomposition of 38.2 per cent of the labile portion of *B* by a single distillation, since the volume of oil lost plus the volume of oil recovered should be equal to the total volume of oil decomposed, assuming that no intermolecular changes such as polymerization or depolymerization occurred. The increase in saturation of *E* over *B* is 54 c.c., which means that 54 c.c. of the new saturated compounds in *E* was formed by the cracking of *B*. Hence *E* also contains a large amount of secondary products, all of which cannot be exactly determined. But since the cracking produced about equal amounts of saturated and other oils in *D* and since the amount of secondary unsaturated and basic substances in the heavy oils is at least equal to or more than that of the saturated hydrocarbons, it may be safely assumed that at least 54 c.c. of oil other than that which was saturated was produced at the same time, or a total of at least 108 c.c. Hence the sum of all the secondary products recovered and the oil lost amounts, in a single distillation, to a minimum of 55.7 per cent of the labile and unsaturated oils in *B*. But since the ratio between the saturated and other compounds in the heavy fractions of the secondary oils is probably nearer to 1:2 or 1:3 than 1:1 (according to the saturation for the distillates from the fourth distillation above 276 deg., and assuming the theory to be correct that the greater part of these distillates is new oil), it is more probable that closer to 65 or 70 per cent of the labile oils decomposed during the one distillation. This indicates, therefore, that at least 44 and perhaps as much as 50 to 60 per cent of the distillates (aside from the original saturated compounds) produced from *B* and found in *C* are entirely new oils and were not present in the crude.

If the same calculations are made for the oils for the fourth of the first series of distillations, the decomposition will be found to have been about 70 to 85 per cent of the unsaturated and basic heavy oils. Hence the new oils produced from that material form at least 57 and probably as much as 85 per cent of the oils from the fourth distillation.

That the extent of the decomposition is at least as great as has been indicated may be confirmed convincingly by a further study of the nitrogen and sulphur losses. Since the total loss of nitrogen by four

¹¹Comptes rend., vol. 168, pp. 1111, 1324; vol. 169, pp. 185, 285 (1919)

distillations was 7.65 g., the weight recovered in the secondary oils (to 276 deg.) only 1.96 g. and the weight in the undistilled crude (above 276 deg.) 15.68 g., then the total decomposition of nitrogen compounds was at least 61.3 per cent. If the amount of nitrogen in the secondary products above 276 deg. could have been determined, it would have raised the amount of decomposition to probably 80 or 85 per cent of the nitrogen compounds in the crude above 276 deg., because most of the nitrogen is in the heavy oils, whereas only that in the lighter portion could be determined with certainty. The total sulphur loss was at the same time 1.91 g., the known amount recovered 1.02 g. and that in the undistilled crude 4.64 g. Hence the decomposition of sulphur compounds amounted to a minimum of 63.1 per cent of those present in the original residue of the crude oil above 276 deg. Although these percentages are perhaps not exact, due to the fact that all the compounds of either nitrogen or sulphur may not contain the same number of nitrogen or sulphur atoms, they represent averages which are sufficiently accurate for the present considerations and help to confirm the calculations made in the preceding paragraph and the conclusions drawn therefrom.

VERIFYING THE PRODUCTION OF SECONDARY OILS BY VARYING THE DISTILLATION PROCEDURE

Since it is very important as well as interesting to know conclusively whether the distillates from the heavy oils are actually new products and whether the decomposition is as great as the results thus far attained indicate, another sample of *B* was distilled in a somewhat different manner than before. The purpose was to distill until cracking commenced, separate the primary distillate, and subject the remainder to a slow distillation in order to crack as much of the labile material as possible in a single operation without attacking appreciable quantities of the saturated hydrocarbons. The secondary oils could then be separated at the temperature at which cracking began. Since they would be almost free from the primary oils, a clearer view would be obtained of the extent of the decomposition and the changes produced in the unstable substances.

A 300-c.c. portion of *B* was distilled as before with a few exceptions. A shorter condenser was used, and it was held in a vertical position. A short, tubular separatory funnel was attached, by means of a two-hole rubber stopper, to the end of the condenser tube to serve as a gas trap so that the distillate could be drawn off as desired without permitting the escape of gas formed during the distillation. A T-tube, placed in the other hole in the stopper and closed at one end with a piece of rubber tubing and a pinch cock, conveyed the gas to bottles, where certain constituents could be removed. It also served as a safety device to prevent the sucking back of liquid from the bottles. The first bottle contained a saturated solution of copper sulphate acidified with 10 per cent of sulphuric acid. This solution absorbed the hydrogen sulphide and ammonia. A second bottle contained a solution of silver chloride in ammonia, which was used to absorb any acetylene that might have been produced. The gas then passed into a large test tube surrounded by cold water and containing 10 c.c. of bromine and 4 c.c. of water, to absorb ethylene and its gaseous homologues. The levels of the liquids in the various containers were so

adjusted as to produce a pressure of only about 2 cm. of water in the distillation flask.

The pinch cock was not closed until the air was expelled from the flask. The distillation was continued to 320 deg., when a slow but steady stream of gas began to bubble through the liquids in the bottles. This showed that cracking began in earnest at this temperature, although bubbles appeared at irregular intervals before 300 deg. All the distillate was now permitted to run out of the trap and into a graduate, where it was measured. It was labeled "*A'*," and preserved for analysis.

The rest of the distillation was made at a slower rate (one drop every two seconds) until there was no further increase in the amount of condensate. The trap was again drained and the oils measured. This cracked distillate was called "*C'*." A portion was withdrawn

TABLE IV. DATA FROM DISTILLATION OF *B*.

Distillate	Per Cent Yield	Sp. Gr.	Per Cent Sat.	Total Sat. C. c.	Weight, G.
<i>A'</i>	23.3	0.892	32.4	75	208
<i>B'</i>	46.7	0.978	1.1	5	457
<i>C'</i>	33.1	0.882	39.1	129	292
<i>D'</i>	19.8	0.848	47.4	94	168
<i>E'</i>	13.3	0.932	26.9	35	124

Total weight loss: 18.2 per cent of original oil (or 35.3 per cent of *B'*)

Loss in volume.....	13.6 per cent of original oil.
Volume of new oils in <i>D'</i>	19.8 per cent of original oil.
Volume of new saturates in <i>E'</i>	3.0 per cent of original oil.
Volume of other new oils in <i>E'</i>	8.4 per cent of original oil.

Total volume of oil decomposed.....	44.8 per cent of original oil.
Original volume of basic and unsaturated oils in <i>B'</i>	46.2 per cent of original oil.
Total decomposition of unsaturated and basic oils in <i>B'</i>	97 per cent
Secondary, or new oils in <i>C'</i>	94 per cent

for analysis and the remainder distilled in the usual manner. The oils which came over up to 320 deg. C. were separated, measured and labeled as "*D'*." The residue above 320 deg. C. was called "*E'*." The data from the distillation, together with analyses and calculations, appear in Table IV. The temperature curves for the distillation appear in Fig. 1 (p. 732). The wash liquors will be considered later.

PRODUCTION OF SECONDARY OILS VERIFIED

The results in Table IV furnish incontrovertible evidence of the truth of previous calculations and deductions and of the theory that the very heavy oils decompose almost completely into new products. It is also conclusively proved that these unstable and unsaturated and basic oils are the actual source of the saturated hydrocarbons in the secondary distillates. There can be no doubt that *D'*, which is 60 per cent of *C'*, is a new oil not present in the crude. The same is true of the 3.0 per cent of saturated compounds in *E'*. The 8.4 per cent of the remaining secondary oils in *E'* were calculated from the ratio between the new saturates and the unsaturated portion of *E'*. Hence it was here assumed that all of *B'* decomposed, with the exception of saturates; which seems to be the very question for which proof is being sought. However, the assumption was made for only a minor portion of the distillate. It is justified here because the decomposition amounts to 85 per cent, even if the ratio is assumed to be 1:1, which must be greater than the true ratio, because the latter decreases with increase in the boiling point of the oil and is 1:1 for the oils below 254 deg. Even with a decomposition of 85 per cent of the labile oils of *B'* the ratio is about 1:2.4, which makes the secondary unsaturated oils in *E'* amount to 7.2 per cent. Hence the assumption cannot be very far from the truth. In either case the final results—

namely, 97 per cent for the amount of decomposition of the unstable oils above 320 deg. and 94 per cent for the quantity of new secondary oils in this distillate—are sufficiently exact for present considerations.

The above experiments also establish the fact that there is no appreciable cracking of the oils boiling below 320 deg. when they are distilled at atmospheric pressure (which is about 615 mm. in Golden). Decomposition begins in earnest at about that temperature and becomes more and more pronounced as the temperature rises. The temperature of the oil necessary to give a vapor temperature of 320 deg. varies, of course, with the rate of distillation and the size and shape of flask used, but was about 375 to 380 deg. in this case.

It may be mentioned here that the unstable bitumens contain oxygen in small amounts, in addition to sulphur and nitrogen. This is shown by the fact that tiny drops of water have always been found in the secondary oils. The water was, of course, formed by the cracking of compounds which contain oxygen and hydrogen.

From what has already been said there can be no further doubt that the heavy fractions of crude Colorado shale oils are unstable, unsaturated, contain sulphur, nitrogen and oxygen, that they are largely decomposed by two or three ordinary distillations (or a single slow one) at atmospheric pressure and with a loss of much nitrogen and sulphur into much more stable products of simpler composition, lower specific gravity and higher saturation, and that the lighter of these products (below 276 deg.) consist mainly of paraffins, olefines and nitrogen bases with some aromatics, diolefines and compounds of sulphur and nitrogen.

MECHANISM OF THE REACTIONS DURING DISTILLATION AT ATMOSPHERIC PRESSURE

Since the nature of the labile material is very complex and the products of its decomposition so numerous, it is very difficult to advance a satisfactory explanation or even a comprehensive hypothesis for the mechanism of the reactions that must have occurred. Considering that the loss in weight is more than 35 per cent of the unstable oils and that some aromatics and nitrogen bases were formed, it seems that a rather complete disintegration of the heavy molecules took place with a subsequent recombination of some of their parts, rather than a mere splitting-off of certain atoms or groups so as to leave the main, catenary or nuclear structure. Perhaps both kinds of decomposition occurred. In any case, the resulting products should be of a more stable character, such as that actually observed. Hence the formation of saturated and stable compounds from unsaturated and labile substances is not only possible but reasonable, in spite of the fact that the cracking of petroleum gives products of a lower saturation.¹² The diverse results are merely due to the inherent differences in the parent material. As a matter of fact, energy and thermochemical considerations would lead one to expect that the more unsaturated and unstable the oil the more readily should it decompose into products of greater stability. The results of cracking heavy fractions of shale oils are, therefore, in harmony with modern theory.

It was hoped that some of the data might serve to throw a little light on the reactions which occur during the cracking of the unstable oils. For this reason

attempts were made to separate ethylenes and acetylene from the gases. Since the gas contained much hydrogen sulphide and some of it went over into the silver solution, it was necessary to redissolve the precipitate in strong HCl and pass the gas through three bottles of acid copper sulphate solution, one of sodium hydroxide and then into a fresh ammonical silver chloride solution. No precipitate was observed in this solution; hence no acetylene was present in the gas.

Since about 10 c.c. of bromides were formed, the gases must have contained olefines. A satisfactory fractionation of such a small amount of liquid was, of course, not possible. However, the series of boiling points observed during two rough fractionations showed the presence of bromides of ethylene, propylene and butylene and other heavier bromides which decomposed during the distillation at atmospheric pressure. The presence of these compounds was roughly confirmed by specific gravity determinations on three fractions.

The fact that much of the gas was not absorbed by any of the solutions used shows that it probably contained hydrogen and members of the methane series.

The presence of ethylenes in the gas indicates that a rather severe decomposition might have occurred. The presence of aromatics in the distillates confirms this deduction. Yet the absence of acetylene in the gas suggests that the aromatics were formed by a splitting of heavy polycyclic molecules, or heavy aromatic derivatives, rather than by a polymerization of acetylene. But then there is also the possibility that the acetylene either polymerized completely or combined with some other unsaturated hydrocarbon and consequently would not be found in the gas. It is obvious, therefore, that the evidence from these experiments is far too meager to serve as a basis for any intelligent considerations. Since the author does not desire to indulge in any mere speculations, a decision of the question must be left for further investigation.

NATURE OF THE COLORADO SHALE OILS

In concluding the discussion of results from this work the author wishes to make a few remarks concerning the nature of the crude shale oils, their distillates and the organic material in the shale which is the base of these products. It is already well known that true Colorado oil shales actually contain no oil, since only insignificant amounts of organic matter can be extracted with solvents. A destructive distillation is necessary before oil can be obtained. Therefore the oil is, of course, different from the parent substance. It has also been established that the less the decomposition of this material during the carbonization of the shale the more unsaturated and unstable, and the heavier is the oil.¹³ This is evident from the fact that oils of this character are produced when steam and inert gases, such as hydrogen, are used to minimize cracking, and because only the oils which have suffered extensive cracking are at all stable, saturated and contain many of the lighter constituents. The questions are then: Where do the light, saturated and stable oils of the crude originate? Are they entirely secondary products from the decomposition of the oil, or primary products of the carbonization of the "kerogen," or organic material in the shale? Are all the saturated hydrocarbons produced by secondary reactions, or does the original kerogen contain some of them? Since the oil is more and more unsaturated as it is produced with

¹²Rittman and Twomey, *J. Ind. Eng. Chem.*, vol. 8, p. 20 (1916).

¹³Botkin, *CHEM. & MET. ENG.*, vol. 24, p. 876 (1921).

less and less decomposition, there seems to be no doubt that the kerogen itself is very unsaturated. It is the writer's opinion that the substance which yields the saturated oils contains no saturated compounds whatever. If that is the case, then the latter were all produced by secondary reactions.

THEORY OF THE FORMATION OF OIL FROM SHALES

The next question which arises is: If saturated hydrocarbons are produced only by secondary decompositions, what is the nature of the primary products and how were they formed? If we consider the results reported in the preceding pages, the answer seems evident. The primary products are, or are similar to, those heavy, unstable fractions of the crude oil which decompose during distillation. They represent that portion of the organic matter in the shale which distilled over without cracking on account of the lowering of the vapor pressure in the retort by the presence of lighter constituents and gas produced during the cracking of some of the primary oil. The presence of such large amounts of this primary bitumen in the crude oil might easily be accounted for by slow rates of the cracking reactions, and hence incomplete equilibrium under the conditions of retorting.

But these heavy primary oils are soluble in the usual organic solvents, such as carbon bisulphide, ether, benzene and the like. The original kerogen of the shale is almost insoluble. If it is assumed that this unstable material has the same or similar composition as the kerogen, how can this difference in solubility be explained? In the writer's opinion, the transformation from insoluble to soluble substances might easily be accounted for by a depolymerization, or some similar reaction, in which the complexity of the very heavy molecules is reduced without a change in composition. Results of this kind have been observed by Engler and Lederer.¹⁴ Further research on this theory is necessary.¹⁵

On the basis of the evidence and considerations presented herein a quite satisfactory theory can be formulated to explain the formation of oil from shales of the Colorado type and the manner in which lighter and more saturated products can be obtained by cracking distillates of this crude oil. The carbonization of the shale must occur in two stages: (1) A depolymerization of the organic matter, or kerogen, to complex, heavy, unsaturated and unstable oils which do not distill at atmospheric pressure without decomposition; and (2) a cracking of this primary material into simpler oils of lower molecular weight, greater stability and containing up to about 50 per cent of saturated hydrocarbons. When the decomposition is only partial the result is an oil similar to the ordinary crude oils from Colorado shales. Complete decomposition of the primary oil yields a product similar to the distillate from the fourth distillation, or *C'*. By varying the conditions that exist during the retorting of the shale, oils may be obtained which vary from products which are practically entirely primary to those which are completely secondary. Hence careful control of physical conditions is of importance in commercial operations.

¹⁴Engler-Höfer, "Das Erdöl," vol. 1, p. 30 (1913).

¹⁵Since this paper was written an article has appeared by R. H. McKee and E. E. Lyder (*J. Ind. Eng. Chem.*, vol. 13, pp. 613 and 678), who have recently investigated the thermal decomposition of oil shales. Their conclusions are in accord with those presented in the present contribution. The theory is much strengthened by the fact that our conclusions were arrived at by different methods of investigation.

SUMMARY

1. The changes produced in a Colorado shale oil by successive distillations at atmospheric pressure have been investigated through a study of the specific gravities, vapor temperatures, saturation, sulphur and nitrogen in 10 per cent fractions. The light fractions are very stable and are not altered to any appreciable extent by redistillations. The heavy fractions are unstable and decompose easily. Most of the decomposition occurs during the first distillation.

2. Each decomposition is attended by the following phenomena: (a) The formation of gas; (b) a decrease in the weight and volume of oil recovered; (c) an increasing stability of the distillates; (d) a lowering of the specific gravity; (e) a loss of sulphur; (f) a loss of nitrogen, and (g) an increase in the amount of saturated hydrocarbons in the distillate. After the third distillation has been made the total volume of saturated compounds begins to diminish.

3. The light and middle fractions of the crude oil are very stable. Although decomposition commences when the vapor temperature is about 300 deg. C., it is not appreciable until about 320 deg. is reached.

4. It has been proved that new saturated hydrocarbons are formed during cracking distillations of crude oils and that the heavy, unsaturated bitumens in the oil (boiling above about 320 deg.) are the source of these saturated compounds.

5. The lighter secondary product (boiling below 276 deg.) consists mainly of paraffins and olefines, together with lesser amounts of organic nitrogen bases, aromatics, diolefines, and compounds of sulphur and nitrogen. It is quite similar, therefore, to the primary light oil which is found in the crude products.

6. The heavy, unstable bitumens in the crude oil have been shown to be very complex substances which contain sulphur, nitrogen (in large quantities) and oxygen, but practically no saturated hydrocarbons.

Evidence has been presented which supports the theory that these unstable compounds are merely intermediate products of the carbonization of oil shales. They decompose easily, and practically completely, when subjected to destructive distillation at atmospheric pressure, yielding the stable, secondary products.

7. A theory has been presented to explain the formation of oil from Colorado shales. According to this theory, heat first effects a depolymerization (or some similar transformation) of the kerogen to less complex, heavy, unstable and unsaturated compounds which resemble that fraction of the crude oil which boils above 320 deg. These labile oils then decompose to a varying degree, with the formation of simpler, stable products. It is this secondary decomposition which accounts for the presence of the light constituents in crude oils.

ACKNOWLEDGMENT

The author takes this opportunity to express his appreciation of the assistance rendered by C. P. Hackett, who made the distillations and most of the analyses recorded in this paper. Thanks are also due to J. P. Bacca, who made a number of the sulphur determinations. The valuable criticisms and suggestions of Dr. Victor C. Alderson and Prof. A. H. Low were of great aid in the preparation of the manuscript, and are acknowledged with pleasure.

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Influence of Mass in Heat-Treatment*

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IT IS well known that the mass of a piece of steel which has been heat-treated greatly influences the physical properties of the steel, but very little has been done to ascertain whether the law of the relation between the mass and the physical properties can be mathematically determined. With this idea in mind, the writer has prepared the following paper, the object of which is to point out that such a law exists and that it can be mathematically determined.

In the *Journal of the American Steel Treating Society*, Vol. 1, No. 1, October, 1918, I wrote an article under the heading, "Mathematical Discussion of the Influence of Mass on Heat-Treating," showing that the product of the surface per pound of steel (S) and diameter or thickness (D) is respectively $S \times D = 7.062$ (for plates), 14.125 (for rounds) and 21.185 (for spheres), these constants being in the ratio 1:2:3. The equation $S \times D = C$ represents a hyperbola in which the asymptotes are rectangular.

Not having any actual data at hand at that time, it was decided to search for some which would define somewhat closer than heretofore the mathematical relationships which exist in regard to this question. In October, 1920, the report of the British Engineering Standards Association was published and it was in this report, No. 75, that the writer found some very reliable data affording an excellent opportunity for this study.

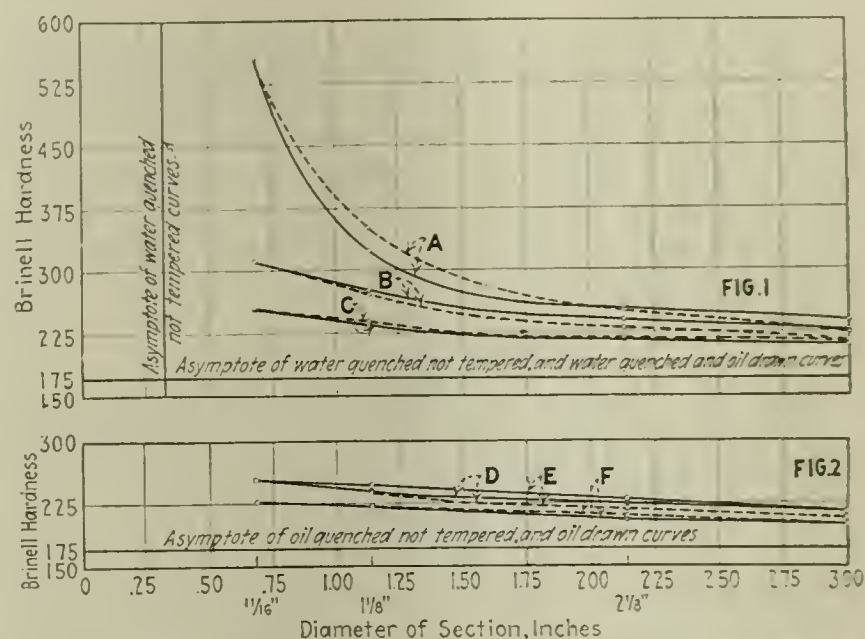
The analysis of one of the steels tested in the British investigation was as follows:

C	Mn	S	P	Si	Ni	Cr	W	V
0.45	0.78	0.02	0.025	0.32	Nil	Nil	Nil	Nil

The accompanying test results were obtained from bars of this steel rolled to $3\frac{1}{4}$ in., $2\frac{3}{8}$ in., $1\frac{1}{2}$ in. and $\frac{7}{8}$ in. diameter respectively, and machined to 3 in., $2\frac{1}{2}$ in., $1\frac{1}{2}$ in. and $\frac{1}{2}$ in. diameter respectively. The bars were heat-treated before machining to test-piece dimensions.

The figures in Tables I and II used in this discussion are considered by the British committee as representing the true physical properties of the steel after the specified heat-treatment had been carried out. In this work there were four investigators, one of whom was the manufacturer of the steel; each checked his results in triplicate. The results of the investigators agree very closely on this steel and therefore are considered as representing within experimental error the true

properties of metal of this analysis. It should be kept in mind that the results of these tests represent the physical qualities of the center portions of the rounds and thereby avoid any harmful effects which could be ascribed to the steep gradient of the hardness penetration which exists near the surface. The rolled bars were cut to standard lengths for tensile and Izod tests, the length of the tensile test-bar being 6 in. and that of the Izod $8\frac{1}{4}$ in. In the case of the 1-in. and $\frac{7}{8}$ -in. round rolled bars, the tensile test-pieces were cut 9 in. long, in order to afford a better grip for the testing machine; in cases where very great hardness was expected after heat-treatment, the tensile pieces of the larger diameters were cut 10 in. long. After being cut, all the test-bars were centered in an automatic centering machine in order to get the test-pieces machined truly parallel with the cores of the test-bars.



FIGS. 1 AND 2. BRINELL HARDNESS IN FUNCTION OF SECTION AND HEAT-TREATMENT

Fig. 1—Water-quenched. Fig. 2—Oil-quenched. The unbroken lines were plotted from data given by the British Engineering Standards Association for samples, analyzing C 0.45, Mn 0.78, P 0.025, S 0.02, Si 0.32, and using the formula $B = \frac{nC}{D-d} + b$.

The Brinell impressions on the fractured tensile tests were made upon flat surfaces produced by milling down the shoulder on a screwed end of each specimen to the level of the cylindrical test portion. Only Brinell numbers of the tensile test-pieces are given in this discussion, as they represent the actual hardnesses of the centers of the test-pieces and are geometrically identical.

Using Brinell numbers as ordinates and diameters of the quenched sections as abscissas, two sets of curves were plotted from the British figures as shown in Figs. 1 and 2. The Brinell hardness of any section is in direct ratio to the surface per lb. of steel: $B = nS$, n being a factor which is constant for each steel of a particular analysis. The equation for round bars $S \times D = 14.125$ can thus be written $B \times D = 14.125n$.

This last equation is a true one, but in its present form is unsuitable for our purpose, inasmuch as it does not take into consideration the asymptotes of the curves. It can be seen that the axes of the rectangular system of co-ordinates are not the asymptotes of the curves. The equation changed to take into account the asymptotes reads

$$(B - b) \times (D - d) = 14.125n; \text{ hence}$$

$$B = \frac{14.125n}{(D - d)} + b \quad (1)$$

B is the Brinell hardness of any section desired; n is

TABLE I. TESTS ON BARS OF VARYING MASS

Water-quenched from 870 deg. C., and not tempered

Diameter of Section Treated, In.	Maximum Stress	Yield Point	Elongation	Red. of Area	Izod Impact	Brinell
$3\frac{1}{4}$	269,000	258,000	3.0	4.0	3	555
$2\frac{3}{8}$	150,000	95,000	12.0	28.0	14	321
$1\frac{1}{2}$	125,000	83,000	18.0	43.0	16	255
$\frac{7}{8}$	116,000	76,000	23.0	54.0	24	241

TABLE II. TESTS ON BARS OF VARYING MASS

Oil-quenched from 870 deg. C., and not tempered

Diameter of Section Treated, In.	Maximum Stress	Yield Point	Elongation	Red. of Area	Izod Impact	Brinell
$3\frac{1}{4}$	130,000	96,000	18.0	50.0	22	255
$2\frac{3}{8}$	125,000	83,000	20.0	49.0	27	241
$1\frac{1}{2}$	116,000	76,000	23.0	54.0	24	228
$\frac{7}{8}$	110,000	72,000	23.0	55.0	26	217

*A paper presented before the Indianapolis meeting of the American Society for Steel Treating, Sept. 23, 1921.

a factor which is constant for each steel of a particular analysis, and which appears to be the square of the hardening capacity; D is the diameter of a section; b stands for the horizontal asymptote, which for this steel corresponds to a Brinell hardness of 175; d corresponds to the vertical asymptote of the hyperbola and whose value obtained from equation 1 is

$$d = D - \frac{14.125n}{(B-b)} \quad (2)$$

The maximum hardness of this steel was taken to be that of an $\frac{1}{8}$ -in. section quenched in water, which gave a Brinell hardness of 555. Thus the ratio is $555 \div 175$, or 3.17. Now $3.17^2 = 10$. Therefore for 0.45 carbon steel, $n = 10$.

With the discussion as it now stands, the following six curves are considered individually and their equations developed.

(1) 0.45 carbon steel quenched in water at 870 deg., C., and not tempered. From the British experiment, a $\frac{1}{8}$ -in. round section of this steel quenched in water at 870 deg. C. and not tempered had a Brinell hardness of 555. Therefore, substituting in equation 2, using the value 555 for B and $\frac{1}{8}$ for D , there is obtained for d , the vertical asymptote, the value 0.317. Thus the formula for this curve is

$$B = \frac{(14.125) \times 10}{(D - 0.317)} + 175$$

Using this formula, the values for the Brinell hardnesses of other sections quenched in water at 870 deg. C. and not tempered are given in Table III-A.

(2) 0.45 carbon steel quenched in water at 870 deg. C. and tempered at 500 deg. C.

From the British experiment, B is 311 and D is $\frac{1}{8}$ in. Substituting these values in equation 2, $d = -0.352$. The formula for this steel quenched as indicated and drawn at 500 deg. C. is $B = \frac{(14.125) \times 10}{D - (-0.352)} + 175$ and the Brinell hardness of other sections is given in Table III-B.

(3) 0.45 carbon steel quenched in water at 870 deg. C. and tempered at 600 deg. C.

From the British experiment, B is 255 and D is $\frac{1}{8}$. Substituting in 2, $d = -1.072$. Therefore, the formula for this steel quenched as indicated and drawn at 600

deg. C. is $B = \frac{(14.125) \times 10}{D - (-1.072)} + 175$. Table III-C gives the hardness of other sections.

TABLE III. HARDNESS OF 0.45 C STEEL, QUENCHED IN WATER AT 870 DEG. C (See Fig. 1)

Dia. of Section, In.	— Brinell Hardness From — British Report			Brinell Hardness Computed by Formula		
	A	B	C	A	B	C
	Not Tempered	Tempered at 500 Deg. C.	Tempered at 600 Deg. C.	Not Tempered	Tempered at 500 Deg. C.	Tempered at 600 Deg. C.
$\frac{1}{8}$	555	311	255	555	311	256
$\frac{1}{4}$	321	277	235	359	272	239
$\frac{3}{8}$	255	241	217	253	230	219
$\frac{1}{2}$	241	229	212	228	216	210

TABLE IV. HARDNESS OF 0.45 C STEEL, QUENCHED IN OIL AT 870 DEG. C (See Fig. 2)

Dia. of Section, In.	— Brinell Hardness From — British Report			Brinell Hardness Computed by Formula		
	D	E	F	D	E	F
	Not Tempered	Tempered at 500 Deg. C.	Tempered at 600 Deg. C.	Not Tempered	Tempered at 500 Deg. C.	Tempered at 600 Deg. C.
$\frac{1}{8}$	255	255	229	256	256	229
$\frac{1}{4}$	241	248	223	239	239	221
$\frac{3}{8}$	228	228	207	219	219	210
$\frac{1}{2}$	217	217	202	210	210	204

(4) 0.45 carbon steel quenched in oil at 870 deg. C. and not tempered.

From the British experiment, B is 255 and D is $\frac{1}{8}$. Substituting in 2, $d = -1.072$. Therefore, the formula for this steel quenched in oil as indicated and not tem-

pered is $B = \frac{(14.125) \times 10}{D - (-1.072)} + 175$. Using this formula,

the Brinell hardness of other sections quenched in oil and not tempered are given in Table IV-D.

(5) 0.45 carbon steel quenched in oil at 870 deg. C. and tempered at 500 deg. C.

From the British figures, B is 255 and D is $\frac{1}{8}$. Substituting in 2, $d = -1.072$. Therefore, the formula for this steel quenched in oil as indicated and drawn

at 500 deg. C. is $B = \frac{(14.125) \times 10}{D - (-1.072)} + 175$, and the

Brinell hardness of other sections is given in Table IV-E.

(6) 0.45 carbon steel quenched in oil at 870 deg. C. and drawn at 600 deg. C.

From the British figures, B is 229 and D is $\frac{1}{8}$. Substituting in 2, $d = -1.947$. The formula for this steel

is $B = \frac{(14.125) \times 10}{D - (-1.947)} + 175$. Table IV-F gives the

hardness of other sections.

From the foregoing calculations it is apparent that the factors which control d in any carbon steel are the drasticity of the quenching medium and the extent of

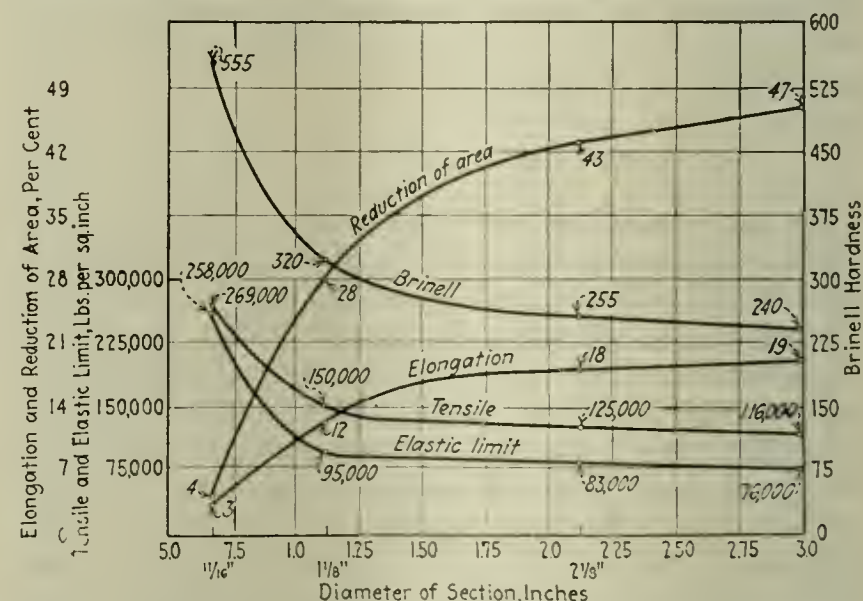


FIG. 3. PHYSICAL PROPERTIES OF 0.45 C STEEL, WATER-QUENCHED FROM 870 DEG. C., NOT TEMPERED

Plotted from data given by the British Engineering Standards Association.

the tempering operation. As the drasticity of the quench becomes less and as the degree of the tempering becomes greater, the vertical asymptote d moves toward the left into the second quadrant of the system of co-ordinates.

It is interesting to compare the Brinell curve with the curves of other physical properties, such as tensile strength, elastic limit, elongation and reduction of area. This has been done in Fig. 3 and shows a similar hyperbolic tendency of these curves. The Brinell and tensile curves run parallel, as is to be expected.

The figures given in this paper speak for themselves, and point to the possibility of mathematically predicting results which are to be expected in different sizes of heat-treated steel.

The author wishes hereby to express his appreciation for the aid rendered by his assistant, H. Blumberg, in the preparation of this paper.

Science and the Coming Agriculture*

Our Future National Strength Depends on Scientific Study of Soil Fertility—Weakness of Eastern Nations Directly Attributed to Lack of Fertilizer for Food Crops—Methods of Estimating Requirements—Definite Problems to Be Solved by the Chemist

BY CHARLES H. MACDOWELL

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THE efficiency of individuals and nations depends on an ample supply of food, clothing, fuel and transportation, and a study of these subjects and their relation to the future of man's welfare is always interesting. History records the fact that the decline and fall of the Roman Empire was due to the decline of crop yields and the failure of agriculture. Rome poured out the fertility of her suburban lands through the great sewer—into the sea; after that she poured out the fertility of Italy into the sea; and later she poured into the sea the fertility of Europe, or so much of it as she could amass under her own control. The constant growth of population was accompanied by a corresponding decline of yield per capita and yield per acre. The prices of food products rose higher and higher and the poorer classes ate less and less and poorer and poorer food, and thus the vitality of proud Rome dwindled away. When the Vandals and the Goths made their way into the northern part of Italy, they did not find the sturdy Roman soldier of the fifth century before the Christian era, but an underfed, anæmic people with weak bodies, and the once glorious Rome perished with only a faint voice.

UNDERNOURISHED RACES DECLINE IN ORIENT

The Oriental nations have developed populations out of proportion to the productive power of their soils, and their peoples are no longer efficiently fed. King estimates that there are provinces in China with a population of 3,480 per square mile, or an average of 240 persons, twenty-four donkeys and twenty-four pigs to every 40-acre farm—a small farm for even a single family in our own country. Whatever has been the unwritten history of China's ancient agriculture, she has in modern time exhausted every possible means to intensify production. Every canal channel, every available portion of her river courses, every sewer in the province—all are periodically scraped for every ounce of plant food to renew the producing power of the soil. The Chinese farmer is efficient. His methods are not scientific, but they are based on centuries of observation and experience. He uses practically no commercial fertilizer, and the soils in most of the fertile sections are out of balance—that is, they do not have the proper proportion of the various plant food elements to grow maximum crops. The nation as a whole has lost much of the individual initiative and lives a life of procrastination and vacillation. The people lack organizing ability in the larger sense and have little interest in outside affairs. Food in China is consumed dangerously near the point of production and drought and storms or other destructive agencies over even

small areas bring on great suffering and loss of life. Much the same condition exists in India. The Chinese and Indians possess common characteristics, and it is because they both as nations have reached the final stage of agriculture.

Japan, with a slightly better system of transportation and a larger knowledge of scientific methods, manages to feed her people fairly well. Japan has a population of 2,349 per square mile, or more than three to the acre of her cultivated lands. She has practically exhausted her cultivable area and must expand in foreign countries if her population is to increase. In her efforts to maintain her soil fertility, she saves and returns to the land 1.75 tons of human excrement per acre annually for each cultivated acre in the kingdom. To this is added mud, animal waste and decaying vegetable matter to the value of \$5 per acre. In this way the country reaches its maximum production all the time in order to maintain human life.

No data are available as to the calories consumed daily by the Chinese and the Indians. The Japanese dietary standard for a man performing ordinary muscular work totals 2,380 calories. It is estimated that the well-to-do class in the larger cities consumes 2,388 calories; that the coast region and middle classes in general consume 2,528 calories; and that the rural classes consume 2,002 calories. Rice supplies about half of the calories consumed; beef, fish, milk, greens, potatoes and pickled and dried radishes the remainder. It may be estimated that the ratio of these foods varies from a normal amount of meat, milk and fish in the best families to an almost exclusive diet of rice in the poorer rural sections, and the effect of this can be seen in the looks, stature and activities of the various classes of the people in the various strata of society. Very little meat is eaten in the Orient, a fact which may have direct relation to the life and progress of the people, and also their stature. Japan produces little livestock, her total pounds per capita being 4.21, as against 163.3 lb. per capita in the United States. As an acre of land will produce only so many pounds of meat, the Mongolian races have for hundreds of years been specializing on human beings, and with only reasonable success, because too many are now being grazed per acre.

EUROPEAN NATIONS FERTILIZE LANDS

Western Europe set out to develop her agriculture on a different basis from the Orient. Germany, Austria, Belgium, France, Spain, Italy and the British Isles are densely populated as compared with the United States. With the great increase in urban population following the intensive industrial development during the last fifty years, and with the decreased emigration,

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the fields of western Europe have been called upon for much greater yields than was necessary before the coming of the towns and cities. In order to obtain the maximum production from their fields, these countries have made use of scientific research and its application to the greatest degree. Their farmers place great confidence in the recommendations of their agricultural experts, and as a consequence they make greater use of science in their farm operations. The principle on which they have developed their agriculture is "greater yield per acre and better crops and livestock." The United States up to a few years ago was developing almost too exclusively on the basis of greater production per man power, regardless of yields per acre. In this respect, Europe would maintain a larger population and feed and clothe them better.

UNITED STATES NOW WASTING FERTILITY

The following comparison places the United States at a disadvantage so far as agricultural efficiency is concerned. Although our country is fifteen times as large as Germany, we produce only the same amount of barley and not quite twice as much oats. Germany produces six times as many potatoes and twelve times as much rice. When the war broke out, Germany had 5,000,000 farms averaging 15 acres, and we had 6,340,000 farms averaging 138 acres. These German farms produced 40 per cent more wheat, rye, barley, oats and potatoes taken together than we produced. Within the last thirty years, Germany has increased her per-acre yield of rye from 15 to 29 bushels, while the United States increased only from 14 to 16; Germany increased her acre yield of wheat from 19 to 30 bushels, the United States from 13 to 15 bushels; Germany increased the yield of barley from 24 to 39 bushels, the United States from 24 to 24.3 bushels; Germany increased her acre yield of oats from 31 to 59 bushels, the United States from 28 to 30 bushels; Germany increased the yield of potatoes from 115 to 208 bushels; the United States from 98 to 100 bushels. Germany has an area equal to the three states Minnesota, Iowa and Missouri, and under normal conditions produces 88 per cent of her food requirements. With a population almost half as large as the population of the United States and with only one-fifteenth the land area, Germany shows an agricultural efficiency about six times that of the United States.

METHOD OF ESTIMATING

How is this scientific or efficiency farming measured? In trying to get an estimate on this point, one would naturally have to take into account such factors as improved preparation, tillage and cultivation, improved seed and breeds, and the new principle of increased soil fertility. The average yield of wheat in Belgium is 37 bushels per acre, and her average consumption of commercial fertilizers 270 lb. per acre. England, on account of her great industries and her limited farm area, is the great importing nation of the world. Yet her yield per acre of wheat is 33.4, as against our 14.8 bushels in the United States. England shows a yield of 29.1 rye, 43.5 oats, against a yield of 16.1 rye and 29.5 oats in the United States.

These higher yields in western Europe indicate a more intensive and scientific agriculture than we have been able to reach in the United States. We are at the present time on trial in our United States agri-

culture. We are either at a standstill or on the decline, so far as acre yield is concerned, in much of our area. With a sparse population and broad areas of uncultivated lands, a nation can choose between extensive and intensive agriculture, but with densely populated country there can be no choice. The intensive method must be followed. We of the United States have been a wasteful people. We have had too much land, and have moved on from state to state in search of the more fertile spots of land, and neglected to maintain the producing power of our conquered area. We have been practicing the soil-robbing method, and with the waste involved and with improved farm machinery our per capita production has exceeded that of Europe. This condition did not exist, however, when a large per cent of our population was still on farms.

BALANCE OF POPULATION AND FERTILITY

Large populations and low crop yields do not go together. In this country our population is rapidly growing and we must more fully utilize nature's stores in our future development. Our national tendency has been to drift from the farm to the towns and cities, because of the great competition of industry with agriculture. Whether agriculture can be maintained on a high acre yield basis with a minimum number of producers is one of the unanswered questions of modern times. Whether the greatest yield can be obtained with farm machinery and large operation we have not yet learned. But that less than 50 per cent of our population are producers is sufficient argument that we are not likely to drift toward the conditions of the Orient. We shall likely maintain our share of the world's industries, and shall be required, if we do this, to make a more efficient farming country. In a way our industries, commerce and transportation have grown more rapidly and more efficiently than our agriculture. These factors must be balanced before we can count ourselves safe for efficiency in a broad national way.

Our population is increasing and our lands at the same time are being depleted. Our ditches are all lined with the fertility of the farms they were dug to drain. From our rivers we lose annually 500,000,000 tons of fertility, thereby diminishing our fertility at a rapid rate. Our sewer pipes are taking from our farms 50,000,000 tons of fertility annually. The crops that are removed from the soil, never to get back to the fields in the form of manure or any other form, take from our farm lands 30,000,000 tons of our fertility annually. In the face of these undeniable facts, our population will be, according to Dr. Edward M. East, of Harvard, more than doubled by the year 2020. At the same time he shows that according to our present methods of agriculture and our present rates of food and clothing consumption 197,000,000 is our ultimate population limit. After that point has been reached, our production and consumption will be on an equilibrium, granting that we utilize every acre of available land for farming purposes, and use it all approximately as we use our farm lands at this time.

FOOD AND CLOTHING CROPS

Our sheep must be used for clothing, and our cotton fields can never yield their place to food crops. In fact, they must be made to grow bigger crops, and more acres must be planted to cotton, as our population reaches nearer and nearer to the ultimate saturation point.

Just what per cent of our farm lands is required to grow the world's clothing no one has figured out, but whatever it is it can never give way to food production. In the case of cotton and sheep, we are growing food and clothing in one, which argues for a degree of efficiency that may be hard to match in growing plants exclusively for clothing. An advancing civilization requires better shelter and clothing as well as food, and there can be no other source for these than our agriculture. These features other than foods are not luxuries, but indices of civilization. They are guides to the progressiveness of nations. To have these and a wholesome system of transportation and commerce means the maintaining of a ratio of populations for production and for other vocations. What these ratios will ultimately be no one can predict, but they must be maintained. If our own people have any claim of superiority at this time, it is because we are better fed and clothed than most of the other nations. In the race for supremacy we shall hold out longer for this reason. But to maintain our place we must turn our attention to some of the great problems of the soil. We must make greater use of these foods we consume by giving greater directive force to our production agencies.

TECHNICAL PROBLEMS INVOLVED

Let us then consider the scientific problems that lie before us. They can be solved only by the scientist. He may be a chemist, he may be a physicist, he may be an engineer. He must be a seeker of knowledge, he must spend his time in research. The basic problem is the ultimate maximum efficient production of food and clothing. The engineer has before him the salvaging of arid but potentially productive regions. He may have to control, conserve and portion out flood waters. He may have to resort to reforestation to control precipitation. We know the general results obtained by devastation of our forests—floods, with consequent erosion of surface fertility. Can our engineers develop a remedy? Granted that production can be obtained, the engineer still has one of the gravest of the problems before him—transportation. Production must seek the level of consumption. Transportation is the only means by which this can be effected and the costs are now in too many instances prohibitive. The engineer must research the operations of transportation, seeking to reduce the cost. The chemist has a field too in fuel efficiency or even synthetic fuels.

CHEMIST'S WORK, THE SOLUTION

The chemist's big agricultural problem is fertility. As a matter of fact very little is known as to the relative importance of the various elements of fertility. Is plant food more important than moisture? Will bacteria destroy soil toxins? We are still groping in the dark on soil fertility. We have data giving specific results of certain fertilizing experiments under one set of climatic conditions on a given crop and soil. But who has made any progress in determining why these results were obtained, or how can they be interpreted in connection with a different set of conditions?

True, our worries on plant food supplies seem to be largely over. For a time it seemed as if the supply of available nitrogen was rather definitely limited. In the past few years the progress made in the fixation of atmospheric nitrogen has opened up unlimited supplies of this element.

If we forget political and geographic boundaries, there is sufficient available potash now blocked out to supply the world for a long time to come. Undoubtedly new deposits will be discovered. The present industrial byproduct waste of available potash will be further studied and this product saved for agriculture. The vast supply of potash in our shales and feldspars and other igneous rocks will remain as a reserve supply in case other sources fail. The potash from these sources is available now at a cost. Probably our chemists will find new processes which will enable these insoluble sources of potash to equal or better foreign prices.

The reserve supply of phosphate seems to be adequate so far as any reasonable time element is concerned. However, before long it will be necessary to call on the immense deposits of Idaho and other Western states. The problem of transportation will again be before us. We have methods now for rendering the insoluble phosphates of lime available for plant food. They are reasonably efficient in so far as there is little waste of phosphoric acid, but they necessitate the use of an equal quantity of sulphuric acid and a 50 per cent dilution of the product. Here again transportation intervenes. The present freight cost precludes the use of any but the higher grade phosphate rocks. The chemist has before him the problem of rendering the phosphoric acid of these insoluble compounds available for plant food without necessitating the reduction of the plant food content so that excess transportation charges may be overcome. He will, in the near future, be called upon to develop processes for utilizing the lower grade phosphates and phosphatic limestones of Tennessee and Kentucky and even to work over the waste dumps of present-day running.

For a long time it has been considered that these three elements, nitrogen, phosphorus and potassium, were the only plant foods necessary to supply ordinary soil. Recent years have brought about some change in this belief. Certain crops seem to demand some other element that is ordinarily not abundant in all soils. For instance, only within the last few weeks it seems to have been proved definitely that the tobacco plant must have a certain amount of magnesia in its food supply in order that it may properly cure. It is claimed that the superexcellence of the Hawaiian pineapple is due to the manganese present in these soils. Are we then to believe that only these two plants are peculiarly susceptible to such conditions? Can we not safely assume that every plant has a similar necessity? Most of the experiment stations of the country are now studying the effect of sulphur, both elemental and in compounds, on various crops. Oregon has shown surprising results on legumes with sulphates. New Jersey applies elemental sulphur for reaction within the soil itself. What a research field is opened to the agriculturalist and to the chemist!

BALANCING FERTILITY

This further leads us to the question of the balanced ration for plants. We are told that a man at a desk needs so many calories per day, the ditch digger so many more, etc. Our physicians have shown us the effect of a properly balanced diet and the dangers of malnutrition. No doubt plants have the same problems. We can assume that plants properly fed will respond in the same general lines that properly fed animals do. They will be more resistant to attacks of insects and to disease. Furthermore, the main function of the

plants under consideration is to feed man, either directly or indirectly through meat producing animals. A plant not properly nourished cannot be expected to produce as wholesome food as one in perfect condition. A horse that breaks into the corn crib will eat until he founders; a plant offered too much of a single food will undoubtedly have the belly-ache. We hear nowadays a great deal of vitamins and various water or fat soluble unknowns. Truly they are unknowns. We know not what they are, or what produces them, yet they seem to be one of the most important factors in nutrition.

We have determined in a vague way that the biological life of a soil has a great deal to do with the fertility of that soil. We know that certain plants such as legumes will not thrive unless nitrifying bacteria are present. Is it not safe to assume that other plants may be as susceptible to the influence of other bacteria and fungi as are the legume family? Bacteria or other microscopic organisms necessary for one plant may be poisonous to another. We know that certain lower forms of life such as the paramecium abound in the soil and live on bacteria. We know certain bacteria are fatal to certain plants. Undoubtedly crop failures are sometimes due to bacteria and famine enters as a competitor to plague, both from bacteria.

CONCLUSION

We could go on almost without end pointing out the problems that confront the scientist. These problems must be solved if this country of ours is to maintain itself in the front rank or as the leader of the nations of the world. Our tendency has been recently to commercialize our science. Our agricultural science must be national, must be removed from politics and commercial influences. We must realize that as a nation we must get more from our soil. Our scientists must solve these vital questions in the near future or the coming generations will find their food supply restricted either as to quantity or variety to a point where degeneration of the race sets in and conditions similar to those now obtaining in the Orient will be in effect here.

The Chilean Iodine Industry

Iodine is a most important byproduct of the Chilean nitrate industry. While iodine is recovered from seaweed in Japan (which country relies solely for its requirements upon this source), and also to some extent in France, Scotland, Norway and the United States, by far the greatest quantity of the element is derived from nitrate of soda.

In Chile the iodine industry is controlled by an association known as the *Combinacion de Yodo*, having its domicile at Iquique, reports Wilfred G. Eyre, clerk in American consulate-general, London, England. This combination at present operates under public deed or contract entered into on April 18, 1894. At a special general meeting held at Iquique on March 28, 1918, this agreement was prolonged to March 31, 1921, and has since been again extended for a further period of three years.

The combination is controlled by a set of bylaws which are of a most comprehensive character, regulating the association in all its spheres of action. The objects of the combination, as set forth in its statutes, are:

- (a) To regulate the export of iodine.
- (b) To regulate the distribution of the quota of each associate in the sales of the combination.

(c) To arrange for the sale of the iodine belonging to the associates and for that purpose entering into consignment contracts.

(d) To enter into an agreement with producers of iodine in other countries for the sale and supply of the iodine necessary to meet consumption through the instrumentality of agents appointed for that purpose or in any other form which may be found convenient.

(e) To bring about in every possible way the consolidation of the combination, procuring the adhesion of new producers and the holders of the stock that later on present themselves; and especially

(f) To obtain an increase in the consumption of iodine by means of propaganda, by offering rewards for the best studies suggesting new uses for iodine or to inventors or to those who discover some new application for this article.

Individual members are prohibited from making, exporting, selling, transferring "or otherwise negotiating" iodine, either in Chile or in any foreign country, except as laid down by the bylaws.

DETERMINATION OF QUOTAS

Each nitrate establishment belonging to an associate of the combination and actually manufacturing nitrate has the right, even if not equipped for iodine manufacture, to a quota in the monthly sales of iodine. This quota is determined in a manner prescribed in the statutes, each producer having the privilege of selecting either of two methods—(a) by actual trial of the establishment's capacity for producing iodine under specified conditions for a period of 90 days, or (b) through the decision of experts.

The statutes also give the combination power to enter into a contract for periods not exceeding 5 years with a European firm for the consignment and sale of iodine on the basis of a 5 per cent commission on sales effected by the European agents.

Article 42 of the statutes provides that the associated manufacturers shall pay a contribution not exceeding 5 shillings per quintal of iodine sold to cover the expenses of administration, which will be collected from the associates according to each one's monthly quota. To increase or reduce the contribution requires the assent of 80 per cent of the total membership.

LONDON SUB-COMMITTEE

Article 54 provides for the setting up in London of a consultative body known as the iodine sub-committee. Five of the six members of this sub-committee must be persons interested in the nitrate industry and members of the iodine combination or directors or legal representatives of nitrate companies associated in the combination, and the sixth a representative of the consignees.

Any member of the sub-committee who ceases to have the necessary qualifications loses his right to membership.

No two members of the sub-committee can be elected from the the same firm or company.

Physical Properties of Pure Platinum

The chemical division of the Bureau of Standards, in co-operation with the heat and optical divisions, has developed methods of obtaining platinum and some of its alloys in a state of extraordinarily high purity. A very sensitive test for the purity of platinum is afforded by the measurement of its "fundamental coefficient"—that is, the mean change of resistance per degree Centigrade in the interval 0 deg. to 100 deg. C. Some measurements of the fundamental coefficient of this recently produced platinum wire have shown values as high as 0.003922. The highest hitherto recorded value of this coefficient was 0.003917.

Uranium Steels

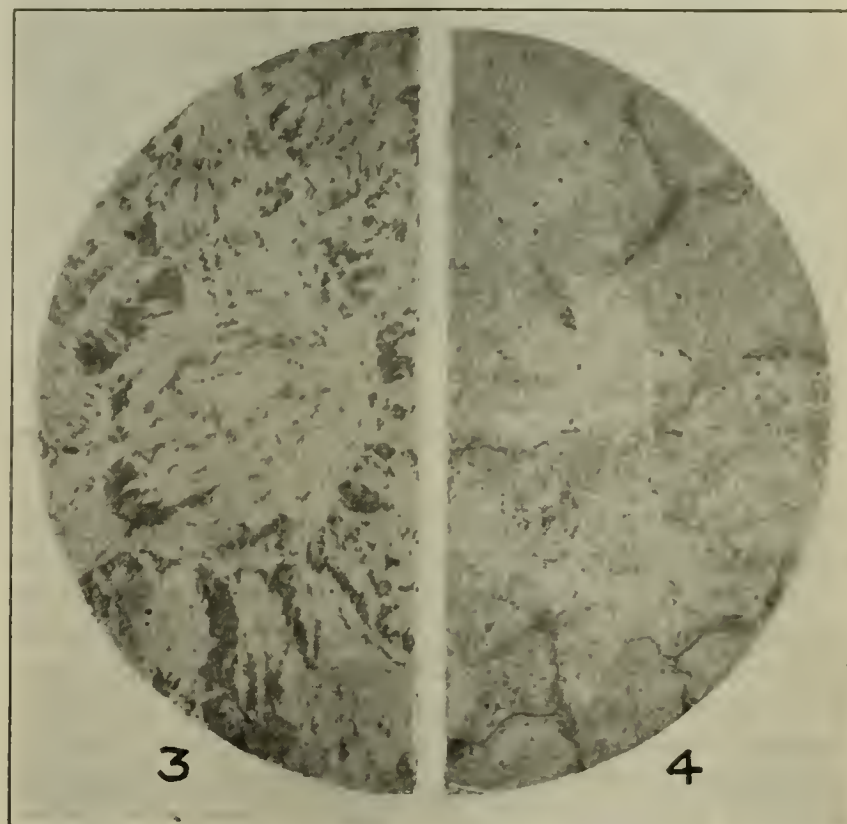
A Discussion of the Microstructure of Steels Containing a Similar Percentage of Carbon and Increasing Percentages of Uranium—Brief Description of the Influence of Uranium as an Alloy in Structural and High-Speed Steels

By HUGH S. FOOTE

IN PEARLITIC ternary steels the special element may exist as (a) dissolved in the ferrite, forming with it a solid solution; (b) combined with carbon as a double carbide of iron and the special element, or as a mixture of the two carbides; (c) partly dissolved in the ferrite and partly combined with the carbon.

Hypo-eutectoid steels containing not more than 0.60 per cent uranium are normally pearlitic, but any increase in the uranium content over this limit produces a characteristic carbidic component which heat-tints in a manner similar to uranium carbide. Fig. 8 shows a eutectic or eutectoid of the carbidic constituent remaining in a steel analyzing C 0.48 per cent and U 4.14 per cent, after being quenched in water from 1,000 deg. C. It is found on analyzing the residue remaining after dissolving annealed pearlitic steels with not more than 0.60 per cent uranium in dilute sulphuric acid with the aid of a galvanic current that the uranium is combined with carbon. At present there is not sufficient evidence to warrant a positive statement in regard to whether the uranium forms a true double carbide or a mixture of the carbides of iron and uranium.

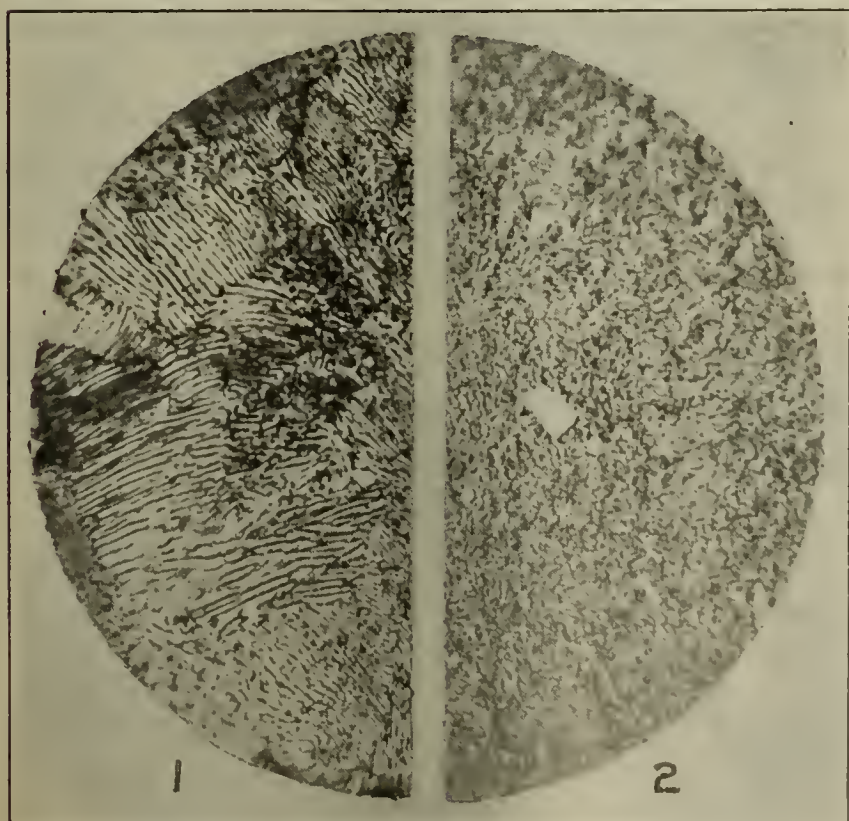
Uranium exerts little, if any, direct influence upon the critical or transformation points of steel up to a content of 2.0 per cent; over this percentage the Ar transformations are lowered and markedly suppressed even at normal rates of cooling. Steels having the lowered



FIGS. 3 AND 4. PEARLITE AND SPECIAL CONSTITUENT IN C 0.31, U 0.86 STEEL. $\times 150$

Fig. 3. Annealed at 1,600 deg. F. Etched with picric acid.

Fig. 4. Quenched in water from 1,830 deg. F. Etched in 1 per cent HCl in alcohol.



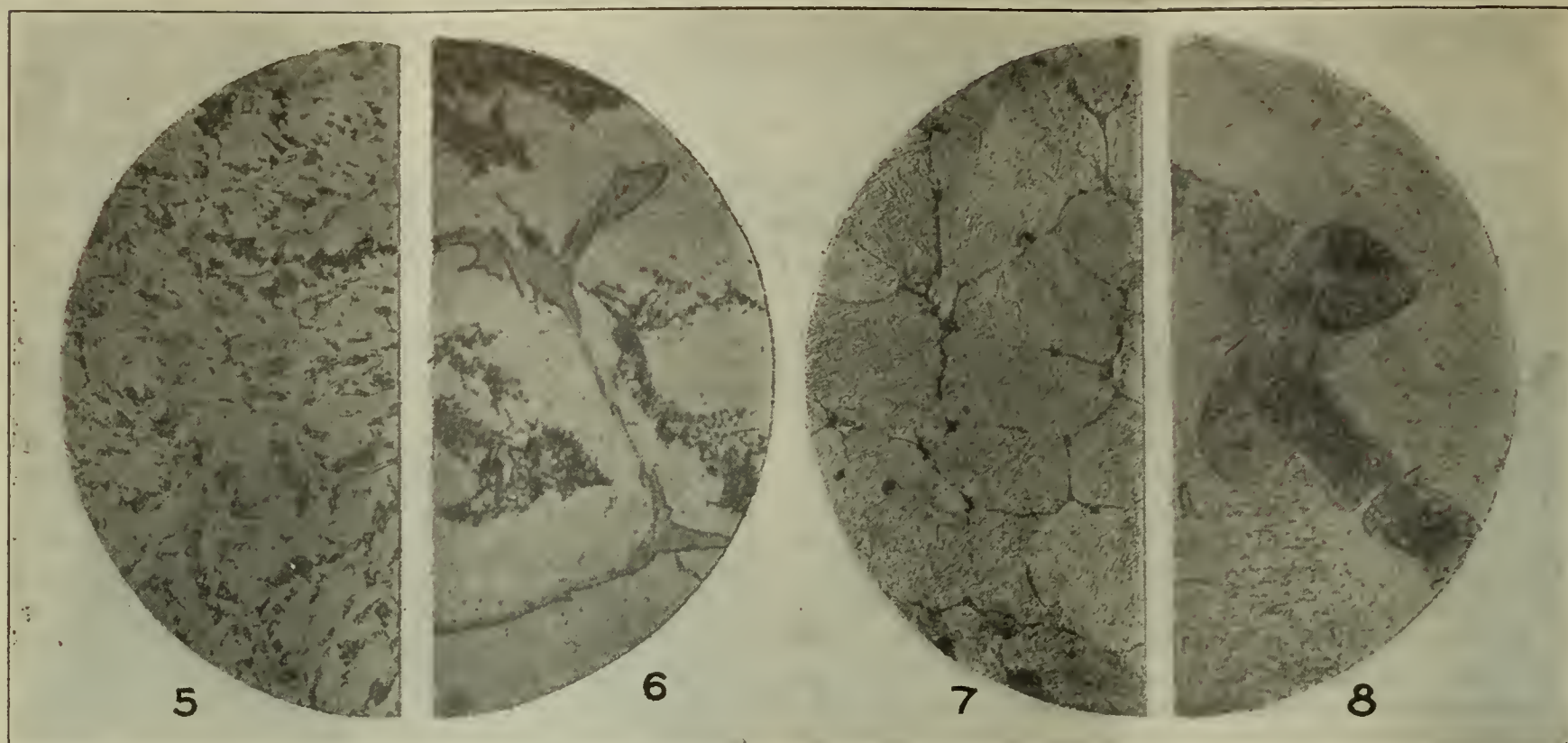
FIGS. 1 AND 2. MICROSTRUCTURE OF LOW C:U STEEL. ETCHED IN 5 PER CENT HNO_3 IN ALCOHOL

Fig. 1. Lamellar pearlite in steel (C 0.74, U 0.36) annealed at 1,600 deg. F. and slowly cooled. $\times 500$.

Fig. 2. White double carbide in steel (C 0.63, U 0.40) oil quenched from 1,480 deg. F. and drawn at 480 deg. F. $\times 1,000$.

transformations are characterized by a martensitic structure, while those having the points suppressed or nearly so exhibit the polyhedral structure of gamma iron and austenite.

The microstructure of pearlitic uranium steels with less than 0.60 per cent uranium shows that they resemble plain carbon steels except that the ferrite-cementite aggregate is finer. Fig. 1 shows a steel with C 0.74 per cent and U 0.36 per cent after annealing at 1,600 deg. F. and slowly cooling to room temperature. With further additions of uranium to about 1.0 per cent the pearlite is no longer lamellar, and a carbidic component is formed. Fig. 3 shows the microstructure of an annealed steel containing C 0.31 per cent and U 0.86 per cent; on quenching the steel is martensitic with the carbidic component rejected to the boundaries of the polyhedral grains. (See Fig. 4.) The microstructure developed by a steel with C 0.48 per cent and U 4.14 per cent, both in the annealed and quenched condition, is illustrated by Figs. 5 to 8. Increasing the uranium, C 0.46 per cent and U 6.97 per cent, produces both on slow cooling and quenching a polyhedral structure containing no traces of martensite; the carbidic component is eutectic in form and is also rejected to the grain boundaries. (See Figs. 9 and 10.) This steel shows also a marked suppression and lowering of the critical points, while an increase in the rate of cooling sup-



FIGS. 5 TO 8. STRUCTURE OF C 0.48, U 4.14 STEEL

Figs. 5 and 6. Annealed at 1,600 deg. F. $\times 150$ and $\times 1,000$ respectively. Etched with picric acid.

Figs. 7 and 8. Water quenched from 1,830 deg. F. $\times 150$ and $\times 1,200$ respectively. Etched with 1 per cent HCl and heat tinted.

pressed the points entirely and produced the same microstructure as quenching (Fig. 11). Likewise, increasing the temperature from which cooling commenced produced a marked weakening and suppression of the points and the steel became much harder than on cooling from lower temperatures. This may be explained as being due to the solution in the iron of a compound of iron, uranium and carbon at high temperature which did not have time to aggregate on cooling.

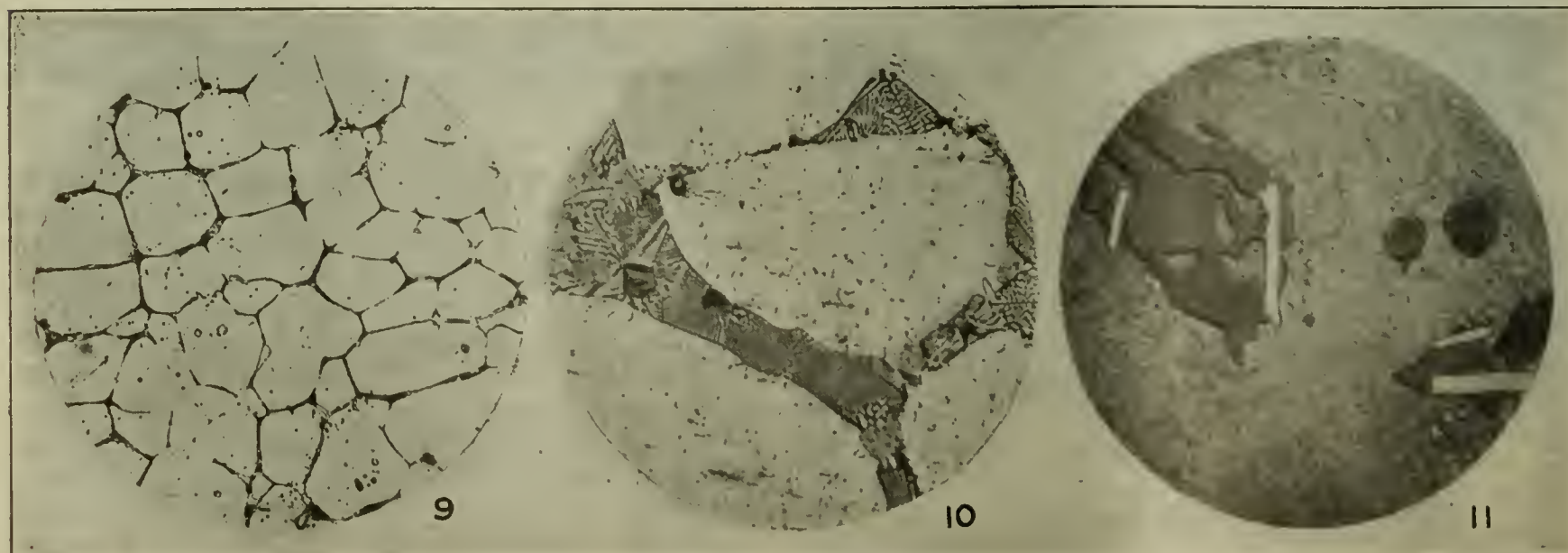
Dr. George K. Burgess, of the Bureau of Standards, states that unlike zirconium and titanium, uranium appears to enter into solid solution in steel—that is, it is a true alloying addition. In the normalized specimens a distinct martensitic and troostitic pattern is present, which undoubtedly is due to the presence of uranium in solid solution, as otherwise the structure would be found to consist of granular pearlite and ferrite.

Uranium steels when quenched sometimes contain microscopic white crystals as is shown in Fig. 2. The microscope shows also that (a) these crystals do not

heat-tint in the same manner as uranium carbide; (b) they are not found in annealed steels; (c) they are etched only by aqua regia; (d) in steels with a uranium content of more than 0.60 per cent uranium where the carbide component is formed, these crystals are found associated with the carbide constituent as is shown by Fig. 11. An explanation of the occurrence of these crystals is derived from the analysis of the residue of quenched steels that have been dissolved in dilute acid and aided by a galvanic current; the indications are that a double or complex carbide of iron and uranium is formed at high temperatures which dissociates or dissolves slowly and remains imbedded in the matrix as isolated, microscopic crystals. Examination of Fig. 8 also confirms the existence of two different crystallographic forms of the carbide component.

PHYSICAL PROPERTIES OF URANIUM STEELS

The most striking features of uranium as an alloy are, first, that it does not need to be augmented or intensified by the addition of other alloys, and secondly, the readiness with which uranium steels lend them-



FIGS. 9 TO 11. STRUCTURE OF C 0.46, U 6.97 STEEL

Fig. 9. Annealed from 1,770 deg. F. Etched with picric acid. $\times 70$.

Fig. 10. Annealed from 1,700 deg. F. Etched with H_2O_2 and NaOH. $\times 300$.

Fig. 11. Quenched in water from 1,830. Etched in HCl and heat tinted. $\times 700$.

selves to a water-quench. Uranium increases the hardness and hardening power of steels by means of its ability to emphasize the characteristics of the cementite; the hardness imparted thereby is not accompanied by as great a degree of brittleness as that induced by other carbide-forming alloys.

Carbon-uranium steels are pre-eminently adapted for uses which necessitate a low drawing temperature, in that they possess under these conditions a remarkable combination of hardness, strength and ductility. The effect of the addition of small amounts of uranium on the physical properties may be ascertained by an examination of the following tests, made on different classes of steel and compared on a basis of like ductility:

Elastic Limit	Tensile Strength	El. 2 In. Per Cent	Red. Area Per Cent
Carbon 0.32 per cent, uranium 0.22 per cent: 154,800	162,800	15.5	59.3
Carbon 0.30 per cent, nickel, 3.50 per cent: 111,000	124,000	15.5	53.0
Carbon 0.30 per cent, chromium 0.95 per cent, vanadium 0.18 per cent: 146,200	162,700	15.0	57.0
Carbon 0.28 per cent, chromium 0.85 per cent, molybdenum 0.37 per cent: 154,000	165,000	15.0	58.5

In other words, the addition of a small amount of uranium imparts to steel a sufficient increase in elastic and tensile strengths to make it comparable to the more complex alloy steels.

SMALL HEATS UNRELIABLE

The system of making steels for test or research purposes in an electric furnace of about 400-lb. capacity was abandoned by the writer because of the many defects in the steel. Moreover, the furnace conditions were not easily controlled, with a result that the product was often such as to lead to erroneous conclusions. The test results that follow were made on steels from electric furnace heats of two tons or more each, and the results are representative of each particular type.

TYPE 628

Carbon 0.32 per cent, uranium 0.22 per cent, manganese 0.66 per cent, silicon 0.23 per cent

All bars were quenched in water from 1,550 deg. F.

Elas. Limit	Ten. Strength	El. 2 In. Per Cent	Red. Area Per Cent	Brinell	Draw. Temp. Deg. F.
210,200	230,300	11.0	43.3	444	400
189,400	213,300	12.0	51.0	418	500
180,700	194,100	13.5	52.0	400	600
154,800	162,800	15.5	59.3	350	700
Charpy impact test, 329 ft.-lbs. per sq.in.					700
Alternating impact, 1,556 blows ($\frac{3}{8}$ in. throw.)					700

TYPE 629

Carbon 0.45 per cent, uranium 0.31 per cent, manganese 0.68 per cent, silicon 0.33 per cent.

All bars were quenched in water from 1,500 deg. F.

Elas. Limit	Ten. Strength	El. 2 In. Per Cent	Red. Area Per Cent	Brinell	Draw. Temp. Deg. F.
225,500	250,300	10.5	42.8	522	500
199,900	217,900	12.5	48.1	477	600
171,400	187,900	14.0	54.2	387	700
Charpy impact test, 178 ft.-lb. per sq.in.					700
Alternating impact, 1,200 blows ($\frac{3}{8}$ in. throw.)					700

TYPE 630

Carbon 0.54 per cent, uranium 0.29 per cent, manganese 0.61 per cent, silicon 0.28 per cent.

All bars were quenched in water from 1,475 deg. F.

Elas. Limit	Ten. Strength	El. 2 In. Per Cent	Red. Area Per Cent	Brinell	Draw. Temp. Deg. F.
258,300	280,500	8.0	34.0	555	500
227,300	249,500	10.0	40.3	495	600
187,200	205,300	11.0	43.3	394	700
Charpy impact test, 134 ft.-lb. per sq.in.					700
Alternating impact, 850 blows ($\frac{3}{8}$ in. throw.)					700

The tension test-bars were first rough-machined to 2 x 0.550 in., threaded, and after heat-treatment, finished by grinding to 0.505 in. diameter. The influence of heat-treatment on reduced cross-section may be observed by comparing tests made from bars heat-treated at 0.550 in. and 1 in. diameter.

Rough-machined to 0.550 in., then heat-treated and ground to 0.505 in.					
Elas. Limit	Ten. Strength	El. 2 In. Per Cent	Red. Area Per Cent	Brinell	Draw. Temp. Deg. F.
194,300	224,800	11.0	39.7	431	400
184,500	206,200	12.0	49.7	418	500
170,000	182,000	12.5	52.7	364	600
150,300	161,600	14.5	54.9	340	700

Heat-treated in 1-in. section, then finished to 0.505 in.					
Elas. Limit	Ten. Strength	El. 2 In. Per Cent	Red. Area Per Cent	Brinell	Draw. Temp. Deg. F.
203,800	223,600	10.5	33.4	444	400
185,000	204,300	11.0	37.0	418	500
170,000	188,100	11.5	43.0	375	600
155,300	165,700	13.0	48.0	340	700

URANIUM-NICKEL STEELS

The combination of small amounts of uranium with nickel produces a type of steel in which the desirable features of each alloying element are magnified. The hardness on quenching is increased by the addition of uranium, thus producing a desirable quality in the case of parts that are to be subjected to wear. The effect of additions up to 0.60 per cent of uranium to pearlitic nickel steels is to decrease the grain size and to make the pearlite more sorbitic.

In general, uranium-nickel steels differ from pearlitic nickel steels in these essentials: (a) they have higher elastic limits for the same ductility; (b) they are harder than nickel steels when heat-treated; (c) they are more susceptible to heat-treatment—uranium-nickel steels harden considerably when cooled in air; (d) they possess superior dynamic toughness and resistance to fatigue when properly heat-treated.

TYPE 638

Carbon 0.28 per cent, uranium 0.35 per cent, manganese 0.49 per cent, silicon 0.16 per cent, nickel 1.25 per cent

All bars were quenched in water from 1,550 deg. F.

Elas. Limit	Ten. Strength	El. 2 In. Per Cent	Red. Area Per Cent	Brinell	Draw. Temp. Deg. F.
196,200	226,200	10.5	38.1	418	400
192,000	209,100	12.0	47.4	418	500
175,000	186,300	12.5	48.6	364	600
155,500	162,800	13.0	50.3	311	700

TYPE 517 (MADE IN 35-TON ACID OPEN-HEARTH)

Carbon 0.39 per cent, uranium 0.22 per cent, manganese 0.60 per cent, silicon 0.20 per cent, nickel 3.00 per cent

All bars were quenched in oil from 1,425 deg. F.

Elas. Limit	Ten. Strength	El. 2 In. Per Cent	Red. Area Per Cent	Brinell	Draw. Temp. Deg. F.
206,400	248,600	13.0	47.7	512	400
199,200	231,600	13.5	51.1	477	500
183,300	202,100	13.5	54.1	418	600
164,100	177,200	15.0	56.0	387	700
Charpy impact test, 156 ft.-lb. per sq.in.					700
Alternating impact, 934 blows ($\frac{3}{8}$ in. throw.)					700

TYPE 178 (MADE IN 6-TON ELECTRIC FURNACE)

Carbon 0.45 per cent, uranium 0.29 per cent, manganese 0.48 per cent, silicon 0.53 per cent, nickel 3.00 per cent.

All bars were quenched in oil from 1,475 deg. F.

Elas. limit	Ten. Strength	El. 2 In. Per Cent	Red. Area Per Cent	Brinell	Draw. Temp. Deg. F.
244,500	290,100	10.0	29.1	555	400
238,900	271,100	10.5	35.5	512	500
212,000	228,000	11.0	39.0	464	600
185,500	198,200	12.0	45.0	415	700
Charpy impact test, 73.8 ft.-lb. per sq.in.					500
Alternating impact, 900 blows ($\frac{3}{8}$ in. throw.)					500

URANIUM HIGH-SPEED STEELS

A metallographic study of uranium high-speed steels indicates that the uranium tends to promote the formation of complex carbides. The cutting efficiency and the property of "red hardness" of high-speed steels is wholly dependent upon complex carbides. According to Osmond, when steels of this type are heated to a high temperature, the carbides dissolve and change the composition of the gamma iron solid solution, by means of which the critical points are lowered. In other words, it is the increased amount of dissolved carbides which causes the end of the transformation to fall below ordinary temperatures, with the result of partial aus-

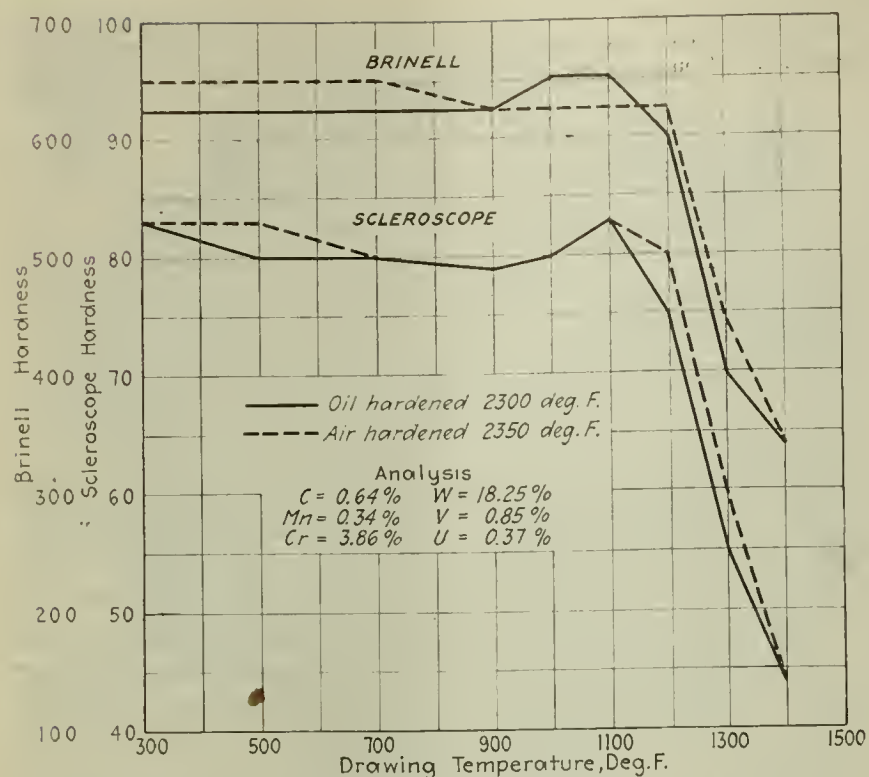


FIG. 12. VARIATION IN HARDNESS OF URANIUM-BEARING HIGH-SPEED STEEL AS DRAWING TEMPERATURE CHANGES

tenitization. The "secondary hardening" is due to the fact that when the partly austenitic steel is tempered, the dissolved carbides are slowly precipitated to a stage where the transformation is completed and the steel is martensitic. According to Scott,¹ the microscopic evidence is positive that the constituent which accompanies the appearance of "secondary hardening" is martensite.

A comparison between the microstructures of a uranium and a uranium-free high-speed steel annealed at the same temperature shows that steels containing uranium show in general a larger number of carbide globules than are found in uranium-free steels; in the

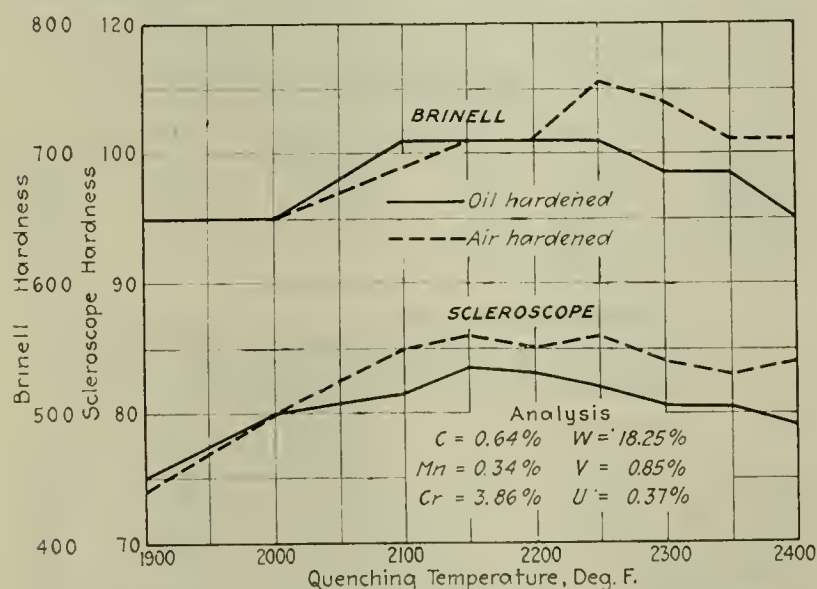


FIG. 13. VARIATION IN HARDNESS OF URANIUM-BEARING HIGH-SPEED STEEL AS QUENCHING TEMPERATURE CHANGES

hardened condition, both classes show practically the same amount of undissolved carbides. Since the complex uranium-carbide is apparently more soluble in gamma iron than those complex carbides ordinarily found in high-speed steels, it is reasonable to infer that uranium exerts an important influence on the property of "secondary hardness."

Curves are shown in Figs. 12 and 13 to illustrate the effect of different quenching and drawing temperatures on a uranium high-speed steel.

Method for Obtaining Color Value of Sugar Solutions

Many sugar solutions, such as molasses, contain so much coloring material that they are too dark to be read on color-measuring instruments even when the thickness of the layer used is decreased as much as is practicable. Dilution of such heavy, dark-colored solutions with water causes some change to take place, resulting in a flocculation and precipitation of a part of the coloring material which is present in the undiluted solution. This precipitated material is so fine that it does not settle and therefore renders the solution turbid. If this turbid solution is used to determine the color value of the original dark-colored solution, an error is caused by the dispersion or scattering of the light by the fine precipitated particles. If these particles, which are known scientifically as dispersoids, are filtered off and the remaining clear liquid used, an error is likewise made, since a part of the coloring matter which was originally present has now been removed.

A new method for the measurement of the color value of sugar solutions is being developed by the United States Bureau of Standards in which these errors are avoided. The method consists essentially in diluting the dark-colored solution in a concentrated sugar sirup of known color value. The dilution with water decreases the protective influence of sucrose, which acts as a protective colloid, while the dilution with concentrated granulated sirup maintains the same state of equilibrium and prevents the precipitation of the coloring material. Beer's law is valid only as long as flocculation and change in color value are prevented. If laboratory practice invalidates the law, truthful results cannot be obtained. This fact has been ignored by technical sugar chemists up to the present time. The basic principles of technical colorimetry stated by Stammer, long before the days of colloidal chemistry, have never been tested under more modern conditions.

Production of Asphalt Increases

The quantity of native asphalt and native bitumens sold in the United States in 1920 was 198,497 short tons, valued at \$1,213,908, according to the United States Geological Survey. This was an increase of 125 per cent in quantity and of about 78 per cent in value over 1919. Gilsonite was reported from Uinta County, Utah, wurtzilite (or elaterite) from Duchesne County, Utah, and grahamite from Pushmataha County, Okla.

The sales of manufactured asphalt obtained from domestic petroleum amounted to 700,496 short tons, valued at \$11,985,457, or \$17.11 a ton. Compared with 1919 these figures indicate an increase of 14 per cent in quantity and 37 per cent in value.

The sales of asphalt manufactured in the United States from Mexican petroleum in 1920 amounted to 1,045,779 short tons, valued at \$14,272,862, or \$13.65 a ton. This was an increase of 55 per cent in quantity and of 85 per cent in value over 1919.

Coal Production in France's Devastated Region

Considerable progress was made in the exploitation of the war-damaged coal mines of France during the first half of 1921. Altogether the mines in the Departments of the North and the Pas-de-Calais produced 7,344,000 tons of coal during the first six months of 1921, as against 3,534,000 tons in 1920. During the first half of 1913 they produced 14,946,000 tons.

¹Howard Scott, Bureau of Standards Scientific Paper 359.

Air Required in Baking Cores Made With Linseed Oil

Results of Laboratory and Plant Experiments on the Consumption of Air and Oxygen in Baking Linseed Oil-Bound Cores, Together With a Review of Available Data on the Absorption of Oxygen by Linseed Oil in Drying

BY A. A. GRUBB AND U. S. JAMISON*

THE ventilation of an electric core oven is a problem quite different from that of an oven using coal, coke, oil or gas as its source of heat. In the latter case the hot gases from the burning fuel are permitted to pass over the cores; these gases contain a large percentage of uncombined oxygen, so there is always present a great excess of oxygen over any quantity actually required in the baking process. The ventilation required to maintain proper combustion is always sufficient, too, to carry out of the oven any water vapor and other gases which may be formed.

But not so with the electric oven. No ventilation is required for operation of the heating elements, so any air passed through the oven is for the sole purpose of supplying oxygen and carrying off gases; further ventilation results only in loss of expensive heat energy.

Linseed oil differs from water-soluble binders in that its hardening in the core in the process of baking depends upon oxidation rather than merely losing moisture. Water is used in green core sand along with oil to improve the green bond properties and permit the sand to be packed closely enough that the oil can cement contact points together. In sands containing clay or other natural bond the water also serves to form a sort of plaster or semi-solution of this bonding material so that upon drying the grains of sand are cemented together.

The quantity of air which should be supplied to the baking cores is determined, then, by two factors: first, the moisture coming off the cores must be diluted or carried out of the oven, and second, sufficient oxygen must be supplied to oxidize the oil properly. It may be necessary to supply an excess of oxygen over that actually used; if so, how great an excess?

MOISTURE ELIMINATION

Green core sand contains on an average about 6 per cent of moisture. This is nearly all in the vapor form before the bake is half completed. A series of temperature readings made by means of a thermocouple point located in the center of a baking core show that the rise in temperature is retarded somewhat in the neighborhood of 212 deg. F., after which it again continues to rise at its former rate, indicating that the water has been vaporized. Each 100 lb. of green core sand contains about 6 lb. of water, which upon vaporizing expands to about 165 cu.ft. at 212 deg. F. and to still greater volumes at higher temperatures. The steam would thus drive practically all the air from the oven or at least dilute it to an extent that there would be insufficient oxygen for the bake were it not for the admission of fresh air through ventilating ports or openings about the doors. These considerations point to the necessity of introducing some air into the oven in

order to carry out the water vapor. Inasmuch as practically all the oxidation occurs during the latter half of the bake, the need for air is not imperative until after all the water has been vaporized and the temperature has risen pretty well toward maximum.

OXIDATION OF LINSEED OIL

Upon exposure to the air linseed oil absorbs oxygen and is converted into a tough or even hard varnish. Ordinarily this transformation is very slow, but it may be hastened by raising the temperature 300 or 400 deg.; higher temperatures are apt to cause at least partial decomposition.

According to Cloez¹ fresh linseed oil is composed as follows:

	Per Cent
Carbon.....	77.57
Hydrogen.....	11.33
Oxygen.....	11.10

When thoroughly dried he found that 100 g. of this oil had increased to 107 g. as follows:

	G.
Carbon.....	72.27
Hydrogen.....	10.57
Oxygen.....	24.16
Total.....	107.00

These figures indicate that in drying 100 g. of linseed oil, 5.3 g. of carbon and 0.76 g. of hydrogen are given off. Possibly these were given off in part as hydrocarbons, but it is more probable that they were oxidized to carbon dioxide and water. The figures also show that 13.06 g. of oxygen were absorbed and retained. If we assume that the carbon and hydrogen which were lost were oxidized to carbon dioxide and water, then the 5.3 g. of carbon would unite with 14.1 g. of oxygen to form 19.4 g. of carbon dioxide, and the 0.76 g. of hydrogen would unite with 6.08 g. of oxygen to form 6.84 g. of water. The complete drying of 100 g. of linseed oil would then require 33.24 g. of oxygen and would produce 19.4 g. of carbon dioxide. A. Genthe,² another investigator, found that in drying, linseed oil absorbed 23 per cent of oxygen. The work of these investigators, then, indicates that between 30 and 40 g. of oxygen is required to completely dry 100 g. of fresh linseed oil.

LABORATORY TESTS

A number of experiments were made to determine the quantity of air which should be supplied and the quantity of oxygen actually used in thoroughly baking linseed oil cores. A Vitrosil tube, 1 in. in diameter and 12 in. long with a 4-in. transparent section in the middle, was set up horizontally in such manner that it could be heated with bunsen burners. In the ends of

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¹Allen's Commercial Organic Analysis, vol. 2, p. 345.

²Ibid., vol. 2, p. 348.

the tube were placed rubber stoppers, one of which supported a thermometer so set that it showed the temperature in the middle of the tube. Air entering the tube was passed through a calcium chloride tube to insure dryness. Upon leaving at the other end of the vitrosil tube, the gases were drawn through another calcium chloride tube and a soda lime and caustic tube for carbon dioxide absorption. A calibrated water-bottle aspirator was used for drawing air through the train. The air which was received in the water bottle was analyzed for oxygen content by means of an Orsat gas apparatus. The difference between this value and 20.8 was taken as a measure of the oxygen used in baking the core.

The core sand used in the tests was one of the standard mixtures used in our core room. It consisted of 70 volumes of Michigan City lake sand, 30 volumes of sand-blast dust, 8 volumes of water and 2 volumes of raw linseed oil. According to weight such a mixture is 5.05 per cent water and 1.18 per cent linseed oil. The

TABLE I. LABORATORY TESTS ON OIL-BOUND CORES

No.	Wt. of Green Core, G.	Loss in Weight, G.	Water, G.	Carbon Dioxide, G.	*Air Used, C.c.	Oxygen Used, C.c.	O Used per G. of Oil, G.	Temp. Range, Deg. F.	Mean Temp., Deg. F.	Breaking Strength, G.
1	8.371	0.420	0.113	0.140	767	115	1.55	475-530	500	127
2	8.524	0.431	0.094	0.107	1,000 656	108	1.43	440-540	500	257
3	8.339	0.413	0.306	0.042	990 656	82	1.11	470-520	478	326
4	8.431	0.402	0.372	0.030	648	74	0.99	348-360	452	523
5	8.314	0.420	0.210	0.034	664	69	0.94	418-432	422	612
6	8.491	0.391	0.361	0.028	633	68	0.90	420-442	422	523
7	8.342	0.451	0.224	0.031	651	66	0.89	420-440	425	457
8	8.378	0.408	0.106	0.053	620	65	0.87	380-410	400	585
9	8.196	0.392	0.169	0.018	1,070 648	52	0.71	361-378	365	775
10	8.529	0.380	0.175	0.018	676	49	0.65	368-388	377	672
11	8.535	0.431	0.307	0.010	633	35	0.47	350-374	360	613
12	8.375	0.390	0.289	0.021	620	32	0.43	358-384	370	590
13	8.915	0.346	0.056	0.013	892	34	0.43	300-335	315	359
14	8.934	0.408	0.428	0.007	1,160 199	31	0.39	380-398	390	588
15	8.287	0.343	0.074	0.018	672 787	29	0.39	280-320	300	466
16	8.776	0.411	0.411	0.012	1,070 115	24	0.31	380-398	389	265
17	8.681	0.381	0.006	0.006	642 622	24	0.31	338-342	340	133
18	8.861	0.401	0.435	0.010	122	23	0.29	380-404	391	329

* When two numbers for "Air Used" are given in the table, the upper one indicates the number of cc. air admitted or passed over the core while it was baking.

sand, water and oil were measured out accurately and mixed in a glass-stoppered salt bottle to prevent evaporation. The cores were made and baked in 3-in. nickel combustion boats. The boats were filled with green core sand, firmly pressed down and then stroked off even with the edges. This produced cores of uniform size. All the test-cores were baked for 45 minutes. When baked they were allowed to cool in a desiccator and were then tested for strength by resting them on two knife edge supports $1\frac{1}{4}$ in. apart and applying weight midway between the supports. Breaking strengths of less than 450 g. indicate cores that would be unsatisfactory for general foundry work on account of their fragility, while results over 600 g. indicate very strong substantial cores.

The accompanying table shows the results of eighteen tests, together with some of the calculated results. They are arranged in order according to the quantity of oxygen absorbed per gram of linseed oil in the core. In several of the experiments the tube was cooled as soon as the bake was complete and more air was then passed through to sweep the tube. The second number gives this total volume which was sampled for the oxygen determination. In addition to the tests recorded

in the table, two cores were baked in an atmosphere of carbon dioxide; they were of a grayish color and so weak that they could scarcely be supported on the fingers. Four cores were also baked in a large excess of air, the ends of the Vitrosil tube being left partly open; the average baking temperature was 393 deg. F. and the average breaking strength was 612 g.

DISCUSSION

While the results were not as uniform as might be desired, we believe they were as nearly so as could be expected from this sort of problem and this method of handling it. A survey of the figures shows the following points worthy of notice:

1. The nine strongest cores—Nos. 4, 5, 6, 8, 9, 10, 11, 12 and 14—were baked at an average temperature of 395 deg. F. They used 0.73 g. of oxygen per g. of linseed oil and broke under an average load of 609 g.

2. Nos. 1, 2 and 3 were baked at too high temperatures; the average was 493 deg. F. They used 1.36 g. of oxygen per g. of oil and broke under a load of 237 g.

3. Nos. 13, 15 and 17 were baked at too low temperatures; the average was 318 deg. F. They used only 0.38 g. of oxygen per g. of oil and broke under a load of 319 g.

4. Nos. 16 and 18 were baked at the proper temperature, but insufficient air and oxygen were supplied; the average baking temperature was 390 deg. F. They used only 0.30 g. of oxygen per g. of oil and broke under a load 297 g. Practically all the oxygen admitted to the cores was used.

5. Considering the nine strongest cores mentioned above, 5,341 c.c. of air supplied the oxygen for baking 76.2 g. of green core sand; this was in the ratio of 8.5 lb., or 112 cu.ft., of air at room temperature to each 100 lb. of core sand. Oxygen to the amount of 475 c.c. was absorbed; this was about 40 per cent of oxygen content of the air supplied to the cores.

6. No. 14 used 75 per cent of the oxygen supplied to it and produced a fairly strong core.

PLANT TESTS

An attempt was made to check the above results by tests in an electric core oven in our foundry core room. This oven had a volume of 350 cu.ft. and was equipped with a fan and ventilating device so arranged that the

TABLE II. TESTS ON LARGE CORE OVEN

Wt. of Cores, lb.	Time in Oven, Min.	Fan Recirculating, Min.	Fan Exhausting, Min.	Air Admitted to Cores, Lb.	Average Strength, Lb.
1 300	68	12	3	85	55
2 287	65	12	1	40	61
3 320	70	15	0	17	54
4 312	78	0	0	17	52
5 337	70	0	1	40	53

air in the oven could be recirculated or fresh air could be introduced from without, part of the exhaust passing up the flue. When the fan was operated, it was set to recirculate entirely or else to recirculate and introduce fresh air at the rate of about 300 cu.ft. per minute. This figure was determined by placing a Pitot tube draft gage in the exhaust flue. The temperature of the oven was controlled by a thermostat. Five bakes were made, varying the quantity of air introduced. In addition to the regular cores, twelve test briquets, similar in shape to those used in cement testing, were placed on each rack. The test-cores were made of the same mixture as the laboratory test. After baking, they were broken on a Wadsworth core-testing machine; a breaking strength of 40 lb. indicates a fair core, above

60 lb. a very strong one. Table II gives a summary of the results obtained.

In each case except No. 4 the fan was operated near the middle of the bake. This was done in order to clear the oven of water vapor and other gases. In No. 1 the fan exhausted for 1 minute about a quarter of an hour before the rack was removed. The figures on "Air Admitted to Cores" were calculated from the period the fan was exhausting and drawing in air, and the estimated air content of the oven was added in; hence these figures are very approximate.

Oxygen determinations were made on samples of air drawn from the oven during the latter part of bakes Nos. 1, 4 and 5. No. 1 gave values of 19.8 per cent and 18.0 per cent. No. 4 gave 11.3 per cent and 13.0 per cent. No. 5 gave 16.7 per cent, 14.1 per cent and 15.0 per cent.

DISCUSSION

The test-cores differed but little in strength—all were good. Evidently we were unable to cut down the air supply to a point where the strength of the cores was seriously affected. Ventilation served possibly to reduce the time of bake, but even in No. 4, with no fan ventilation, there was sufficient air in the oven or enough leaked in around the doors to produce good cores. According to the laboratory test, 300 lb. of cores should require about 2.5 lb. of oxygen. However, 17 lb. of fresh air contains only 3.9 lb. of oxygen, so either the "Air Admitted" figures given in the table are too low or the oxygen determinations are too high. It is very likely that more air than that recorded got into the oven, as there were rather loose fitting doors at both front and rear. Even when making allowance for these possible errors, it is evident that from 8 to 10 lb. of air, possibly less, supplies sufficient oxygen to bake properly 100 lb. of green core sand.

CONCLUSIONS

In order to bake linseed oil-bound cores properly, at least 1 lb. of oxygen should be supplied for each pound of linseed oil in the cores. This would require about 4.5 lb., or 60 cu.ft., of fresh air. Each 100 lb. of green cores should then have at least 5 lb., or 67 cu.ft., of air. These figures indicate only the minimum quantity required for oxidation purposes. It is well to change the air in an oven at least once after the moisture has been vaporized. Where fuel is cheap, greater excesses of air probably have no harmful effect and may be of advantage.

In the correct bake linseed oil uses about 0.73 per cent of its weight of oxygen. This figure is considerably higher than those given by Cloez and Genthe, referred to above, for oxygen used in drying linseed oil. We need not be surprised at this, because a properly baked core is more than dried. We have found in our core room that a linseed oil core shows a slight greenish tinge when merely dried out. When a brass casting is poured about such a core, a "core blow" is very apt to result and the core, instead of becoming very fragile and easy to remove, bakes hard in the casting. On the other hand, when baked to a decided brownish color, they can usually be knocked out of the castings without trouble.

These facts indicate that in core baking the oxidation process is carried beyond the drying stage; the oil is actually burned in a slight degree.

Legal Notes

BY WELLINGTON GUSTIN

The Conrad Patents, the Noiseless Gear. Using Bakelite Micarta, Void for Lack of Invention

The Conrad patents, No. 1,167,742 and No. 1,167,743 for a noiseless gear, the material of which is a composition of bakelite and fiber, known as "Bakelite Micarta," of which Conrad was not the inventor, have been held void for lack of invention in the United States District Court, Southern District of Ohio, by Judge Peck. (Westinghouse Electric & Manufacturing Co. vs. For-nica Insulating Co., 270 Fed., 632.)

The complainant sought to enjoin defendant from the manufacture and sale of blanks to be used in the making of gear wheels composed of a fibrous material with a phenolic condensation product for a binder, which was charged to be a contributory infringement of said Conrad patents as owned by it. The defense was that the patents were void for want of invention, or, if showing invention, because Conrad was not in fact the first inventor, and for want of novelty.

DESCRIPTION OF THE PATENT IN DISPUTE

The subject-matter of the patent was the non-metallic or noiseless gear. The object sought by the inventor was the production of a gear wheel which would be light, strong, durable, infusible and impervious to moisture and to most chemicals. To obtain this result, said the court, sheets of fibrous material, such as cloth or paper, are impregnated with an adhesive liquid material, preferably a phenolic condensation product, such as bakelite dried in an oven, laid together with the treated side of one to the untreated side of the next, hydraulically pressed under heat until the material is fully impregnated and firmly cemented into a hard, compact mass, and, after cooling, subjected to a baking process. The result obtained is a laminated fibrous material, capable of withstanding great heat, of high tensile strength, which can be turned and bored in the same manner as wood. The finished plates are then cut into gears in the usual way. As a modification metallic end plates or shrouds were placed on gears to protect the edges of the composite structure from injury and to give added strength.

The binding material, bakelite, is described as a condensation product of phenols and formaldehyde. Claim 7, which is typical of those relied on, states: "A gear having a self-sustaining working body portion, composed of fibrous material and a phenolic condensation product."

The complainant produced by the process a gear which was highly useful and commercially successful, but also superior in some adaptations to all preceding types of noiseless gears. The question presented to the court was, How much of this result can be attributed to the exercise of the inventive faculty of Conrad?

GEARS DESCRIBED IN BAEKELAND PATENT

The new element that made this success possible was a composition of bakelite and fiber, together known as "Bakelite Micarta." This material was admitted to be the production of Dr. L. H. Baekeland, covered by his patent No. 941,605. It is said that the same process of

building up the laminated material described in Conrad's patents is fully set forth by Dr. Baekeland in his composite cardboard patent of March 5, 1912, No. 1,019,406. On Dec. 16, 1910, Dr. Baekeland filed his application for a patent on a "machine element," meaning thereby gears, pulleys, etc. This application, filed 2½ years before that of Conrad, although not allowed until after Conrad's application had been filed, was considered in determining the question whether Conrad was the first inventor under the patents in suit. Baekeland described a gear made of a phenolic condensation product, either compounded with fiber, or built up with layers of wood, cardboard, paper, or similar porous material, and compressed between metal plates. This was to be done either with or without the use of interior metal strengthening plates. The gears were then to be cut from disks of the material so formed. He described such gears as capable of withstanding comparatively high temperature and of enduring conditions destructive to most plastic compositions, as being of great hardness, toughness and wearing qualities, and, as against metal gears, silent in operation. The difference between the two patents appears that in Baekeland the reinforcing plates are considered essential to the strength of the gear, while in Conrad they were considered optional with the gear maker.

WAS CONRAD'S ADVANCE PATENTABLE, ASKS THE COURT

Conrad knew the material as suitable for gears without reinforcement as well as with it. Baekeland's material was bakelite, fiber and metal; Conrad's was bakelite and fiber, with or without metal, as conditions might warrant. Conrad's advance was that the supporting metallic plates might, in cases, be omitted. Was this invention in a patentable sense, the court asks.

Bakelite Micarta is described as a hard, fibrous substance, strong, insoluble, infusible and resistant to water, oil and most chemicals. It was at the time of the application for patents in suit used mostly as an electric insulating material. Noiseless gears of rawhide, compressed fiber, or fabroil, and vulcanized or hard fiber were common. Rawhide and fabroil were compressed and held in shape by end plates. Hard fiber, on the other hand, was a self-sustaining material. It was composed of cotton-rag paper treated with chloride of zinc, which rendered it gelatinous and adhesive. The layers of material, having been so treated, were pressed together and formed a laminated, fibrous, self-sustaining, hard material, useful for gear making. The resemblance of Bakelite Micarta, the new material, to the hard fiber was striking. The difference was that the Micarta contained a new and better binding cement, and the process of its manufacture was not injurious to the fiber and left it unimpaired. The question arises, Was it after all anything more than an improved hard fiber?

Then if hard fiber had been familiarly utilized for the manufacture of noiseless gears for years, was it a patentable invention for Conrad to employ the greatly improved hard fiber, Micarta, which itself was not his invention, for the same purpose? The answer to this question determined the matter for the court.

The old hard fiber gears had been used with and without end plates and shrouds. Conrad described in his patent a gear made of Micarta without such supports, but did so as an alternative. In his claim he is careful to limit the use of the material to the "working body portion," thus covering a gear supported by end

plates, they not being the working body portion thereof. Therefore the court held that Conrad's effort was but the skillful selection of material rather than invention, and that both his patents were void.

Substitution of one material for another, which does not involve change of method nor develop novelty of use, even though it may result in a superior article, is not necessarily a patentable invention, says the court.

The bakelite gear was held to be an infringement of the compressed fiber or fabroil gear in the case of General Electric Co. vs. Continental Fiber Co., which the reader may find in vol. 256 of the *Federal Reporter*. It was here held by the Circuit Court of Appeals that the Miller patent for the use of compressed textile fabrics for gear manufacturing was fundamentally new and entitled to a broad range of equivalents. Its infringement was based on the ground that both depend upon the presence of a large number of fibers in a small space.

Condition in Offer Prevents Contract Agreement

In an action by the Atlantic Terra Cotta Co. against the Chesapeake Terra Cotta Co. (113 Atlantic, 156) plaintiff sought to recover damages for the wrongful repudiation of an alleged contract to accept and use certain terra cotta. A memorandum of the alleged agreement was made in writing and signed by both parties. The first condition of plaintiff's proposal was as follows: "(1) This proposal is good for thirty days from date, and acceptance thereof is subject to a form of contract satisfactory to us."

Now the court said that had this proposal been omitted from the written offer made by the plaintiff, the written acceptance of the defendant could have been held to constitute a valid contract, upon the ground that although neither the offer nor the acceptance contained any express intent as to the time of delivery or payment, yet in such case the absence of the ordinary stipulations as to time of delivery and time of payment would be supplied by implication of law. Where no time for delivery is fixed by such a contract, the law implies delivery within a reasonable time. Where no time of payment is fixed by such a contract, the law implies that the time of payment is upon the delivery of the goods.

WRITTEN CONDITION WAS ONE PRECEDENT TO CONTRACT

The essential question, therefore, was whether this cited condition was one precedent to the formation of a contract between the parties in reference to the offer that a formal written contract should be executed, and whether writing upon the offer that it was accepted did create a contract.

The Supreme Court of Errors of Connecticut in the case affirmed the judgment of the trial court that such acceptance of the offer did not create a binding contract, but said the completing of a contract depended upon later extension of a formal contract.

Further, this court says: "Where there is no written proposal or acceptance expressed to be subject to a formal contract, but there has been a reference to a written contract in the negotiations, then it becomes a question of fact whether the parties intended the agreement in a certain memorandum to constitute a contract or intended that there should be no contract until the execution of a formal written contract; and such intention is to be gathered from the language used when interpreted in the light of the attendant circumstances."

Non-Magnetic, Flame-, Acid- and Rust-Resisting Steel

New High Alloy Steels Developed in the Research Laboratory of the Crucible Steel Co. Which Can Easily Be Worked and Machined, but After Heat-Treatment Become Hard and Resistant to Attack of All Agencies

A SHORT NOTE on a "Highly Resistant Alloy Steel" appeared in CHEMICAL & METALLURGICAL ENGINEERING for Sept. 22, 1920 (vol. 23, p. 568), following the presentation of a paper on this subject before the American Society for Steel Treating, by Charles M. Johnson, director of research department, Crucible Steel Co. of America. This paper has been printed in full in the July 1, 1921, issue of that society's *Transactions*.

Several of these high-alloy steels were studied primarily in an effort to find a steel which could be forged, rolled or sheared in thicknesses down to 0.01 in., be machinable in the cold, yet offer maximum resistance to cutting flames. It was found that polished samples of sheet made from the experimental melts, when immersed twenty-four hours in various solutions, showed remarkable resistance to acid solution, as indicated in Table I.

These steels have therefore been called "Rezistal," and a certain amount of them placed on the market. When attacked by an oxyacetylene flame it takes twenty times as long to melt a hole through it as does ordinary steel. Exposed to oxidizing flame Rezistal is only slightly stained after several hours in a gas furnace at 1,100 deg. C. (2,000 deg. F.), indicating its utility for racks, clamps and other heat-treating fixtures. Tests for thirty minutes at 1,100 deg. C. are also included in Table I, + measuring gain in weight, — loss. Copper solutions, which plate out readily on high-chromium steel, will not deposit copper on grades 3 and 4. Rezistal will remain for days in Pittsburgh tap water, developing only the faintest traces of rust; it resists saturated H_2CO_3 even better. Paring knives from grade 2 will not stain in fruit juices, but furthermore do not stain the operators' fingers if the handles are made of wood or fiber.

Further tests by corroding agents follow:

Lead. A 1,200-g. crucible of No. 3 gained 0.43 g. after holding lead eight hours at 900 deg. C. (1,650 deg. F.). No scaling occurred on the outside.

Cyanide. Metallic samples were immersed one hour in NaCN at 1,000 deg. C. (1,850 deg. F.). Grade 3 lost 154 mg. per sq.in.; copper steel 482; wrought iron 478.

Concentrated Salt Solution. Slight tarnish after seventy-two hours.

Pasty Quick Lime. No change after 170 hours.

Neat Cement. No change after twenty-two days.

Concentrated Carbolic Acid. Trace of discoloration after ninety-two hours.

Oxalic Acid. Lost 1.41 mg. per sq.in. in ninety hours.

Hot Asphaltum. Slight discoloration suggesting an enamel after one hour.

Silver Nitrate. No effect, cold or hot.

Saturated Alum Solution. Slightly etched in spots after twenty-two hours.

Caustic Soda. No effect after three hours' boiling in 20 per cent solution.

Rancid Butter. No effect after eight days.

Sulphurous Acid. Quickly assumes dark protective coating, after which loses 0.3 mg. per sq.in. per day.

Mercuric Chloride. Bright and lustrous after 120 hours in cold (loss 0.45 mg. per sq.in.) or thirty minutes in boiling N 1000 solution (loss 2.1 mg.).

Lactic Acid. No effect after twenty-four hours in 0.2 or 1.0 per cent solution; loss in latter case 0.1 mg. per sq.in.

Gasolene. Slight brown tarnish after thirty days; loss 0.63 mg. per sq.in.

MAGNETIC PROPERTIES

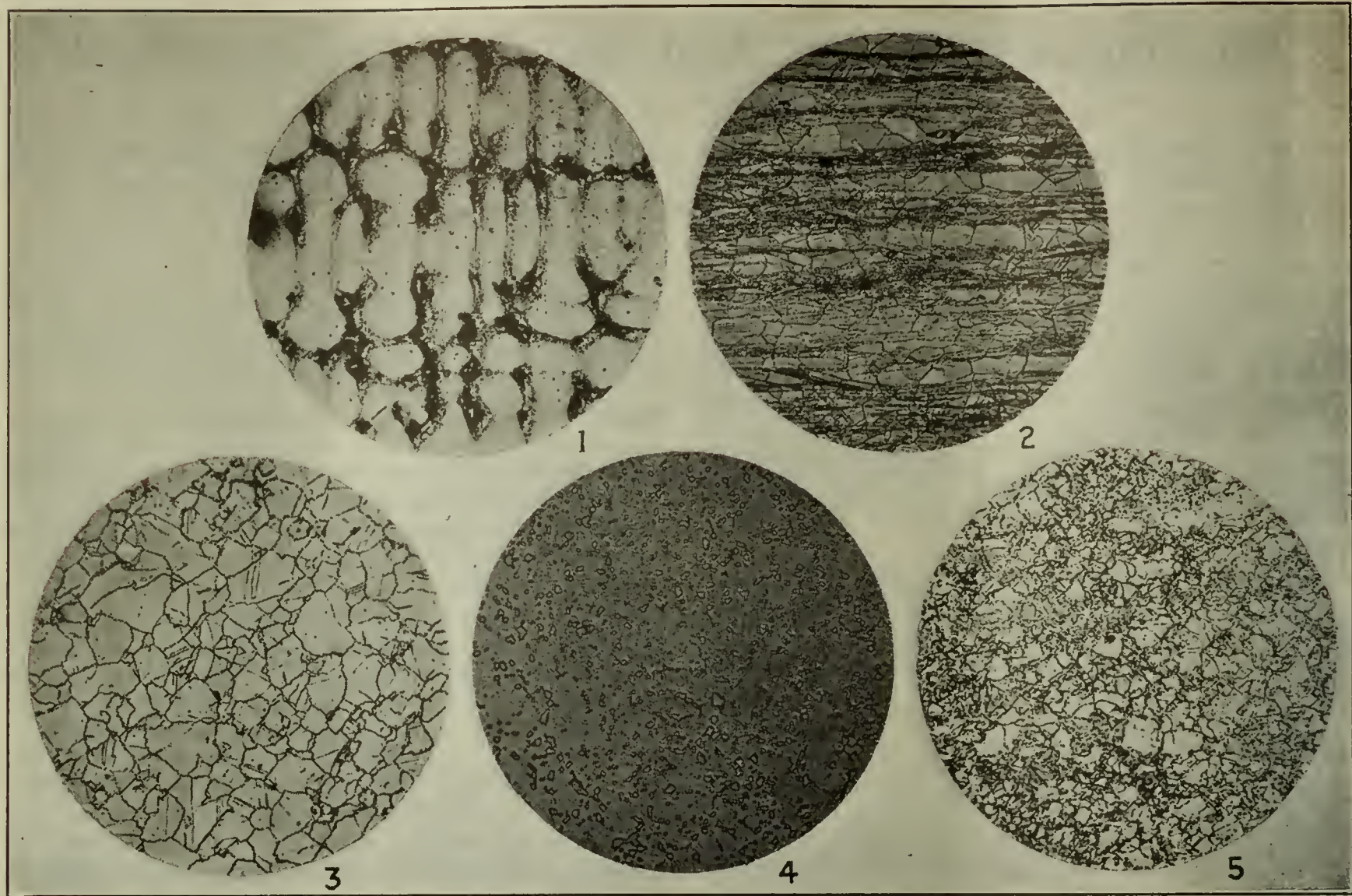
Grades 2 and 3 are both non-magnetic in the rolled condition or after extended heat-treatments. The permeability with respect to air is 1.05, and the residual magnetism not greater than 4 lines per sq.cm. After prolonged heating at 700 deg. C. (1,300 deg. F.) a slightly greater attraction to a magnet was noticed, but this was lost by a short heat to 870 deg. C. (1,600 deg. F.). It is of interest to note in this connection that high-carbon manganese steel of the Hadfield type shows a similar slight increase of magnetic susceptibility at about 650 deg. C. (1,200 deg. F.), but more so at 595 deg. C. (1,100 deg. F.) after ten minutes' heating and also loses this increased susceptibility at about 815 deg. C. (1,100 deg. F.) after ten minutes. Cold work increases the magnetic susceptibility of grade 3 to a noticeable extent. To remove this, heat to 1,000 to 1,100 deg. C. (1,950 deg. F.) for a few minutes; cool in air and heat again if necessary.

Three grades of Rezistal were immersed in boiling liquid air for ten minutes together with a piece of ordinary sheet steel and a piece of 25 per cent nickel steel. The 25 per cent nickel steel showed strong magnetic susceptibility (about the same as ordinary steel), but after removing it from the boiling air this effect was entirely gone in one minute. The three grades of Rezistal were not attracted by the magnet immediately after removing from the liquid air or when still immersed.

It was also found that while the ordinary sheet steel on being taken out of the liquid air was very brittle and could be snapped off with a pair of pliers, the new alloys and also 25 per cent nickel steel were apparently as tough as ever, showing no indication of brittleness. Therefore Rezistal can be described as tough and strong in all temperatures from — 185 to + 1,300 deg. C.,

TABLE I. CORROSION TESTS. LOSS IN MG. PER SQ.IN.

	Glacial Acetic	32 per Cent H_2SO_4	10 per Cent H_2SO_4	32 per Cent HNO_3	19 per Cent HCl	Cold Concentrated HNO_3	Water Saturated With Oxygen	Oxidizing Atmosphere at 1,100 deg. C.
Grade 5-2	2 0						0.00	.....
Grade 4-2	6 15	3 3	3 2	0 41	33 3	0 37	0.00	.....
Grade 3-2	0 33	6 3	5 4	0 50	41 0	0 36	0 00	+ 4.6
Grade 2-2	0 26	86 1	68 3	0 26	99 2	0 37	.....	+ 44.8
Grade 4-5	.....	.....	.....	.....	.....	.....	.....	— 0.3
Grade 5-1	.....	.....	.....	.....	.....	.....	.....	0.00
High Cr:Ni steel	7 93	Sol.	111 3	0 27	462 8	.....	.....	— 57.1
High Cr:Si steel	0 00	Sol.	.....	0 50	.....	.....	.....	.....
25 per cent Ni steel	7 81	9 0	11 0	Sol.	22 3	.....	.....	.....
38 per cent Ni steel	13 8	4 1	4 1	Sol.	19 0	.....	.....	.....
Wrought iron	19 3	Sol.	490 0	Sol.	261 5	.....	7 20	.....
Copper steel	12 2	96 3	73 4	Sol.	201 2	.....	.....	— 967
Monel metal	0 70	1 2	1 3	Sol.	13 1	.....	0 08	— 338
High Cr steel	0 67	Sol.	Sol.	0 10	457 3	.....	0 00	— 520



FIGS. 1 TO 5. TYPICAL MICROSTRUCTURE OF REZISTAL

Fig. 1. Ingot of grade 2. Brinell No. 179.
Fig. 2. Transverse section of sheet made from the same material as shown in Fig. 1.
Fig. 3. Hammered bar made from grade 2. Brinell number 228.

Fig. 4. Same as Fig. 3, after being held one month at approximately 900 deg. C. Brinell number 302.
Fig. 5. Grade 2, air-quenched after one hour at 1,100 deg. C. Brinell number 223.

which is a fairly good range. This ought to make very good material for bottles for transporting liquid air, as it did not become brittle at the lower temperatures.

PHYSICAL PROPERTIES

Figs. 1 to 5 show typical microstructures. Ingots show cored structure. Heat and work convert this into polyhedral crystals of a solid solution—sometimes laminated—which persists to high quenches, finally recrystallizing at about 400 deg. C. Quenching from five minutes at 1,300 deg. C. gives very coarse polyhedral grains with faint ghost-like markings suggesting the old location of bands of flattened crystals. The original paper gives many tests after various heat-treatments; from which the following in Table II have been selected to indicate what results can be had.

Modulus of elasticity of Rezistal is about 27,200,000 in tension and 11,700,000 in torsion. In 0.038-in. sheets (Brinell 244) it will stand three or four 90-deg. reverse bends, and can be bent flat around a pin four thicknesses in diameter without cracking. Various grades have impact strength of from 16 to 53 ft.-lb., being highest in specimens oil-quenched from 1,200 deg. C.

For machining, this steel should be heated at about 800 to 850 deg. C., held there until thoroughly heated and then allowed to cool to room temperature before it is taken out of the furnace. It can then be machined, drilled or milled with high-speed tools. For cutting to length, a friction saw running at high speed or a thin carborundum wheel can be used. The best method found so far is to use a thin metal slitting saw of

regular standard high-speed steel. This steel cannot be cut successfully with an ordinary hacksaw.

When annealing for cold-forming, the steel should be brought to a temperature of 1,150 to 1,200 deg. C. and

TABLE II. PHYSICAL PROPERTIES OF REZISTAL

Grade	State	Yield Point	Ultimate Strength	Elongation	Reduction in Area	Hardness (Brinell or Shore)
2-1	As rolled.....	107,300	146,900	25.5	40.1	302
2-1	Oil-quenched from 1,320 deg. C.....	56,600	109,500	67.5	67.5	187
3-2	As rolled.....	85,700	118,000	33	48.2	228
3-2	Oil-quenched from 1,040 deg. C.....	75,100	113,100	39	60	228
2-6	Air-quenched from 900 deg. C.....	79,600	130,200	33.5	28.3	50
2-6	Oil-quenched from 900 deg. C.....	75,800	137,900	38.05	33.9	50
2-6	Water-quenched from 900 deg. C.....	77,400	130,400	36.5	36.4	50
3-8	Water-quenched from 600 deg. C.....	111,600	126,900	25	37.9	55
3-8	Water-quenched from 850 deg. C.....	98,500	131,300	31	37.9	47
3-8	Water-quenched from 1,050 deg. C.....	78,700	120,700	45	45.7	40
3-8	Water-quenched from 1,200 deg. C.....	57,900	99,400	60	51.1	38
3-8	Air-cooled after 1 hr. at 1,300 deg. C.....	53,900	99,200	43.5	43.6	

held at this temperature for one-half hour in thicker sizes. In thin sheets it need not be held more than five or ten minutes; then turned over and held ten minutes more. It should then show a scleroscope hardness of 30.

This steel can be welded best with the oxyacetylene flame and a suitable flux, using a strip of the same material to fuse the edges together. The sand-blasted

or pickled sheets should weld the best; if scale be still on the sheets, it may interfere seriously with the welding. This material gives excellent welds on cast iron by the electrical welding method.

ESTABLISHED USES

Rails, racks and trays in enameling furnaces ranging from 1,600 to 1,800 deg. F. where ordinary steels scale heavily at these temperatures.

Valves and parts for internal combustion engines to resist high temperatures together with corrosive fumes.

Cooking utensils, such as pots, skillets, etc., that are to be kept bright.

Spatulas, paper cutters, trays in gas ranges that burn and rust readily when made of ordinary steel.

Vault plates and hinges that are to resist attack of oxy-acetylene flame and burglars' saws and drills.

Annealing and case-hardening boxes.

Flue dampers in furnace stacks.

Rivet-heating furnaces.

For instruments in all places where a steel is desired that is of the lowest magnetic susceptibility.

Containers for acetic acid and other corrosive organic acids.

Shafts for motor boats to resist sea water.

Paring knives for fruits and vegetables.

Rifle and shot gun barrels, stainless, non-rusting and non-corroding from ammunition.

Cast lead pots.

Cast cyanide pots.

Cast parts of rivet-heating furnaces.

Rust-resisting wire for umbrellas.

Wire of high electrical resistance (560 ohms per mil ft.).

Hardening trays for steel stamps.

PROPOSED USES

Boiler tubes—either water or fire tubes.

Boxes for safe deposit vaults.

Planes for aircraft, light and having great strength and ductility in thin sections for highly stressed parts.

Oil burners.

Tips for oxyacetylene cutting torches.

Roof gutters and conductors.

Check valves and valves of all kinds in steam lines.

Pipes and tanks for carrying commercial sulphuric and nitric acids at atmospheric temperatures.

Pipes for corrosive mine waters.

Pickling vats and rods for same.

Nails for resisting acids.

Hotel and kitchen cutlery, non-breakable, super-stainless, easily sharpened and requiring no heat-treatment by the cutlery manufacturer.

Saw-tooth bread and cake cutters.

Rust-resisting tapes.

Hot plates in laboratories, highly resistant to acid and heat attack.

Muffles for heat-treating furnaces operating at less than 1,100 deg. C. (2,000 deg. F.).

Hoods and running boards for automobiles.

Turbine blades.

Fertilizer pans.

Tubes for annealing needles.

Dies for die casting.

Pyrometer-protection tubes.

Valves and valve seats for steam traps.

Polished surfaces of flatirons.

Golfstick heads.

Hooks and wires for suspending parts to be hardened at high temperature, such as high-speed steel.

Perforated bottoms for tanners' tanks.

Art vases and statuettes.

Tunnels for manufacture of lamp black.

Wire spokes for automobiles, motorcycles, bicycles, etc.

Burial caskets.

Mine water pumps and machinery, highly resistant to cold sulphuric acid.

Castings for resistance to acetic, sulphuric and nitric acids at ordinary temperatures.

Castings to resist rusting at atmospheric temperatures and to resist scaling at temperatures up to 1,100 deg. C. (2,000 deg. F.).

Wire of great toughness and rust resistance, for mine cables and cables for incline planes.

Runners for ice boats.

Punties for polishing glass.

Rods for skimming brass.

Wire to stand red heat continuously in shoe machinery.

A Hardened Lead for Bearing Metal

IN DISCUSSING P. H. Brace's paper on Calcium¹ presented before the last meeting of the British Institute of Metals, R. T. Rolfe, a member, wrote that he was particularly interested in lead alloys containing calcium and other alkaline earth metals designed to replace ordinary tin-base alloys for bearing purposes.² This application apparently arose out of the war-time scarcity of tin. One of the proprietary alloys sold for this purpose which he had used experimentally for the lining of some main and connecting-rod bearings for a hot-bulb oil-engine gave on analysis the following results:

INGOT METAL AS RECEIVED

	Per Cent		Per Cent
Antimony	nil	Zinc	0.04
Arsenic	0.01	Magnesium	nil
Tin	nil	Barium	1.30
Copper	0.04	Calcium	0.79
Bismuth	nil	Lead	97.05
Aluminum	nil	Oxygen (difference)...	0.66
Iron	0.11		
Nickel	trace		100.00
Cobalt	nil		

This alloy was stated to contain "from 97 per cent to 98 per cent of lead, the balance being barium and calcium used as hardening elements," with which specification the analysis agreed very well.

A photomicrograph, magnified 150 diameters, of the alloy, etched with acid ferric chloride, is shown in Fig. 1, and depicts the hard spots of the intermetallic lead-alkali compound set in a lead matrix, the structure being thus typical of a normal bearing alloy.

The lead so hardened, which was manufactured by an electrolytic process, was certainly much harder than ordinary lead, as would be seen by the comparison below of the Shore and Brinell hardness figures of the two:

	Brinell Hardness Figures		Shore Hardness Figures	
	Load 500 Kg.	Load 1,000 Kg.	Ordinary Hammer	Magnifier Hammer
"Hardened" lead.....	31.2	26.5	7.5	13.5
Ordinary lead.....	8	(Unmeasurable)	2	3

Again, the "hardened lead," when struck by a hammer, emitted a distinct "steel-like" ring, in marked contrast with the note obtained from ordinary lead.

The alloy was stated to have been tested in properly

¹CHEM. & MET. ENG., vol. 25, p. 105 (July 20, 1921).

²Jour. Institute of Metals, vol. 25, p. 171.



FIG. 1. LEAD, ALLOYED WITH BARIUM AND CALCIUM. X 150. ETCHED WITH ACID FERRIC CHLORIDE

designed bearings up to a pressure of 6,000 lb. per sq.in., with satisfactory results.

Mr. Rolfe was not in a position to say how the bearings lined with this alloy compared in service with those lined with ordinary white metal of Admiralty composition. In the meantime there were several points which required consideration as regarded the possible replacement for bearing purposes of the ordinary white metals by such an alloy.

In melting this alloy there was an oxidation of the calcium and barium, much more dross being produced, particularly if any stirring was done, than with the tin-base alloys. The ultimate end would be that the hardening effect would disappear, the lead reverting to the ordinary variety. To avoid this, it was therefore advisable not to have a pot of the metal standing molten, but to melt down the required quantity at the moment it was to be used. It would appear that there was likely to be a certain amount of oxidation in the metal as manufactured, which would increase with remelting, some oxide being mechanically contained, the rest being rejected. It would be noted that, in the analysis of the metal first quoted, a deficiency of a little more than $\frac{1}{2}$ per cent, not found by a very careful search for any other possible metals, has therefore been described as "oxygen."

In lining the bearings referred to, a temperature of about 450 deg. C. was found to be the best at which to pour. It was necessary to have the mandrel fairly hot. If feeding was not properly done, a shrinkage cavity was left just below the point at which the metal was run in.

COST COMPARISONS

The alloy in question cost £100 per ton at a time when the cost of the white metal alloy of Admiralty composition (tin 85 per cent, copper 6.5 per cent, antimony 8.5 per cent) was £210 per ton. On the other hand, owing to the greater specific gravity of the lead alloy (11.04 against 7.20), the cost, volume for volume, became £167 for the lead alloy, as compared with £210 for a ton of Admiralty composition white metal. The "hardened lead" therefore showed a saving of about 20 per cent as compared with Admiralty white metal, but approached fairly closely in cost to some of the tin-base metals in which a proportion of lead was added, but which, however, were quite as satisfactory for general bearing purposes as the Admiralty alloy. For example, the alloy 70 per cent tin, 6 per cent antimony, 6 per cent copper and 18 per cent lead had been demonstrated by Mr. Rolfe to be as reliable in service as the other, while its cost would have been £180 as compared to £210 for the other.

"Hardened lead" was claimed to be a better bearing metal than tin-base alloys, although this appears doubtful. It would be seen, however, that there was no such advantage on the score of cost as might be expected from an alloy composed of about 98 per cent lead.

Permanency of hardness in this bearing alloy was said to be fully maintained after extended periods of use. The decrease in hardness up to 200 deg. C. was stated to be less than in the case of tin-base alloys.

There is at present no information on the relative corrodibility.

The writer would be much indebted to Mr. Brace if he could afford any further information, particularly as to the behavior of "hardened lead" bearings in serv-

ice, in, for example, high-speed inclosed engines, turbines, etc.

Mr. Brace also noted that alloys of this type had found successful application to crankshaft bearings in American automobile engines. Oxidation was so troublesome when casting thin sections that the Westinghouse company had not used these alloys to any extent. It found that whereas the Brinell hardness of freshly cast metal was about 12 (10 mm. ball, 500 kg. load) it increased to about 20 upon aging.

Regenerative Furnaces for Heat-Treating*

LIKE the thermally efficient gas or oil engine, the regenerative furnace has its limitations as well as its field of usefulness. It is an efficient type of furnace for releasing and utilizing heat from fuel, and is particularly suitable for the use of fuels, such as producer gas, which, by reason of chemical composition and low calorific intensity, will not produce high temperatures without regeneration.

The regenerative principle, by recovering a part of the sensible heat carried out of the heating chamber by the spent gases, and utilizing it to preheat the air or fuel, or both, permits a high hearth temperature and results in economy of fuel.

The regenerative furnace should be considered when the temperature and nature of the heating process, the size of the furnace, the cycle of operation or the plant conditions will not permit of a simpler or cheaper method of securing the result desired.

Regeneration, like recuperation, is really an indirect method of utilizing or recovering heat, and at times is limited to preheating the air alone, since certain fuels, such as natural gas and other hydrocarbon gases, cannot be preheated to the extent possible with producer gas. When the temperature requirements and plant conditions permit the use of furnaces with more direct methods of utilization or recovery, the regenerative principle is unnecessary. But where a high temperature is required, as for heavy forging, welding or melting operations, it is frequently necessary to resort to regeneration in order to establish a sufficient temperature differential, to increase the rate of heating, or to make possible the attainment of the desired working temperature, regardless of the saving in fuel or cost of furnace.

Considerable time is required to raise the temperature in the regenerative furnace from a comparatively cold condition to a relatively high working temperature. This is objectionable when the furnace is used only 8 or 10 hours per day, unless the heat is maintained between shifts to balance radiation and flue losses. Temperature requirements and the nature of the heating process or of the fuel may, however, make this furnace and practice desirable even under such intermittent operation. The objection does not hold when the furnace is operated continually at working temperature and capacity in two or more shifts.

Practically all regenerative furnaces are of the "batch" type, and therefore are limited in ability to maintain the chamber continually at full working capacity and at uniform temperature.

Regeneration should not be considered when the furnaces required are comparatively small and scattered. The floor space required for a regenerative furnace is

*Extracts from a bulletin (copyrighted) by W. S. Rockwell Co., entitled "The Variety of Furnaces."

relatively large, due to the area of the regenerators, reversing valves, flues and chimney, which frequently occupy a greater space than the furnace itself. This, with the heavier foundations required, must be considered with the production requirements, plant conditions and the space available for the furnaces, machines and operatives.

There is a limit in the size of a regenerative furnace below which it is impracticable to go, because the possible economy in fuel is outweighed by other considerations related to the cost of installation and operation.

The tendency to consider the regenerative or recuperative furnace as a possible solution of the so-called fuel problem should lead to consideration of conditions responsible for the limited use of such furnaces in the past and the extent of their use in the future.

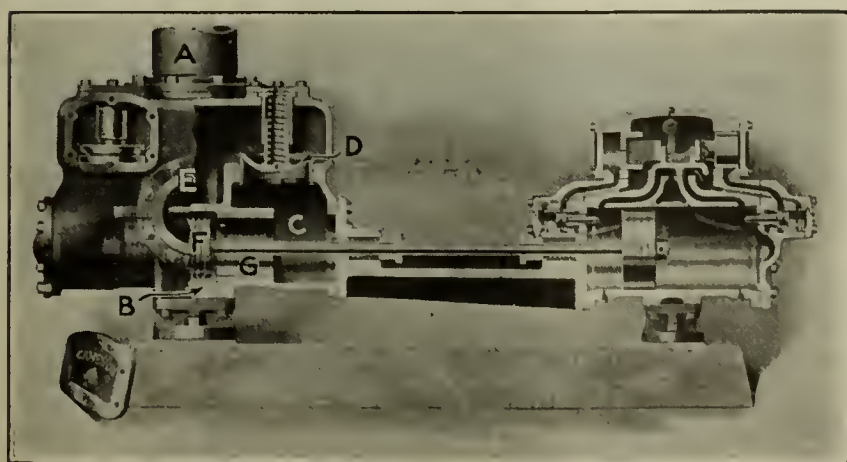
The flexibility of such highly concentrated fuels as natural gas and oil and their relative cheapness in the past made it possible for the manufacturer to conduct many of his heating operations without regard to fuel conservation. As fuel was cheap and apparently not worth saving, the regenerative furnace did not often appeal to him. Production, rather than cost of fuel, was the order of the day. This, with a relatively low labor cost and working conditions not now countenanced, have been responsible for the lack of progress in furnace design that should have followed as a matter of course.

Changing conditions and the demand for better quality and decreased cost, coupled with relatively higher prices for material, fuel and labor, will compel an increasing appreciation of all the factors that control the selection and use of furnaces and fuels for the production of heat-treated products.

Magma Pump

A special pump designed to handle viscous fluids such as tar, heavy crude oils, pulp, molasses, etc., has been developed recently by the A. S. Cameron Steam Pump Works.

These Cameron Magma pumps are of the direct-acting piston plunger type operated either with steam or compressed air. The pump end is of special construction, with ports of such generous proportions that



CAMERON MAGMA PUMP

the liquid and foreign matter, held in suspension, are afforded unimpeded passages; also the discharge valves, instead of being of the flat type, are bowl-shaped and easily reseal themselves by the inclosed valve spring when the piston starts in the reverse direction. These discharge valves are particularly simple in construction, operate in a vertical plane and are very accessible.

The pump cylinder has either a removable cast-iron

or bronze bushing through which a solid grooved piston works. The grooved piston has the effect of helping to keep the bushing lubricated, and also, as this pump is designed to handle viscous fluids, these grooves eliminate the necessity of packing of any kind.

Referring to the sectional view of the pump: *G* is the cylinder, *F* is the piston and *A* the port connected with the source of supply. The necessity for inlet valves is eliminated by having the pump placed below the level of the source of supply. In this way the fluid comes readily into the pump through port *A*. From port *A* it passes into chamber *B*. The piston *F* in its travel closes the port *B*, leaving the fluid free to pass into the opposite end of the cylinder *G*, in which a partial vacuum has been created. The return of the piston forces the fluid into chamber *C* and up through bowl valve *D*. The discharge opening is designated by the letter *E*.

The driving end is of the standard steam-thrown valve type used in other Cameron pumps.

Synopsis of Recent Chemical & Metallurgical Literature

Metallography of the Oxyacetylene Weld as Affected by Enameling.—In the July, 1921, issue of the *Journal of the American Ceramic Society* is an interesting article by Emerson P. Poste, on "The Metallography of the Oxyacetylene Weld as Affected by Enameling." A discussion of the cooling of steel through the critical range is followed by consideration of the general structure of low-carbon material and of mechanical and thermal treatment, including the statement of the essential conditions for annealing. The temperature reached by the steel in the enameling operation is discussed with reference to the annealing temperature. An examination of plates and welds before and after enameling shows that a thorough annealing of the weld is accomplished during the process.

Action of Titanium in Blast-Furnace Slags.—Much attention has been given to the possibilities of commercial utilization of titaniferous iron ores, in view of their abundance, accessibility, high iron content and unusually low sulphur and phosphorus. If the titanium could be handled, the pig iron resulting should be excellent for bessemer steel. Indeed such ores were used for centuries in certain European forges. Despite a 6-year campaign at Sanford Hill, Dr. Forbes' successful experiment in 1868 at Norton, England, Dr. Rossi's more recent work at Niagara Falls, N. Y., in 1914 and at Patea, New Zealand, titaniferous ores are not wanted by the modern blast-furnace plant.

In the course of studies at Queen's University, Kingston, Ont., it occurred to the investigators that a great commercial drawback is due to the fact that titanium is always reckoned as an acid substance in computing the burden, and a corresponding amount of limestone is added to neutralize it. High titanium in a charge thus meant large amounts of stone and a corresponding low iron. But from its chemical characteristics titanium should act either as an acid or a base, depending upon whether the slag were excessively basic or acid, respectively, much as alumina

TABLE I. TYPICAL SLAGS

	According to Stoughton	According to Feild and Royster	From McIntyre Furnace
FeO.....	33	35	3.46
SiO ₂	41	40	26.72
CaO.....	11	5.5	25.81
MgO.....	12	13	5.99
Al ₂ O ₃	..	..	11.86
TiO ₂	..	..	25.1

is now supposed to act in furnaces smelting copper or lead ores. W. M. Goodwin in vol. 13, *Transactions* of the Royal Society of Canada, June, 1921, reports some successful experiments designed to prove this supposition.

Comparison of a slag analysis from the McIntyre furnace in the Adirondacks with average analyses quoted in the literature (Table I) substantiated this contention.

An ore containing 67 per cent Fe_2O_3 and 11.8 per cent TiO_2 was therefore mixed with charcoal and sufficient silica sand to give a slag containing approximately 36 per cent SiO_2 , and smelted in a small arc furnace. Table II gives

TABLE II. RESULTS OF EXPERIMENTAL RUNS

	1	2	3	4
Slag Analysis: FeO	2.9	4.0	3.7	3.1
SiO ₂	44.5	35.3	35.6	36.2
CoO	7.0	6.0	8.1	8.4
MgO	13.2	12.1	10.8	10.6
Al ₂ O ₃	13.8	17.5	15.9	16.9
TiO ₂	17.4	26.1	25.6	21.7
MnO	0.3	0.3	0.6	0.4
Nature	Fluid	Fluid	Very fluid	Fluid
Pig Analysis: C	2.53	2.53	2.56	3.04
Si	4.99	3.91	1.28	1.90
Ti	0.02	0.02	0.01	0.01
Temperature, deg. C:				
Slag stream	1300	1200	1430	1390
Furnace lining	1360	1315	1325	1360

data on the results. Temperatures were taken by optical pyrometers, and for various reasons are thought to be considerably too low. Run 4 was chilled by too-rapid chargings, and the iron could not be tapped. However, all slags were quite fluid, despite the rather wide variation in composition, particularly the silica content. The iron should be suitable for some foundry purposes, or for steel making.

Recent Chemical & Metallurgical Patents

British Patents

For complete specifications of any British patent apply to the Superintendent, British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Oxyaldehydes.—Oxyaldehydes are prepared by the interaction of phenols or their derivatives with formaldehyde and a nitroso compound in the absence of an organic solvent. The preparation of vanillin by treating guaiacol and formaldehyde with p-nitrosodimethylaniline in aqueous hydrochloric acid solution is described. (Br. Pat. 164,715; not yet accepted. Société Chimique des Usines du Rhône, Paris. Aug. 4, 1921.)

Electrolytic Iron.—An electrolyte contains iron chloride and an aluminum salt or colloidal alumina. Aluminum chloride or sulphate may, for example, be added, or aluminum dissolved in the iron chloride solution. Hydrochloric acid may be added to redissolve precipitated alumina or to prevent its precipitation; or fresh aluminum salt may be added to compensate for precipitation. A suitable solution contains 200 to 250 g. of iron and 5 to 15 g. of aluminum per liter. Current densities of 5 to 10 amp. per sq.dm. may be used, and the temperature may be 75 to 80 deg. C. Cast iron anodes may be used. (Br. Pat. 164,725; not yet accepted. Société d'Electrochimie et d'Electrometallurgie, Paris. Aug. 4, 1921.)

Sodium Cyanide.—Sodium cyanide is obtained from mixtures or solutions containing it together with sodium chloride and alkaline earth compounds such as the product obtained by fusing calcium cyanamide with sodium chloride, by precipitating the alkaline earth by adding a suitable sodium salt, such as sodium sulphate or carbonate, and concentrating the solution at the same time, or subsequently so as to salt out the sodium chloride and leave the cyanide in solution. For this purpose sodium cyanide, or its mixture with sodium chloride, may be added to the solution. If an

excess of cyanide is used the part remaining undissolved may be recovered by leaching the remaining solids. (Br. Pat. 164,719; not yet accepted. Deutsche Gold und Silber-Scheide Anstalt, vorm. Rössler, Frankfurt-on-Main, Aug. 4, 1921.)

Electrolytic Chromium.—Chromium is deposited electrolytically from solutions of alkali chromites or mixtures of alkali chromites with other chromium compounds prepared by adding solutions of caustic alkalis to solutions of chromium salts. The alkali should be added in such quantity that the chromite formed is dissolved. In baths containing chrome alum or chromium sulphate, the green form should be used. (Br. Pat. 164,731; not yet accepted. E. Liebreich, Berlin. Aug. 4, 1921.)

Drying and Liquefying Nitrous Gases.—Water is removed from the gases produced by the oxidation of ammonia, to enable them to be condensed without injury to the refrigerating apparatus, by spraying with liquid nitrogen oxides in packed towers of known type. Preferably, the gases are first washed with nitric acid of less than 68 per cent strength to secure partial dehydration. Using gases containing from 1 to 19 per cent of nitrogen oxides and liquid nitrogen oxides, both at 15 deg. C., and with a preliminary washing with nitric acid of 15 to 50 per cent strength, the issuing gases are cooled to -2 to -20 deg. C., owing to the loss of latent heat of the evaporated nitrogen oxides. The gases, being practically free from water and nitrous and nitric acid vapors at this temperature, are then liquefied by cooling—for instance to -100 deg. C.—in a refrigerating apparatus such as is used for condensing nitrogen oxides obtained by the oxidation of nitrogen. A portion of the liquid nitrogen oxides so obtained is used for treating further quantities of nitrous gases. (Br. Pat. 164,734; not yet accepted. Officine Electrochimiche Dr. Rossi and C. Toniolo, Legnano, Italy. Aug. 4, 1921.)

Tropine Derivatives.—Tropinone monocarboxylic ester is obtained by partial saponification and elimination of carbon dioxide from tropinone dicarboxylic ester (which can be obtained by condensing together acetone dicarboxylic ester, succindialdehyde and methyl amine). In an example the dicarboxylic ester is boiled with alcoholic potash, acidified, supersaturated with ammonia, and the monocarboxylic ester isolated by extraction with ether or chlorinated hydrocarbons. (Br. Pat. 164,757; not yet accepted. Firm of E. Merck, O. Wolfes and H. Maeder, Darmstadt. Aug. 4, 1921.)

Artificial Silk.—Artificial silk filaments, threads and fibers of cellulose acetate and other esters of cellulose are treated with hot water or steam, solution of ammonium, calcium or potassium sulphocyanide, or acetic acid, and dried without tension, to render them more or less crinkled in appearance and softer to the touch and to reduce their luster, thereby obtaining a product resembling wool or hair. Water at a temperature of 80 deg. C. or at the boiling point may be used; solutions of the chemical substances are preferably used at ordinary temperatures. The threads may be wound into hanks before treatment, and the hanks may be cut into lengths and spun or twisted into chappe or spun silk form and afterward treated. (Br. Pat. 165,164. British Cellulose & Chemical Mfg. Co. Aug. 17, 1921.)

Tanning Fish Skins.—A process for tanning fish skins, such as the skins of catfish, skate, etc., consists in salting the skins; liming in a dilute solution, preferably softened with soda, the strength being progressively increased by additions of milk of lime; rinsing and, with or without puering, submitting to the action of a vegetable or chemical tanning agent which is only slightly acid or is neutralized. For chrome tanning, the skins are puered with weak chicken manure, then treated in a solution of sodium chloride to which hydrochloric acid is added gradually in increasing quantities. After soaking in soft water, the skins are then tanned in pure chromate in gradually increasing quantities, with or without the addition of hydrochloric acid. They are then washed in soft water and protected from the action of light, being subsequently treated with sodium thiosulphate or with soda and finally freed from acid by means of tepid water and chalk. (Br. Pat. 165,199. E. Knudsen, Orkadalen, Trondhjem, Norway. Aug. 17, 1921.)

Current Events

in the Chemical and Metallurgical Industries

Many Plants Resuming Operations

Glassware.—The Ball Bros. Glass Mfg. Co., Muncie, Ind., manufacturer of fruit jars, is arranging for the immediate resumption of operations at its plant, giving employment to about 1,000 workers. For some time past only about 200 operatives have been engaged at the plant.

The Lippincott Glass Co., Alexandria, Ind., has resumed the operation of its 20-pot furnace, giving employment to about 300 persons on a division of time. It is planned to place all departments in service at an early date, with working force totaling about 500 men.

The Kane Window Glass Co., Kane, Pa., has resumed production at its plant, with employment of about 250 men. The American Window Glass Co., in the same city, has arranged for the immediate operation of a portion of its plant, employing about the same number of operatives.

Ceramic.—The Metropolitan Paving Brick Co., Canton, Pa., has placed its entire seven plants in operation for the first time in several years.

The W. S. George Pottery Co., Canonsburg, Pa., is operating on a normal basis, with employment of the usual working force. The Canonsburg Pottery Co., with plant on Meadow Lane, is also engaging under normal production.

The Standard Sanitary Manufacturing Co., Louisville, Ky., has adopted a night working schedule at its plant, giving employment to about 100 men. It is expected to increase this number to about 400 operatives gradually.

Rubber.—The New Jersey Rubber Co., Lambertville, N. J., has adopted a night schedule of operation at its mill on certain days.

Paper.—The Jessup & Moore Paper Co., Wilmington, Del., has resumed production under a 24-hour working schedule at its local paper mills, and at its pulp mills at New Castle, Del. Increased operations are also under way at the company's plants at Providence and Elkton, Md.

Metal.—The National Enameling & Stamping Co., Granite City, Ill., has resumed operations at its plant, following a shut-down for several months. Three furnaces will be used at the present time.

Sugar.—The American Sugar Refining Co., 117 Wall St., New York, N. Y., has resumed operations at its Chalmette refinery, following a shut-down of several weeks. All of the other refineries of the company are now in operation.

The Chemical Welfare of America

A very strong plea for the continuation of the license system, covering the admission of dyes and fine organic chemicals into the United States, was made Thursday noon, Oct. 13, by Dr. Ellwood Hendrick in an address before the Rochester Chamber of Commerce on the subject "The Chemical Welfare of America."

The license system was adopted at the request of President Wilson and was continued at the request of President Harding. It is virtually an embargo against German dyes and fine chemicals, but it permits importation of any chemical or dye which is not produced in the United States in quality, quantity or at a price making it desirable for use. Dr. Hendrick pointed out that if this embargo is not renewed when it expires Germany is in a position to flood the United States with dyes manufactured with cheap labor and from cheap raw materials so that within two weeks the dye industry of this country would be wrecked.

The history of the dye industry from its beginning in England in 1856 was outlined. Dr. Hendrick showed clearly how that "key" industry fell into the hands of capitalists who, of course, immediately eliminated all scientific research work and operated simply on a money-making basis.

The Germans, being rich after the Franco-Prussian war,

took up the dye industry and developed the scientific side. So within the period of the following forty years they not only developed the science of dye chemistry to a very high point but evolved the many chemical byproducts which are now common drugs, medicines and other useful organic chemicals. But the Germans also developed a new line of research which was unknown to the world until the fateful fall of Liège—the making of poison gases. These are direct products from the experimentation carried on in the dye factories of Germany.

Between 90 and 95 per cent of all the dyes needed can now be manufactured without difficulty in the United States, and these dyes can be made at a cost which will not unnecessarily add to the cost of the dyed materials. Two cents worth of dye will color a dozen pairs of stockings and the cost of dye for an excellent suit of clothes never exceeds the half-dollar mark. So the cost of dyes becomes a very insignificant factor. Labor costs, being high, tend to make the American dyer skimp in the use of his dyes and complaints result.

The plea for the preservation of the dye and organic chemical industry in the United States is not based alone on the value of this industry in its production of dyes and chemicals but on the fact that the plants stand always at the command of the Government, not to recruit or train soldiers or to incite warlike feeling, but as laboratories where scientific research may be continually carried on and which will immediately become arsenals of chemical warfare munitions.

Naturally everyone sincerely hopes that war will never come again, but should such a frightful thing occur the country that is making the greatest progress in science will be best equipped to turn out munitions of the nature that will insure its success.

Agreements for the limitation of armaments or elimination of chemical warfare are very good as far as they go. However, wars usually follow the breaking of contracts between nations and "when once the fight is on the lid is off."

"The opponents of the license system include the owners of certain woolen mills, the Amoskeag Company of New Hampshire and a number of sincere persons who are uninformed on the subject and who, like most of us, hate the word embargo," said Dr. Hendrick. "I would not number among those uninformed persons Senator Moses of New Hampshire, who, whatever his motives may be, conducts himself like an attorney for the Amoskeag Company, and leads the opposition for the licensing system."

"In favor of the continuance of the license system you will find the American Chemical Society, the American Drug Manufacturers Association and countless other organizations as well as large numbers of individuals who are fully informed on the real situation."

Over one hundred members of the Rochester Section of the American Chemical Society were in attendance with the business men to hear Dr. Hendrick.

Conference on Soap Specifications Planned

The soap section of the American Specialty Manufacturers' Association, which represents 90 per cent of the soap manufacturers of the country, has appointed a committee consisting of A. Campbell, of the Globe Soap Co., St. Bernard, Ohio, chairman; W. H. Raymond, of Armour & Co., Chicago; H. M. Thayer, of N. K. Fairbank & Co., Chicago, to confer with soap chemists of the Bureau of Standards of the Department of Commerce relative to the revision of soap specifications which are contained in Bureau of Standards Circular 62, issued in 1916. It is expected that a conference with the committee will be arranged shortly.

Industrial Cost Association to Meet

From Nov. 2 to 4 the Industrial Cost Association will hold its second National Cost Conference at the William Penn Hotel, Pittsburgh. Sessions will be open to members and executives and department heads of industrial plants. The advance program follows:

WEDNESDAY, NOV. 2

10:30 a. m. Opening of conference. Address by Horace S. Peck, comptroller, S-K-F Industries, Inc., New York, and national president, Industrial Cost Association.

1:45 p. m. Address of welcome. E. V. Babcock, Mayor of Pittsburgh and president, Babcock Lumber Co.

2:15 p. m. "What the Sales Manager Should Have From the Accounting Department," S. B. Taylor, general sales manager, S-K-F Industries, Inc., New York City.

4:15 p. m. "Inventories: Methods of Completing the Physical Count," E. C. Grimley, Victor Talking Machine Co., Camden, N. J. Discussion led by Christopher Haigh, supervisor of costs, General Electric Co., West Lynn, Mass.

8 p. m. "Responsibility of the Comptroller or Accountant in Times of Business Depression," F. S. Willett, comptroller, Dodge Manufacturing Co., Mishawaka, Ind. Discussion led by F. C. Poag, analyst, Allied Chemical & Dye Corporation, New York.

9:30 p. m. "Idleness and Its Relation to Industry, in Retrospect," T. W. Dinlocker, assistant comptroller, S-K-F Industries, Inc., New York, and A. W. Wainwright, works auditor, Skayef Ball Bearing Co., Hartford, Conn.

THURSDAY, NOV. 3

9 a. m. "Terminology," Addison Boren, Yale & Towne Manufacturing Co., Stamford, Conn., chairman, National Terminology Committee, Industrial Cost Association.

10 a. m. "Budgeting the Plant and Office," H. S. Breitenstein, chief accountant, Bureau of Accounting Revision, Department of Controller, City of Pittsburgh. Discussion led by Weston J. Hibbs, treasurer, U. G. I. Contracting Co., Philadelphia.

2 p. m. "Sanitation and Safety," J. B. Ayres, sanitation and safety engineer, National Tube Co., National Works, McKeesport, Pa. "Cost and Profits of Welfare, Sanitation and Safety," Major William Hogg, assistant to vice-president, National Tube Co., Pittsburgh, Pa.

7 p. m. Informal banquet, President Peck, toastmaster. "Looking Into the Future," Newcomb Carlton, president, Western Union Telegraph Co., New York. "Federal Taxation," Sanford Robinson, New York City.

FRIDAY, NOV. 4

9 a. m. "How Can a Cost System, Although Efficient, Demoralize an Organization?" J. M. Howell, supervisor of costs, General Electric Co., Schenectady, N. Y. Discussion led by Ernest J. Wessen, cost engineer, W. T. Rawleigh Co., Freeport, Ill.

10:30 a. m. Reports of committees on "Distribution of Burden in Abnormal Times," "Trade Association Uniform Cost Systems," etc.

2 p. m. Plant visits.

All those planning to attend the conference are requested to notify immediately the national secretary, A. A. Alles, Jr., 2828 Smallman St., Pittsburgh, Pa.

Industrial Electric Heating Directory Planned

The Industrial Heating Division of the Power Sales Bureau of the National Electric Light Association is about to compile a directory of manufacturers and users of industrial electric heating equipment.

This includes the following equipment which is electrically heated: Steel furnaces, non-ferrous furnaces, heat-treating furnaces, japanning ovens, drying ovens, core ovens, bread-baking ovens (commercial), welding, rivet heating, electrochemical equipment.

Manufacturers and users of such equipment are requested to furnish data to R. T. Kaighin, care of Cleveland Electric Illuminating Co., Cleveland, Ohio.

Program, American Gas Association Meeting

The third annual convention and exhibition of the American Gas Association will be held in Chicago, Nov. 7 to 12, with headquarters at the Congress and Auditorium hotels. The following program has been arranged for the Technical Section:

WEDNESDAY AFTERNOON, NOV. 9, 2 O'CLOCK

Opening remarks and report of chairman, R. B. Harper, Peoples Gas Light & Coke Co., Chicago, Ill.

Report of nominating committee and election of officers, L. R. Dutton, chairman, Philadelphia Suburban Gas & Electric Co., Jenkintown, Pa.

Paper: "What Goes On in a Water Gas Machine?" M. E. Benesh, Peoples Gas Light & Coke Co., Chicago, Ill.

Report of committee on complete gasification of coal, A. W. Warner, chairman, Philadelphia Suburban Gas & Electric Co., Chester, Pa.

Report of gas oil committee, W. H. Fulweiler, chairman, United Gas Improvement Co., Philadelphia, Pa.

Report of refractory materials committee, W. H. Fulweiler, chairman, United Gas Improvement Co., Philadelphia, Pa.

THURSDAY AFTERNOON, NOV. 10, 2 O'CLOCK

Report of committee on increasing distribution capacity, C. N. Chubb, chairman, United Light & Railways Co., Davenport, Ia.

Paper: "Utilization of Compressed Air for Clearing Gas Piping," J. T. Griffin, Consolidated Gas, Electric Light & Power Co., Baltimore, Md.

Report of committee on consumers' meters, J. A. Clark, Jr., chairman, Public Service Gas Co., Newark, N. J.

Report of cast-iron pipe standards committee, Walton Forstall, chairman, United Gas Improvement Co., Philadelphia, Pa.

THURSDAY AFTERNOON, NOV. 10, 2 O'CLOCK

Report of chemical committee, C. A. Lunn, chairman, Consolidated Gas Co., New York, N. Y.

Report of purification committee, A. C. Fieldner, chairman, Bureau of Mines, Pittsburgh, Pa.

Effect of moisture on activity and capacity of iron oxides for gas purification, William A. Dunkley, Bureau of Mines, Urbana, Ill.

Seaboard liquid process for gas purification, F. W. Sperr, Jr., Koppers Co., Pittsburgh, Pa.

Determination of hydrogen sulphide in illuminating gas, C. W. Jordan, United Gas Improvement Co., Philadelphia, Pa., and W. H. Fulweiler, United Gas Improvement Co., Philadelphia, Pa.

FRIDAY AFTERNOON, NOV. 11, 2 O'CLOCK

Paper: "Some Experiments With the Mixing of Different Gravity Gases in Holders," H. E. Bates, assistant to engineer, Peoples Gas Light & Coke Co., Chicago, Ill.

Report of committee on deposits in gas pipes and meters, O. A. Morhous, chairman, Consolidated Gas Co., Astoria, L. I., N. Y.

Report of carbonization committee, J. Hawley Taussig, chairman, U. G. I. Contracting Co., Philadelphia, Pa.

Report of committee on disposal of waste from gas plants, F. W. Sperr, Jr., chairman, Koppers Co., Pittsburgh, Pa.

In addition, a paper, "Why Should Gas Companies Sell Their Tar to Distillers Instead of Working It Themselves?" by R. P. Perry, vice-president The Barrett Co., will be presented at the general session, Thursday morning, Nov. 10, at 10 o'clock.

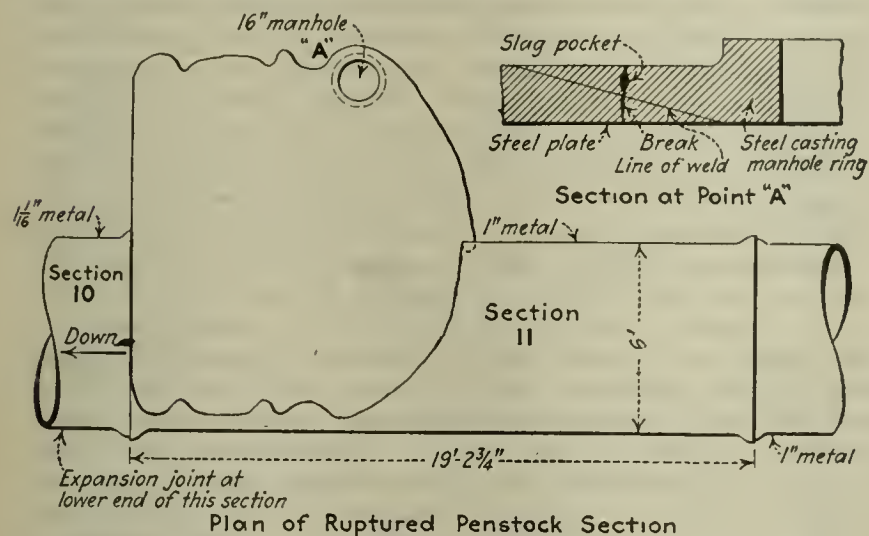
To Study Medicinal Properties of Gases

Studies of the physiological effects of war gases has led some of the chemists of the Chemical Warfare Service to believe that certain gases may be beneficial in the treatment of diseases of the nose, throat and lungs. Some research along that line is to be attempted at Edgewood and General Fries is acquainting medical schools and research institutions with these findings in the hope that they may take up experiments of that character.

Hammer-Welded Joints in Penstock Withstand Bursting Pressures

Engineering News-Record for Oct. 20, 1921, reports the bursting of a 6 ft. hammer-welded penstock on the Big Creek No. 8 hydro-electric plant of the Southern California Edison Co. The break occurred immediately after a short circuit on the electrical system had caused a corresponding disturbance in the hydraulic lines; in fact, the conditions were such that a severe water hammer may easily have caused excessive pressure in the pipe. The static head at the point in question was 560 ft., the pipe had passed a shop test 50 per cent in excess of this load, and the completed penstock had been tested under full static head without indicating any weakness.

A sketch of the pipe, furnished by the M. W. Kellogg Co., the maker, is shown in the accompanying illustration.



Early reports stated that near point A, a $\frac{1}{2} \times 2\frac{1}{2}$ -in. discoloration on the fracture indicated a defect in the weld between plate and manhole casting. Microscopic examination of the metal by the New York Testing Laboratories showed this defect to be an accumulation of slag inclusions in the cast metal. Doubtless this defect was responsible for initiating the tear. The break passed along the manhole-ring casting, but did not cut across the ring. Except at this manhole, the break did not follow welded joints, but went through original metal. The longitudinal tear crossed a circumferential weld, and the circumferential part of the break occurred about a foot beyond that weld. In all there were 5,000 lin.ft. of hammer-welded joint in the penstock, none of which gave any evidence of weakness under the unusual stresses set up by the accident.

Labor Troubles in the German Chemical Industry

A message from Frankfort-on-Main says that the Chemical Industry Employers' Union and representatives of the workers' unions have come to an agreement respecting the resumption of work in the factories which have been closed—the Chemische Fabrik Griesheim-Elektron at Griesheim, the Farbwerke Hoechst and the Vereinigte Kunstseidefabriken Kelsterbach.

The agreement is based on the chemical industry's imperial tariff and the chemical industry's district agreement. The reinstatement of the dismissed workers will take place as requirements demand and as the managements of the works shall decide. No indemnification for the days lost will be paid.

The staff of the Griesheim-Elektron works has rejected this agreement by 1,202 to 236 votes, but less than 50 per cent of the workers used their votes.

Dye and Chemical Control Extended

By an overwhelming vote on Oct. 18 the House of Representatives passed the bill extending until Feb. 1 the emergency tariff bill, one section of which authorizes the control of the imports of dyes and certain chemicals. The dye control feature of the bill did not receive general discussion, although Representative Frear of Wisconsin took advantage of the opportunity to denounce the Chemical

Foundation and the embargo plan of protecting the dye industry. Mr. Frear took exception to remarks attributed to Mr. Garvan intimating that the German dye trust is able to influence members of the United States Senate and House of Representatives. So far as his own attitude is concerned, Mr. Frear stated, he is influenced "by the fact that the American public was paying four prices for its dyes and poor dyes at that."

In the course of his remarks Mr. Frear intimated that the investigation of the so-called dye lobby authorized in July might be taken up in the near future.

Glass Standardization Conference

Standardization of the different kinds, qualities and sizes of window and plate glass used as a building material and for many other purposes was discussed at a conference of glass distributors, architects and engineers of the Bureau of Standards of the Department of Commerce held on Oct. 19, at the Bureau of Standards.

Confusion is declared to exist in the glass and glazing fields so far as qualities and sizes of glass are concerned, and this conference outlined a program that will be participated in by the manufacturers, distributors, architects and the Bureau of Standards, and which it is believed will result in the elimination of unnecessary sizes, standardize quality and enable a more efficient use of this building material.

The task, as outlined at the conference, included the formation of a commercially usable scientific classification of glass. At present building glass is classified as rolled plate glass, blown cylinder or drawn sheet glass. The plate glass includes polished glass ranging in grade from that used for the highest quality mirrors to that used for skylights, different kinds of glass in which wire netting has been placed to prevent shattering and ornamental glass of various sorts. The drawn sheet glass is used for windows in different qualities.

Committees were designated by the conference to gather data on and consider different phases of the window and plate glass situation.

At a later date after the committees have had time to accomplish something, another conference will be called.

Those present at the conference were: J. W. Ginder, office of the Supervising Architect; Sullivan W. Jones, American Institute of Architects; S. F. Voorhees, American Institute of Architects; George H. Mayer, American Window Glass Co., Pittsburgh, Pa.; W. C. McCance, local manager, Pittsburgh Plate Glass Co., Baltimore, Md.; S. C. Gilmore, secretary, Hires-Turner Glass Co.; R. W. Spille, local manager, Hires-Turner Glass Co.; L. P. Forman, American Window Glass Co., Pittsburgh, Pa.; R. J. Potbury, Bureau of Yards and Docks, Navy Department; F. C. Brown, N. F. Harriman, P. H. Bates, W. A. Hull and A. E. Williams of the Bureau of Standards.

New Chemical and Oil Companies

During the month of September 35 new companies, with capital of \$50,000 or over, were organized to manufacture chemicals, chemical byproducts, dyes and affiliated products. The total capitalization was \$7,450,000, as compared with an aggregate capital of \$7,720,000 for 37 companies organized in the same month of last year and \$15,495,000 aggregate capitalization of companies in this line organized in August, 1921. The indicated investment of companies in the chemical industry for the first nine months of the present year, January-September, totals \$91,835,000, as against \$175,642,000 for the corresponding period of a year ago.

Oil companies organized during the same month of September, 1921, totaled 66, with an authorized capital of \$50,000 or larger. The total indicated investment of the companies stands at \$53,862,000, as compared with \$136,100,000 in the same month of a year ago and \$141,544,000 in August of the present year. It is the third lowest month for organizations of this character in 1921, the peak month of which was April, with total indicated capitalization of companies of \$227,470,000. For the first nine months of the present year the indicated capital investment aggregates \$1,046,463,600, divided among 752 organizations. In the corresponding period of 1920, 2,212 companies were formed, with a combined authorized capital of \$1,913,976,700.

Personal

J. O. ELTON, recently assistant manager of the Great Falls smelter of the Anaconda Copper Mining Co., is assistant general manager for the International Smelting Co., succeeding O. M. Kuchs.

C. POWELL KARR, metallurgist with the Bureau of Standards and an authority on non-ferrous alloys, has been appointed a member of the engineering committee of the National Research Council, which has to do with investigations of molding sand and foundry refractories.

O. M. KUCHS, who has been assistant general manager in Utah for the International Smelting Co., has become general manager for the Andes Copper Mining Co., with headquarters at Potrerillos, Chile. He sails from New York on Oct. 26.

H. C. PARMELEE addressed the junior and senior classes in chemical engineering at the Sheffield Scientific School of Yale University, Oct. 19.

FLOYD W. PARSONS has been appointed editorial director of *Gas Age-Record*. Formerly Mr. Parsons was editor of *Coal Age*, one of the McGraw-Hill engineering publications, and later conducted a department in the *Saturday Evening Post* under the title "Everybody's Business."

W. N. WATSON and C. F. NORTH, chemists for the U. S. Tariff Commission, have been transferred to the Treasury Department for work in New York in connection with the special investigation of American valuation.

S. L. WILLIS, who was formerly in charge of ceramic investigations for the U. S. Tariff Commission, has resigned to accept a position with the Corning Glass Co.

W. W. WITMER has recently become associated with the Hoskins Process Development Co., Chicago. Since graduating at Purdue University in 1909 Mr. Witmer has been employed by the du Pont company. He has been located at Repauno, N. J., Barksdale, Wis., Louviers, Col., and du Pont, Wash., holding positions ranging from chemist to assistant manager of the Barksdale plant.

Obituary

Colonel SPENCER BORDEN, chemist and manufacturer, of Fall River, Mass., died suddenly of heart trouble at the Woodstock Inn, Woodstock, Vt., on Oct. 17. He had been associated with Thomas A. Edison in his early work and had organized the New England branch of the latter's business. Colonel Borden was seventy-two years old.

JOHN G. LUKE, president of the West Virginia Pulp & Paper Co. and a pioneer manufacturer of sulphite pulp, died on Oct. 15 in St. Luke's Hospital in New York City, following an operation two weeks previously for appendicitis. Mr. Luke was born on April 29, 1857, in Rockland, Del., where his father was employed as superintendent of the mills of the Jessup & Moore Paper Co. The son entered the employ of this mill at the age of sixteen, and subsequently worked in several of the largest paper mills in this country. As superintendent of the Richmond Paper Co. of Richmond, Va., he became familiar with the sulphite process, which was then in an experimental stage, and from the experience gained in this plant he organized his own company and built a mill at Piedmont, W. Va. This was the beginning of the West Virginia Pulp & Paper Co.

Prof. J. ERNEST WOODLAND, head of the science department of Mechanics Institute of Rochester, N. Y., died on Oct. 17 of apoplexy. Prof. Woodland, who was fifty-five years of age, was formerly a member of the faculty of the University of Rochester and at one time was chairman of the Rochester Section of the American Chemical Society.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, Oct. 24, 1921.

The pending railroad strike stimulated buying of chemicals during the past week and the market has shown more action than at any time so far this year. The movement gained more strength as the week progressed and in some directions demand has been greater than the available supply of material. There were some, however, who viewed the situation quite pessimistically and believed that should the controversy be straightened out before the time set for the walkout, conditions would be far more serious than the recent depression. Consumers all around are showing an added interest, and indications clearly point to a steady development. The recovery in prices made by various basic chemicals is significant that the reaction has about been completed and those close to the pulse of trading are convinced that production is well adjusted and that normality in market conditions is only a matter of a short time. The most encouraging feature at present is the interest shown by the leading domestic consumers, and among these are the paper, paint and soap industries. Paper mills have been buying in larger volume during the past few weeks and bleaching powder manufacturers have found a steady market for their entire output. Soap-makers have purchased large quantities of imported caustic potash and were eager to stock up additional quantities at the close of the week. The textile industry has been a steady buyer of chemicals, but purchases were chiefly for small quantities.

CHEMICALS

Prices on *caustic potash*, 88-92 per cent, have once more regained their steadiness under an improved consuming inquiry for spot and future shipments. Some material was available at 5½c. per lb. for imported, but the general quotation among first-hand holders was 6c. Factors in this product believe that the market is slated for considerably higher prices before the turn of the year. Shipments were nominal, with 5½c. asked subject to cable confirmation. *Bichromate of soda* is slightly higher on spot, with sales recorded at 7½c. per lb. The demand for this product is increasing and sellers state that they have received a greater amount of inquiries during the past week. Producers quote the market at 8c. per lb. Spot supplies of *cyanide of soda*, imported, are very scarce and the market is decidedly stronger and higher. German 120 per cent is quoted at 25c. per lb., which is considered an inside price by the few holders of spot material. Goods afloat are held at 22c. per lb. For the 128 per cent German make afloat 25c. per lb. was named. French 125-128 per cent for shipment is offered at 23c. per lb. Prices on *nitrite of soda* are somewhat firmer and business is reported slightly better, even though actual orders call for small quantities only. Sellers quote the domestic brands at 6¾c. per lb. and the imported at 6½c. Prices on *prussiate of soda* have advanced sharply since the beginning of the week under an active inquiry and a scarcity of supplies. Holders are asking up to 15c. per lb. for imported material. Sales of spot goods are reported as high as 14½c. per lb. and this price is also named for October shipment from abroad. November-December shipments are held at 14½c. per lb. The demand for solid *caustic soda* has continued quite active so far this month. While there still are a few lots at 4c. per lb., the majority of holders are above this level for standard brand goods and quote \$4.05 per 100 lb. ex-store. Sales of outside brands have gone through at \$3.90 per 100 lb., but these are fast dwindling from the market. Manufacturers are still quoting unchanged figures at the works for contracts over the year. Spot *ammonium sulphate* in double bags for export is quite difficult to locate and odd lots picked up here and there have brought \$2.75 per 100 lb. Makers are quoting single bags at \$2.75 per 100 lb. ex-dock New

York for small quantities. The market is in an extremely firm position with supplies almost impossible to find and demand very acute both from domestic and export buyers. Prices on *barium chloride* from abroad have been much firmer and quotations from importers are higher at \$46@ \$49 per ton for prime material. Domestic makers are still unable to compete. Prices on *nitrate of soda* are much firmer. Importers have announced an advance in price for futures, but have not named any definite quotation. Spot and future deliveries are higher at \$2.35@ \$2.45 per 100 lb. Imported *permanganate of potash* U.S.P. is quoted lower at 18c. per lb. Single bags of light *soda ash* in less than carload lots are moving freely at \$2.10 per 100 lb. and upward. Large dealers state that 2c. per lb. could probably be done for carlots, although the tone of the market is quite firm. Sales of barrels are reported at \$2.45@ \$2.50 per 100 lb. Prices remain unchanged at the works. Trading in *glycerine* during the week was very light, with little variation in price. Dynamite sold at 12c. per lb. and c.p. at 14½c. per lb. in drums. Leading producers of *copper sulphate* are still quoting at the former basis of 5½c. per lb. for carload quantities of standard 99 per cent. large crystals. The tone of the market is somewhat firmer with the advance in copper. There were quantities of imported material on the spot market that sold down to 5c. per lb., but these are being taken off the market very quickly.

COAL-TAR PRODUCTS

Buying in the coal-tar products industry has been somewhat spotty, with a lack of interest noted early in the week and a decided improvement during the last few days. The latter part of the week was experienced by a constant increase in the number of orders and inquiries and the market all around reflected a renewed activity to a considerable extent. The definite extension of the provisions of the emergency tariff until Feb. 1, 1922, is expected to lead to some fairly good buying, as most consumers have been holding off purchasing until some definite action had been taken. The scarcity of benzene is affecting production of many other products and in some instances makers have had to shut down until supplies can be procured. Resale stocks of most commodities are being taken off the market gradually and makers seem well satisfied with this method of obtaining normality in the market. Prices are generally quoted at former levels, but real business is being transacted at slightly under listed prices. The demand for *benzene* is exceeding the supply and no immediate relief can be seen in view of the present output of coke ovens, which even with the recent increase is only at 25 per cent normal. Resale stocks are very hard to locate and are generally held at 40c. per gal. Refiners' prices for future delivery are 27@33c. per gal. A slight improvement in *naphthalene flakes* was reported, but the balls have remained dormant. Some sellers are inclined to be firmer in their views, but supplies are still plentiful and sales around 6½c. per lb. are still being made. First hands ask up to 8c. per lb., but not very much business is being placed at these levels. Official Government resellers of *phenol* ask 12c. per lb., but prime goods on the open market can be had down to 9½c. per lb. There were a few sales recorded at 9c. per lb. during the past few days and the inquiry seems to be increasing. Resale stocks of *aniline oil* are large and buying must become far more active before the market can be called steady, even though there is a scarcity of benzene. The general asking price is 18c. per lb., but sales were made at the close of the week down to 17c. per lb. Resellers of *dimethylaniline* are obtaining the passing business at 41c. per lb., which is about 5c. per lb. under the makers. The demand is fairly active and the market is a trifle firmer, as most of the second-hand material is being cleared off the market. Manufacturers of *dinitrobenzene* have sold as low as 21c. per lb. during the week on actual business. Quotations, however, are given at 23@25c. per lb., according to brand and quantity. Producers of *paranitraniline* are quoting former prices of 77@80c. per lb. according to brand. Business around the trade on this product has been more or less fair, but rumors of imported German goods at ridiculously low figures have put a dent in any real trading.

The Chicago Market

CHICAGO, Oct. 21, 1921.

There was little or no change in the general chemical market during the past two weeks. Most factors report a very good volume of business and all are apparently satisfied. The bulk of the business continues to be for small quantities but occasionally a large order is noted. Prices are firm as a rule although with actual business in sight many of the regular prices can be shaded. This is noticeable especially among the smaller factors. The railroad situation is firming up prices and any radical reductions can scarcely be expected for some time. The fact that quite a few speculators are taking on rather heavy stocks shows that at least some are expecting a rising market.

INDUSTRIAL CHEMICALS

The *caustic soda* situation lacks new developments and prices are unchanged. Supplies are not heavy and 4½c. for the ground 76 per cent and 4c. for the solid were the best prices noted. *Soda ash* continues to move well and is firm at \$2.60 per 100 lb. for material in cooperage. *Potash alum* appears to be enjoying a good demand and 5½c. per lb. for the lump and 6½c. for the powdered were the prevailing quotations. *Sal ammoniac* is rather quiet and supplies are available at 7½c@7¾c. per lb. for the white granular 98-100 per cent. There was a brisk demand for *carbon tetrachloride* and 10½c. for large drums was the inside figure. *Formaldehyde* is still very quiet, with 12c. per lb. the figure generally named, although this could probably be shaded slightly. *Glycerine* has shown but little activity and the price lacks quotable change. Refiners are asking 14½c.@14¾c. per lb. for the large drums.

Caustic potash continues firm and unchanged in price, with supplies available at 6½c. per lb. for the 88-92 per cent grade. *Potassium bichromate* is quoted at 13c.@13½c. per lb. and the soda at 9½c. for single casks. A decline of 1c. per lb. was noted in some quarters on *potassium permanganate*, and U.S.P. crystals of foreign origin are now available at 23c. for small lots. *Bicarbonate of soda* is offered at \$2.60 per 100 lb. for single barrels. *Sodium fluoride* is not so active, but prices are unchanged at 11c.@12c. per lb. according to quantity. *Zinc sulphate* is quiet at 3½c. per lb. for the tech. cryst. in single barrel lots.

No changes of any consequence were noted in the list of acids. Supplies are plentiful and are said to be moving well. *Acetic acid* is firm, with supplies of the 28 per cent available at \$2.65@ \$2.75 per 100 lb. and glacial at \$10.25 to \$10.75. *Oxalic acid* is in fair demand at 17c. per lb. *Citric* and *tartaric acids* are very quiet, with domestic makers apparently in control of the market. *Hydrochloric acid* is quiet and unchanged as to price.

The Iron and Steel Market

PITTSBURGH, Oct. 21, 1921.

There has been very little change in the iron and steel market situation in the past week. There was such steady increase in demand after the turn that occurred about the middle of July that a failure in the market to improve seems very like a backset, and this may account for the somewhat unfavorable view of the market situation entertained in some quarters this week.

There is no evidence, however, that demand for steel products has actually fallen off in any particular. The record of production up to this week is one of practically constant increases. Steel ingot production seems now to be at somewhat more than 35 per cent of capacity, this comparing with an average rate of about 32 per cent in September, while at the low point, about the middle of last July, the rate was under 20 per cent.

As everyone is more or less interested in the threat of a railroad strike, beginning October 30, there has naturally been an effort to discern an influence of the strike talk upon the state of the steel market. It does not appear, however, that the actual market has taken much cognizance of the possibility of a railroad strike, and that is natural enough after all, for what should a buyer or seller do if he expects a railroad strike? Should he buy or not buy, or should he sell or not sell?

Of more importance to the steel market, unquestionably,

is the matter of freight rates. Reductions have been expected for a long time, and buyers are probably taking more interest now, seeing that there is a somewhat nearer approach of the expected reductions. Producers of steel, in defending their prices during the last few months, have laid much stress upon the influence of high freight rates on their raw and intermediate materials, in making high costs as compared with conditions in 1913, and therefore high selling prices. Naturally buyers of steel would expect lower prices in the event of freight rate reductions. Whether this would affect their buying conduct is a question, if it is true as has been claimed that at best purchases of steel have been for immediate utilization only. Forward buying has been absent from the market, and buying for immediate use could not well be postponed. As to freights on steel bought, buyers would in general get the benefit of rate reductions irrespective of date of purchase, since sales are usually made on a delivered basis with a freight allowance.

OPERATIONS

As formerly, the sheet branch leads the divisions of the finished steel trade in point of mill activity, with an operation of about 90 per cent in the Steel Corporation's sheet mills and an operation probably over 75 per cent among the independent sheet mills. The trend, however, is slightly downward. Tin plate mill activity is distinctly on the decrease, with an operation of 50 to 55 per cent this week, but the bulge in activity that began in September was quite out of season. The various wire and pipe mills are operating generally at between 40 and 60 per cent. These are high percentages when the rate of ingot production is not much over 35 per cent, but operations at bar, shape, plate and rail mills are very light. Bar mills are doing the best of the four classes. Structural mill operations have been increasing lately. The Bridge Builders' and Structural Society reports fabricated steel lettings in September at 48 per cent of the fabricating shop capacity, against 33 per cent for August and an average of 28 per cent in the eight months ended with August. A few releases on rail contracts have been received in the past two or three weeks, but rail production is nevertheless very light. Contracts for this year were not heavy, but no small part of the tonnage will be carried over.

STEEL PRICES

On the whole it can be said that the trend in steel prices is toward stiffness. There is certainly no downward trend in general. There are, however, various cross-currents. In bars, shapes and plates several mills are firmer in their price views than a few weeks ago, but there is some aggressive selling with very close prices named, possibly a shade lower than two or three months ago. It is distinctly favorable, however, that the general level on these three products is not materially lower, even in a period of two or three months. In sheets the price situation is somewhat complicated. Nearly all the independent sheet mills have announced a second advance of \$5 a ton, following the one that occurred in September, but there is question whether the advance will really be established, and there is room for suspicion that there is a "paper" advance, made chiefly for the purpose of encouraging the placing of orders at the former prices. There is also the complication that while the advance now talked of would raise blue annealed from 2.50c. to 2.75c., there has been selling of late at the old price of 2.25c., ruling before the September advance. The September advances in black sheets to 3c. and in galvanized to 4c. are well held. In wire products 60-day contracts were made just before the Sept. 12 advance, and some small sales are now being made at the advanced prices, but it is understood that some attractive orders are being accepted at the old prices. Tubular goods are quite steady in price, with the usual exception of line pipe.

The pig-iron markets are distinctly dull, whether from consumption failing to increase or from buyers having renewed expectations of lower prices on account of prospective reductions in coke and limestone freight rates. Quotations in the local market are unchanged at \$20 for bessemer, \$19.25@20 for basic and \$21 for foundry, f.o.b. valley furnaces, freight to Pittsburgh being \$1.96.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots	Less Carlots
Acetic anhydride.....lb.	\$0.12 - \$0.12	\$0.40 - \$0.45
Acetone.....lb.	2.75 - 3.00	1.3 - 1.3
Acid, acetic, 28 per cent.....100 lbs.	5.50 - 5.75	3.25 - 3.50
Acetic, 56 per cent.....100 lbs.		6.00 - 6.50
Acetic, glacial, 99½ per cent, carboys.....100 lbs.	10.50 - 11.00	11.25 - 10.50
Boric, crystals.....lb.	12½ - 13	13½ - 14
Boric, powder.....lb.	13 - 13½	14 - 14½
Citric.....lb.		45 - 47
Hydrochloric.....100 lb.	1.25 - 1.50	1.60 - 1.75
Hydrofluoric, 52 per cent.....lb.	12 - 12½	12½ - 13
Lactic, 44 per cent tech.....lb.	09½ - 10	10½ - 12
Lactic, 22 per cent tech.....lb.	04½ - 05½	06 - 07
Molybdic, C.P.....lb.	3.25 - 3.50	3.60 - 4.00
Muriatic, 20 deg. (see hydrochloric).....lb.		
Nitric, 40 deg.....lb.	06½ - 06½	06½ - 07
Nitric, 42 deg.....lb.	06½ - 07	07½ - 07½
Oxalic, crys tals.....lb.	15½ - 16	16½ - 17
Phosphoric, 50 per cent solution.....lb.	13 - 13½	14 - 18
Picric.....lb.	20 - 25	27 - 35
Pyrogallol, resublimed.....lb.		1.75 - 1.90
Sulphuric, 60 deg., tank cars.....ton		11.00 - 12.00
Sulphuric, 60 deg., drums.....ton		13.00 - 15.00
Sulphuric, 66 deg., tank cars.....ton	17.00 - 18.00	
Sulphuric, 66 deg., drums.....ton	21.00 - 22.00	22.50 - 23.00
Sulphuric, 66 deg., carboys.....ton		
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	21.00 - 22.00	
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	23.00 - 23.50	24.00 - 24.50
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	31.00 - 32.00	33.00 - 34.00
Tannic, U. S. P.....lb.		75 - 85
Tannic (tech.).....lb.	45 - 48	50 - 55
Tartaric, imported crystals.....lb.		26 - 27
Tartaric acid, imported, powdered.....lb.		27½ - 28½
Tartaric acid, domestic.....lb.		35
Tungstic, per lb. of WO.....lb.		1.10 - 1.20
Alcohol, Ethyl.....gal.		4.65 - 4.90
Alcohol, Methyl (see methanol).....gal.		
Alcohol, denatured, 188 proof.....gal.		35 - 36
Alcohol, denatured, 190 proof.....gal.		37 - 38
Alum, ammonia, lump.....lb.	03½ - 03½	04 - 04½
Alum, potash, lump.....lb.	03 - 04	04½ - 04½
Alum, chrome lump.....lb.	10 - 11	11½ - 12½
Aluminum sulphate, commercial.....lb.	01½ - 02	02½ - 02½
Aluminum sulphate, iron free.....lb.	02½ - 02½	03 - 03½
Aqua ammonia, 26 deg., drums (750 lb.).....lb.	07½ - 07½	08 - 08½
Ammonia, anhydrous, cyl. (100-150 lb.).....lb.	30 - 32	33 - 35
Ammonium carbonate, powder.....lb.	07 - 07½	08 - 09
Ammonium chloride, granular (white sal ammoniac).....lb.	06 - 06½	06½ - 07
Ammonium chloride, granular (gray sal ammoniac).....lb.	06½ - 07	07½ - 08
Ammonium nitrate.....lb.	07½ - 07½	07½ - 08½
Amylacetate.....gal.		3.25 - 3.50
Amylacetate tech.....gal.		2.50 - 3.00
Arsenic oxide, (white arsenic) powdered lb.....lb.	05½ - 06	06½ - 06½
Arsenic, sulphide, powdered (red arsenic) lb.....lb.	11 - 11½	12 - 13
Barium chloride.....ton	47.00 - 48.00	49.00 - 50.00
Barium dioxide (peroxide).....lb.	20 - 21	22 - 23
Barium nitrate.....lb.	07½ - 08	08½ - 09
Barium sulphate (precip.) (blanc fixe) lb.....lb.	04 - 04½	04½ - 05
Bleaching powder (see calc. hypochlorite).....lb.		
Blue vitriol (see copper sulphate).....lb.		
Borax (see sodium borate).....lb.		
Brimstone (see sulphur, roll).....lb.		
Bromine.....lb.	27 - 28	28½ - 30
Calcium acetate.....100 lbs.	2.00 - 2.05	
Calcium carbide.....lb.	04½ - 04½	05 - 05½
Calcium chloride, fused, lump.....ton	23.50 - 24.00	24.50 - 25.50
Calcium chloride, granulated.....lb.	01½ - 02	02½ - 02½
Calcium hypochloride (bleaching powder) 100 lb.....lb.	2.50 - 2.60	2.70 - 3.25
Calcium peroxide.....lb.		1.40 - 1.50
Calcium phosphate, tribasic.....lb.		15 - 16
Camphor.....lb.		76 - 77
Carbon bisulphide.....lb.	06½ - 06½	07 - 07½
Carbon tetrachloride, drums.....lb.	10½ - 10½	11 - 12
Carbonyl chloride, (phosgene).....lb.		60 - 75
Caustic potash (see potassium hydroxide).....lb.		
Caustic soda (see sodium hydroxide).....lb.		
Chlorine, gas, liquid-cylinders (100 lb.) lb.....lb.	08 - 09	09½ - 10
Chloroform.....lb.		40 - 43
Cobalt oxide.....lb.		2.00 - 2.10
Copperas (see iron sulphate).....lb.		
Copper carbonate, green precipitate.....lb.	19 - 19½	20 - 21
Copper cyanide.....lb.		50 - 62
Copper sulphate, crystals.....lb.	05 - 05½	05½ - 06
Cream of tartar (see potassium bitartrate).....lb.		
Epsom salt (see magnesium sulphate).....lb.		
Ethyl Acetate Com. 85%.....gal.		1.00 - 1.10
Ethyl Acetate pure (acetic ether, 98% to 100%).....lb.		40 - 42
Formaldehyde, 40 per cent.....lb.	11½ - 12	12½ - 13
Fusel oil, ref.....gal.		3.25 - 3.75
Fusel oil, crude.....gal.		1.75 - 2.00
Glauber's salt (see sodium sulphate).....lb.		14 - 15
Glycerine, C. P. drums extra.....lb.		3.50 - 3.60
Iodine, resublimed.....lb.		10 - 20
Iron oxide, red.....ton	18.00 - 19.00	20.00 - 23.00
Iron sulphate (copperas).....lb.		10½ - 12½
Lead acetate.....lb.		10 - 11
Lead arsenate, paste.....lb.	09 - 09½	15 - 20
Lead nitrate.....lb.	07½ - 08	08½ - 09
Litharge.....lb.		1.30 - 1.40
Lithium carbonate.....lb.	08 - 08½	09 - 10
Magnesium carbonate, technical.....lb.	2.50 - 2.75	
Magnesium sulphate, U. S. P.....100 lb.		1.10 - 1.75
Magnesium sulphate, technical.....100 lb.		66 - 68
Methanol, 95%.....gal.		70 - 72
Methanol, 97%.....gal.		12 - 12½
Nickel Salt, double.....lb.		14 - 14½
Nickel salt, single.....lb.		
Phosgene (see carbonyl chloride).....lb.		42 - 45
Phosphorus, red.....lb.	40 - 41	30 - 35
Phosphorus, yellow.....lb.		11½ - 11½
Potassium bichromate.....lb.	10 - 11	

	Carlots	Less Carlots
Potassium bitartrate (cream of tartar)..... lb.	\$. . . \$. . .	\$0.25 - \$0.28
Potassium bromide, granular..... lb.		.14 - .20
Potassium carbonate, U. S. P..... lb.	.20 - .21	.22 - .25
Potassium carbonate, 80-85%..... lb.	.04 - .04	.05 - .06
Potassium chlorate, crystals..... lb.	.08 - .08	.08 - .12
Potassium cyanide..... lb.		.26 - .28
Potassium hydroxide (caustic potash)..... lb.	.05 - .06	.06 - .08
Potassium iodide..... lb.		2.60 - 2.75
Potassium nitrate..... lb.	.07 - .07	.08 - .09
Potassium permanganate..... lb.	.18 - .19	.20 - .22
Potassium prussiate, red..... lb.	.28 - .29	.29 - .30
Potassium prussiate, yellow..... lb.	.20 - .20	.21 - .22
Rochelle salts (see sodium potas. tartrate).....	. . . . .	. . . . .
Salammoniac (see ammonium chloride).....	. . . . .	. . . . .
Sal soda (see sodium carbonate).....	. . . . .	. . . . .
Salt cake (bulk)..... ton		20.00 - 22.00
Silver cyanide..... oz.		1.35 - 1.38
Silver nitrate..... oz.		.46 - .47
Soda ash, light..... 100 lb.	2.05 - 2.10	2.15 - 2.50
Soda ash, dense..... 100 lb.	2.35 - 2.40	2.45 - 2.70
Sodium acetate..... lb.	.04 - .04	.04 - .05
Sodium bicarbonate..... 100 lb.	2.00 - 2.25	2.50 - 2.75
Sodium bichromate..... lb.	.07 - .08	.08 - .08
Sodium bisulphate (nitre cake)..... ton	5.00 - 5.25	5.50 - 6.50
Sodium bisulphite powdered, U.S.P..... lb.	.04 - .05	.05 - .06
Sodium borate (borax)..... lb.	.05 - .06	.06 - .07
Sodium carbonate (sal soda)..... 100 lb.	1.75 - 1.90	2.00 - 2.25
Sodium chlorate..... lb.	.07 - .07	.08 - .08
Sodium cyanide..... lb.	.25 - .26	.27 - .30
Sodium fluoride..... lb.	.10 - .11	.11 - .12
Sodium hydroxide (caustic soda)..... 100 lb.	4.05 - 4.15	4.20 - 4.75
Sodium hyposulphite..... lb.		.03 - .03
Sodium nitrite..... lb.	.06 - .07	.07 - .07
Sodium peroxide, powdered..... lb.	.25 - .26	.27 - .30
Sodium phosphate, dibasic..... lb.	.04 - .04	.04 - .05
Sodium potassium tartrate (Rochelle salts) lb.		.21 - .24
Sodium prussiate, yellow..... lb.	.14 - .14	.14 - .15
Sodium silicate, solution (40 deg.)..... 100 lb.	1.00 - 1.15	1.25 - 1.40
Sodium silicate, solution (60 deg.)..... lb.	.02 - .03	.03 - .03
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	1.50 - 1.75	2.00 - 2.25
Sodium sulphide, fused, 60-62 per cent (conc.) lb.	.04 - .04	.05 - .06
Sodium sulphite, crystals..... lb.	.03 - .03	.03 - .04
Strontium nitrate, powdered..... lb.	.12 - .13	.13 - .20
Sulphur chloride, red..... lb.	.05 - .05	.05 - .06
Sulphur, crude..... ton	18.00 - 20.00	
Sulphur dioxide, liquid, cylinders extra..... lb.	.08 - .08	.09 - .10
Sulphur (sublimed), flour..... 100 lb.		2.25 - 3.10
Sulphur, roll (brimstone)..... 100 lb.		2.00 - 2.75
Tin bichloride, 50 per cent..... lb.	.18 - .19	
Tin oxide..... lb.		.38 - .40
Zinc carbonate, precipitate..... lb.	.16 - .16	.17 - .17
Zinc chloride, gran..... lb.	.09 - .09	.10 - .11
Zinc cyanide..... lb.	.42 - .44	.45 - .47
Zinc dust..... lb.	.11 - .11	.11 - .12
Zinc oxide, XX..... lb.	.07 - .07	.08 - .09
Zinc sulphate..... 100 lb.	3.00 - 3.25	3.30 - 3.50

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude..... lb.	\$1.15 - \$1.20
Alpha-naphthol, refined..... lb.	1.25 - 1.30
Alpha-naphthylamine..... lb.	.17 - .20
Aniline oil, drums extra..... lb.	.17 - .20
Aniline salts..... lb.	.24 - .26
Anthracene, 80% in drums (100 lb.)..... lb.	.75 - 1.00
Benzaldehyde U.S.P..... lb.	1.25 - 1.35
Benzidine, base..... lb.	.90 - 1.00
Benzidine sulphate..... lb.	.75 - .85
Benzoic acid, U.S.P..... lb.	.60 - .65
Benzoate of soda, U.S.P..... lb.	.52 - .55
Benzene, pure, water-white, in drums (100 gal.) gal.	.27 - .32
Benzene, 90%, in drums (100 gal.)..... gal.	.25 - .28
Benzyl chloride, 95-97%, refined..... lb.	.25 - .27
Benzyl chloride, tech..... lb.	.20 - .23
Beta-naphthol benzoate..... lb.	3.50 - 4.00
Beta-naphthol, sublimed..... lb.	.70 - .75
Beta-naphthol, tech..... lb.	.31 - .34
Beta-naphthylamine, sublimed..... lb.	1.75 - 1.85
Cresol, U. S. P., in drums (100 lb.)..... lb.	.16 - .17
Ortho-cresol, in drums (100 lb.)..... lb.	.25 - .27
Cresylic acid, 97-99%, straw color, in drums..... gal.	.70 - .80
Cresylic acid, 95-97%, dark, in drums..... gal.	.65 - .70
Cresylic acid, 50%, first quality, drums..... gal.	.45 - .50
Dichlorobenzene..... lb.	.06 - .09
Diethylaniline..... lb.	1.00 - 1.15
Dimethylaniline..... lb.	.41 - .50
Dinitrobenzene..... lb.	.23 - .27
Dinitrochlorobenzene..... lb.	.23 - .25
Dinitronaphthalene..... lb.	.30 - .35
Dinitrophenol..... lb.	.35 - .40
Dinitrotoluene..... lb.	.25 - .30
Dip oil, 25%, car lots, in drums..... gal.	.30 - .35
Diphenylamine..... lb.	.60 - .70
H-acid..... lb.	1.10 - 1.20
Meta-phenylenediamine..... lb.	1.15 - 1.20
Monochlorobenzene..... lb.	.12 - .14
Monoethylaniline..... lb.	1.60 - 1.70
Naphthalene crushed, in bbls..... lb.	.06 - .07
Naphthalene, flake..... lb.	.06 - .07
Naphthalene, balls..... lb.	.08 - .09
Naphthionic acid, crude..... lb.	.70 - .75
Nitrobenzene..... lb.	.12 - .15
Nitro-naphthalene..... lb.	.30 - .35
Nitro-toluene..... lb.	.15 - .17
Ortho-amidophenol..... lb.	3.00 - 3.10
Ortho-dichlorobenzene..... lb.	.15 - .20
Ortho-nitro-phenol..... lb.	.75 - .80
Ortho-nitro-toluene..... lb.	.15 - .20
Ortho-toluidine..... lb.	.20 - .25
Para-amidophenol, base..... lb.	1.40 - 1.45
Para-amidophenol, HCl..... lb.	1.70 - 1.80
Para-dichlorobenzene..... lb.	.12 - .15
Paranitroaniline..... lb.	.77 - .80
Para-nitrotoluene..... lb.	.80 - .85
Para-phenylenediamine..... lb.	1.70 - 1.75
Para-toluidine..... lb.	1.25 - 1.40
Phthalic anhydride..... lb.	.40 - .50

Phenol, U. S. P., drums..... lb.	.09 - .12
Pyridine..... gal.	2.00 - 3.50
Resorcinol, technical..... lb.	1.50 - 1.60
Resorcinol, pure..... lb.	2.00 - 2.25
Salicylic acid, tech., in bbls..... lb.	.18 - .20
Salicylic acid, U. S. P..... lb.	.19 - .22
Salol..... lb.	.60 - .70
Solvent naphtha, water-white, in drums, 100 gal..... gal.	.25 - .28
Solvent naphtha, crude, heavy, in drums, 100 gal..... gal.	.14 - .16
Sulphanilic acid, crude..... lb.	.27 - .30
Tolidine..... lb.	1.30 - 1.35
Toluidine, mixed..... lb.	.43 - .45
Toluene, in tank cars..... gal.	.25 - .28
Toluene, in drums..... gal.	.28 - .31
Xylidines, drums, 100 gal..... lb.	.40 - .45
Xylene, pure, in drums..... gal.	.40 - .45
Xylene, pure, in tank cars..... gal.	.45 - .45
Xylene, commercial, in drums, 100 gal..... gal.	.33 - .35
Xylene, commercial, in tank cars..... gal.	.30 - .30

Waxes

Prices based on original packages in large quantities.

Bayberry Wax..... lb.	\$0.19 - \$0.20
Beeswax, refined, dark..... lb.	.24 - .25
Beeswax, refined, light..... lb.	.28 - .30
Beeswax, white pure..... lb.	.36 - .42
Candellila wax..... lb.	.24 - .25
Carnauba, No. 1..... lb.	.46 - .47
Carnauba, No. 2, North Country..... lb.	.24 - .24
Carnauba, No. 3, North Country..... lb.	.14 - .15
Japan..... lb.	.21 - .22
Montan, crude..... lb.	.05 - .05
Paraffine waxes, crude match wax (white) 105-110 m.p..... lb.	.03 - .03
Paraffine waxes, crude, scale 124-126 m.p..... lb.	.02 - .02
Paraffine waxes, refined, 118-120 m.p..... lb.	.03 - .03
Paraffine waxes, refined, 125 m.p..... lb.	.03 - .03
Paraffine waxes, refined, 128-130 m.p..... lb.	.03 - .04
Paraffine waxes, refined, 133-135 m.p..... lb.	.04 - .05
Paraffine waxes, refined, 135-137 m.p..... lb.	.05 - .06
Stearic acid, single pressed..... lb.	.09 - .09
Stearic acid, double pressed..... lb.	.10 - .10
Stearic acid, triple pressed..... lb.	.11 - .11

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl..... 280 lb.	\$5.55 - 5.65
Rosin E-I..... 280 lb.	5.75 - 6.25
Rosin K-N..... 280 lb.	6.35 - 6.75
Rosin W. G.-W. W..... 280 lb.	6.90 - 7.40
Wood rosin, bbl..... 280 lb.	6.25 - 6.25
Spirits of turpentine..... gal.	.74 - .74
Wood turpentine, steam dist..... gal.	.72 - .72
Wood turpentine, dest. dist..... gal.	.71 - .71
Pine tar pitch, bbl..... 200 lb.	 6.50
Tar, kiln burned, bbl. (500 lb.)..... bbl.	 11.00
Retort tar, bbl..... 500 lb.	 11.00
Rosin oil, first run..... gal.	.35 - .35
Rosin oil, second run..... gal.	.37 - .37
Rosin oil, third run..... gal.	.44 - .44
Pine oil, steam dist., sp.gr., 0.930-0.940..... gal.	1.90 - 1.90
Pine oil, pure, dest. dist..... gal.	1.50 - 1.50
Pine tar oil, ref., sp.gr. 1.025-1.035..... gal.	.46 - .46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla..... gal.	.35 - .35
Pine tar oil, double ref., sp.gr. 0.965-0.990..... gal.	.75 - .75
Pine tar, ref., thin, sp.gr., 1.080-1.960..... gal.	.35 - .35
Turpentine, crude, sp. gr., 0.900-0.970..... gal.	1.25 - 1.25
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990..... gal.	.35 - .35
Pinewood creosote, ref..... gal.	.52 - .52

Solvents

73-76 deg., steel bbls. (85 lb.)..... gal.	\$0.37 - .37
70-72 deg., steel bbls. (85 lb.)..... gal.	.35 - .35
68-70 deg., steel bbls. (85 lb.)..... gal.	.34 - .34
V. M. and P. naphtha, steel bbls. (85 lb.)..... gal.	.23 - .23

Fertilizers

Ammonium sulphate, bulk and d. bags..... 100 lb.	\$2.70 - 3.00
Blood, dried, f.o.b., N. Y..... unit	4.00 - 4.00
Bone, 3 and 50, ground, raw..... ton	30.00 - 32.00
Cyanamide, f.o.b. works..... unit	4.50 - 4.50
Fish scrap, dom., dried, f.o.b. works..... unit	2.90 - 3.00
Nitrate soda..... 100 lb.	2.35 - 2.45
Tankage, high grade, f.o.b. Chicago..... unit	3.00 - 3.10
Phosphate rock, f.o.b. mines, Florida pebble, 68-72 p.c..... ton	4.50 - 6.50
Tennessee, 78-80 p.c..... ton	8.00 - 9.00
Potassium muriate, 80 p.c..... ton	37.50 - 40.00
Potassium sulphate..... unit	1.15 - 1.20

Crude Rubber

Para-Upriver fine..... lb.	\$0.21 - .21
Upriver coarse..... lb.	.11 - .12
Upriver caucho ball..... lb.	.11 - .12
Plantation—First latex crepe..... lb.	.15 - .15
Ribbed smoked sheets..... lb.	.15 - .15
Brown crepe, thin, clean..... lb.	.15 - .15
Amber crepe No. 1..... lb.	.17 - .17

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls..... lb.	\$0.10 - \$0.10
Castor oil, AA, in bbls..... lb.	.11 - .12
China wood oil, in bbls. (f.o.b. Pac. coast)..... lb.	.15 - .16
Cocoonut oil, Ceylon grade, in bbls..... lb.	.09 - .10
Cocoonut oil, Cochin grade, in bbls..... lb.	.10 - .11
Corn oil, crude, in bbls..... lb.	.09 - .09
Cottonseed oil, crude (f. o. b. mill)..... lb.	.07 - .07
Cottonseed oil, summer yellow..... lb.	.08 - .09
Cottonseed oil, winter yellow..... lb.	.09 - .09

Linseed oil, raw, car lots (domestic)	gal.	.68	—	.69
Linseed oil, raw, tank cars (domestic)	gal.	.63	—	.64
Linseed oil, in 5-bbl lots (domestic)	gal.	.71	—	.72
Olive oil, Denatured	gal.	\$1.15	—	\$1.20
Palm, Lagos	lb.	.07	—	.07½
Palm, Niger	lb.	.06½	—	.06½
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.08	—	.08½
Peanut oil, refined, in bbls.	lb.	.11½	—	.11½
Rapeseed oil, refined in bbls.	gal.	.90	—	.91
Rapeseed oil, blown, in bbls.	gal.	.92	—	.94
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.08½	—	—
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.07½	—	—

FISH

Light pressed menhaden	gal.	\$0.40	—	—
Yellow bleached menhaden	gal.	.42	—	—
White bleached menhaden	gal.	.44	—	—
Blown menhaden	gal.	.48	—	—

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	\$24.00	—	30.00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	20.00	—	24.00
Barytes, crude, 88% @ 94% ba., Kings Creek	net ton	10.00	—	12.00
Barytes, floated, f.o.b. St. Louis	net ton	23.00	—	24.00
Barytes, crude, first grade, Missouri	net ton	7.00	—	—
Blanc fixe, dry	lb.	.04	—	.04½
Blanc fixe, pulp	net ton	45.00	—	55.00
Casein	lb.	.07	—	.10
Chalk, Precipitated, domestic, extra light	lb.	.04½	—	.05
Chalk, Precipitated, domestic, light	lb.	.04	—	.04½
Chalk, Precipitated, domestic, heavy	lb.	.03½	—	.04
Chalk, Precipitated, English, extra light	lb.	.04½	—	.05
Chalk, Precipitated, English, light	lb.	.04½	—	.05
Chalk, Precipitated, English, dense	lb.	.04	—	.04½
China clay (kaolin) crude, f.o.b. mines, Georgia	net ton	6.50	—	8.50
China clay (kaolin) washed, f.o.b. Georgia	net ton	9.00	—	10.00
China clay (kaolin) powdered, f.o.b. Georgia	net ton	13.00	—	20.00
China clay (kaolin) crude f.o.b. Virginia points	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points	net ton	13.00	—	20.00
China clay (kaolin), imported, lump	net ton	12.00	—	20.00
China clay (kaolin), imported, powdered	net ton	25.00	—	30.00
Feldspar, crude, f.o.b. Maryland and North Carolina points	net ton	5.00	—	7.50
Feldspar, crude, f.o.b. Maine	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore	net ton	27.00	—	30.00
Fullers earth, f.o.b. Mines	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Pa.	net ton	15.00	—	18.00
Fullers earth, powdered, f.o.b. Fla.	net ton	18.00	—	—
Fullers earth, imported, powdered	net ton	24.00	—	27.00
Graphite, Ceylon lump, first quality	lb.	.06	—	.07
Graphite, Ceylon chip	lb.	.04½	—	.05
Graphite, high grade amorphous crude	lb.	.00¾	—	.02½
Kieselguhr, f.o.b. mines, Cal.	per ton	40.00	—	—
Kieselguhr, f.o.b. N.Y.	per ton	61.00	—	—
Magnesite, calcined	per ton	66.00	—	70.00
Pumice stone, imported	lb.	.03	—	.40
Pumice stone, domestic, lump	lb.	.05	—	.05½
Pumice stone, domestic, ground	lb.	.06	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore	net ton	—	—	10.00
Quartz (acid tower) 1½ @ 2 in., f.o.b. Baltimore	net ton	—	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore	net ton	—	—	17.00
Quartz, lump, f.o.b. North Carolina	net ton	5.00	—	7.50
Shellac, orange fine	lb.	.66	—	.68
Shellac, orange superfine	lb.	.70	—	.72
Shellac, A. C. garnet	lb.	.53	—	.55
Shellac, T. N.	lb.	.59	—	.61
Soapstone	ton	2.00	—	15.00
Sodium chloride	long ton	12.50	—	13.00
Talc, paper-making grades, f.o.b. Vermont	ton	11.00	—	18.00
Talc, roofing grades, f.o.b. Vermont	ton	8.50	—	13.00
Talc, rubber grades, f.o.b. Vermont	ton	11.00	—	18.00
Talc, powdered, Southern, f.o.b. cars	ton	7.50	—	11.00
Talc, imported	ton	30.00	—	40.00
Talc, California talcum powder grade	ton	18.00	—	25.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh	per ton	\$50.00	—	—
Carborundum refractory brick, 9-in. { less than carlot	1,000	1250.00	—	—
Carborundum refractory brick, 9-in. { carload lots	1,000	1100.00	—	—
Chrome brick, f.o.b. Eastern shipping points	net ton	52-55	—	—
Chrome cement, 40-45% Cr ₂ O ₃	net ton	30-32	—	—
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in car lots, f.o.b. Eastern shipping points	net ton	33-35	—	—
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	35-40	—	—
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	30-35	—	—
Magnesite brick, 9-in. straight	net ton	65-70	—	—
Magnesite brick, 9-in. arches, wedges and keys	net ton	77	—	—
Magnesite brick, soaps and splits	net ton	98	—	—
Silica brick, 9-in. sizes, f.o.b. Chicago district	1,000	40-42	—	—
Silica brick, 9-in. sizes, f.o.b. Birmingham district	1,000	42-45	—	—
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.	1,000	35-38	—	—

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	\$200.00	—	\$225.00
Ferrochrome per lb. of Cr. contained, 6-8% carbon, carlots	lb.	.11	—	—
Ferrochrome per lb. of Cr. contained, 4-6% carbon, carlots	lb.	.11	—	.12
Ferromanganese, 76-80% Mn, domestic	gross ton	60.00	—	63.00
Ferromanganese, 76-80% Mn, English & German	gross ton	59.00	—	60.00
Spiegelisen, 18-22% Mn	gross ton	25.00	—	27.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo	lb.	2.25	—	—
Ferrosilicon, 10-15%	gross ton	38.00	—	40.00
Ferrosilicon, 50%	gross ton	60.00	—	65.00
Ferrosilicon, 75%	gross ton	130.00	—	135.00
Ferrotungsten, 70-80%, per lb. of contained W	lb.	.40	—	.45
Ferrouanium, 35-50% of U, per lb. of U content	lb.	.60	—	—
Ferrovanadium, 30-40% per lb. of contained V	lb.	4.25	—	4.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content	net ton	\$8.00	—	\$10.00
Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃	ton	24.00	—	26.00
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard	ton	24.00	—	26.00
Coke, foundry, f.o.b. ovens	net ton	4.25	—	4.50
Coke, furnace, f.o.b. ovens	net ton	3.25	—	3.50
Coke, petroleum, refinery, Atlantic seaboard	net ton	12.00	—	13.00
Fluorspar, gravel, f.o.b. mines, New Mexico	net ton	15.00	—	—
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	20.00	—	22.00
Ilmenite, 52% TiO ₂ , per lb. ore	lb.	.01½	—	.01½
Manganese ore, 50% Mn, c.i.f. Atlantic seaport	unit	.20	—	.21
Manganese ore, chemical (MnO ₂)	net ton	50.00	—	55.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.	lb.	.55	—	.60
Monazite, per unit of TbO ₂ , c.i.f., Atlantic seaport	unit	30.00	—	—
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.12	—	.12
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport	unit	.13	—	.13
Pyrites, domestic, fines, f.o.b. mines, Ga.	unit	.11	—	.12
Rutile, 95% TiO ₂ per lb. ore	lb.	.15	—	—
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal)	unit	2.75	—	3.00
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.	unit	3.00	—	3.25
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	1.25	—	1.75
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.25	—	2.50
Vanadium pentoxide, 99%	lb.	2.00	—	14.00
Vanadium ore, per lb. of V ₂ O ₅ contained	lb.	1.00	—	—
Zircon, washed, iron free, f.o.b. Pablo, Florida	lb.	.04½	—	.13

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	13.00
Aluminum, 98 to 99 per cent	24.50 @ 25.00
Antimony, wholesale lots, Chinese and Japanese	5.00 @ 5.25
Nickel, ordinary (ingot)	41.00
Nickel, electrolytic	44.00
Monel metal, shot and blocks	35.00
Monel metal, ingots	38.00
Monel metal, sheet bars	40.00
Tin, 5-ton lots, Straits	28.00
Lead, New York, spot	4.70 @ 4.75
Lead, E. St. Louis, spot	4.45 @ 4.50
Zinc, spot, New York	5.05 @ 5.10
Zinc, spot, E. St. Louis	4.675

OTHER METALS

Silver (commercial)	oz.	\$0.71½
Cadmium	lb.	1.00-1.25
Bismuth (500 lb. lots)	lb.	1.50 @ 1.55
Cobalt	lb.	3.00 @ 3.25
Magnesium (f.o.b. Philadelphia)	lb.	1.25
Platinum	oz.	82.00
Iridium	oz.	150.00 @ 170.00
Palladium	oz.	55.00-60.00
Mercury	75 lb.	38.00-39.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	20.50
Copper bottoms	28.00
Copper rods	19.00 @ 19.75
High brass wire	15.75
High brass rods	13.25
Low brass wire	17.25
Low brass rods	17.25
Brazed brass tubing	25.00
Brazed bronze tubing	23.75
Seamless copper tubing	19.50
Seamless high brass tubing	18.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current	Cleveland	Chicago
Copper, heavy and crucible	9.50 @ 10.00	9.25	9.50
Copper, heavy and wire	9.00 @ 9.25	8.50	8.50
Copper, light and bottoms	7.50 @ 8.00	7.50	7.25
Lead, heavy	3.25 @ 3.50	3.25	3.25
Lead, tea	2.25 @ 2.35	2.25	2.25
Brass, heavy	4.25 @ 4.50	4.50	5.00
Brass, light	3.25 @ 3.50	3.25	3.50
No. 1 yellow brass turnings	4.00 @ 4.25	4.25	4.50
Zinc	2.00 @ 2.25	2.00	2.25

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ½ in. and larger, and plates ½ in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes	\$2.88	\$2.88	\$2.88
Soft steel bars	2.78	2.78	2.78
Soft steel bar shapes	2.78	2.78	2.78
Soft steel bands	3.42	3.48	3.48
Plates, ½ to 1 in. thick	2.83	2.88	2.88

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation California

SELMA—The Fresno Tire & Rubber Co., Fresno, Cal., is planning for the erection of a new plant at Selma, estimated to cost about \$200,000, including machinery.

MARIA—The Imperial Valley Gypsum & Oil Co., Spreckels Bldg., San Diego, Cal., has acquired property at Maria, Imperial Co., comprising about 170 acres of land, as a site for the erection of a new oil refinery and gypsum manufacturing plant. For raw material supply for the latter works, the company has purchased extensive deposits about 25 miles north of Maria. The initial plants are estimated to cost about \$150,000.

MARTINEZ—Fire, Oct. 5, damaged a portion of the local oil refinery of the Associated Oil Co., with loss estimated at about \$50,000.

BERKELEY—The Superior Tile & Products Co., 1910 Prince St., has preliminary plans under way for the erection of a new plant, estimated to cost about \$15,000.

CARPINTERIA—The Carpinteria Clay Products Co., recently organized with a capital of \$150,000, has commenced the operation of a local plant for the manufacture of brick and tile products. At a later date it is planned to expand the works, with department for the production of chinaware and other ceramic products. The company is headed by Lyman T. Gage, B. C. Sutton and L. L. Brentner.

Connecticut

NEW LONDON—The Massachusetts Oil Co., Pequot Ave., will make extensions in its local works, including the erection of a 1-story building, 30 x 75 ft., to cost about \$12,000.

Delaware

WILMINGTON—The Christiana Leather Co., headed by James J. O'Neill, president of the Wilmington Leather Co., is arranging for the early opening of its tannery, with initial capacity of about 250 skins per day. The plant will give employment to about 100 men.

Florida

PENSACOLA—The Southern Pine Extracts Co. is planning for the establishment of a new local plant for the manufacture of pine oils, turpentine and kindred products. James W. Ely is head.

JACKSONVILLE—The Tidewater Glass Mfg. Co. is perfecting plans for the erection of its proposed new local plant on waterfront property totaling 325 x 1,500 ft., recently acquired. The works will consist of three complete operating units, each 2-story, 60 x 300 ft., and estimated to cost about \$150,000, including machinery. The plant will specialize in the manufacture of glass bottles, jars, etc. Erection bids will soon be asked. B. R. Kessler is secretary.

Illinois

CHICAGO—The Waterway Paper Products Co., Kedzie Ave. and 32d St., has commenced the erection of its proposed new plant at location noted, consisting of a main 1-story building, 80 x 180 ft., with power plant, 33 x 60 ft., estimated to cost about \$200,000, with machinery. Frank D. Chase, Inc., 645 Michigan Ave., is architect and engineer.

Indiana

VINCENNES—Fire, Oct. 11, destroyed a portion of the flour-milling plant of the Atlas Mills, with loss estimated at close to \$200,000, with machinery.

Maryland

FROSTBURG—The Big Savage Brick Co. has commenced the erection of a new drying department at its plant and will soon inaugurate operations for other extensions, estimated to cost about \$85,000. D. A. Benson is manager.

BALTIMORE—The Spanish-American Cork Products Co., Westport, near Baltimore, is planning for the immediate rebuilding of the portion of its local plant on Fish House Road, recently destroyed by fire with loss of about \$75,000. O. J. Harms is president.

Massachusetts

SOMERVILLE—Masury, Young & Co., 196 Milk St., Boston, Mass., manufacturer of oil products, etc., will equip a portion of its new 3-story building now being erected on Rollins St., Somerville, 35 x 75 ft., as an oil-testing works.

CHELSEA—The United Indigo & Chemical Co., 960 Broadway, will commence the immediate rebuilding of the portion of its plant recently destroyed by fire, with cost estimated at \$21,000. John Cowen is superintendent.

Michigan

DETROIT—The Detroit Sand Lime Brick Co., 507 Vinton Bldg., will soon take bids for the erection of its proposed new plant. Plans are nearing completion.

New Hampshire

HINSDALE—Fire, Oct. 5, destroyed a portion of the paper mill of the G. A. Robertson Co., with loss estimated at close to \$100,000, including machinery.

New Jersey

JERSEY CITY—The Apex Color Works, Inc., 61 Cornielson Ave., has completed plans and is taking bids for the erection of a new 1-story plant, 50 x 100 ft., on Van Winkle Ave., estimated to cost about \$22,000. Edward Patterson, 76 Montgomery St., is architect.

WOODSTOWN—The South Jersey Farmers' Exchange is considering tentative plans for the erection of a new local plant for the manufacture of fertilizer products.

BAYONNE—The Standard Oil Co. of New Jersey, 26 Broadway, New York, is arranging an appropriation of \$2,000,000, for extensions and improvements in its three refineries in this section, comprising the Constable Hook works at Bayonne; the Eagle Works at Jersey City, and the Bayway plant at Elizabeth. Walter C. Teagle is president.

New York

LONG ISLAND CITY—A. L. Reade & Co., 141 West 36th St., New York, manufacturer of celluloid specialties and novelties, has leased the 2-story brick building now being erected on Ely Ave., near the Bridge Plaza, Long Island City, for a new plant.

BUFFALO—The Buffalo Specialty Co., 375 Ellicott St., is said to be planning for the rebuilding of its plant at Bridgeburg, Ont., destroyed by fire, Oct. 13, with loss estimated at about \$50,000.

BUFFALO—The Niagara Gas Corp., 186 Main St., has preliminary plans under way for the erection of a new gas filtration and purifying plant at South Buffalo, in the vicinity of the works of the Donner Union Coke Co., estimated to cost about \$350,000. The company recently took over the artificial gas plant of William J. Judge, and has increased its capital to \$4,000,000.

Pennsylvania

POTTSTOWN—The Hydro United Tire Co., manufacturer of automobile tires, has awarded a contract to Graham & Wells, 3649 Filbert St., Philadelphia, Pa., for the erection of a 2-story plant addition, 134 x 170 ft.

EASTON—The Forbes Aluminum Products Co., Steele Bldg., has awarded a contract to the R. T. & C. D. Stewart Construction Co., 26 Center Sq., for the erection of its new plant in the South Side section, to consist of a number of buildings of various size, estimated to cost about \$150,000. Later proposed extensions will bring the ultimate investment to close to \$500,000. The company was incorporated recently under Delaware laws with capital of \$4,500,000. Ewing M. Forbes is president. A. D. Chidsey, Jr., 341 Northampton St., Easton, is architect and engineer.

BETHLEHEM—The Travelers' Rubber Co. will install new machinery at its plant for increased production, estimated to cost about \$30,000.

NEW BRITGTON—The Townsend Co., manufacturer of iron and wire products, has construction under way on a new wire mill on Fallston Ave., occupying a large portion of a 3-story building, 124 x 128 ft.

South Carolina

COLUMBIA—The Halo Co., recently organized with a capital of \$400,000 to manufacture extracts, has plans under way for the erection of a new local plant, 50 x 140 ft. Bids will be asked in about 60 days. E. M. Lowman is secretary.

Tennessee

MEMPHIS—The Memphis Cotton Seed Products Co., recently organized, has acquired a local site for the erection of a new mill. Preliminary plans are under way. A. G. Roberts is president.

MEMPHIS—The Stryker Kot-N-Wood Products Co., has acquired local property as a site for its proposed new mill, 60 x 200 ft., for the manufacture of plaster-board products from cotton stalks. The machinery installation will include hydraulic presses, digesters, shredders, mixers, etc. Other plant unit will be constructed at a later date. George B. Stryker is president.

KNOXVILLE—The Knoxville Pure Paint & Varnish Co., recently formed with a capital of \$150,000, has awarded a contract to Worsham Bros., Knoxville, for the erection of a 2-story and basement plant, 50 x 125 ft., for the manufacture of paints, oils, varnishes, etc., estimated to cost about \$32,000. J. R. Lee is president and J. C. Trewitt, vice-president.

Texas

DALLAS—The Dallas Oil Refinery Co., 3131 Oak Lane, has preliminary plans under way for the erection of a new oil-refining plant on local site.

SAN ANTONIO—The Grayburg Pipe Line Co., Grayburg Bldg., has awarded a contract to J. S. Young, Somerset, Tex., for the construction of a new oil works, estimated to cost about \$40,000 and of which the machinery installation will represent about \$25,000.

DALLAS—In connection with the remodeling of the plant of the Eastland Oil & Refining Co., recently acquired, the Trinity Oil Corp. has tentative plans under way for the erection of a new lubricating oil manufacturing plant on an adjoining site. Harry Pennington, Oklahoma City, Okla., is president; J. W. Rieker, Dallas, is manager.

DALLAS—The Fleischmann Yeast Co. has arranged for the erection of a new 2-story building, to be occupied under lease, 50 x 115 ft., estimated to cost about \$30,000. It will be equipped for the manufacture of yeast products. Headquarters of the company are at 701 Washington St., New York, N. Y.

Virginia

PORTSMOUTH—The Chesapeake Mfg. & Creosoting Co., Money Point, near Portsmouth, is reported to be planning for the rebuilding of the portion of its plant, recently destroyed by fire with loss estimated in excess of \$200,000.

West Virginia

HUNTINGTON—The Camp Glass Co., Twenty-fifth St., is planning for extensions and improvements in its plant to cost about \$30,000. The company is operated by the Interstate Glass Co., Bradford, Pa. Daniel Camp is manager.

STAR CITY—The Star Glass Co. has awarded a contract to the Pittsburgh Bridge & Iron Works, Farmers' Bank Bldg., Pittsburgh, for the erection of a new plant to total about 60,000 sq. ft. of floor space. The structure will be equipped for the manufacture of illuminating glassware products.

New Companies

THE RUSH PORCELAIN Co., Room 1922, 24 Archer Ave., Chicago, Ill., has been incorporated with a capital of \$40,000, to manufacture porcelain products and kindred specialties. The incorporators are Charles G. Rush, H. Jones and L. L. Cowan.

THE REGAL MFG. Co., Kansas City, Mo., has been incorporated under Delaware laws with capital of \$200,000, to manufacture chemicals, insect powders and affiliated specialties. The incorporators are Ray M. and H. L. Dunnett, and Frank D. Auwarter,

Kansas City. The company is represented by the Corporation Service Co., Wilmington, Del.

GEORGE H. CLARK & Co., INC., Worcester, Mass., has been incorporated with a capital of \$32,000, to manufacture paints, oils, etc. George A. Clark is president; and Harry A. Clark, 25 West St., treasurer.

THE INSTANT CHEMICAL MFG. Co., New York, N. Y., has been incorporated with a capital of \$250,000, to manufacture chemicals and affiliated products. The incorporators are F. M. Dunn, J. L. Nichols, and Guernsey Price, 1 Liberty St.

THE GEM FOUNDRY Co., Muskegon, Mich., has been incorporated with a capital of \$10,000, to manufacture brass, aluminum and other metal castings. The incorporators are Harry J. Pangburn, Samuel Feltman and Jacob A. Poupstra, Muskegon.

THE HOWARD FINISHING Co., Meriden, Conn., has been incorporated with a capital of \$50,000, to manufacture glassware, porcelain products and kindred specialties. The incorporators are J. L. Howard, Meriden; W. J. Howard, Hartford, Conn.; and J. J. Howard, New Haven, Conn.

THE JUST SOAP MFG. Co., INC., Kearny, N. J., has been incorporated with a capital of \$25,000, to manufacture soaps, washing powders, etc. The incorporators Jacob B. Cohen, William M. Grant, and Lovett A. Grant, Lincoln Highway, Kearny.

THE UNITY UTILITIES CORP., New York, N. Y., has been incorporated with a capital of \$100,000, to manufacture rubber products. The incorporators are W. B. Sorrelle, H. A. Jacobson and L. J. Annen. The company is represented by H. P. Freese, 27 William St.

THE ILLINOIS-WYOMING OIL Co., 2135 West 72d St., Chicago, Ill., has been incorporated with a capital of \$50,000, to manufacture oil products. The incorporators are John F. Stoner and Frank A. Foltz.

THE PROVIDENCE BRASS REFINISHING Co., 47 Mill St., Providence, R. I., has filed notice of organization to manufacture brass, bronze and kindred metal products. William Carroll, 175 Hoyt Ave., Rumford, R. I., heads the company.

THE FEDERAL CARBONIC GAS Co., Jersey City, N. J., has been incorporated with a capital of \$500,000, to manufacture carbonic gas and other commercial gas products. The incorporators are Frank E. Taylor, Thomas J. Burke and R. Emmett Sullivan, 57 Randolph Ave., Jersey City.

THE WALKER LUBRICATING OIL & REFINING CORP., New York, N. Y., has been incorporated under Delaware laws with capital of \$2,000,000, to manufacture refined oil products. The incorporators are T. B. and W. D. Walker, and John J. Ford, New York. The company is represented by the Delaware Registration Trust Co., 900 Market St., Wilmington, Del.

THE FORT MCCOY TURPENTINE Co., Fort McCoy, Fla., has been incorporated with a capital of \$40,000, to manufacture turpentine and kindred products. W. J. Wilson is president, and J. H. Burroughs, secretary and treasurer, both of Fort McCoy.

THE AURORA LEATHER Co., 6030 South State St., Chicago, Ill., has been incorporated with a capital of \$15,000, to manufacture leather products. The incorporators are Abraham Sohn and N. S. Wolf.

THE WELNESS PAINT Co., New York, N. Y., has been incorporated with a capital of \$10,000, to manufacture paints, varnish, etc. The incorporators are P. J. Welch, B. W. and T. F. Guinness. The company is represented by D. F. Griffin, 44 Court St., Brooklyn, N. Y.

THE DOSCH CHEMICAL Co., Wilmington, Del., has been incorporated under Delaware laws with capital of \$2,500,000, to manufacture chemical products. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington.

THE IOTLA CLAY & MICA Co., Iotla, N. C., has been incorporated with a capital of \$50,000, to manufacture clay products, mica goods and kindred specialties. The incorporators are Herman A. Gudger, Asheville, N. C.; A. W. Mangum, Chapel Hill, N. C.; and Francis A. Gudger, 469 Fifth Ave., New York, N. Y.

THE GARY PAINT Co., Gary, Ind., has been incorporated with a capital of \$10,000, to manufacture paint, varnish, oils, etc. The incorporators are Edward Jacob, C. W. Stilwell and W. A. Elliott, Gary.

THE TANLAC Co., Dayton, O., has been incorporated under Delaware laws with capital of \$50,000, to manufacture chem-

icals and chemical byproducts, drug specialties, etc. The incorporators are L. N. Conrad, J. B. Coolidge and J. J. Gibson, all of Dayton. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington, Del.

THE ANCHORS CHEMICAL & DYE WORKS, East Orange, N. J., has filed notice of organization to manufacture chemicals, dyes and affiliated products. The company is represented by Elwood B. Hendricks, 645 Springdale Ave., East Orange.

THE CUMBERLAND COUNTY REFINERY, INC., Burkesville, Ky., has been incorporated with a capital of \$10,000, to manufacture refined oil products. The incorporators are Ernest J. Schabelitz, Burkesville; and Robert H. Wise, Waynesboro, Pa.

THE COLUMBIA CHINA CORP., Porter, Ind., has been incorporated with a capital of \$500,000, to manufacture chinaware and other ceramic products. The incorporators are J. R. Mendelson, E. T. Morris and L. I. Sutterman, all of Porter.

THE RED STAR LABORATORIES Co., 3256 Franklin Blvd., Chicago, Ill., has been incorporated with a capital of \$25,000, to manufacture chemicals and chemical byproducts. The incorporators are R. A. Murphy, William R. Swisler and G. W. Andrews.

THE LAWRENCE OIL Co., INC., Norwood, Mass., has been incorporated with a capital of \$350,000, to manufacture oil products. Herbert Brady is president, and Ernest H. Grant, 83 Vernon St., Norwood, treasurer.

THE PENN RUBBER BALL CORP., Philadelphia, Pa., has been incorporated with a capital of \$5,000,000 under Delaware laws, to manufacture rubber products of various kinds. The company is represented by Frank R. Hansell, Land Title Bldg.

THE FISK OIL Co., Schenectady, N. Y., has been incorporated with a capital of \$200,000, to manufacture oil products. The incorporators are M. G. and J. F. Hocker, and H. A. Bradshaw. The company is represented by D. B. Sammon, attorney, Schenectady.

THE HUDSON COUNTY LEATHER & SUPPLIES Co., West Hoboken, N. J., has been incorporated with a capital of \$50,000, to manufacture leather chemicals and kindred supplies. The incorporators are P. Coniglio and Frank Valvano, 118 Summit Ave., West Hoboken.

THE KEYSTONE REFRACTORIES Co., Minneapolis, Minn., has been incorporated with a capital of \$600,000 under Delaware laws, to manufacture firebrick and other refractory products. The incorporators are H. B. Finch, W. K. Nash and C. R. Wilson, Minneapolis. The company is represented by the Delaware Registration Trust Co., 900 Market St., Wilmington, Del.

THE UNITED STATES AUTO PAINT Co., 20 Warrington St., Providence, R. I., has filed notice of organization to manufacture paints, etc. R. Gighotti heads the company.

THE EDWARDS PETROLEUM Co., Los Angeles, Cal., has been incorporated with a capital of \$250,000, to manufacture petroleum products. The incorporators are H. L. Edwards, C. H. Webb and R. M. Galbreth, 607 Citizens' National Bank Bldg., Los Angeles.

THE ATLANTIC EXTRACT Co., Boston, Mass., has been incorporated with a capital of \$10,000, to manufacture extracts, compounds, etc. Martin M. Leibell is president, and Nathan Rubin, Chelsea, Mass., treasurer.

THE CEMENT TILE & PRODUCTS Co., Wilmington, Del., has been incorporated under state laws with a capital of \$100,000, to manufacture tile and affiliated products. The company is represented by the Colonial Charter Co., Ford Bldg., Wilmington.

THE T. C. OIL Co., Montgomery, Ala., has been incorporated with a capital of \$200,000, to manufacture petroleum products. The incorporators are T. C. Hadley, Montgomery; R. A. Cooper & W. A. McSwain, both of Columbia, S. C.

THE JURICH Co., New York, N. Y., has been incorporated with a capital of \$15,000, to manufacture paints, varnishes, etc. The incorporators are L. and T. O. Jurich, and C. Hattendorf. The company is represented by Charles Novello, 320 Broadway.

THE UNITED ZINC Co., 23 West Illinois St., Chicago, Ill., has been organized to manufacture zinc products. The company

is headed by Edward F. Mestling and Willis H. Huston.

THE PARDUE OIL CORP., Wilmington, Del., has been incorporated with a capital of \$5,000,000 under Delaware laws, to manufacture petroleum products. The company is represented by the Colonial Charter Co., Ford Bldg., Wilmington.

THE HARBOR REFINING Co., Long Beach, Cal., has been incorporated with a capital of \$1,000,000, to manufacture refined oil products. The incorporators are J. W. Tucker, J. S. Harper, W. A. Miller, Jr., and D. L. Akeley, all of Long Beach.

Capital Increases, Etc.

THE ANCHOR LEATHER Co., 1001 West Division St., Chicago, Ill., has filed notice of increase in capital from \$50,000 to \$300,000.

THE ATLAS CRUCIBLE STEEL Co., Dunkirk, N. Y., is arranging for a bond issue of \$4,000,000, and of which \$2,000,000 will comprise the initial distribution, to be sold at an early date.

THE CREPE-KRAFT Co., Newark, N. J., manufacturer of paper products, has filed notice of change of name to the Krepkraft Co. A new plant is now being established in a portion of the former works of the Universal Caster & Foundry Co., Jackson Ave.

THE REFINING & ASSAYING CORP., 40 West Broadway, New York, N. Y., has filed notice of dissolution under state laws.

THE CRYSTAL CHEMICAL Co., organized under New York laws to manufacture chemicals, has filed notice of organization to operate in New Jersey. Charles Kanter, 747 Broad St., Newark, N. J., is representative.

THE PHILLIPS PETROLEUM Co., 115 Broadway, New York, N. Y., operating oil refineries, has arranged for a bond issue of \$3,500,000.

THE ELECTRIC ALLOY STEEL Co., Youngstown, O., is arranging for a preferred stock issue to total \$750,000.

THE BLUE RIDGE PAINT & COLOR Co., Allentown, Pa., has been adjudged an involuntary bankrupt. John G. Diefenderfer is referee.

Coming Meetings and Events

ACADEMY OF POLITICAL SCIENCE will hold its forty-first annual meeting at the Hotel Astor, New York City, Nov. 4 and 5.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its seventy-fourth meeting at Toronto, Canada, Dec. 27 to 31, 1921.

AMERICAN CERAMIC SOCIETY will hold its twenty-first annual meeting at St. Louis, Feb. 27 to March 2, 1922.

AMERICAN GAS ASSOCIATION will hold its third annual convention in the Congress and Auditorium Hotels, Chicago, the week of Nov. 7. More than 100 manufacturers will exhibit their latest gas-burning appliances.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its annual winter meeting at Baltimore, Md., Dec. 6 to 9. Headquarters will be at the Southern Hotel and the sessions will be held in the Engineers' Club.

INDUSTRIAL COST ASSOCIATION will hold its second national conference at Pittsburgh, Pa., Nov. 2-4, with headquarters at the William Penn Hotel.

INDUSTRIAL RELATIONS ASSOCIATION OF AMERICA will hold its annual convention at the Waldorf-Astoria, New York, Nov. 1-5.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stettens Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

The following meetings are scheduled to be held in Rumford Hall, the Chemists' Club, New York: Nov. 11—American Chemical Society (in charge), Society of Chemical Industry, American Electrochemical Society, Société de Chimie Industrielle, joint meeting; Nov. 18—American Electrochemical Society, regular meeting; Dec. 2—Society of Chemical Industry, regular meeting; Dec. 9—American Chemical Society regular meeting.

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Recognizing Our Organic Chemical Industry

AN EVENT of historical importance to the chemical industry occurred in Washington last week at the meeting which resulted in the organization of the Synthetic Organic Chemical Manufacturers Association. This new economic factor carries with it more significance than the usual trade association, for it marks the union of all the elements which go to make up our organic chemical industry. The manufacture of pharmaceuticals, synthetic drugs, aromatic, photographic and other fine chemicals is to be recognized as essential, if not equivalent, parts of an industry of which dyes and intermediates are only an important branch.

The association has wisely selected Dr. CHARLES H. HERTY, editor of the *Journal of Industrial and Engineering Chemistry*, to be its first president. His vigorous enthusiasm and indomitable spirit have won for him a position second to none in the fight for the adequate recognition of American chemical industry.

Railroad Strike Is Called Off

BEATING an ignominious retreat, the railroad labor leaders decided on October 27 to call off the strike of the five railroad brotherhoods and thus relieve business of the apprehension under which it has labored for several weeks past. In explanation of their action, Mr. SHEPPARD, president of the Order of Railway Conductors, is reported to have recognized the fact that public opinion had discountenanced the strike and that the Government had decided to marshal all its forces against the strike, should it be called. Had he stopped at that explanation his words would have commanded the respect that is due a man who sees the light and acts accordingly, but he weakened his cause by his reported statement that the railroads had succeeded "in their misleading propaganda to the effect that we really would be striking against the Government." No sane man had ever thought otherwise.

One other phase of the strike cancellation, as reported in the daily press, will be worth remembering. It is stated that after reaching the decision to cancel the strike "all of the union men were smiling as they came out and many of them jocularly pushed and shoved each other down the stairs." A ghastly joke, indeed, that they had played on American business, causing disturbance, unrest, uneasiness and apprehension for weeks, only to yield at last to the authority which they should have respected in the beginning. One is forced to the conclusion that the leaders never intended to call the strike and that the vote was used only as a club to coerce the Government into meeting their demands. Labor leaders have only to continue to play this kind of joke on the American public to experience for themselves and followers the fate of the one who cried "Wolf! Wolf!"

How to Reduce Taxes

THE future of the coal-tar dye industry is, alas, in the lap of politics. We had hoped that it would forge ahead, establishing itself by its own merits; we watched with interest and enthusiasm the extraordinary achievements of American chemists, as they accomplished forty years' work within the space of five years, and we hoped that this great feat would speak for itself. Instead of this the industry has been made the butt of undeserved complaint. Sometimes it seems as though, as a sequel of war, people have gone to the dogs for their principles as well as for their habits of thought!

At the last count we had 213 concerns making coal-tar products and eighty-two making synthetic dyes in the United States. They are making today 90 to 95 per cent of the dyes needed and used. And they are good dyes, despite the fact that the markets are flooded with wares that fade out on almost any provocation. We have discussed this matter before, but let's repeat a little of it to bring out the facts. We buy, for instance, a pair of black socks, and when they come back from the wash they are a dirty greenish gray. The dealer, to whom we complain, regrets that he cannot guarantee goods colored with American dyes. Now there never was made any better sulphur black than is made right here in this country. But while sulphur black costs 20 cents a pound and direct black \$1.10, it is much cheaper to dye with the latter, because it requires scarcely any work to put it on. Sulphur black, on the other hand, must be developed on the fiber, and that takes time and labor; and wages are high in the dyehouses. So the owner of the goods while they are in process has them dyed by the cheaper method, and direct black will not stand laundering, but sulphur black, rightly applied, will. This holds true all the way down the line; it requires labor and handling and care to put the right dye on the goods so that it will hold. The value of the dye that goes on a single garment is negligible. The main cost is the labor of putting it on. The difference between the cost of wearing apparel with German dyes free of duty and under embargo is a small fraction of a cent on a pair of socks and a few cents on a suit of clothes or a woman's dress. And every dye is available to the dyer.

Suppose our license system or embargo were allowed to lapse, what would happen? The Interessen Gemeinschaft, or German Dye Trust, has packed up, awaiting shipment, immense supplies of dyes of all sorts. Within two weeks it can land in New York, in two ships, dyes to supply the American market for more than a year. It can pay any duties we want to impose, its costs are one-half to one-third of American costs and while Germany is poor the I. G. is rich. Just two weeks' privilege under any kind of a tariff will enable it to kill the American industry.

Well, what of it? Most people don't care very much where the dyes are made that color their clothes. Financially speaking the industry is not important. All the dyes used in the country in a year amount in value to only a few months' sales of the Woolworth 5 and 10 cent stores. The profits or losses of the dye manufacturers do not constitute a national issue. True, no industry requires so many trained chemists in proportion to its product, but even that scarcely touches public opinion. If chemists lose their jobs, so do others. Why worry? Why make such a fuss over this thing? Just a little patience, please, and we shall reach the core of the problem.

We are talking of reducing armaments, and LORD knows we all want big armaments and big armies and navies reduced. We are sick of war, although we have not yet learned to put aside that which above all other things leads to war, which is the spirit of anger and hatred and mistrust. There is so much hair-trigger wrath abroad on earth that no nation can afford to give up all thought of defense at this time, although the costs of defense are killing costs.

In the meantime, chemical warfare has arrived. Nobody likes it, but it is bound to endure because it is more effective than powder and ball. One battalion of well-trained C.W.S. troops with proper materials can utterly defeat a whole brigade. At the beginning of the great war there wasn't any such thing as chemical warfare and at the Armistice 55 per cent of the warfare was chemical. Agreements and treaties will not put an end to it, because the army that uses it against an enemy that does not will win. Efficiency counts.

Now we are struggling under a burden of taxation that is using up our substance, destroying initiative and halting progress, almost wholly because of military costs. And in this very dye industry we have a self-contained arsenal, available for the production of munitions of war, which does not cost the Government one penny, which pays taxes, which does not encourage warfare or make men want to fight, which in times of peace gives us only materials used in peace, but which is ever ready, in time of war, to produce such potential munitions that no nation will dare to attack us. It leads to greater relief from taxation than any measure now before the American people.

Facts and Fancies

About the Oppau Explosion

SIX WEEKS has elapsed since the Oppau disaster, but notwithstanding the extraordinary interest in this subject, the technical press both in this country and abroad has published surprisingly little in the way of a scientific explanation of this calamitous explosion. Chemists and engineers of all countries have studied closely the meager reports which have been published not only for what they contribute to our general knowledge of explosions but also because of the probable effect upon the German nitrogen industry. Explosive experts are especially concerned with the accounts of the nature of the damage and demolition and the distances at which the effects of the explosion were felt. Even the war yielded few if any examples of such tremendous disruptions from which comparable data and experiences could be gained. The catastrophe at Halifax resulting from the explosion of three million pounds of TNT involved only about one-third of the

mass of material reported to have exploded at Oppau. On other pages of this issue the reader will find an authentic report of the explosion prepared by one who had an unusual opportunity to study the scene of the disaster. With it are a number of excellent photographs, a careful study of which should prove of value in helping to gage the magnitude of the occurrence and to test the various theories regarding its possible origin.

The fact remains that little is known regarding the real cause of the explosion. The blasting of the caked material with dynamite, which to the uninitiated appears to be extremely hazardous, is common practice in ammonium-nitrate plants both in this country and abroad. Moreover, ammonium sulphonitrate, the mixed salt at Oppau, has always been regarded as non-explosive. The director of the Physikalisch Technische Reichsanstalt was unable to explode the material except when it was tightly packed in iron pipe and given an unusually violent detonation. Recent experiments conducted in this country with crystallized NH_4NO_3 , $(\text{NH}_4)_2\text{SO}_4$ and with intimate mixtures of the two powdered salts tend to confirm this supposition.

The theory of the spontaneous decomposition of the salts, which from the chemists' point of view is at least within the realm of possibility, is regarded as purely speculative by some of the foremost explosive experts. One circumstance, however, which appears to strengthen the argument in favor of this theory is the report that on the night preceding the explosion certain observers had noted a change in color and a slight rise in the temperature of the mass. The bursting of one of the synthetic-ammonia catalyzers, which at first was hailed as a most likely explanation of the preliminary and detonating explosion, is now almost entirely discredited by the photographs showing so little damage to the part of the plant in which the catalyzer bombs were housed.

Furthermore we are confronted with the fact that ammonium nitrate itself is something of a mystery. Those who know anything about powder plants cannot help recalling instances when it acted as it shouldn't. We are told that once upon a time, of twenty vessels working up ammonium nitrate, No. 6 and No. 18 suddenly exploded, demolishing several others. At the same instant some barrels of nitrate in a storage shed went off and only scattered holes in the ground were left to mark the places where they stood. Surrounding barrels were broken and charred, but did not explode.

A very plausible explanation of such an occurrence was to assume that a minute amount of some highly unstable impurity was located somewhere within two or three of the barrels and its peculiar sensitiveness was responsible for the explosion. At Oppau, however, the ammonia used was a synthetic product which should have been unusually free from pyridine and similar impurities contained in ammonia from byproduct coking plants. Nor should nitric acid made by the oxidation of this ammonia contain traces of nitrated cellulose such as are carried over in the spent acid commonly used in powder plants. These are circumstances which undoubtedly would have made for greater stability of the ammonium nitrate prepared from such materials.

Still another very puzzling question is to explain the means by which the explosion spread from one center to another. If we accept the contention that heat, rather than shock or pressure waves, is the primary cause of detonation, we are unable to account for the fact that there is practically no evidence of fire in the

spaces which separate the explosive centers, notwithstanding that much of the wreckage is apparently made up of timber and other flammable material.

It is easy, perhaps, to account for the fact that certain portions of the plant are relatively undamaged while across the river in Mannheim extensive destruction was reported. A phenomenon which has often been noted in connection with large explosions is that the rush of air appears to take a wave-like course, harmlessly passing over one district only to dip down at some distance and wreck havoc with all that comes in its path. This, too, explains why observers in different localities will often report conflicting views regarding the relative intensity of two explosions.

To summarize what we know and don't know about the explosion is a difficult task, but it is certain that much remains to be learned. A scientific review of the facts reported from the scene of the catastrophe and an intensive study of the nature of ammonium nitrate and its mixtures may not explain all of the mysteries of the Oppau explosion, but it will do much to prevent the recurrence of similar disasters.

Earnings in the Steel Industry

THE financial report of the United States Steel Corporation for the third quarter of 1921 is very gratifying from the economic viewpoint, since it shows that it will be possible to cheapen the price of steel still further in the future and thus broaden the opportunity for its use. Wall Street regards the report as "bad, but not nearly as bad as expected."

Estimates made from time to time indicate that the Steel Corporation's shipments of steel products for sale in the September quarter amounted to about 1,200,000 tons, so that with earnings reported of \$18,918,058 the earnings were about \$15.75 per ton. Shipments averaged only about 30 per cent of capacity, and the earnings were small on that account, not on account of the rate per ton.

Already steel prices make a very fair comparison with pre-war levels, but every dollar a ton reduction will help broaden the demand for steel in future years. On a weighted average, steel prices now are about 28 per cent above the ten-year pre-war average, 34 per cent above the average of 1913 and 63 per cent above the low point of December, 1914.

It is true that independent steel companies have lately been showing large losses, in contrast with the Steel Corporation's profits. The statement frequently made that the Steel Corporation has a great "advantage" over the independents does not provide an explanation for this divergence. The Steel Corporation's inherent advantage is not large per ton, and it existed in 1912 and 1913, when the independents made profits although the Steel Corporation's earnings were \$10 per ton against \$15 per ton last September or in the September quarter. The explanation rather is that in 1920, when the independents advanced prices freely while the Steel Corporation held its prices down, the independents acquired expensive habits, which must be shaken off. Then there is probably a difference in that the Steel Corporation made radical allowances for excess inventory valuations in 1920, while the independents may have left some of that adjustment for this year. Another factor affecting comparisons at present is that in recent months the Steel Corporation has had a

heavier operation than the independents, by reason of good will acquired by the price limitation policy of 1920.

Altogether, the outlook for steel supplies in the future at really very moderate prices is greatly improved.

Social Stepping

A Business Necessity

NOW the season of increased human sociability approaches. Michigan Boulevard squaws, corner grocery habitués, statesmen, working girls, fishermen, profiteers, flappers, engineers, bathers and chemists will soon be forced to spend more time indoors and partake with different degrees of enjoyment of interior recreations. And it is well that nature so orders, for there is a very serious side to the seeming lightness of social frolicking. Social contact with fellow humans has more to do with the success of the individual than the same amount of time spent grinding at work without respite. This applies to personal development and business progress alike.

There is a chap who was so puritanical in his youth that he preached to his high school class against dancing at parties. A kindly old lady took stock of him in his first year at college and talked him into getting a girl and a dress suit. This chemist has never lost his appetite for hard work, but is now so filled with gregariousness that he will travel across the continent to a convention if dancing is among the listed events. He has broadened into a well-poised successful engineer.

EDISON has long been reputed as an inveterate worker, yet we find him in his later and we hope wiser years associating with men in other walks of life. Had he stepped away from the bench occasionally during his earlier years the general philosophy he now propounds would be less ingenuous, more sound. Litterateurs and artists have long dealt with society as a medium for their business activity. Observation of other men's motives has always been their stock in trade. Our more successful scientists count heavily as social bears. Chemists' clubs in Chicago, New York and elsewhere have the community's progressive men of science most active in social affairs.

In past years some scientists have succeeded in spite of their secluded lives, but never because of uninterrupted work within their cells. Since success in chemistry is becoming more a question of industrial application and less a matter of mystifying the public, the individual chemist must develop into a social mixer. As the business man would put it, he must sell himself through his personality and purchase current knowledge with discrimination. Ability to discriminate between buncombe and truth is an art most easily acquired by close study of the human vender. Secluded preachers are easy marks for book agents and overstudious truthseekers soft stuff for blue-sky salesmen, for both types lack experience in reading human character.

Application at the wheel without respite will only grind the rut deeper. Accomplishment of the artisan's task requires that the cutting tool move forward after the proper depth has been reached. Performance of organizations without wastage calls for co-ordination of efforts of all the separate parts. Human contact in a lighter vein is the best co-ordinator. Both the community and the individual profit if each one goes out stepping occasionally. This season is a good time for it.

Readers' Views and Comments

Impact Strength of Monel Metal and Aluminum Bronze

To the Editor of Chemical & Metallurgical Engineering

SIR:—Mr. Waltenberg's description of impact tests on Monel metal, on page 322 of your issue for Aug. 24, brings out very clearly the excellent resistance of this material to shock, but does not seem to do entire justice to other materials with which it might be compared. For instance, it might be expected that a metal with a ductility represented by 45 per cent elongation in 2 in. would have a greater impact resistance than metals with from 2 to 23 per cent elongation, yet these are the only metals on which impact figures are given in this article in comparison with Monel. In spite of the better shock resistance of the latter, it is doubtful if it will displace the heat-treated alloy steels of higher strength from many of their present applications.

Aluminum bronze, however, is an alloy with which Monel metal might well be compared, and some impact results on this alloy would have been of more practical interest in this connection. Reference might be made for this purpose to a "Study of Impact Tests on Alloys," published by A. B. Wilson on page 616 of *The Foundry* for Aug. 1, 1920. Unfortunately the nearest approach to Izod or Charpy tests that he reported are Fremont tests, where the cross-section area of the specimen at the notch was only 10 x 7 mm. instead of 10 x 8 mm., as in Mr. Waltenberg's tests. The extra millimeter in thickness would have a disproportionately greater effect on the results in this test in favor of the Monel metal, so a strict comparison is impossible. But even under these adverse conditions, and on cast material, a figure of 88.4 ft.-lb. was obtained for aluminum bronze, which is higher than that for any of the steels quoted by Mr. Waltenberg. Under the same conditions this figure would undoubtedly approach or surpass the showing of cast Monel metal; and well-annealed titanium-treated cast steel has given even higher figures than this.

The method given for determining the quality factor places a decided premium on the elongation at the expense of the tensile strength, so that Monel metal, with the highest elongation of any of the metals given, is bound to come out ahead. For instance, a common annealed brass would have by this method about the same high quality as the heat-treated nickel-chromium steel. The figures given here for aluminum bronze seem to be minima taken from a specification, instead of good average results like those for Monel metal. By referring again to Mr. Wilson's article mentioned above, it may be seen that proper comparative figures for cast aluminum bronze would be 80,000 tensile strength and 35 per cent elongation, giving a quality factor of 1,167 instead of the 875 obtained from Mr. Waltenberg's figures. This would place aluminum bronze above all but one of the steels, which is about where it belongs in a "quality" comparison of this kind. And it should also be remembered that the figures I have given above are for cast aluminum bronze, and thus subject to more or less improvement by skillful mechanical work.

Metallurgical Engineer,
Titanium Alloy Manufacturing Co., Niagara Falls, N. Y.

GEORGE F. COMSTOCK.

Recovery of Volatile Solvents by the Bregeat Process

To the Editor of Chemical & Metallurgical Engineering

SIR:—My attention has been directed to the letter of Messrs. Roulleux and Dort, in your Aug. 3 issue, in reply to a letter by James C. Lawrence, in your July 20 issue.

As a rule I do not think anything is gained by entering into controversy, but there are several statements in the former letter to which I feel it my duty to take exception, particularly the following: "Until the Bregeat process had been developed solvent recovery was not an industry by itself. The Bregeat process is responsible for bringing solvent recovery out of the class of an incidental and casual art into that of an independent and well-established business." This statement ignores altogether the work done by the Scott Co. which for twenty years has been making and installing solvent recovery apparatus. These installations have been furnished to prominent firms throughout the world for various industrial purposes, whereas the Bregeat plants tabulated in the article published in your issue for May 25 were chiefly, if not wholly, for war-time purposes, installed when expense was not an item to be considered. The number of installations made by the Scott Co. during the last twenty-odd years speaks for itself regarding the work of that firm in developing solvent recovery. The fact that up to the present time British manufacturers have been the largest users of solvent recovery apparatus for industrial purposes and that these installations have been built mainly by British firms is sufficient evidence of where the process has been largely developed.

ERNEST SCOTT & Co.

Fall River, Mass.

H. AUSTIN.

Studies in Colorado Shale Oils

To the Editor of Chemical & Metallurgical Engineering

SIR:—On pages 452 and 453 of your Sept. 7 edition appears an article written by Arthur J. Franks in which he makes a statement that for the determination of sulphur, "the peroxide fusion method does not require more time and energy than the oxygen bomb method." My experience in this work has been that considerably more time is required to determine sulphur by the fusion method than by the use of the oxygen bomb washings. The bomb that I have been using is the standard oxygen bomb furnished with the Parr oxygen bomb calorimeter and is equipped with a rubber gasket. I agree with Mr. Franks that when a lead gasket is used some extra time will be required. However, recent determinations made in our laboratory have proved conclusively to me that as far as the time element is concerned the advantage lies in favor of the oxygen bomb method. The results of these determinations, as well as many others I have run, show that more consistent results are obtained by the use of the fusion method, that slightly lower results are given by the oxygen bomb determinations, and as stated before, that much time is saved by using the oxygen bomb.

PAUL F. HOOTS,

Chemist, New Orleans Railway & Light Co.
New Orleans, La.

Italian Chemical Industries

FROM OUR SPECIAL CORRESPONDENT

GENEVA, ITALY, Oct. 5, 1921.

SEPTEMBER was a very fair month for the Italian chemical and metallurgical industries, and the number of orders, together with a further rise in foreign exchange, kept prices high. In some cases, especially with goods of foreign importation, there was an increase in price. The greater part of the business remained in the hands of French and German exporters owing to the lower rate of exchange in France and Germany compared with that of the United States and England.

ITALIAN POTASH MINES

The Italian firm Società Mineraria Coloniale Italiana, of Massaua, possesses potash mines capable of producing, when worked under normal conditions, from 5,000 to 8,000 tons per month of potash material. These mines are located in Abyssinia close to the Eritrea frontier, and the mineral is transported to Massaua (Italian Eritrea Colony) in part over land and in part by water through the seaport of Marsa Fati-mari. The firm employs, when working full time, more than 1,000 persons, most of whom are natives. In 1917 one-half of the production of the mines was sent to Italy, two-sevenths to France, one-seventh to England and the rest to Egypt. The Italian who discovered the mines in 1911 obtained from the Abyssinian Government a concession for their exploitation for thirty-five years.

ITALIAN SULPHUR INDUSTRY

The crisis in the Sicilian sulphur industry led to several meetings at the Ministry of Industry at Rome, where the representatives of the miners and the workmen insisted that no reduction of present wages should be enforced, as the cost of living has recently increased. The Consorzio Obigatorio per l'Industria Zolfifera Siciliana insisted on the necessity of its being authorized to conduct the refining of sulphur on its own account, or on the authorization to have refining conducted on its own products by the refineries already working. This position is easily understood when it is considered that exportation of refined ground sulphur increased during the first four months of the year to 15,887 tons, from 12,202 tons in 1920 and 5,951 tons in 1919 during the corresponding months and the exports of flowers of sulphur during the same months were 4,406 tons, against 6,921 tons in 1920 and 4,171 tons in 1919. There was also much discussion on the grinding of sulphur, the Sicilian producers giving an idea of the loss caused by this being conducted outside the island of Sicily.

NEW COMMERCIAL CONVENTION

A new commercial convention has been arranged with Poland for an exchange of products between the two countries despite the drastic exportation and importation prohibitions. The convention will continue in effect for six months. An agreement for nine months has also been arranged with Germany by which Italy will facilitate the importation of the following products: Synthetical essential oils and products, explosives, gelatine, coal-tar colors, colors for printing, colors for paints, articles of perfumery with and without alcohol, toilet soaps, lubricants and combustible mineral oils.

Germany consents to the importation of lemon oil, orange oil, bergamont oil, lavender oil, peppermint oil, and other natural essential oils, citric acid, tartaric acid, oleic acid, liquid and solid tanning extracts, licorice extract, glycerine, talc, citrate of lime, pumice stone, raw boric acid, clove oil, seed oils, washed industrial olive oil and sulphide green olive oil.

ITALIAN ESSENTIAL OILS

The Agricultural Federation of Western Liguria has formed several organizations, among other places at Carpasio, Porto Maurizio, for the distillation of aromatic flowers and plants, and is encouraging the substitution of modern plants working with steam for the old Arab apparatus of the Middle Ages using direct fire. The federation is also encouraging the cultivation of aromatic plants. Fields have been placed at its disposal at San Remo, on the Riviera, where experimental cultivation will be carried on. At Porto Maurizio capitalists are projecting the establishment of a large plant for the extraction of the essence of roses and other flowers and plants to produce natural perfumes and aromatic products. During 1920 Italy exported 2,539 tons of fresh flowers, in 1919 2,109 tons and in 1918 1,163 tons.

ITALIAN MANNA PRODUCTION

Italy is the only country in the world where the manna plant is utilized for medicinal purposes, although it grows as a tree also in other portions of Europe and in America. Castelbuono, in Sicily, is the principal center of the manna tree cultivation, nearly two-thirds of the entire Italian production being collected there. For this reason there has been established at Castelbuono an experimental station for the growing of the manna tree. The cultivation of some new species will be essayed and the various species of manna will be classified according to their botanical origin and their physical characteristics. Their employment in the different industries will be studied and an attempt will be made to intensify their use in pharmacy. Their therapeutic effects will be closely studied in relation to other pharmaceutical products of analogous properties of nature. Besides this, the chemical characteristics of the various adulterations will be investigated, as well as control of prices.

ELECTRIC RAILWAYS IN ITALY

The general director of state railways has proposed to the Italian Government that Germany be made to deliver, on account of war reparation, a certain quantity of electrical materials, not obtained quickly enough in Italy itself, for the electrification of the most urgently needed electric lines. It has been proposed to electrify the Pisa-Leghorn and Brennero-Verona-Bologna lines and those in the Istrian peninsula and Trento district. Express service is also being considered between Rome and Naples. Projects are also being studied for the electrification of the Naples-Reggio-Calabria and Paola-Cosena lines. For this vast system of electrification 90,000,000 lire has already been obtained.

ITALIAN PRODUCTION OF MINERALS

The quantities in tons of ores mined in Italy during the past year were: Iron, 473,000; manganese, 29,140; copper, 6,360; lead, 34,425; zinc, 73,180; silver, 500; antimony, 125; iron pyrites, 316,500; iron-copper pyrites, 4,400; and metallic mercury, 855.



Photo by Underwood & Underwood.

A PARTIAL VIEW OF THE WRECKAGE CAUSED BY THE OPPAU EXPLOSION

The Explosion of the Nitrate Plant at Oppau

Some Interesting Comments on the Disastrous Effects and the Possible Causes of the Fatal Explosion at the Plant of the Badische Anilin und Soda Fabrik at Oppau, Germany, on Sept. 21, 1921

UNUSUAL interest attaches to the serious explosion which wrecked a large part of the extensive chemical works at Oppau, Germany, caused much damage to the surrounding country and was responsible for the deaths of hundreds of employees. Although a number of theoretical explanations have been proposed, the fact remains that little is known, or probably ever will be known, regarding the true origin of the explosion. In the following pages, however, there is presented an interesting report of a German chemist and engineer who was in the region at the time and later inspected the scene of the disaster. There are also included a number of unusual photographs, which when carefully studied in connection with the accompanying map, clearly reveal the extent and nature of the damage caused by the explosion.

First-Hand Impressions of the Oppau Disaster

BY DR. ING. CARL COMMENTZ

It was the privilege of the writer to inspect the Oppau plant of the Badische Anilin und Soda Fabrik on Sept. 29, 1921, or a little more than a week after the fatal explosion which so completely destroyed this important center of German chemical industry. Words cannot picture the extent of this destruction and even the photographs which accompany this article give but a limited conception of the almost inconceivable wreckage caused by the sudden explosion of about 4,500 tons of the practically unknown chemical fertilizer ammonium sulphonitrate. The explosion itself is a mystery and very probably will remain so, for apparently no one was aware of any unusual danger incident to the manufacture and storage of this chemical product.

THE STORY OF THE EXPLOSION

The story of the terrible disaster is a very short one. At 7:29 and again at 7:32 in the morning of Sept. 21, there occurred two terrific explosions in the northern

part of the plant, which is devoted to the production of ammonium nitrate and other salts. The large buildings containing the ammonium sulphonitrate disappeared entirely and nothing was left in their place except a mammoth crater 250 ft. in diameter and more than 50 ft. in depth. This crater filled with water immediately after the explosion, so that its apparent depth is somewhat deceiving. (See Figs 1 and 2.)

No one of the workmen in or near this part of the plant escaped and there is none left to give an account of what immediately preceded the explosion. In all 430 lives were lost and included in this number are over 200 whose bodies had not been recovered even after a week of diligent search. General work had not yet begun at the time of the explosion and of the 7,000 employees only about 2,225 were at the works.

The village of Oppau, surrounding the plant on three sides and inhabited mostly by its workmen, suffered great damage. Over 70 per cent of the thousand dwell-



FIG. 1. A VIEW FROM THE EDGE OF THE CRATER CAUSED BY THE EXPLOSION

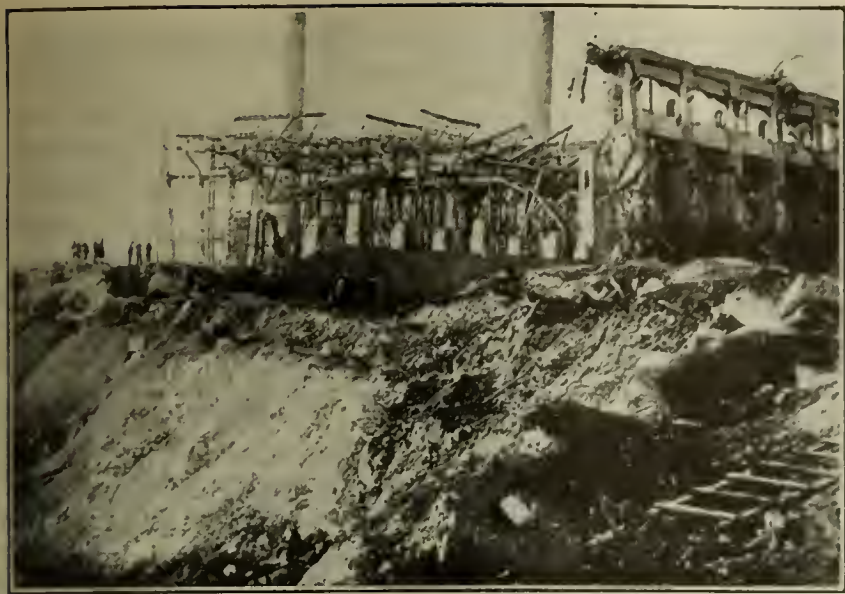


FIG. 2. LOOKING SOUTHEAST FROM THE SCENE OF THE EXPLOSION. THE WALL STANDING AT THE RIGHT IS THAT OF ONE OF THE TWO STORAGE HOUSES

ings were either totally or partly wrecked. Most of the houses were occupied at the time and the fact that the loss of life in the village was comparatively small (only fifty were killed) is perhaps explained by the fact that in many cases the walls and roofs were sucked away rather than falling in or down upon the occupants. The damage to property in Oppau has been estimated at 175,000,000 marks.

EFFECTS ON NEIGHBORING DISTRICTS

Houses in the adjacent city of Ludwigshaven and in Mannheim, which lies opposite to Ludwigshaven on the right bank of the Rhine, were damaged, walls were shaken down and practically all windows were broken. At these places and at Heidelberg, which is about fourteen miles from Oppau, the effect of the explosion was first felt by two very heavy earthquake-like shocks. In Mannheim some seconds later and in Heidelberg 82 seconds after the shocks there came an enormous rush of air which broke windows and doors and caused damage to gas holders, oil tanks, and many river barges. The sound of the explosion and the earth shocks reached as far as Bayreuth, at a distance of 145 miles, and the air pressure wave caused considerable damage in Frank-



FIG. 3. DAMAGED BUILDING NEAR THE EXPLOSION

furt, which is about 53 miles from the scene of the explosion.

The process for the manufacture of the different salts from the synthetic ammonia was in operation before the outbreak of the war and two types of mixed salts were known—viz., the so-called “ammonsulfatsalpeter” ($(\text{NH}_4)_2\text{SO}_4 \cdot \text{NH}_4\text{NO}_3$) and the “kaliammonsalpeter” ($\text{K}_2\text{SO}_4 \cdot \text{NH}_4\text{NO}_3$). Although the former was the cause of the explosion, its production, handling and storing had never been regarded with suspicion, nor had it ever shown evidence of spontaneous ignition. Indeed, when stored in large quantities it forms itself into a hard, rocky mass and it has been common practice to blast the material with dynamite in order to prepare it for transportation.

THEORIES REGARDING THE ORIGIN OF THE EXPLOSION

No one will ever be able to give the exact cause of the explosion, but some facts which may have an important bearing on the subject were brought out in a recent discussion of the affair in the German Reichstag.



FIG. 4. A STREET IN THE VILLAGE OF OPPAU

It was said that the company intended to blast the material on a much larger scale in the near future, but it was not proved that this change had been put into effect. In past years about 16,000 blastings of the salt had been made with dynamite without any mishaps. Another cause which was spoken of is the reported explosion of a gas engine which gave a shock severe enough to detonate the large mass of mixed salt. It was also recorded that prior to the explosion the color of the salt was known to have changed from its usual pure white color to a slightly yellow color; and that the temperature in the storehouse had risen to 100 to 120 deg. F. during the night preceding the explosion. This would appear to strengthen the suspicion that by some sort of a decomposition there had been a spontaneous ignition of the mass.

EXPERIMENTS WITH THE MIXED SALT

The director of the Physikalisch Technische Reichsanstalt reported on experiments with ammonium sulphonitrate which had been made in his Institute directly after the catastrophe. A large number of unsuccessful attempts were made to explode this material, even with strong blasting dynamite cartridges such as are commonly used for mining purposes. However, using a very strong initial explosive and with the material packed into iron piping, the Institute succeeded in ex-



FIG. 5. DESTROYED HOUSES IN OPPAU

ploding a part but not all of the ammonium sulphate. Fire and high temperatures appear to have no exploding effect on this salt. The director concluded that nothing could be deduced from the experiments which might be said to have caused the explosion.

The management of the Badische company has announced that the manufacture of the salt will be abandoned at once and the ammonia will be used for the production of ammonium sulphate. The part of the plant in which the synthesis of ammonia was carried out is nearly intact and will require practically no rebuilding.

Ludwigshaven, Germany.

Evidence From the Photographs

EDITORIAL COMMENT

Several excellent photographs of the damage done by the Oppau explosion have now reached America. Some of them have been published in the newspapers, mostly using as subjects demolished residences in the town itself. The latter are of little technical interest, except that they bear evidence that much of the damage was done by violent expansion of the air within the dwelling, throwing debris into the streets and yards. This is a characteristic type of damage observed in the vicinity of heavy explosions. That the walls burst outward rather than collapsed inward is doubtless the reason the loss of life in the town was not far greater.

All trustworthy reports of the disaster agree that the damage was so extensive and violent that it could not possibly have been caused by anything but a large amount of solid or liquid explosive. It perhaps requires no argument to discredit early newspaper reports of a gas explosion; the airplane view in Fig. 7 shows a crater that would be expected from no less than thousands of tons of TNT. Comparison of this photograph with the map reproduced in Fig. 6 shows the

culprit to have been housed in the left of the pair of buildings marked "Ammonium Nitrate Plant," and the range of its destruction extended to the outer circle.¹

Some very interesting circumstantial evidence can be drawn from these two illustrations. In the first place, no disastrous explosion occurred in the material in the buildings marked "Storage"—either within that set of four long walls in the immediate foreground or the pair of arch roofed warehouses three tiers away. Second, the crater was excavated by a shock whose main effect was expended in a vertical cone. Note the way the upper ends of the walls of the storage buildings are trimmed off, also the way the near corner of the building at the left is shot away, leaving spindly steel columns standing near by. No great sidewise earth jar occurred, else the four tall smokestacks certainly would have collapsed. Third, there was more than one explosion. Note a small crater between the large one and the railroad grade to the right, where once a small unnamed building stood. A ragged trench appears to extend forward from the sulphuric acid concentrators, perhaps toward the narrow building shown in the extreme lower right hand corner of the map. If this is the result of a train of explosives, it may account for the total demolition, except for the foundations, of the building alongside. Protected as it was by the railroad embankment, it should not have been so completely razed by the main blast. Furthermore, a building

¹This map is adapted from that appearing in *CHEM & MET. ENG.*, vol. 24, p. 394, March 2, 1921, and was derived in the first instance from an article, bearing all the earmarks of authenticity, in *La Technique Moderne*, November, 1920.

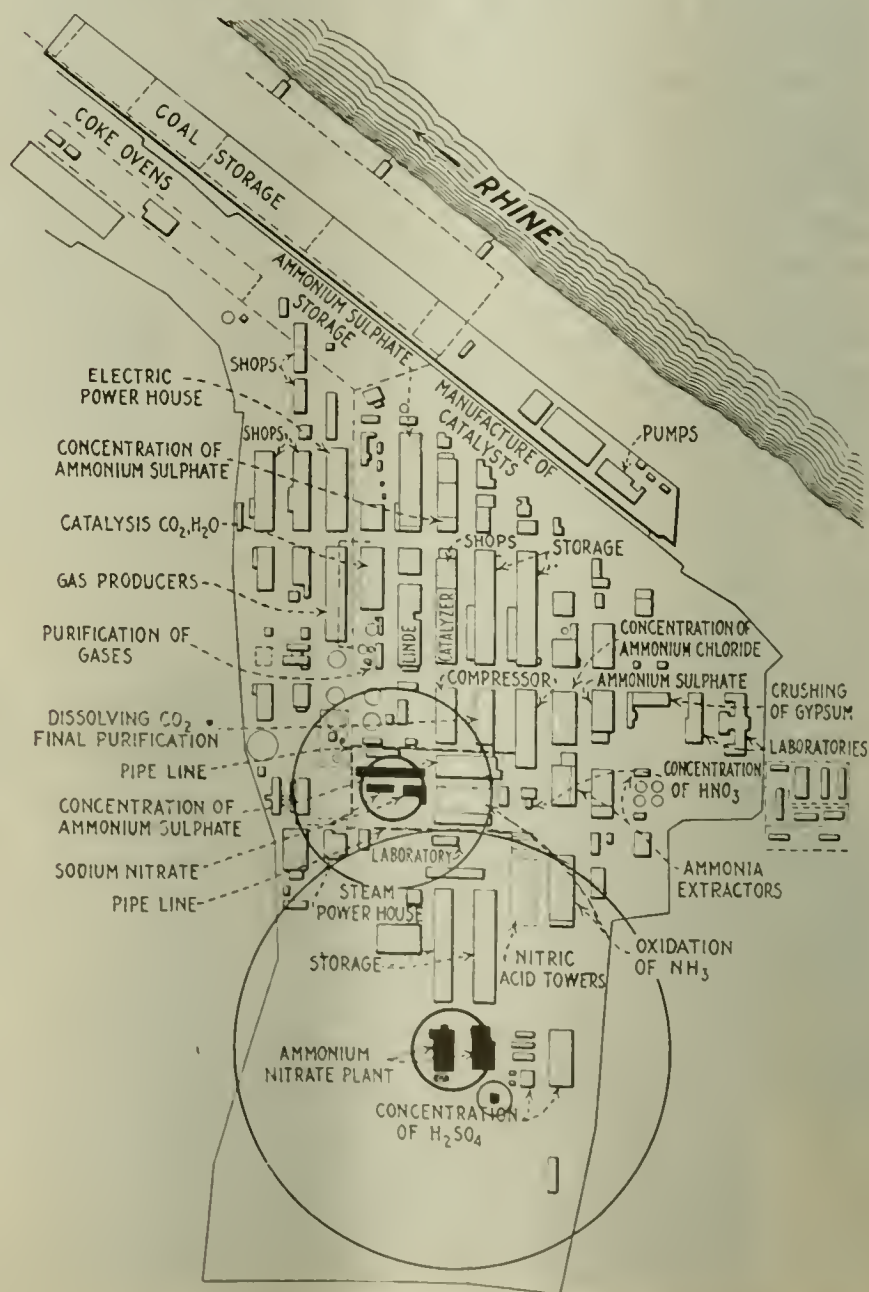


FIG. 6. MAP OF THE WORKS AT OPPAU

devoted to the oxidation of ammonia at the extreme right border appears to have been demolished, possibly from an internal explosion, since nitric acid towers and pipe and conveyor trestles immediately alongside appear relatively unhurt. But most striking of all is the disappearance of buildings in the central portion of the area, marked in black on the map, and supposed to house apparatus for working up sodium nitrate. The fact that nitric acid at Oppau was made by the oxidation of synthetic ammonia makes it at least doubtful if sodium nitrate was being used or stored. It might even be possible that these buildings were being used as storage for ammonium nitrate. At any rate a relatively small space appears to have been swept clean by a blast which also went up, rather than sidewise, as can be inferred from the condition of neighboring pipe lines, conveyor galleries and gas-holders, and the litter of collapsed steel and wood immediately alongside to the right, shown in the photograph at the top of page 818.

WERE THE AMMONIA CATALYZERS RESPONSIBLE?

On the basis that the published map of the works is approximately correct, reasonable surmises as to the nature of the explosive are not forthcoming. Evidently gas could not do it. Nor would one expect that the amount of material in process, even in so large a plant as Oppau, if detonated could cause more than local damage. Yet the pictorial evidence is overwhelming in showing that the known storage buildings were not the seat of any explosions.

In view of the oft-repeated statement that ammonia catalyzers or converters burst at practically the same time as the main explosion, Prof. R. S. Tour of the University of Cincinnati expresses the opinion that this could have detonated large piles of "mischsalz" in the vicinity. He thinks that it may have been caused by the practice of injecting air into the synthetic ammonia converters for starting or to maintain temperature. The men at Oppau themselves realized that this was a dangerous practice, and made various attempts to develop operation so that this step could be avoided. Could this account for the isolated areas where excessive damage can be observed? The catalyzer building is so far from the observer in Fig. 7 that it is impossible to judge whether there was unusual destruction at that point—the front wall is gone, although the roof seems to be unharmed. Even though some of the catalyzers exploded, why should this have detonated material several hundred feet away? We are advised that explosions are caused by heat, rather than shock. And yet intermediate areas are covered with broken timbers—in fact, one of the peculiar things about the disaster is that it was not followed by fire.

One may object that the main crater cannot be explained by the bursting of chemical apparatus holding less than thousands of tons of the most violent explosive. On the other hand, neither ammonium nitrate nor the mixed salts (ammonium sulphate-ammonium nitrate) are usually regarded as explosive. Pure nitrate must be highly compressed and slightly heated before it can be detonated by a blasting cap. The commercial

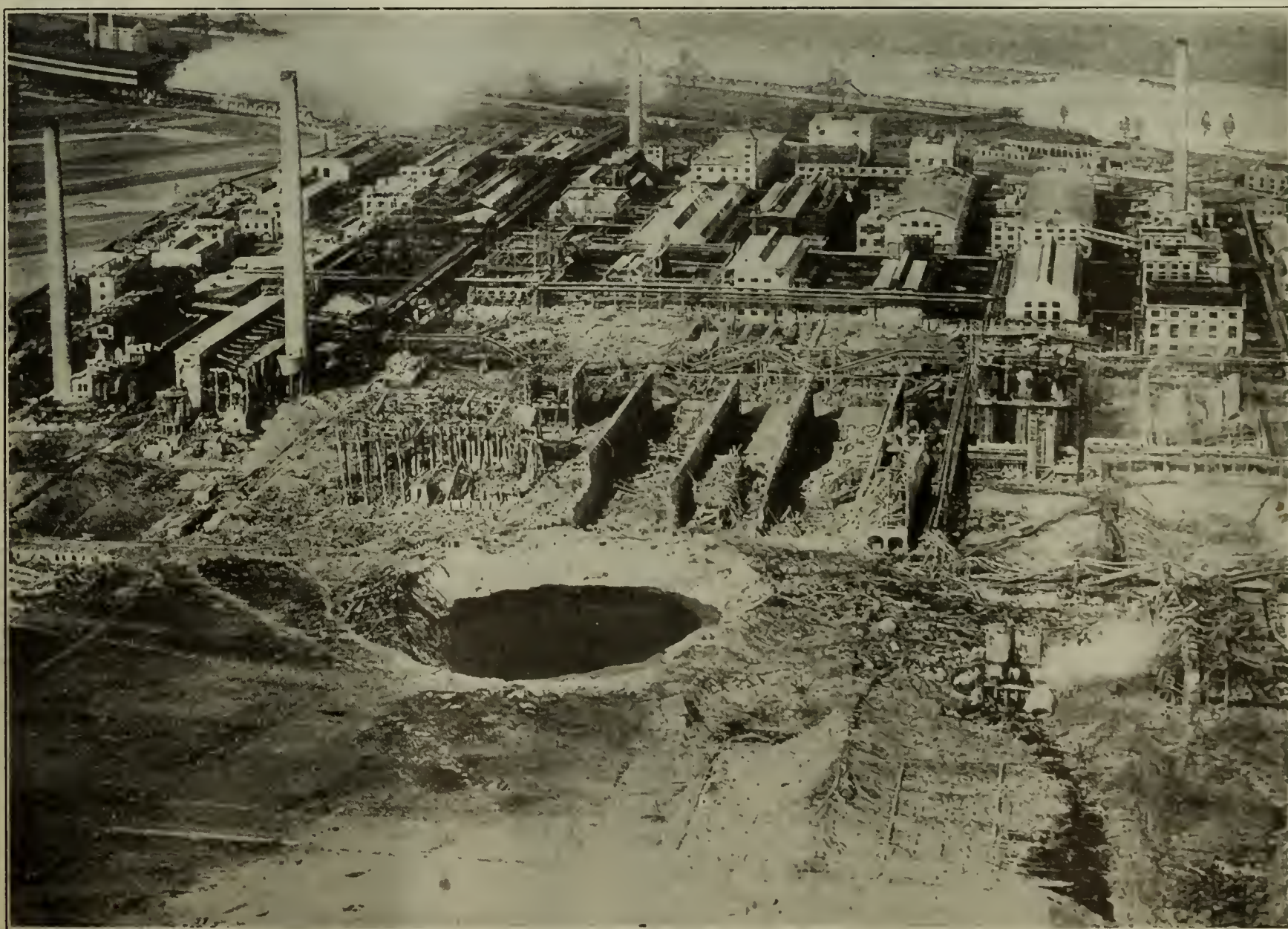


Photo by Underwood & Underwood.

FIG. 7. AIRPLANE VIEW OF OPPAU PLANT OF BADISCHE ANILIN UND SODA FABRIK
TAKEN AFTER THE DISASTER

salt cakes very easily, and it has been common practice to break large masses by dynamite when necessary to move it. Consequently it is fairly insensible to detonation. Intimately mixed with nitroglycerine, powdered aluminum or TNT, it was used extensively during the war as a high explosive, the two latter being commonly known as amonal and amatol. By the effects, one is tempted to suppose that it was some cellars full of this stuff which let go or perhaps even some forgotten mines prepared for the day when the Allied troops would appear along the Rhine!

Spontaneous Decomposition of the Mixed Salts

Dr. Ing. E. Hene of Stassfurt, in the Oct. 6 issue of *Chemiker-Zeitung*, suggests a gradual decomposition of the ammonium nitrate-ammonium sulphate mixture which might have caused the initial detonation of the Oppau explosion.

A possibility is suggested by the fact that one of the mixed salts—e.g., the sulphate—might have an acid reaction. The free sulphuric acid would liberate nitric acid from the ammonium nitrate, and this acid could react in various ways with the ammonium salts. For example, the following reactions are known:

- (1). $6\text{HNO}_3 + 5(\text{NH}_4)_2\text{SO}_4 = 18\text{H}_2\text{O} + 8\text{N}_2 + 5\text{H}_2\text{SO}_4 + 536 \text{ cal.}$
- (2). $2\text{HNO}_3 = 2\text{NO}_2 + \text{O} + \text{H}_2\text{O}.$
- (3). $\text{N}_2\text{O}_3 + (\text{NH}_4)_2\text{SO}_4 = \text{H}_2\text{SO}_4 + 3\text{H}_2\text{O} + 2\text{N}_2 + 138 \text{ cal.}$

It will be noted that in reaction 1 only 3 molecules of H_2SO_4 are required to produce the 6 molecules of HNO_3 , which react to regenerate not 3 but 5 molecules of H_2SO_4 . Furthermore, reactions 1 and 3 are exothermic. Hence under favorable circumstances it is possible for a small initial amount of free H_2SO_4 to produce a gradual increase of temperature and of acidity, thereby hastening the decomposition and eventually leading to detonation and explosion. Although the conditions may not seem to be favorable for reactions 1 and 3, it is possible that the pressure in the interior of storage piles, combined with the fact that the heat of reaction cannot be dissipated readily, may influence the reactions.

If these surmises are correct, it would seem that the addition of an alkali such as ammonium carbonate would be advisable. Large storage piles should be avoided and the piles should be turned over from time to time in order to prevent local overheating.

Production of Iron and Steel in Italy

The iron and steel industry in Italy, which succeeded in establishing itself in the pre-war period, reached its maximum activity during the war, but it has since rapidly declined, and it has suffered perhaps more than any other Italian industry from the present crisis. The principal cause of the difficulties encountered by the Italian industry lies in the high cost of fuel. In 1919, and still more in 1920, Italian iron and steel were produced at a cost 500 lire per ton in excess of the cost of foreign competitive products; and while the Italian industry was in this unfavorable condition, the home market was completely and freely open to importations from abroad, reports Consul General Osborne of Genoa in *Commerce Reports*.

Data in regard to the production, importation, exportation and apparent consumption of ore, pig iron, and finished iron and steel follow:

PRODUCTION, IMPORTS, EXPORTS, AND CONSUMPTION

Years	Production Tons	Imports Tons	Exports Tons	Amount for Consumption Tons
Iron and Manganese Iron Ores				
1913.....	603,116	8,026	9,660	601,482
1914.....	706,246	4,592	8,944	701,894
1915.....	679,970	7,607	157	687,420
1916.....	946,604	739	30	947,313
1917.....	998,632	313	327	998,618
1918.....	694,677	1,951	66	696,562
1919.....	465,655	12,533	1,679	476,509
1920.....	423,300	1,607	5,786	419,121
Pig Iron				
1913.....	426,754	240,039	1,809	664,984
1914.....	385,340	237,178	1,250	621,268
1915.....	377,510	247,301	1,401	623,410
1916.....	467,005	305,550	974	771,581
1917.....	471,188	319,967	433	790,722
1918.....	313,576	119,606	301	432,881
1919.....	239,710	223,811	441	463,080
1920.....	*	165,070	42	*
Iron and Steel				
1913.....	933,500	277,255	28,116	1,182,639
1914.....	911,000	244,816	14,107	1,141,709
1915.....	1,009,240	226,156	133,073	1,102,323
1916.....	1,269,486	317,862	31,840	1,555,508
1917.....	1,931,641	192,410	23,341	2,100,710
1918.....	992,529	656,668	2,700	1,646,497
1919.....	731,823	465,731	6,354	1,191,200
1920.....	*	269,846	1,311	*

* Figures not available.

The amount of iron ore existing in Italy is estimated at about 40,000,000 tons and is irregularly distributed. The most important mines are those of Elba (up to now actively exploited), those of Cogne in Piedmont and those of Nurri in Sardinia.

Table of Statistics of Canadian Chemical and Allied Industries*

Industry	No. Plants 1918 1919	Capital Invested Includes Value of Lands, Building Machinery, Materials on Hand and Bills Receivable	Cost of Materials Used	Value of Products Made
Ammonia.....	3 3	\$432,440 \$511,414	\$205,195 \$129,478	\$409,437 \$331,581
Boiler compounds.....	4 6	176,789 144,994	55,660 70,305	137,076 188,144
Drugs and chemicals.....	36 34	20,550,661 13,495,257	11,995,916 1,957,683	20,670,178 5,090,338
Disinfectants.....	7 6	67,942 115,324	44,760 52,427	116,083 154,138
Dyes and colors.....	3 4	194,917 245,642	135,191 156,870	222,882 279,542
Explosives.....	11 8	19,172,539 12,840,937	23,025,839 2,017,306	45,402,892 4,495,609
Fertilizers.....	15 15	3,064,111 3,331,403	1,573,582 1,289,785	2,562,688 2,249,621
Gas, illuminating and fuel.....	38 38	26,937,885 26,972,854	3,456,396 4,046,563	7,282,147 7,213,544
Glass.....	11 13	7,443,525 7,231,774	2,056,739 2,267,686	6,662,116 7,171,006
Glue.....	11 13	1,562,086 1,620,433	812,923 748,051	1,488,147 1,510,112
Gold refining†.....	4	840,917	3,133,073	4,331,010
Ink.....	14 16	1,022,089 1,234,672	876,672 969,595	1,746,935 2,019,037
Leather.....	139 113	28,435,806 34,599,542	23,681,659 34,283,896	35,357,450 46,996,298
Liquors, distilled.....	6 5	10,018,168 8,154,002	2,271,178 724,268	2,883,115 1,288,477
Liquors, malt.....	63 57	32,433,507 28,119,477	6,543,058 8,093,403	16,370,946 20,169,074
Matches.....	3 4	2,301,622 2,493,997	771,077 1,076,788	1,545,680 2,207,221
Oils.....	19 18	4,493,292 3,925,103	5,759,895 7,908,060	7,080,512 9,768,699
Compressed gases.....	14 16	1,736,913 1,824,911	89,042 133,821	1,063,771 1,172,778
Paints and varnishes.....	45 44	15,784,610 17,830,072	9,203,530 10,835,474	17,796,518 19,506,653
Patent medicines, etc.....	125 123	9,434,904 11,167,869	5,549,532 5,872,989	13,487,905 13,671,350
Soap.....	28 26	13,086,933 12,017,281	14,595,624 12,070,181	20,944,909 17,384,260
Starch and glucose.....	12 7	3,784,664 6,332,658	4,992,705 5,709,203	7,788,742 7,953,273
Sugar.....	8 8	37,256,851 38,725,542	15,403,037 86,308,204	58,812,219 102,630,086
Tallow.....	5 5	79,117 77,251	61,933 70,762	93,627 127,053
Wood distillation.....	13 13	3,612,573 5,760,395	3,319,731 1,173,473	7,634,122 2,812,037
Petroleum.....	10 10	35,745,410 43,158,655	24,454,575 26,264,839	37,866,907 43,256,317
Miscellaneous.....	18 30	14,426,783 19,741,875	2,731,486 3,813,190	9,644,632 13,408,391
Total.....	663 630	\$294,097,054 \$301,672,404	\$196,799,978 \$218,044,300	\$329,492,636 \$332,964,639

* From *Canadian Chemistry and Metallurgy*.

† Included with Metallurgical Works in 1919.

Silicate of Soda in Papermaking

BY JAMES G. VAIL

Chemical Director, Philadelphia Quartz Co., Philadelphia, Pa.

SILICATE of soda is a material which finds application in a great many branches of industry. Probably no heavy chemical has a wider range of uses. In its diversified application it has touched the experience of almost every one. Most papermakers are aware that it is used in the manufacture of paper and that it is added to the beater and precipitated with alum in the same manner as rosin size is precipitated, but only a small number know definitely the properties which its use imparts to paper. Some confusion is found also as to the respective functions of silicate of soda and rosin size in paper. Rosin size is necessary to give water resistance, but, as has been pointed out by Klemm¹ and others, resistance to printers' ink is produced with silicate of soda. A good deal of work has been done in the laboratory to show the nature of the precipitate which is formed from silicate of soda and the conditions under which this precipitate separates from the water in the beater and is retained among the fibers of the paper, modifying the character of the finished sheet.

The observations which are to be reported here are based also on practical experience with large quantities of paper. These have led to a better understanding of the behavior of silicate of soda in the beater and on the paper machine and have given a basis for better judgment of the conditions for its successful use.

NATURE OF SODIUM SILICATE

Before considering details of handling silicate of soda, it is necessary to make plain what we mean by this term. Silicate of soda is not the name of a definite salt, but rather the general name for an indefinite number of products composed of silica and soda in varying proportions. Different ratios of silica and soda, along with different concentrations of the solutions, give varying properties, both chemical and physical. It is this ability to modify the properties of silicate of soda which accounts for its great variety of uses. Adhesives, plastic cements, quick setting cements, sizings, gels, water softeners, detergents, paints and cements for digester lining are all included in its scope of usefulness. As drawn from the furnace, silicate of soda looks like glass. Like glass, the proportions of its ingredients may be varied within wide limits without much change in appearance. It differs from glass in that it may be dissolved in water. It comes upon the market in concentrated solutions. Much misunderstanding of results harks back to the assumption that silicate of soda is a definite thing, and many published articles report results which it is impossible to confirm or disprove without knowing just what grade of silicate of soda was used. Because two samples of silicate of soda look alike it does not follow that they are alike. Solutions ranging from 34 to 54 per cent total solids may have identical viscosity. The body of silicate is no index to the amount of solids present. To avoid confusion all manufacturers have established certain brands which represent definite compositions of silicate.

PRECIPITATION WITH ALUM

To precipitate silicate of soda in paper stock the soda is neutralized with alum. Hence a silicate with the

smallest possible amount of soda should be chosen for reasons of economy. The lowest alkalinity which is practical from a commercial viewpoint is represented by a solution containing 7 per cent total alkali as Na_2O and a ratio of soda to silicate approximating 1 to 4. A product of lower relative alkalinity is too nearly insoluble to be of commercial use. Failure to neutralize the soda completely will result in an imperfect precipitation on the one hand and injury to the rosin sizing of the paper on the other. A silicate of 1 to 2 ratio requires twice as much alum to produce a given effect on the paper.

A solution of the 1 to 4 ratio is a jelly at 37 deg. Bé. corresponding to 34 per cent total solids. When this is diluted to the concentration corresponding to that which obtains in the beater and a solution of alum is slowly added, the solution becomes more and more turbid until it becomes acid in reaction and a precipitate separates from the solution. Other precipitating agents, such as niter cake, calcium sulphate or even hard water, will precipitate silicate of soda, and when these are used the amount of alum added for the silicate can be proportionately reduced. This is a large factor in some mills. The precipitate is very bulky and light and readily becomes entangled with the fibers, assisting in their retention on the wire and cementing them together. If an insufficient amount of alum be added, no precipitation will occur and without precipitation the advantage of using silicate is lost. It is, therefore, of first importance to see that a sufficient amount of alum is used to give an acid reaction. The precipitate contains the elements of an aluminum silicate. It probably contains along with the aluminum silicate both aluminum hydroxide and hydrated silica. Silicate of soda thus differs from rosin size, which begins to precipitate when the first small quantity of alum is added.

TEXTURE DEPENDS ON DILUTION

The texture of a silicate precipitate depends on the dilution of the silicate and the alum. Under the conditions occurring in the beater a light flocculent product, well adapted to harden and increase the strength of the paper, is produced, but if the chemicals were mixed in relatively concentrated condition the material thrown out would be granular, sandy or lumpy, just as would be the case if dry alum were mixed with a strong solution of rosin size. When the light flocculent precipitate is dried, it hardens to a horny consistency, too hard to be crushed easily by the hand. In this hard condition it still retains a considerable amount of water, which contributes largely to its toughness. The apparently dry precipitate always contains at least 25 per cent of water under the conditions of drying paper.

RETENTION AFFECTED BY CONCENTRATION

The effect of retaining this material in the substance of paper is shown first of all by an increase in the ash of the paper. A study involving 550 tons of paper and an examination of 1,200 samples gave an average of 1 per cent in ash with an average addition of 3.48 per cent of liquid silicate based on dry fiber. The amount of dry alum necessary for the precipitation of the silicate was 25 per cent of the weight of the silicate solution. The average retention was 66 per cent of the total silica in the silicate, plus the Al_2O_3 of the alum. There is good reason to suppose that the use of larger proportions of silicate, as reported by Blasweiler,² would

¹Klemm, *Mineralische Leimung von Druckpapier*. *Wochbl. Papierfabr.*, 1907, No. 25, p. 1983.

²*Papierfabrikant*, 1921, vol. 33, p. 875.

not only produce more marked effects on the paper but would be accompanied by a higher percentage retention. Amounts as high as 10 per cent of the dry fiber will make the stock appreciably slower on the wire, but this effect was not observed at 5 per cent or less.

STRENGTH AND INK TESTS OF PAPER

The hardness and the finish of the paper were determined by the combined judgment of several experienced papermakers, as we know of no method of reducing these qualities to a numerical standard. From comparison of sheets, which differed only by the silicate content and the alum requisite for its precipitation, the statement is warranted that the use of silicate in every case produced a harder and a smoother sheet. The Mullen tests of the papers in this series when averaged show a gain of 12 per cent in favor of the papers containing silicate. Ink resistance was studied in four different grades of paper by the floating method with standard ink. In three of these grades the papers containing silicate showed better ink resistance than those which contained none. This may be attributed to the increased retention of rosin in the paper, there being no reason to believe that sodium silicate can of itself increase the resistance of paper to water or to an aqueous ink.

In studying the effect of the addition of silicate to the beater, it was observed that the increment of ash increased over a period of several hours, sometimes reaching its maximum as late as 7 hours after stock containing silicate came on the machine. This is interpreted to mean that a larger precipitation of the silicate and better retention develops as the white waters from which the silicate has been precipitated are returned to the machine and to the beaters.

EFFECTS ON COLORS

Silicate, like rosin size, should be handled in such a way that its alkalinity does not affect adversely the colors used in the paper. Where the silicate is added first and is completely precipitated with alum before the addition of the color, no interference with the color has ever been experienced, but it is not safe to add the necessary quantity of alum and then a color sensitive to alkali before the silicate, because when the silicate is added it is certain to be for a short time locally in excess, and the full strength of some coloring materials is not restored by the alum. Owing to better retention some papers show an improvement in color when silicate is used and when handled with proper regard to its alkaline character, satisfactory coloring is always practicable in papers containing silicate.

From the point of view of maximum retention, the experiments point to the following order of additions to the beater as the most satisfactory: (1) Silicate, (2) alum for the silicate, (3) rosin size, (4) clay or other fillers, and (5) alum for the rosin size. Many variations are possible without destroying the effect of the silicate, this being simply the preferred practice.

PAPERS TREATED WITH SILICATE

The grades of paper which have been considered in careful tests include cover, envelope, papeterie, book, writing, kraft, tissue and boxboard. It would not be reasonable to say that silicate of soda should be used in every mill or even in every mill that requires the properties in paper which the use of silicate tends to impart, but it has been found possible in some cases

to make a paper of acceptable quality with a less expensive furnish and in other cases to get a grade of hardness and finish not otherwise obtainable. In mills where the trim from combining machines using silicate as an adhesive is furnished to the beaters the resulting paper may be improved by precipitating the silicate with alum. Silicate of soda is always helpful in bristol boards, because of the cementing action on the fibers which tend to stand up as a fuzz or beard on the surface. This characteristic is also very useful in certain kinds of wrapping paper and the cheaper grades of writing paper. All paper that is judged by its rattle and snap can be improved by the judicious use of silicate.

SILICATE-STARCH GOOD SIZING AGENT

As pointed out by Wrede,³ papers intended for printing may be sized with silicate of soda or with silicate and starch in such a way as to provide all the qualities required in printing and with the added advantage that they are not subject to discoloration on long exposure to light, as are all papers which have been sized with rosin size. Printing ink is an oily substance and it is possible to produce a paper which gives perfect satisfaction in offset printing without showing much resistance to water. The more general recognition of a distinction between water resistance and oil resistance will do much to extend the usefulness of silicate of soda in the paper industry.

Belgian Industry Statistics

The table given below shows the production of the various branches of Belgian industry during 1920. These statistics were estimated at the Ministry of Economic Affairs and were obtained from production figures and average prices:

Industry	Production Metric Tons	Value Francs
Mines:		
Coal.....	22,413,535	2,016,000,000
Coke.....	1,801,280	180,000,000
Briquets.....	2,923,363	321,500,000
Quarries:		
Marble, building stone, flux, paving stone, sand.....		231,000,000
Cement.....	648,147	95,600,000
Metallurgy:		
Pig iron.....	1,128,518	564,259,000
Zinc.....	82,960	149,000,000
Copper.....	4,850	25,000,000
Finished steel.....	1,071,856	810,000,000
Finished iron.....	197,032	170,000,000
Mechanical construction figures unobtainable.		
Glass:		
Plate glass.....	*2,419,315	109,000,000
Window glass.....	*26,449,583	300,000,000
Flint-glass industry.....		96,000,000
Chemistry:		
Soda, potash, chloride of lime, calcium chloride, etc.....		38,152,000
Sulphuric acid, hydrochloric acid, nitric acid, sodium sulphate, superphosphates.....		183,925,000
Soap.....		18,000,000
Matches.....		11,500,000
Byproducts of coal—		
Alkali.....	894	57,182,000
Anhydrous ammonia.....	62	
Ammoniac sulphate.....	9,048	
Benzene.....	4,194	
Dissolvent.....	759	
"Brai" (rosin, pitch, tar).....	25,872	
Naphthalene.....	4,702	
Creosote.....	5,543	
Tar.....	28,304	10,000,000
Light oils.....	1,785	
Powder and explosives.....	2,200	
Textiles:		
Cotton spinning.....	29,750	1,192,000,000
Flax.....	21,900	400,000,000
Wool (prepared).....	20,618	400,000,000
Artificial silk.....	1,890	113,500,000
Weaving (insufficient information for estimating value).		
Paper and cardboard.....	106,097	180,000,000

* Square meters.

³Wrede, *Wochbl. Papierfabr.*, 1913, vol. 10, p. 835.

Radium Production in America—I

Grinding—Dissolving—Filtering—Crystallization—Conversion of Chloride Into Bromide—Tubing of Radium Bromide—Recovery of Vanadium and Uranium—Recovery of Radium From the Gelatinous Silica Press Cake

By H. D. d'AGUIAR

THE American radium-bearing ores are the carnotites found chiefly in the Paradox Valley of Colorado, deposited on and impregnating a fine grained, porous sandstone.

The carnotite, which is potassium uranium vanadate, is a bright canary-yellow crystal when pure, but the ore, as found, has usually the appearance of a dirty, mud-colored sandstone. The ores usually run from 1.5 to 2.8 per cent uranium oxide, though occasionally pockets containing ores running 10 and even 18 per cent uranium oxide are found. The higher grade ores are readily distinguished from the low-grade ones by their color, which becomes more and more yellowish as the values increase.

As radium is a product of the disintegration of uranium and as the amount of radium present is always in fixed proportion to the amount of uranium present, the percentage of uranium is an index of the milligrams of radium contained.

The ore occurs in pockets and though the actual mining difficulties may be few, the location of the deposits far from railroads, in a country where even wagon roads are next to impossible, together with the shortage of water, makes the mining operation difficult enough. The ore as mined is sacked and transported by burros to the camp, where it is weighed and assayed for uranium content by means of the alpha ray electroscope. The bags are then marked with lot numbers and shipped to the reduction works.

GRINDING AND DISSOLVING

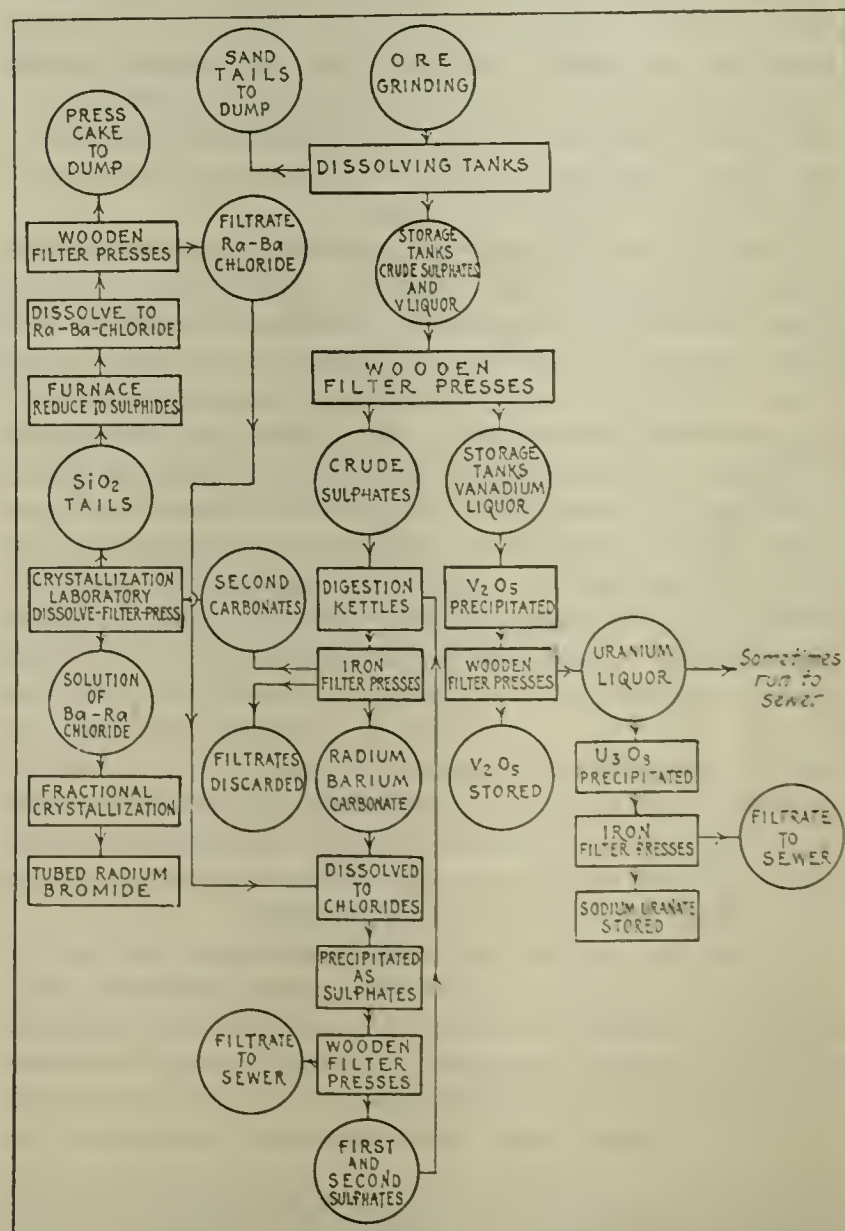
On arrival at the reduction works the various lots of ore are weighed and stored separately in a dry warehouse. The action of water on the ore alters the uranium:radium ratio and would carry away much of the fine high-grade material; therefore it is important to keep the ore dry.

From the warehouse the ore is sent to the grinding mills, where it is reduced by means of Hardinge or other suitable ball mills to pass 60 mesh. The lots are either run through the mills separately or lots of about the same values are combined into one large lot.

Two samples of the ground ore are taken. One is sent to the analytical laboratory for determination of uranium oxide, vanadium oxide, barium and calcium oxides and moisture. The other sample is sent to the electroscopic laboratory, where the percentage of uranium present is determined by radio-activity with the alpha ray electroscope. The results obtained by the two laboratories on uranium should check closely.

The analyzed ore is sent to the dissolving tanks. These tanks are acid-proof and good service is given by tanks constructed of acid-proof brick. The tanks are shallow and about 60 sq.ft. in area. The ore is spread in a layer from 4 to 6 in. deep on the bottom of the tanks

and is then wet down carefully with water or weak vanadium-uranium liquor from previous extractions. So prepared, the ore is ready for the extraction of the uranium, vanadium and radium. This is accomplished by treating the ore with the amount of hydrochloric acid necessary to dissolve all values as computed from the chemical analysis and the number of pounds of ore placed in the tank. During the addition of the hydrochloric acid the ore is continually turned and agitated so that the acid may act evenly on the entire mass. Sulphuric acid is then added in sufficient quantity to precipitate all barium and calcium. Water or more weak vanadium liquor from previous extractions is then added. The stirring is continued throughout the entire operation. The liquor, which now contains the uranium and vanadium in solution and the barium-radium sulphate in suspension, is removed by decantation through an opening in the side of the tank at a height flush with the top of the bed of sand tails. The bed of sand remaining in the tank is washed with water or more weak



FLOW SHEET OF RADIUM PRODUCTION PLANT

vanadium liquor and is again stirred to remove any sulphates. The liquor first decanted and the first wash waters go to a storage tank, while the succeeding wash waters, being weaker in radium values, go to a second storage tank. These weak liquors are used for first washes on new lots of ore, the sulphates accumulating in this tank being periodically cleaned up and combined with other lots of sulphates.

The sand tails before being conveyed to the dump are carefully sampled and a sample is sent to the electroscopic laboratory for analysis. The tails should show little or no activity. An activity equivalent to 0.05 per cent uranium oxide should be the maximum permissible, the determination being made immediately after drying and cooling.¹

FILTERING

The liquor and sulphates in the first storage tank are siphoned or pumped to a wooden frame filter press equipped with Duriron pumps. The vanadium-uranium liquor passing through as filtrate is pumped to storage tanks. The first wash waters from this operation are also pumped to this tank, while the remaining part of the wash water which shows vanadium is pumped to the storage tanks containing the last washes from the sand tails.

When the press cake has been washed, the press is stripped and the cake sampled and weighed. One portion of the sample is sent to the analytical laboratory for determination of moisture and barium sulphate. The other portion goes to the electroscopic laboratory, where the radium content is determined by means of the emanation electroscope.

These crude sulphates are transferred to pressure kettles, where water and a calculated excess of sodium carbonate are added and the mass is "cooked" under steam pressure until the barium sulphate together with the radium sulphate, which always follows barium, is converted to the carbonate with formation of an equivalent amount of sodium sulphate.

The contents of the pressure kettles are then pumped through iron frame filter presses. The sodium sulphate liquor, containing the excess unchanged sodium carbonate, is run to the sewer. However, a careful check is kept on this liquor by sampling frequently and having the samples analyzed to make sure that it contains no radium. A very minute activity is sometimes found, but as a rule these liquors contain no radium at all.

The frames and cloths used on the filter presses are carefully inspected to make sure that they fit perfectly and that the cloths are free from thin spots or holes. Any leakage would be the cause of losing radium-bearing material of considerable activity. The radium-barium carbonate so obtained is stripped from the presses, sampled and weighed. One-half of the sample is sent to the analytical laboratory for the determination of barium and moisture, while the other half goes to the electroscopic laboratory for determination of radium content by the emanation method.

The barium-radium carbonate so obtained is dissolved in a tank with dilute, sulphate-free hydrochloric acid. This acid chloride solution, together with the insoluble matter, is pumped through a wooden frame filter press. The filtrate, together with the first wash waters, is run to a storage tank, while the later, weaker, wash

water is run to a second storage tank. The press cake, which is chiefly gelatinous silica, requires thorough washing to remove all possible soluble values. This cake is never washed free from radium values, so when the activity has been reduced to the minimum compatible with economical working of the plant, the cake is stripped, and when a sufficient quantity has accumulated the whole lot is reworked separately.

The chloride liquor in the first tank is treated with sulphuric acid to precipitate the barium-radium chloride present as the sulphate. Samples of the liquor are tested from time to time during the precipitation to insure an excess of sulphuric acid.

TREATING THE WASH WATERS

At this time an excess of sulphuric acid is added to the second tank containing the wash waters. The small amounts of sulphates so precipitated are allowed to settle to the bottom of the tank. The bulk of the supernatant liquor is then decanted through a filter press having wooden frames. When the liquor has been drawn down close to the sulphates, they are stirred up and thus transferred to the press. The sulphates in the main tank are not allowed to settle, but pumping is commenced as soon as sulphation is completed. The filtrate and washings may be discarded. The sulphate cake when washed free from acid is stripped, sampled and weighed. Barium sulphate and moisture are determined in the analytical laboratory and the radium content in the electroscopic laboratory by the emanation method.²

These second sulphates are transferred to the pressure kettles, mixed with a calculated excess of sodium carbonate, and converted to carbonate by heating with steam under pressure in the same manner as before. When the conversion has been completed, steam is shut off and the carbonates and liquor are pumped through an iron frame filter press and washed with water until the washings are free from alkali. The washings are tested from time to time by the electroscopic laboratory to make certain that they are free from radium. When the wash water runs free from alkali, the carbonate cake is stripped, sampled and weighed. The radium content is determined by the electroscopic laboratory and the barium carbonate and moisture by the analytical laboratory.

If the foregoing operations have been properly conducted, the second carbonates will be of sufficient purity, of high activity, and suitable for delivery to the crystallizing laboratory.

CRYSTALLIZATION

The crystallization laboratory receives from the plant the weighed, analyzed carbonates. The laboratory is charged with the number of milligrams of radium contained in each lot of carbonates delivered. The efficiency of the extraction work is reckoned from the number of milligrams of radium in the ore treated divided into the number of milligrams in the carbonates delivered to the crystallization laboratory. The percentage so obtained will be raised somewhat by the radium recovered by reworking the press cake from the first carbonates.

The carbonates received from the plant are dissolved

¹The process of extracting the values by means of nitric acid has been tried. Though perhaps a gram or so of radium has been produced by this method of extracting, it is needlessly expensive and has never met with much favor.

²For the precipitation of the sulphates a solution of sodium sulphate can be used to good advantage instead of sulphuric acid, providing the price of the sodium sulphate is low enough to make the cost of the sulphate radical contained as low as or lower than the cost of the sulphate radical in the sulphuric acid.

in dilute, sulphate-free hydrochloric acid. The acid solution of barium-radium chloride so obtained is filter pressed through a wooden frame press. The filtrate from the press goes to a system of large crystallizing pots. These pots may be either of acid-proof enamel ware or earthen ware. The cake in the filter press, again consisting chiefly of gelatinous silica, is washed thoroughly with sulphate-free water, the washings going to a special pot for concentration before being combined with the main portion of the filtrate. The press cake is stripped, sampled and analyzed for moisture and radium content. After weighing, the amount of radium contained can be computed. This cake is then returned to the plant for reworking, and the crystallizing laboratory is credited with the amount returned.

The volume of the chloride liquor obtained in dissolving the carbonates and washing the press cake is measured. A sample is then taken and sent to the electroscopic laboratory for determination of the radium content. The milligrams so found plus those found in the press cake should equal in amount the milligrams in the carbonates delivered to the laboratory.

SEPARATION OF RADIUM FROM BARIUM

Separation of the radium from the barium by fractional crystallization is started as soon as the chloride liquor has been sampled. This first liquor is concentrated by boiling until close to the saturation point. It is then allowed to cool. On cooling, crystals of radium-barium chloride will form. These crystals will be richer in radium in proportion to barium than was the original liquor. The mother liquor is removed from the crystals and its volume carefully measured. It is then sampled and the radium content is determined by the electroscopic laboratory. The crystals are dissolved in sulphate-free water and hydrochloric acid. The volume of this solution is also measured, a sample taken, and the amount of radium contained determined. The solution of the first fraction crystals is again crystallized, when there will be obtained another crop of crystals richer in radium in proportion to barium than were the first crystals. The first mother liquor is concentrated further, cooled, and another crop of crystals obtained which are weaker in radium than the first fraction, but richer in radium in proportion to barium than was the mother liquor from which they were obtained. These processes are repeated until the mother liquors are practically free from radium.

It is never possible in practice to get the mother liquors free from all traces of radium. The fractional crystallizing continually reduces the bulk of the crystals, with a corresponding increase in the amount of radium per pound of barium. When the bulk of the crystals is small enough they are transferred from the pots to a table, where the crystallization is carried on in large silica dishes. The procedure on the table is exactly the same as in the pots, the only difference being that a smaller volume is handled. As the purity increases with each fractionation, more and more care is required in handling the succeeding fractions, as the loss of a little liquor or a small amount of crystals with their high radium content is a serious matter.

CONVERSION OF CHLORIDES INTO BROMIDES

When the fractionation has proceeded to a point of sufficient purity, the fractions are delivered to the bromide table, where the chlorides are converted to bromides and the purification by fractional crystallization

is continued. The bromide crystallizing is usually carried out in a separate room. Each fraction received from the chloride tables is carefully sampled and analyzed. The reason for duplicate determinations on these samples is to avoid even the temptation of theft as well as to supply an accurate record of the work in the two branches of the crystallizing laboratory.

The fractions as received by the bromide room, after sampling, are carefully carbonated with ammonium carbonate, which precipitates the radium and barium as carbonates. The carbonates are separated from the liquid by filtration through suction funnels. The carbonates on the filter are washed with dilute ammonium carbonate solution and then dissolved in hydrobromic acid. This original bromide solution is measured, sampled and analyzed as a check against losses in the conversion process. After sampling, the crystallization of the bromides is commenced. The crystals of each fraction and also the mother liquors of each fraction are sampled and analyzed. When the purity has been carried to a point where the crystals can be handled in small dishes of about 6-in. diameter, further fractionations are carried out in a water bath. The final fraction is carefully crystallized, the mother liquor is decanted from the crystals, and the crystals are carefully dried to remove all moisture. The radium bromide so obtained is immediately tubed.

TUBING OF RADIUM BROMIDE

The tubing process is the transferring of the radium bromide to a small thin-walled glass tube by means of a small metal applicator. The tube is then sealed by drawing to a point in a small gas flame. The process must obviously be conducted where there are no air currents to carry away any of the dry radium bromide. The tube is preferably made of potash glass and is of a size selected to hold easily the amount of radium bromide ready for tubing. While transferring the bromide to the tube it is held with forceps and not with the fingers. It is perhaps easier to hold the tube in the fingers while filling, but this is done only at the risk of severely burning the fingers. A radium burn is by all means to be avoided as, unlike a burn from fire, it continues to attack the flesh and if at all severe even parts of the finger bones will be destroyed.

The different fractions obtained in the bromide crystallizations are preferably tubed separately so that a check on the crystallizing work may be kept. With a little practice a good operator can keep the bulk of the radium in the first two fractions, the succeeding fractions containing only a small percentage of the total amount. Carelessness will result in the radium scattering through all the fractions, resulting in needless work and loss of time.

The tubed radium from the bromide room is delivered to the electroscopic laboratory for estimation by means of the gamma ray electroscope. Tubed radium, of course, on account of its activity is never kept in the electroscopic laboratory, but in a safe or vault provided for the purpose and located some distance from the laboratory, the radium being taken in only for estimation and immediately returned. A reading is made on the tube as soon after its delivery by the crystallizing laboratory as possible so that the crystallizing laboratory may know the amount tubed in each fraction and be guided in their work. The first reading, made immediately after tubing, is never accepted as anything but approximate. Four days later a second reading is

made and recorded and the final reading is made after thirty days have elapsed since tubing, the radium then being in equilibrium with its emanation and the results accurate and final. The final readings on each tube are credited to the crystallization laboratory. The amount tubed divided by the amount delivered to the crystallization laboratory will give the percentage of recovery.

RECOVERY OF VANADIUM AND URANIUM

The vanadium-uranium liquors in the storage tanks, from which the sulphates have been removed, are allowed to collect until the tanks are nearly full. Sodium carbonate is added until the liquid is but slightly acid, then sodium nitrite is added, and the tank is heated to boiling by steam. If the liquid is but slightly acid at this time, the vanadium oxide, carrying some iron and uranium and considerable amounts of soda salts, will be precipitated. The precipitation is never complete, but if the acidity is checked by volumetric control tests during the process, a very good recovery is obtained. The precipitate will be granular in character and will filter readily. When the reaction has been completed, the vanadium oxide is separated by filter pressing. The cake is analyzed for moisture and vanadium oxide. A comparison of the vanadium oxide so precipitated with the amount in the ore treated will give the percentage of recovery. The vanadium oxide so precipitated finds a ready-market with manufacturers of ferro-alloys.

If it is desired to recover the uranium oxide remaining in the filtrate from the precipitation of the vanadium oxide it is returned to tanks for the purpose and the uranium precipitated as sodium uranate by addition of sodium hydroxide until the liquor is alkaline. The sodium uranate so precipitated will carry the rest of the iron in the solution and also the major portion of the unprecipitated vanadium. The precipitate is extremely hard to handle through a filter press and the lack of a market for any considerable amount of uranium salts makes it nearly always advisable to run the filtrate after precipitation of the vanadium to the sewer without attempting to recover the uranium. Such will be the case, at least, until there is a definite market for the impure sodium uranate.

RECOVERY OF RADIUM FROM THE GELATIOUS SILICA PRESS CAKES

The press cakes are dried and ground in a ball mill with one-half their weight of a mixture containing two-thirds lampblack and one-third barium chloride. The mixture is transferred to a graphite crucible and roasted at a temperature of about 1,050 deg. C. The result is the dehydration of the silica and conversion of any sulphates to sulphides. The mixture is permitted to cool and is then transferred to an acid-proof tank, where it is extracted with dilute, sulphate-free hydrochloric acid. When the reaction is complete, the chloride liquor is separated from the residue by filtering through a wooden frame filter press. The press cakes are discarded. The filtrate is run to a tank together with all the sulphate-free water used in washing the press cakes. Washing is continued until the filtrate is free from barium as determined by testing with dilute sulphuric acid. The chloride liquor is then treated with sulphuric acid to precipitate the radium-barium chlorides present as sulphates. The sulphates are separated from the acid solution by filtering through a wooden frame filter press and washing with water until the filtrate is free from acid. These sulphates are treated

exactly as were the sulphates from the dissolving tanks. They will be of a higher purity than the sulphates from the dissolving tanks and unless they are combined, after weighing and analysis, with a lot of sulphates obtained by direct extraction, the first carbonates from them can, as a rule, be delivered to the crystallization laboratory.

Part II will be published in a subsequent issue.

German Potash Industry

From statistics published by the Statistische Reichsamt (Federal Bureau of Statistics) it will be noted that the production of potash salts fell greatly during the war, but rose very rapidly from less than 8,000,000 tons in 1919 to over 11,000,000 tons in 1920. The latter figures approximate those for 1912 and 1913, as will be seen from the following, which gives statistics for gross production of potash salts from 1911 to 1920:

	Tons		Tons
1911.....	9,706,507	1916.....	8,642,887
1912.....	11,070,014	1917.....	8,938,738
1913.....	11,607,511	1918.....	*9,438,251
1914.....	8,171,512	1919.....	7,772,036
1915.....	6,879,476	1920.....	11,386,439

*Alsace production is included in first half of 1918, but not for the later periods.

The refining process through which potash salts are passed before they are sold reduces the weight considerably. The following table contains figures for sales of potash salts for the years 1911-1920, inclusive:

	Metric Tons		Metric Tons
1911.....	4,541,653	1916.....	3,775,961
1912.....	4,736,103	1917.....	4,598,857
1913.....	5,187,298	1918.....	4,834,327
1914.....	3,998,756	1919.....	4,155,104
1915.....	2,991,071	1920.....	4,313,325

It will be noted in the table following that in 1913 over 500,000 tons of potash was exported, whereas in 1919 there was exported less than 200,000 tons and in 1920 less than 250,000 tons. According to the explana-

FOREIGN AND DOMESTIC SALES OF POTASH, 1911-1920

Year	Domestic Sales		Sales		
	For Industrial Purposes	For Agricultural Purposes	Total	Foreign	Total
	Metric Tons	Metric Tons	Metric Tons	Metric Tons	Metric Tons
1911.....	57,498	422,341	479,839	460,088	939,927
1912.....	65,181	463,384	528,565	480,654	1,009,219
1913.....	68,180	536,103	604,283	506,086	1,110,369
1914.....	54,182	483,627	537,809	366,179	903,988
1915.....	46,887	520,211	567,097	112,679	679,776
1916.....	44,483	680,561	725,044	158,932	883,976
1917.....	37,096	834,382	871,478	132,803	1,004,281
1918.....	38,032	821,684	859,716	141,948	1,001,664
1919.....	28,266	608,767	637,033	174,969	812,002
1920.....	.....	.....	690,000	233,644	923,644

tion furnished by the Statistische Reichsamt, one of the principal reasons for this great decrease in the export of potash is the fact that during the war great efforts were made to produce potash in North America so as to become independent of Germany. According to the figures furnished, nearly 250,000 tons was exported to North America in 1913 and only 70,000 tons in 1919.

Taxation of American Enterprises in Germany

The taxes payable by American enterprises in Germany and the conditions under which the taxation is imposed are enumerated in an article entitled "Taxation of American Corporations in Germany," prepared for the Bureau of Foreign and Domestic Commerce. Multigraph copies have been made and will be supplied by the bureau and its district and co-operative offices to interested inquirers who refer to file No. CL-C2.

Unusual Grain Growth Due to Critical Strain

By A. P. KNIGHT

THE fact that unusually large grains may develop during annealing metals which have undergone a certain amount of cold work is not new. Many investigators have caused the formation of very large grains in critically strained metal by annealing for long periods at temperatures very close to the melting

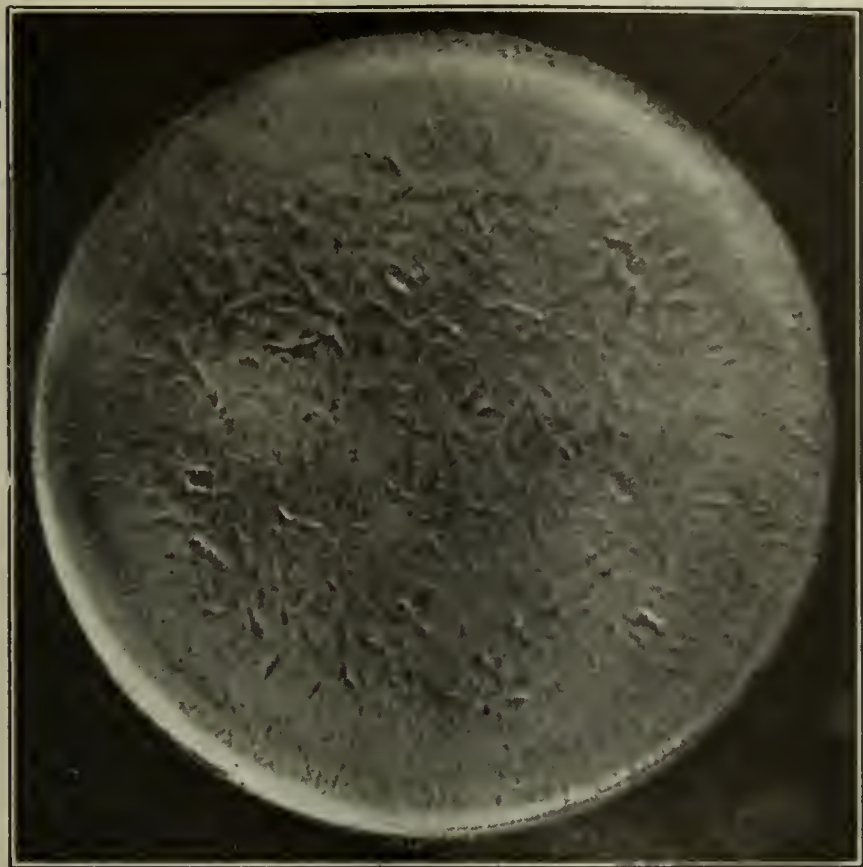


FIG. 1. ROUGH SURFACE OF SHELL AFTER TAPERING.

point of the metal in question. It is perhaps not so common for great grain growth to occur due to a critical strain previous to annealing where the cold-working of metal is rather severe and the annealing is done at as low a temperature as is practicable.

One of these problems recently taken up for investigation in this laboratory was an aluminum coffee pot, manufactured in this plant, the bottom of which had a very rough appearance, while the sides were smooth. These coffee pots are made by cold-drawing aluminum circles through dies into the form of shells. The shells are then annealed for forty-five minutes in a muffle maintained at 800 deg. F. This method of annealing, which has been used for some time on similar aluminum coffee pots of a smaller size, caused complete softening of the cold-worked metal

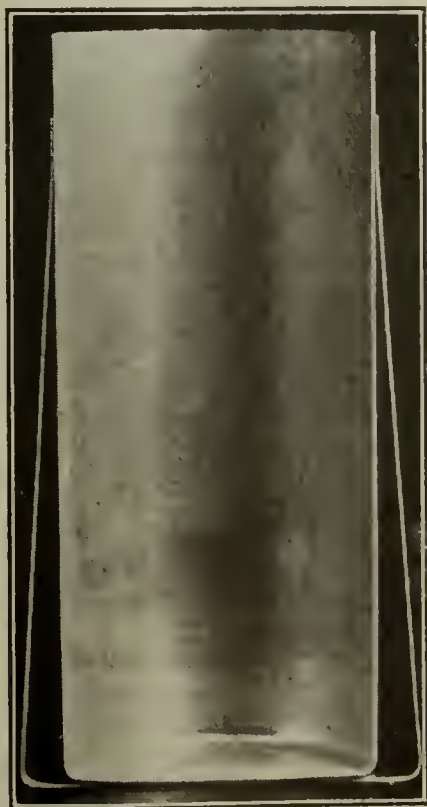


FIG. 2. VERTICAL SECTION OF SHELLS AFTER DRAWING AND AFTER TAPERING. $\frac{1}{2}$ ACTUAL SIZE

and produced a fine-grain structure. The shells are then put through a tapering operation which enlarges the diameter of the bottom and forms a tapered shell. Fig. 1, a photograph of the bottom of one of these larger coffee pots, shows this rough appearance. This rough surface did not appear until after the tapering operation, which caused more or less of a stretch in the metal forming the bottom. Fig. 2 shows the shell cut in half just before the tapering operation, placed inside a shell split after tapering. It will be noticed that the second operation reconverts the lower portions of the side walls into part of the bottom, thus shortening the length of the shell.

The bottom of the pot shown in Fig. 1 was etched with hydrofluoric acid in order to develop the grain structure, as it was suspected that the rough surface was due to deformation of very large grains previously caused by "overannealing." Fig. 3 is a photograph of this bottom after etching. As can be seen, the metal in the bottom of this aluminum coffee pot is composed of crystals which are unusually large. It will also be noted that the shape and size of the overgrown crystals in Fig. 3 correspond to the rough spots in Fig. 1, and the bottom of the shell after the first forming operation (Fig. 2). It is evident that the rough spots in Fig. 1 are individual grains of great size which are more clearly shown on etching. Some of these grains measured as much as $\frac{1}{2}$ in. in length.



FIG. 3. ETCHED SURFACE SHOWN IN FIG. 1. $\frac{1}{2}$ ACTUAL SIZE

Such observations led to the belief that the outer edge (about $\frac{3}{4}$ in. in width), composed of small grains, represented metal drawn down from the side and much more strongly worked than the original bottom, both before and after the anneal. It appeared also that the inner portion was metal which must have undergone a very moderate amount of work.

It was at first thought that these coffee pots had been annealed at too high a temperature. If this had been the case, the whole shell would have shown large grains, but it was found upon examination that the large grains were confined to the bottom of the tapered

shell. The walls or sides of the shell were found to be composed of uniformly small grains characteristic of properly annealed aluminum.

In order to settle the question as to whether the cause of the unusually large grains in this article was local overheating, one of the cylindrical shells before it had been annealed was taken and a strip $\frac{1}{2}$ in. wide extending across the bottom and part way up the side was cut out with a hacksaw. This strip was then annealed in a small laboratory electric muffle at a uniform temperature of 900 deg. F., for one hour. Under these conditions cold-worked aluminum should show a uniformly small grain structure.

Microphotographs were made from the annealed strip

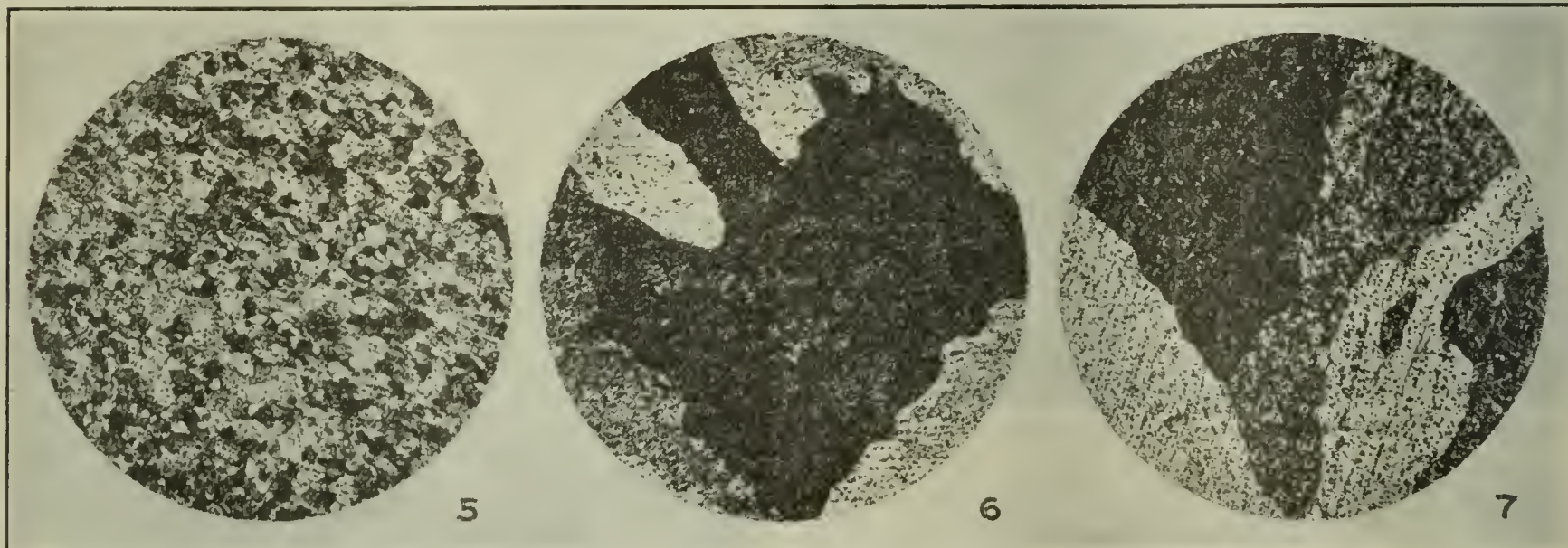


FIG. 4. STRIP CUT FROM SHELL BEFORE ANNEALING OR TAPERING

4 per cent. A test-bar of aluminum elongated 4 per cent and annealed under the above conditions shows grains measuring $1\frac{1}{2}$ in. in length. As the amount of elongation was increased from 4 to 14 per cent in different test-bars, the grain size on annealing decreased to a point where they were barely visible to the unaided eye. In the test-bars which were elongated over 14 per cent, the crystals as shown by the photographs in their paper are too fine to be seen without the aid of a microscope.

With the view of finding out if lowering the temperature of annealing or shortening the time in the muffle would prevent this excessive grain growth, a strip of metal was cut from another aluminum shell and annealed at 700 deg. F. in the laboratory electric muffle for one hour. This strip was polished, etched and examined throughout its length under the microscope. It was found to be composed of uniformly fine grains and to be soft and ductile.

A large number of these cylindrical shells were then annealed in the regular factory muffle at 700 deg. F. and after they had been put through the tapering operation



FIGS. 5 TO 7. MICROSTRUCTURE OF AREAS A, B AND C (FIG. 4) RESPECTIVELY. $\times 35$

of metal at the Points A, B and C, the locations of which are shown in Fig. 4. Fig. 5, taken from the side of the shell quite near to the bottom (Position A), shows a fairly fine grain for aluminum. B and C are represented in Figs. 6 and 7, and show such great grain size that only part of any one crystal can be shown at the magnification used—in fact, these are the smallest crystals that could be found in the section.

The only conclusion that can be arrived at from the above microphotos taken from a small strip of metal which has had a uniform laboratory anneal is that part of this metal was in a "critically strained" condition before annealing. As is well known, metal which has been worked or strained a certain definite amount (usually within fairly narrow limits) will produce very large grains on proper annealing. This is especially true if the metal is annealed for a long time and at a temperature near its melting point. Carpenter and Elam, in a paper entitled "Crystal Growth and Recrystallization in Metals," read before the British Institute of Metals' on Sept. 15, 1920, show by a series of elongation tests on aluminum followed by annealing at 1,022 deg. F. for sixty-five hours that this critical point for aluminum corresponds to an elongation of

all were examined for rough appearance of the bottom which would denote excessive grain growth. Not one was found that had this rough surface. Apparently a difference of only 100 deg. F. in the annealing temperature prevented abnormal grain growth in the critically strained metal of the bottom of this aluminum coffee pot.

Since the above tests have been made several lots of these pots have been annealed at the lower temperature and the rough appearance of the bottom has been entirely eliminated, although the metal is formed in the same machines as before and possess the same original deformation.

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Hydro-Electric Projects in Spain

Hydro-electric projects to develop a total of over 750,000 hp. are under consideration in Spain at the present time, according to a recent report of Commercial Attaché Cunningham, Madrid. Of these, the Douro enterprise is the most important and is expected to develop energy to the extent of 450,000 hp. With scarcely 10 per cent of the 6,000,000 hp. of hydro-electric resources in Spain being utilized at this time, further development is essential to the best interests of the country.

The Manufacture of Nitroglycerine

A Concise Account of the Technology Involved in the Commercial Production of Nitroglycerine and a Consideration of the Properties of This Commodity Which Are Responsible for Its Important Industrial Applications

BY E. M. SYMMES

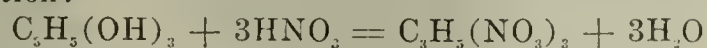
Chemical Department, Hercules Powder Co.

WHILE there are many articles in the technical literature bearing on the manufacture of nitroglycerine, most of them refer to small-scale operations or describe processes so old that they cannot be compared with present practice. There have been as many advances in the science of glycerine nitration in the past few years as there have been in similar chemical manufacturing lines, but they have not received the attention here that they deserve and that they have been accorded abroad.

This short article will deal with the manufacture of nitroglycerine as applied to the manufacture of high explosives where large-scale operations are the rule and where chemical purity in the restricted sense is not necessary. This does not mean, however, that purity and stability are neglected, but that only such precautions are taken as to the purity of the product which are important in view of safety and the high quality of the finished material.

From a review of the literature on the subject it might be thought that charges of nitroglycerine of about 100 to 200 lb. each were made, whereas the present practice in modern plants is to nitrate approximately 1,300 lb. of glycerine, producing about 3,000 lb. of nitroglycerine at each operation. About 7,000 lb. of mixed nitric and sulphuric acids is required to accomplish this.

The chemical and physical properties of nitroglycerine have been stated so frequently that reference to them is merely to refresh recollection. Glycerine is a triatomic alcohol, and nitration proceeds according to the equation:



STRENGTH AND PURITY OF MATERIALS USED IN MAKING NITROGLYCERINE

While some small quantity of nitroglycerine would be made by using strong nitric acid according to the equation just stated, the yields would be very low on account of the water which is formed interfering with the course of the reaction. In commercial practice comparatively large quantities of sulphuric acid are added to the nitric acid before use, to combine with the water as fast as it is formed and thus remove this water from the sphere of action. Typical nitrating acids are as follows:

	Per Cent
H ₂ SO ₄	55.00-54.50
HNO ₃	42.50-44.25
HNOSO ₄	0.50- 1.25
H ₂ O.....	2.00- 0.00

After nitration, spent acids result. The composition of typical spent acids from the above mixed acids would be:

	Per Cent
H ₂ SO ₄	76.60-75.90
HNO ₃	6.40- 6.60
H ₂ O.....	17.00-17.30

The nitrosylsulphuric acid should be as low as it is possible to obtain, since it is inert in the nitrating reactions. The sediment, or mud, in the mixed acids should also be as low as possible because sediment contributes to lessened yields of nitroglycerine. Water-white acids are usually used; these are made by permitting the acid to stand in storage tanks until it is in that condition.

In general, the mixed acids should have as little water present as possible, even going so far in this respect as to have a negative quantity. This is accomplished by using only high-strength nitric acid and fuming sulphuric acid, the latter containing 20 to 40 per cent free SO₃. It can be realized that the less water present in mixed acid the less the volume of the spent acid produced, and consequently the less nitroglycerine lost by solution in the spent acid.

The glycerine employed is the so-called dynamite glycerine, an article of commerce which contains about 98.5 per cent glycerine. It has a slight odor, somewhat similar to acrolein, and undoubtedly contains either a slight amount of this body or something similar to it. No effort is made to deodorize it before use in nitroglycerine manufacture. Small quantities of fatty acids are particularly undesirable on account of producing a scum, or slime, later on during the separation of the nitroglycerine from the spent acids, or in washing the nitroglycerine with water to remove the acid it has dissolved. Its specific gravity at 15 deg. C. should be not less than 1.26175. The color of the glycerine is no criterion of its usefulness. A water-white glycerine may sometimes be entirely unsuitable, whereas a dark-colored sample may work perfectly.

Glycerine, when exposed to severe cold, crystallizes into transparent crystals which melt at 17 deg. C. Both crystallization and melting take place slowly.

USE OF GLYCERINE-SUGAR SOLUTION AND SIMILAR MIXTURES

Various patents have been taken out, both in this and in foreign countries, on the use of a glycerine-sugar solution to take the place of glycerine alone. Such a mixture can be nitrated, separated, washed and neutralized in the same way and with the same apparatus as is used with glycerine alone, since the sugar, on nitration, becomes a nitrosaccharose, which is perfectly soluble in the nitroglycerine. On account of the cheaper price of the sugar, an appreciable saving is introduced. A great many tons of cane sugar are consumed in the United States every year in this way by the explosives industry.

Many patents have also been taken out on the production of explosives containing nitroglycerine and other bodies which will lower the freezing point of the mixture to a considerable degree. Most of these are mixtures of nitroglycerine with a nitro-aromatic compound such as nitronaphthalene, nitrotoluene, nitroxyline, and the like, but some depend upon the nitration of a mixture of glycerine and diglycerine. This mixture can be prepared by heating glycerine in contact with a condensing agent, such as sodium carbonate or acetate.

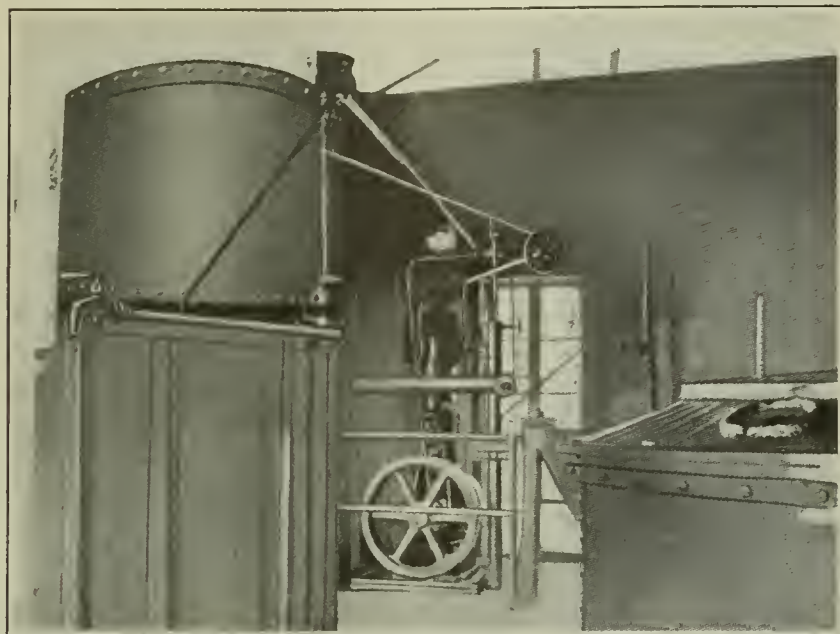


FIG. 1. VIEW OF NITRATOR AND ELEVATED RESERVOIR FOR WEIGHING AND STORING GLYCERINE

Water is split off under such conditions and distilled from the glycerine, leaving a mixture of glycerine and diglycerine, the relative proportions of the two depending upon the time and temperature of heating. Such a mixture can be nitrated, separated, washed and neutralized in the same apparatus used for nitrating glycerine itself.

The appearance of such nitroglycerine substitutes differs little from nitroglycerine itself. The one having a certain substitution of sugar is a little more viscous, and that containing some diglycerine has a slightly darker color.

DESCRIPTION OF NITRATOR AND ITS OPERATION

The type of nitrator in use at the present time is shown in Fig. 1. It will be noted that the reservoir for the glycerine at the left is supported on a frame at such a height that the glycerine will flow by gravity through an iron pipe and spigot to the nitrator. The glycerine feed-tank and its support are on platform scales to permit measuring accurately the quantity used, since the proportion of the glycerine to the nitric acid must be carefully controlled. This glycerine has been previously heated to a temperature of about 100 deg. F. to render it more fluid. This heating is done in a separate house, so arranged that the drums in which the glycerine is received may be drained for 24 hours in a heated room, since glycerine clings very tenaciously to the walls of the container. About 1½ lb. of glycerine will remain clinging to the sides of the drum no matter how long this draining may continue. This amount could be recovered only by washing out the drums with water, an operation which would be uneconomical on plants not having a glycerine refinery.

The mixed acid is weighed out in a tank placed on scales outside the nitrating house and transferred to the nitrator by gravity or compressed air, depending

upon the topography of the ground. All of the mixed acid, amounting to about 7,000 lb., is put into the nitrator at once.

The nitrator is of steel-plate construction, having three concentric seamless steel coils in it. These coils carry cold calcium chloride brine to remove the heat of the reaction. Agitation is accomplished by two vertical shafts having paddles at their lower ends. The shafts are supported by a double bearing in the upper framework so that no step-bearing inside the nitrator is necessary. Naturally, such a step-bearing could not be lubricated and would be a source of great danger. The agitator is driven by a steam engine, which can be seen in Fig. 1. A steam-engine drive is subject to fewer interruptions than any other type and its speed can be closely regulated merely by a throttle and governor. Reliability of agitation is important, since, if agitation stops, the incoming glycerine will not be driven under the surface of the cold acid, but will tend to remain on or near the surface of the acid and will cause local heating which will soon lead to decomposition and finally ignition. To avoid the possibility of accident in case the motive power for agitation fails suddenly, a perforated air coil is placed in the bottom of the nitrator, so that the charge can be agitated temporarily in such case.

TEMPERATURES OF NITRATION

With refrigerating effects commonly employed, a charge of about 1,300 lb. of glycerine will be nitrated in from 50 to 60 minutes. The refrigerating machines in use at the present time are of the 40-ton compression type. To permit sufficient capacity of the brine coolers, about 20,000 gal. of calcium chloride brine is circulated



FIG. 2. LEAD TANK IN WHICH NITROGLYCERINE IS SEPARATED FROM THE SPENT ACIDS

from a storage tank through the refrigerating machine and through the coils of the nitrator. This whole amount of brine is brought to a temperature of a few degrees below 0 F. before starting operations in the morning, and will rise only a few degrees as each charge is run through the nitrator.

Temperatures of nitration range from 45 to 34 deg. F., the lower temperatures being used whenever possible. It is well known that the lower the temperature of nitration the higher the yield of nitroglycerine. The temperatures commonly employed are lower than the freezing point of nitroglycerine, yet no freezing takes

place either during nitration or during the subsequent separation, probably because of the influence of the relatively large amount of acid present. That the nitroglycerine does not freeze at these temperatures when undergoing separation and when it contains only a very small amount of acid is probably due to the super-cooling phenomenon to which nitroglycerine is subject.

At the end of the nitration a large stop-cock at the base of the nitrator is opened and the emulsion of nitro-



FIG. 3. RUBBER-LINED GUTTERS IN WHICH NITROGLYCERINE FLOWS TO STOREHOUSE

glycerine and spent acid flows down into an open, shallow, lead tank, known as the separator. (See Fig. 2.) Here it is allowed to stand until the nitroglycerine comes to the surface as a clear, pale yellow oil, very similar in appearance to a light lubricating oil, and the milky spent acid has settled to the bottom. The sides of the lead separator have thick plate-glass windows set in by glycerine litharge cement, so that the course of the operation can be watched. On looking through these windows the contents of the separator will first be seen as a homogeneous emulsion. In a few minutes small globules of nitroglycerine can be seen to move slowly upward and on reaching the top merge into a layer of nitroglycerine which spreads over the entire surface of the tank. This action continues until, on looking through the windows, a sharp line is seen between the two layers, when separation is considered complete.

PURIFICATION OF THE NITROGLYCERINE

The spent acid is then drawn off through a bottom stop-cock and sent to the acid recoveries for working up into nitric and sulphuric acids of usual strengths, to be used over again in the process. The nitroglycerine, still containing a small quantity of dissolved acids, is dropped slowly into a tank of warm water at about 90 to 100 deg. F., agitated with air, and, after settling for a few minutes, is sent to the next house by gravity flow through a V-shaped wooden gutter lined with sheet rubber. (See Fig. 3.) In this house, the so-called neutralizer, it is received in lead tanks holding a solution of sodium carbonate. These are shown in Fig. 4. Such a quantity of sodium carbonate is present as will be certain to show a small excess after all the acid has been neutralized. Agitation is here also accomplished with air. This washing with alkaline solution is continued until the nitroglycerine gives a neutral test to litmus paper. A few hours' settling after this process reduces the moisture which the nitroglycerine con-

tains to 0.30 to 1.50 per cent. The nitroglycerine is stored under a small quantity of the sodium carbonate solution, and drawn out through rubber hose as required for use.

METHODS OF HANDLING NITROGLYCERINE, AND ITS IMPORTANT USES

For transportation to the point of consumption, the dynamite or gelatine mixing houses, or the smokeless powder mixers, the nitroglycerine prepared as above is drawn out of the neutralizing tanks by a rubber hose into small buggies having copper-lined tanks and rubber-tired wheels. The valve controlling the flow of nitroglycerine to these buggies is nothing more than a gigantic laboratory pinch-cock, operating by mere compression of the rubber hose.

The platform scale used to weigh out the nitroglycerine required is covered with sheet rubber, as are also the weights, so that no shock would be possible even if the weights were accidentally dropped. Scrupulous cleanliness is enforced throughout these operations. Workmen are required to wear standard uniforms and nail-less shoes, so that there will be no possibility of shock or friction against metallic objects on the floor.

Important uses for nitroglycerine other than for dynamite are for oil-well torpedoes and double-base smokeless powder. For shooting oil wells a can containing nitroglycerine and provided with a detonating cap is dropped down the well, exploding when it reaches the bottom. Double-base smokeless powder consists of nitrocotton and nitroglycerine, the amounts of the latter sometimes reaching as high as 40 per cent. Such a smokeless powder has many advantages over one made of nitrocotton only, and is the standard military powder for Great Britain.

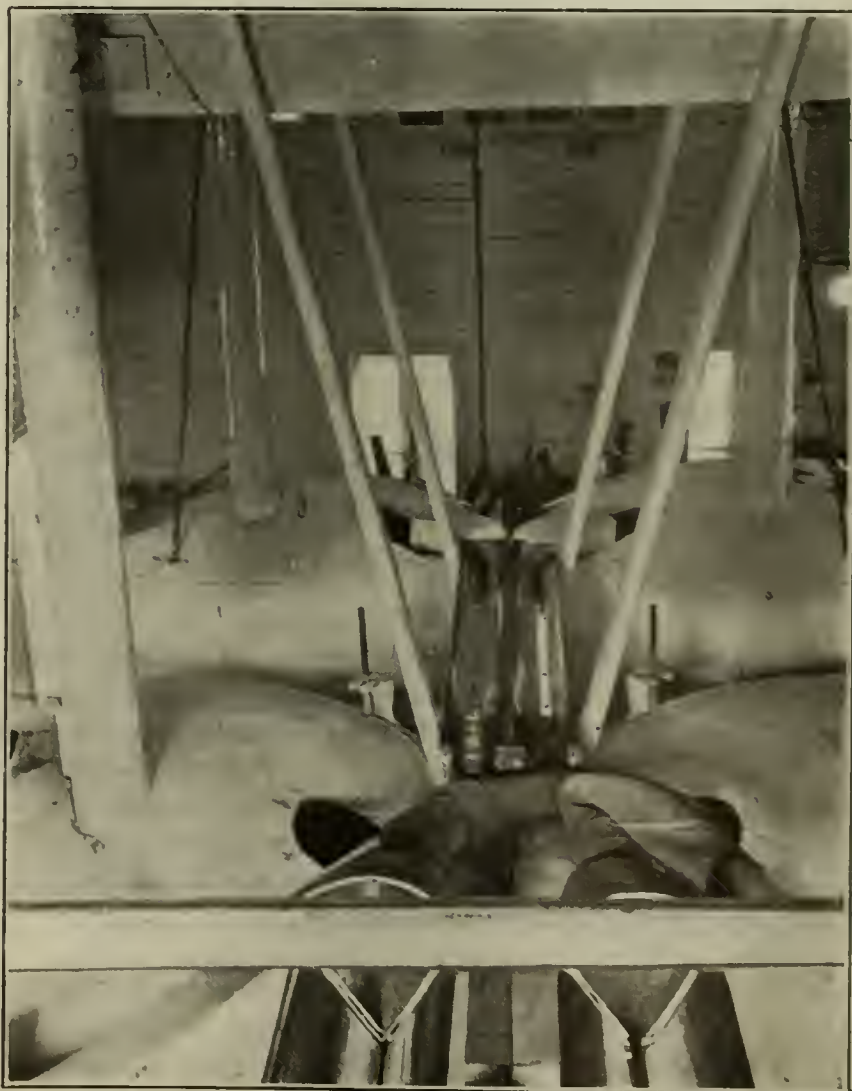


FIG. 4. NEUTRALIZERS IN WHICH FINAL PURIFICATION IS EFFECTED

PHYSIOLOGICAL PROPERTIES OF NITROGLYCERINE

Nitroglycerine exerts a temporary poisonous effect on human beings. The small quantities of it volatilized in the air of the working buildings will give a person unaccustomed to it a severe headache in the course of a few minutes. Mere contact with the skin also results promptly in headaches, on account of the rapid absorption into the system. Such headaches last for about 12 hours, and after this time no permanent ill effects are ever observed. Contact with nitroglycerine for two or three days causes the system to build up an immunity to its effects, and after this period none of the poisoning effects is noticed. Such immunity is very quickly lost, however. Absence from work for two days or more will destroy it, and the painful process of again acquiring it will have to be repeated.

Extensive medical investigations have shown that no permanent ill effects are suffered by workmen in a nitroglycerine plant. Every large explosives company has in its employ many old and experienced workmen who have been in contact with nitroglycerine every working day for many years. No ill effects which could in any way be attributed to nitroglycerine have ever been proved, in spite of thorough medical investigations undertaken with the idea in mind that such ill effects were present. This differs markedly from experience in the manufacture of many or all of the nitro-aromatic explosives, where severe, definite and permanent poisonous effects are experienced unless great precautions are taken to prevent entry of such compounds into the human system.

This article is intended to cover only a few points in connection with manufacture of nitroglycerine for ultimate use as dynamite or gelatine dynamite, blasting gelatine, smokeless powder or as a liquid for shooting oil and gas wells. These uses comprise practically the entire consumption of nitroglycerine with the exception of a relatively small quantity used as a 1 per cent solution of nitroglycerine in pure grain alcohol, which is employed in medicine as a heart stimulant. No chemical process is involved in the manufacture of dynamite and gelatine dynamite, assuming that the nitroglycerine has already been prepared, since a mere incorporation with suitable absorbents is all that is required. Blasting gelatine is simply a solution of soluble nitrocotton in nitroglycerine, the solution being aided by warming the mixture.

To show the importance of glycerine nitration in the United States it might be mentioned that 50 per cent of the entire production of glycerine in this country is converted into nitroglycerine for use both as liquid nitroglycerine and in commercial high explosives.

Wilmington, Del.

Argentine Cane-Sugar Production in 1920

The Argentine Director of Rural Economy and Statistics reports that the total area under cultivation of sugar during 1920 was 233,700 acres. The amount of cane milled was 3,099,722 metric tons, producing 209,553 metric tons of sugar. During the previous year a total of 297,640 tons was produced. Most of the sugar was produced in the Provinces of Tucuman, Jujuy, Santa Fe and Salta. Small-scale production took place in the Chaco, Corrientes and in the Territories of Formosa and Misiones. The annual consumption of Argentina averages 220,000 metric tons. During the six years 1915-1920 Argentina imported 305,913 tons and exported 137,534 metric tons of sugar.

A New Salt Cake and Hydrochloric Acid Furnace

BY N. A. LAURY

IN THIS journal in May, 1913, there appeared an article from *Zeitschrift für Angewandte Chemie* by Dr. Theodor Meyer in which he said: "The great problem of the muriatic acid industry—the mechanical furnace—is still a problem of the future, and for the present there is little hope that it will soon be solved." Two types of furnaces, both survivals of early days, are still the only ones in common use. Against the pot and muffle furnace there stands the objection of heavy and disagreeable hand labor, and against the mechanically agitated muffle, commonly represented by the Mannheim furnace, there are the poor quality of the salt cake, small capacity and rapid wear of moving parts.

The plant described herein, on which the writer has filed patent papers, was built last year by the Aetna Explosives Co. at Emporium, Pa., and is being successfully operated. It is an internally oil-fired rotary, requiring no hand labor except charging, and it produces 20 tons of good salt cake a day with a minimum of wear.

The most obvious difficulties expected either did not appear at all or were at length overcome. The absorption of the hydrochloric acid from the very dilute gas

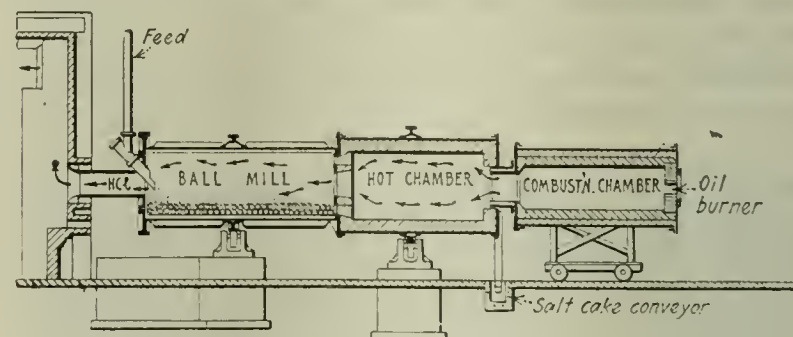


FIG. 1. BALL MILL FURNACE

to form acid of commercial strengths was accomplished by ample cooling of the gas and recirculation of the absorbing acid. The design and specific proportions required for the provision of sufficient heat at one end to produce high-grade salt cake, without causing fusion of the charge in any part of the furnace or wasting too much heat at the outlet, were based on data obtained in small-scale experiments. Owing to the internal application of the heat, the charge does not cake on the walls objectionably. A protective crust 2 in. thick forms over the brick lining, so the bricks are never exposed and thus last indefinitely.

THE FURNACE

Fig. 1 shows a longitudinal elevation of the furnace. It consists of a combustion chamber with oil-burning equipment and a horizontal two-chambered revolving cylinder.

The combustion chamber is lined with firebrick and mounted on a truck for convenience in moving to reach the interior of the furnace. It is made of $\frac{1}{2}$ -in. steel shell 10 ft. long and 4 ft. 8 in. in diameter. The combustion chamber nozzle, which projects slightly into the furnace, is a plain iron casting lined with firebrick. The oil burner is the low-pressure type. It is supplied with air by a Sturtevant blower and with oil by Goulds pumps. The air and oil connections are flexible to

permit the fore and aft movement of the combustion chamber. There is a course of SiloCel brick between the shell and the firebrick lining. This fully protects the shell and saves heat, as at full operation the hand can be borne on the shell.

The furnace is a steel shell in two sections of different diameters, united in the middle by cast-steel flanges. The front or hot section has a 9-in. firebrick lining. Its diameter inside this lining is $4\frac{1}{2}$ ft. and its length 10 ft. It has a plain unlined cast-iron head with a central port 2 in. greater in diameter than the combustion chamber nozzle, to permit discharge of the salt cake. The latter is also beveled toward the bottom to give more room for the discharge. A casing is loosely fitted around this end of the furnace through which the salt cake drops to a worm conveyor. A fan is connected to the top of this casing to conduct the smoke from the hot salt cake to the stack. At the junction of the two sections of the furnace and dividing them into separate chambers there is a cast-iron plate which is bolted to the cast-steel flanges. This plate has a 2-ft. hole in the center for the gas and radial slots near the periphery through which the salt cake passes from the grinding chamber to the hot chamber.

The grinding chamber is lined with chilled iron plates. It is 12 ft. long and $4\frac{1}{2}$ ft. in diameter. It has a cast-iron head which also has a chilled iron lining. It is insulated with asbestos covering. The grinding is done by 3-in. diameter cast-iron balls. An 18-in. cast-iron flue conducts the gas from the grinding chamber to the dust chamber. The charging of the salt and niter cake is also done through this flue.

The large gear on the furnace is driven by a pinion and chain and a 50-hp. motor. After the first few revolutions at starting a little less than 25 hp. is all that is required. The furnace rotates at 20 r.p.m.

THE ABSORBING SYSTEM

The gas is freed from dust, filtered free of sulphuric mist, cooled and absorbed in water.

The dust chamber is made of red brick with an inner

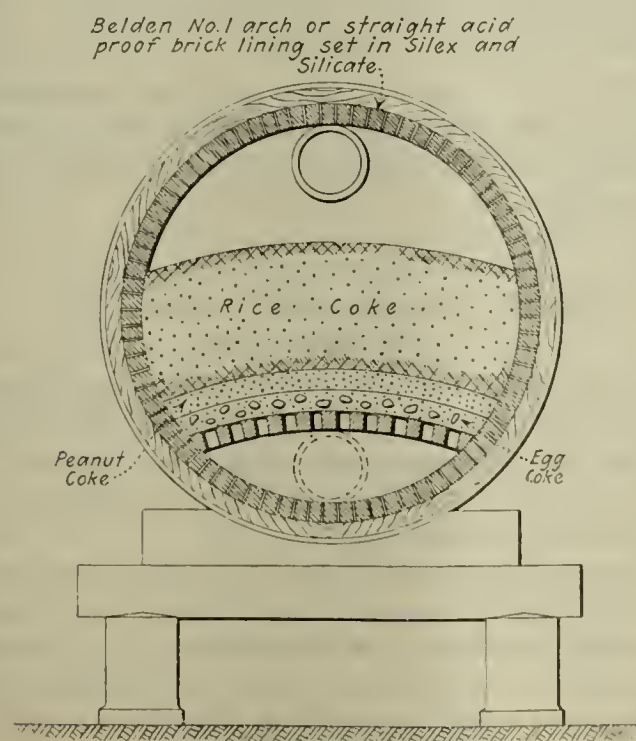


FIG. 2. GAS FILTER

course of acid brick. It is 10 ft. square, 15 ft. high and the walls are 16 in. thick. There are clean-out doors at the bottom.

A 12-in. chemical stoneware line about 50 ft. long conducts the gas to the filter. This is a wooden tank

with tarred staves and acid-brick lining. (See Fig. 2.) It is 6 ft. in diameter and 20 ft. long. The filtering medium is a bed of rice-sized coke 24 in. deep.

The coolers consist of four rows of 6-in. silica ware S pipe over which water is run.

The gas goes to the towers (Fig. 3) through two 8-in. lines; one to each row of six towers run in parallel. From the tower outlets 8-in. connections join at the Duriron fan inlet. The towers are $2\frac{1}{2}$ ft. in diameter and 15 ft. high and are made of chemical stoneware and packed with ordinary ring packing resting on brick grills. In each row of six the gas travels up the first three through a common header, down the next two and up the last. The water is run into the last tower of each row and the HCl solution is circulated at the rate of about 30 lb. a minute on each tower by a pulsometer.

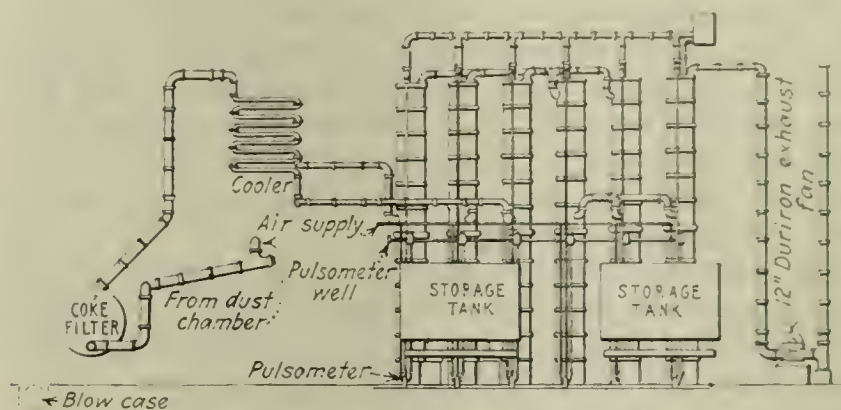


FIG. 3. ABSORBING SYSTEM

The air, separated in the pulsometer splash boxes on the tops of the towers, goes through a 3-in. chemical stoneware line to a coke-packed vessel over the last towers, where it is scrubbed free of HCl by the incoming fresh water for the towers.

The acid is stored in two rubber-lined wooden tanks 12 ft. diameter and 8 ft. deep.

A cheap and very good cement for the stoneware joints is made by stirring into melted coal-tar pitch a small amount of ground barytes, silica or china clay and some short-fibered asbestos. The proportions are chosen for the different joints so that the cement does not get too hard on the cold ones or too soft on the hot ones. A ring of asbestos rope is first placed in the joint and the cement then worked in like putty before it cools.

OPERATION

The normal rate of running is 1 ton of salt cake an hour. This requires 9 to 10 gal. of fuel oil. The burner is easily regulated so that a sootless gas enters the furnace. The heat is regulated according to the quality of the cake. Prime cake has to come out of the furnace at somewhat above 1,000 deg. F. The niter cake is coarsely ground in a single roll coal crusher weighed in a buggy, the required weight of salt shoveled on top of it and the charge slowly dumped into the elevator. This is done every 4 or 5 minutes according to the size of charge handled. It is thoroughly ground in the grinding chamber of the furnace and also has given off 25 per cent of its HCl when it reaches the hot chamber. The balls are always free and clean and the walls of the grinding chamber never get coated.

To keep the crust of cake on the brick lining of the hot chamber at the right thickness a loose rail 9 ft. long is kept in it. If two or three heavy rails are used, the crust is all cut away, but if only a light one or none at all is used the crust gets too thick. The

outside of the furnace is always cool enough to bear the hand.

If there is any interruption of the feed, the fire must be shut off or the charge will fuse on the middle plate and close up the ports. The combustion chamber then must be pushed back and the ports opened with long bars. The operators soon learn to avoid this troublesome job.

The gas leaves the furnace at 300 deg. F., which is close to the minimum that prevents condensation in the grinding chamber, iron flue and dust chamber and represents the best fuel economy possible in the apparatus. Condensation starts in the flue to the filter. The temperature at the filter inlet is 160 deg. F. and at its outlet 125 deg. F. and the coolers bring it down to 80-90 deg. F.

The acid circulated on the strong towers is kept at 20 deg. Bé. unless stronger acid is required. At this strength its temperature does not go above 85 deg. F. even in warm weather. The temperature and strength gradually decrease in each succeeding tower until in the last tower the acid is 3 deg. Bé. and not much warmer than the entering water.

The volume of the cool gas runs close to 2,000 cu.ft. a minute and at the fan it contains 0.006 g. per liter of unabsorbed HCl. At the inlet to the tower the gas contains about 0.05 g. per liter, so that somewhat over 1 per cent of it is lost.

The constant volume and composition of the gas greatly simplifies the filtering, cooling, absorption and the control of the strength of the product. Unlike the intermittent processes, the latter takes care of itself if the water is admitted uniformly.

POINTS TO BE CONSIDERED IN OPERATION OF ABSORPTION SYSTEM

Acid of 20 deg. Bé. has been made with gas containing even less than 3 per cent HCl by volume. This is explained by the cooling effect of the pulsometers, the circulation of 350 to 400 lb. of acid a minute and particularly by the distribution of the absorption over a number of towers in which each step in the process is carried on separately.

Guide posts in rational absorption are indicated by the partial pressures of aqueous hydrochloric acid of different strengths:

Deg. Bé.	Mm. Hg.	Deg. F.
22	174	86
20	33.3	86
19.95	31.5	86
19.2	15.5	86
13.36	0.57	86
3	0.00117	77

At 3 deg. Bé., the strength of the acid in the final tower, the partial pressure is so low and the solubility of HCl is so great that even a very dilute gas is absorbed. This is illustrated by the fact that the small amount of 3 deg. Bé. acid drawn into the fan is rapidly concentrated to 13.36 deg. Bé. by the exit gas containing only 0.0006 g. per liter, unless it is continuously drained out. Below 13.36 deg. Bé. the conditions for absorptions are most favorable. The specific heat of the solution drops but little relatively, while the heat of solution of the HCl has not yet reached its maximum. Furthermore, 13.36 deg. Bé. is the most stable concentration, as it can be distilled without change of strength at 227.37 deg. F.

From 13.36 deg. Bé. to the standard strength of 20 deg. Bé. the process should be regarded as one of con-

centration. The stronger and cooler the gas the better, and the solution should be circulated in large volume. At 19 to 20 deg. Bé. there is a sharp rise in the partial pressure. This is the standard strength and seems to be the maximum for stability. At 22 deg. Bé. the partial pressure is so high that there is considerable loss of HCl on exposure and it should not be used except where this loss is overbalanced by a special demand.

There should be a good in-pull at the joint between the furnace and the flue to the dust chamber. At the top of the dust chamber the draught is normally minus $\frac{1}{8}$ in. of water, at the filter inlet minus $\frac{3}{8}$ in., at the cooler inlet $1\frac{7}{8}$ in., at the inlet to the towers minus $2\frac{3}{8}$ in. and at the fan inlet minus 5 in. The fan is driven at a speed of 1,500 r.p.m. by a 5-hp. motor.

The plant requires a charge man, a tower man and a furnace operator for 24 hours. A repair man and helper are usually kept busy in the daytime.

QUALITY OF PRODUCTS

All commercial strengths of acid can be made. It is clear and has the usual light yellow color. It compares in analysis with pot and muffle acid as follows:

	Deg. Bé.	H ₂ SO ₄ Per Cent	Fe Per Cent	As ₂ O ₃ Per Cent	Free C.
Rotary.....	20	0.07	0.02	0.00013	Trace
Pot and muffle.....	20	0.09	0.02	0.00003	Trace

It was proved by absorbing gas from the furnace through distilled water in glass apparatus that the iron in the product comes from the action of the acid on the material of the towers and packing.

The salt cake is of good color and compares in analysis with pot and muffle cake as follows:

	H ₂ SO ₄	NaCl	Fe ₂ O ₃	Al ₂ O ₃	Insol.	CaSO ₄
Rotary.....	1.21	1.68	0.31	0.21	0.32	0.54
Pot and muffle.....	1.40	0.90	0.20	0.10	0.33	1.32

The size of the cake particles in the cold stockpile is shown by the screen test:

	NaCl, Per Cent	H ₂ SO ₄ , Per Cent
Whole sample.....	1.33	1.04
On 10 mesh, 10.6 per cent.....	1.65	1.10
On 30 mesh, 30.9 per cent.....	1.38	2.78
On 40 mesh, 6.2 per cent.....	1.47	0.63
On 50 mesh, 5.4 per cent.....	1.42	0.29
On 60 mesh, 2.9 per cent.....	1.42	0.29
Through 60 mesh, 42.8 per cent.....	1.24	0.28

The high salt in the 30-mesh portion indicates that these are the largest lumps that come out of the furnace. The 10-mesh fraction probably lumps up on cooling outside.

Rockville Center, L. I.

Export of Copra and Coconut Oil From Philippines

Nearly 10,000,000 kilos of copra cake, copra and coconut oil was exported from the Philippine Islands from Aug. 13 to Aug. 25 last, according to a report of the Philippine Bureau of Customs. The shipments were valued at several million pesos.

The huge consignment, which is believed to be the biggest exported in many months, went to American and European markets. Approximately 1,811,000 kilos of copra cake was exported to Hamburg, Germany, while 1,222,000 kilos went to London, England, and over 1,100,000 kilos to American markets.

The copra shipments were distributed as follows: 1,060,000 kilos went to Germany, 318,000 kilos to Holland and 304,000 kilos to America.

Coconut oil went mostly to the United States, to the amount of 1,222,000 kilos. Holland received 670,000 kilos and London 670,000 kilos.

A Bibliography and Abstracts of Chromium Steels

Chronological Arrangement of Some of the Principal Papers on Chromium and Chromium Alloy Steels Published During the Period 1798 to 1919, With Brief Summary of Their Scope

BY F. P. ZIMMERLI

THIS bibliography on chromium, or chromium alloy steels, is arranged in chronological order. An effort has been made to abstract papers dealing directly with chromium steels and such parts of other papers found to deal with chromium steels. In case the original article was not read it is so stated and both the abstract read and the original journal are listed. In no case, however, are abstracted articles used if the original could be obtained.

FROM 1798 TO 1877

(1) Memoirs on a new metallic substance contained in red lead of Siberia and which one proposes to call "chrome" on account of the property it possesses of coloring the combinations which it enters. L. N. Vauquelin. *Ann. Chim.*, 1798, vol. 25, pp. 21-31 and 194-204.

(2) Concerning the alloys of chromium with iron and with steel. M. P. Berthier. *Ann. Chim. Phys.*, 1821, vol. 17 (second series), pp. 55-64. By fusion in a crucible using forced draft coke fire steel containing 1 to 1.5 per cent chromium was obtained. A knife and a razor made from them had a beautiful damascened finish.

(3) On the alloys of steel. J. Stodart and M. Faraday. *Phil. Trans.*, Roy. Soc. of London, part 1, 1822, pp. 253-270. The authors prepared two alloys of steel and chromium on a laboratory scale. The chromium added should have resulted in approximately 1 and 3 per cent. They were malleable and gave a fine damask.

(4) Note on the crystallization and alloys of chromium. M. E. Fremy. *Compt. rend.*, 1857, vol. 44, pp. 632-634. He reduced chromate and oxide of iron by charcoal, into an alloy with a needle-like structure, very hard, scratching quartz and hardened steel.

(5) Alloys of iron and chromium. M. Sergius Kern. *J. Iron and Steel Inst.*, 1875, vol. 2, pp. 654. A note to the effect that a 74Cr:25Fe alloy was glass hard and that 97.5Fe:2.5Cr was found malleable.

(6) On chromium pig iron made by the Tasmanian Iron Co. E. Riley. *J. Iron and Steel Inst.*, No. 1, 1877, pp. 104-108. It contains 6 to 7 per cent Cr, has a high melting point and is difficult to puddle. Oxide of chromium makes a thick cinder. Welding experiments showed that Cr has none of the deoxidizing powers of Mn.

FROM 1878 TO 1886

(7) Note on chrome steel. G. Rolland. Abstracted in *Proc.*, Inst. of Civil Engineers, vol. 53, 1878, p. 384, from *Ann. des Mines*, vol. 13, p. 152. Chromium increases the hardness and strength but it cannot replace carbon. Analyses show from 0.08 to 9 per cent Cr. Carbon as high as 1.10 per cent. At this time

the steel was made only at Brooklyn (U. S.), Sheffield, (England) and Unieux (France) by crucible or Siemens' furnace.

(8) Magnetization of iron. John Hopkinson. *Phil. Trans.*, Roy. Soc. of London, vol. 176, 1885, part 2, pp. 455-469. Magnetic tests, specific resistance and chemical analysis of 35 chromium steels (forged, annealed and oil-hardened). No marked effect of Cr indicated.

(9) Note on the production, constitution and properties of chrome steel. M. Boussingault. *J. Iron and Steel Inst.*, 1886, vol. 2, pp. 807-830. Shows that Cr does not give iron a tempering power as carbon does, contrary to the assertions of Julius Bauer. Brief description of the difficulties involved in manufacture.

(10) On chrome, pig iron and steel. M. Brustlein. *J. Iron and Steel Inst.*, 1886, vol. 2, p. 770. Describes fracture and a few physical properties of chromium alloys produced at the Unieux works (France).

FROM 1887 TO 1892

(11) The status of chrome steels. H. M. Howe. Abstracted in *J. Iron and Steel Inst.*, 1887, vol. 2, p. 345, from *Eng. and Min. J.*, vol. 14, p. 242. Suggests the following definition: Chromium steel is a variety of steel the physical properties of which are influenced more by chromium than by other non-ferrous elements it contains. This shuts out so-called chromium steels containing but traces of chromium, or none at all.

(12) Note on chrome steel projectiles. *J. Iron and Steel Inst.*, 1887, No. 1, p. 458.

(13) Chrome steel. B. F. Hart and J. Calish. Abstracted in *J. Iron and Steel Inst.*, 1889, No. 1, p. 376, from *Iron*, vol. 33, p. 78. Manufacturing methods at Brooklyn. Tests employed on material used in St. Louis bridge.

(14) On critical points of iron and steel. F. Osmond. *J. Iron and Steel Inst.*, 1890, No. 1, pp. 38-80. Determines that presence of Cr considerably raises A_r . Influence of the maximum temperature before cooling on A_r is greater in Cr than in C steels. A brief bibliography is appended.

(15) Alloys of iron and chromium. R. A. Hadfield, including a report by F. Osmond. *J. Iron and Steel Inst.*, 1892, No. 2, pp. 49-175. Early history and a description of the element Cr and methods of preparing it. The physical properties of ferrochromium and of chromium alloys with, and very low in, carbon. Chromium cannot replace carbon as a hardener, merely acting as an intensifier. In an appendix methods of preparing pure chromium are given. F. Osmond concludes that Cr interferes with and impedes the crystallization of iron. Location of critical points and their change with rates of cooling are reported. Chromium exists in elemental solution, in a compound of Cr, Fe and C in isolated particles, and the same compound

in solid solution. The melting points of some ferros are given.

(16) Chrome steel: its manufacture and uses with complete chemical analyses. F. Hart, Jr., and J. Calish. *Stevens Indicator*, vol. 9, 1892, pp. 49-65. A general article in which the authors give a list of the uses of various chromium steels; describe the more important chromium ores, the method of producing the alloys—especially that employed by the Brooklyn (N. Y.) Chrome Steel Works—their properties and methods for their chemical analyses.

FROM 1893 TO 1894

(17) Preparation of chromium and manganese at a high temperature. H. Moissan. *Compt. rend.*, vol. 116, 1893, pp. 349-351. Chromium oxide mixed with carbon is reduced with a current of 50 v. and 350 amp. Carbon analyzes up to 13 per cent, but if it is broken up, placed in a crucible, brasqued and covered with chromic oxide, Cr quite free from carbon results. By using mixed ores perfectly homogeneous Fe:Cr alloys are obtained.

(18) Some alloys of iron with molybdenum, tungsten and chromium as solutions. J. A. De Benneville. *J. Am. Chem. Soc.*, 1894, vol. 16, pp. 735-757. Alloys, with the exception of some amalgams, are solids at ordinary temperatures; as a solution, they exist only at high temperatures where the laws of solutions apply. From studies of acid attack he finds: (1) A chemical union between constituents. (2) These compounds are distributed uniformly through the alloys. (3) The more stable alloys are definite chemical compounds. (4) The less stable may be definite compounds such as cryohydrates.

(19) The physical influence of elements on iron. J. O. Arnold. *J. Iron and Steel Inst.*, 1894, No. 1, pp. 107-155. Carbide formed by high chromium is noted and the location of critical points given.

(20) Cementation steel, ferrochromium, ferrotungsten and chromium steel. H. Behrens and A. R. Van Linge. Abstracted by *J. Am. Chem. Soc.*, vol. 66, part 2, 1894, p. 452, from *Rec. Trav. Chim.*, vol. 13, pp. 155-188. Ferrochromium contained crystals (hardness in a ground mass of hardness 4.2). The latter is a much better heat conductor. Acids leave bayonet-shaped crystals, non-magnetic, hardness 7.5, analysis approaching $\text{Cr}_2\text{Fe}_3\text{C}_3$. Softer portions of the alloy contain considerable Cr and the hardness is closely connected with the quantity of carbon present.

(21) Chromium. H. Moissan. *Compt. rend.*, vol. 119, 1894, pp. 185-191. Heating chromium with large excess of carbon in electric furnace gives Cr_3C_2 in brilliant lamellæ with a greasy luster. Insoluble in concentrated or dilute nitric acid, aqua regia or concentrated HCl. Fused KNO_3 attacks it readily. Sp.gr. 5.62; harder than topaz, softer than carborundum. Another carbide, CCr , is obtained in lustrous needles sometimes 20 mm. long; sp.gr. 6.75; harder than glass or quartz.

FROM 1895 TO 1902

(22) Ternary alloys of iron with chromium, molybdenum and tungsten. J. De Benneville. *J. Iron and Steel Inst.*, 1895, vol. 1, pp. 202-253. By use of different solvents the author detects $\text{Fe}_3\text{Cr}_6\text{C}_4$ and $\text{Fe}_3(\text{CrMo})_3\text{C}_4$ and carbides of iron other than Fe_3C . An excellent physicochemical investigation.

(23) Chromium:iron alloys. L. Schneider. *J. Iron and Steel Inst.*, 1896, vol. 1, p. 398. Abstracted from

Oesterreichische Z. Berg und Hüttenwesen, vol. 33, p. 297. Rich Fe:Cr alloys which are occasionally used to manufacture exceptionally hard steels exhibit crystals in blow-holes and on the surface, increasing with the chromium.

(24) Welding chrome steel. R. Brown. *J. Iron and Steel Inst.*, 1896, No. 1, p. 472. Successful welding can be done with light blows gradually increasing in strength.

(25) The magnetic properties of iron. Dewar and Fleming. Abstracted by *J. Iron and Steel Inst.*, 1896, No. 2, p. 397, from *Proc.*, Roy. Soc., vol. 60, pp. 57-71. Chromium steels were studied at low temperatures.

(26) A new silicide of chromium. Ch. Zettel. *Compt. rend.*, 1898, vol. 126, pp. 833-834. A compound, SiCr_3 , is reported to be very stable and insoluble except in HF.

(27) Researches upon the combinations of silicon and chromium in ferrous products. A. Carnot and Guital. *Compt. rend.*, 1898, vol. 126, pp. 1240-1245. $3(\text{Cr}_3\text{C}_2)(\text{Fe}_3\text{C})$ exists in ferrochromium; $(\text{Cr}_3\text{C}_2)_3(\text{Fe}_3\text{C})$ in low-chromium steel.

(28) Magnetic properties of hardened steels. Mrs. Sklodowska Curie. Société d'Encouragement pour l'Industrie Nationale, 1898, pp. 37-76. Deals with magnetic properties of forty-eight hardened steel magnets in the form of rings and 20-cm. bars.

(29) Researches on the electrical conductivity and magnetic properties of upward of one hundred different alloys of iron. W. F. Barrett, W. Brown and R. A. Hadfield. *Proc.*, Inst. of Electrical Eng., vol. 31, 1900, pp. 674-729. Gives the list of specimens tested; study of their electric conductivity and magnetic properties.

(30) On the increase of electrical resistivity caused by alloying iron with various elements and the specific heat of those elements. W. F. Barrett. *Proc.*, Roy. Soc. of London, vol. 69, 1902, pp. 480-485. Among others three chromium-bearing irons were examined ranging from 2 to 9.5 per cent Cr plus slight impurities.

(31) Magnetic properties of iron. A. Abt. Abstracted by *J. Iron and Steel Inst.*, 1902, No. 2, p. 537, from *Ann. der Physik.*, vol. 6, pp. 774-783. Abt measured the permanent magnetic moment in a large number of hardened steels in different fields. Ni:Cr steel shows the greatest moment, then follow steels containing Cr, Ni, W, C and Mn.

(32) Concerning the magnetic properties of iron and steel at low temperatures. C. C. Trowbridge. *Electrical World and Eng.*, 1902. Abstracted by *Stahl und Eisen*, 1903, vol. 23, No. 1, pp. 150-151. Influence of low temperature depends on the chemical constitution and temporary physical condition, thermal and mechanical treatment of the sample.

FROM 1903 TO 1904

(33) Determination of the points of allotropic changes of iron and its alloys by the measurements of the variations in the electrical resistance. O. Boudouard. *J. Iron and Steel Inst.*, 1903, No. 1, pp. 299-377. Thermal analysis of chromium steels indicates the existence of an anomaly at the same temperatures on heating and cooling.

(34) Properties and constitution of chrome steels. Leon Guillet. *Compt. rend.*, No. 139, 1904, pp. 426-428. Heat-treatment of nineteen different alloy steels gave results somewhat similar to straight carbon steels except in case of double carbide steels.

(35) The development and use of high-speed steel. J. M. Gledhill. *J. Iron and Steel Inst.*, No. 2, 1904, pp. 127-166. Discusses high-tungsten and low-chromium steels.

(36) Chrome steels, L. Guillet. *Revue de Métallurgie*, 1904, pp. 155-184. Carbons from 0.043 to 0.464 per cent; Cr from 0.703 to 31.74 per cent discussed. Hardened pearlitic chromium steels act like carbon steels during quenching. Martensitic Cr steels soften somewhat on quenching, due to a tendency to form gamma iron, the less the lower the carbon. Annealing also softens. Double carbide Cr steels are softened by a quench from 850 deg. without undergoing any microscopic change. At 1,200 deg. C. the carbides dissolve in part or totally according to speed of cooling and initial content. Annealing destroys the double carbide in part.

(37) Heat-treatment experiments with chrome:vanadium steel. H. R. Sankey and J. R. Smith. *Inst. Mechanical Engineers*, parts 3 and 4, 1904, pp. 1235-1317. Open-hearth furnace steel containing C 0.297, Si 0.059, Mn 0.394, Cr 1.066 and V 0.169 was used. Differently heat-treated material was tested for tensile strength, reduction of area, elastic limit, elongation, Arnold's alternating stress, impact test, hard bending and twisting tests. Photomicrographs and cooling curves accompany the data. Comparisons with straight carbon and nickel steels are numerous.

FROM 1905 TO 1906

(38) Chromium steel. A. Brustlein. *Revue de Métallurgie*, 1905, pp. 508-515. Early manufacture at the Unieux Works (France). Production of 55 per cent ferrochromium in old crucibles was stopped when a cupola furnace at the St. Chamond Works started producing it. Steels were manufactured from 0.5 to 3 per cent Cr.

(39) Experimental evidence relating to the effect on mechanical and other properties of iron and its alloys produced by liquid air temperatures. R. A. Hadfield, *J. Iron and Steel Inst.*, No. 1, 1905, vol. 67, pp. 147-206. (Bibliography, pp. 206-220.) Results for all the common steels of Cr and Cr plus other alloying elements in chromium steels containing W, Ni, Mn, Cu and Mn:Si. No distinct effects of chromium were observed.

(40) The types of structure and critical ranges on heating and cooling of high-speed steels under varying thermal treatment. H. C. H. Carpenter. *J. Iron and Steel Inst.*, No. 1, 1905, pp. 433-473. Does not concern chromium steels as such. Photomicrographs show change in constituents by cooling from increasingly higher temperatures. At 1,100 to 1,200 deg. C. structure tended toward austenite, eventually becoming so. Tempering starts at over 500 deg. C.

(41) Recent research made upon industrial alloys and their importance. L. Guillet. *Revue de Métallurgie*, 1906, pp. 87-111. (Chrome steel, pp. 94-96.) General comments on quaternary steels, some of which contain Cr.

(42) Nickel:chrome steels. L. Guillet. *Revue de Métallurgie*, 1906, pp. 332-354. Twenty-eight Ni:Cr steels investigated. They may be pearlitic, martensitic and carbide, of gamma iron or of gamma iron with carbides depending on the sum of C:Ni and Cr; 1.65 per cent C is equivalent to 29 per cent Ni or 18 per cent Cr. Addition of increasing amounts of Cr to a nickel steel will put it through all intermediate

stages to even gamma iron and carbides. Mechanical properties of normal Cr:Ni steels can be reduced from their microstructure by comparison with nickel or chromium steels.

(43) Quaternary steels. L. Guillet. *J. Iron and Steel Inst.*, 1906, No. 2, pp. 1-142. The influence of Cr is superimposed to that of Mn in Cr:Mn steels; when Cr is sufficiently high a carbide is formed. Physical properties and microstructure depend on the sum of Cr, Mn and C being analogous to Cr:Ni steels.

(44) Chromium steel. Abstracted by *J. Iron and Steel Inst.*, 1906, No. 4, p. 926, from *Iron and Coal Trades Rev.*, vol. 73, p. 1263. Low-carbon ferrochromium is best for steel manufacture due to more even solution of carbide. Crystals of carbide cause flaws.

(45) On the art of cutting metals. F. W. Taylor. *Trans., Am. Soc. Mech. Engineers*, vol. 28, 1906. Chromium is shown to be an essential element in modern high-speed steel.

DURING 1907

(46) The influence of chromium on the solubility of iron for carbon and the formation of graphite. Goerend and Stadeler. *Métallurgie*, 1907, pp. 18-24. A_r is constant and equal to 710 deg. C. up to 21 per cent Cr; between 21 and 29 per cent Cr no such point was found. The freezing point varied from 1,130 deg. C. for 0 per cent Cr to 1,535 deg. C. for 62 per cent Cr. A small increase in Cr stops the formation of graphite by silicon. The greater the per cent of Cr the greater the per cent of C can be before the eutectic is reached. High Cr favors formation of gamma iron.

(47) The iron:chromium solutions. Treveschke and G. Tammans. *Z. anorg. Chem.*, 1907, vol. 55, pp. 402-411. Equilibrium diagram. By rapid cooling the Fe:Cr system is a pseudo-ternary one, consisting of Fe, Cr and a compound Fe_xCr_y . The structure and properties of chromium steels depend not only on the Cr content but also upon the temperature to which they have been heated in the liquid state.

(48) The melting of Cr:Ni:Fe alloys. H. Wedding. *Stahl und Eisen*, 1907, vol. 27, pp. 1590-1591. Mobility, the formation of blow-holes and piping gases evolved, on Ni:Cr:Fe alloys.

(49) Chromium:tungsten steels. L. Guillet. *Revue de Métallurgie*, 1907, pp. 5-25. Normal steels show pearlite, martensite or carbide of Fe, Cr and W, which is found with martensite, sorbite or troostite. Ordinary structure is that of a rapidly cooled industrial steel. Physical properties depend on the class: (a) Pearlite steels have tensile strength and elastic limit higher, elongation and resistance to shock lower than ordinary steels; (b) martensite steels have very high tensile strength and elastic limit, with low values for both shock resistance and elongation; (c) carbide steels have low shock values—other properties are dependent on the constituent which accompanies the carbide. Hardening or quenching changes pearlitic to martensitic steels. Martensitic and carbide steels may be softened by quenching (due to gamma iron) more than straight carbon steels. Time and temperature cause solution of carbides and hence intermediate values. Heating to 1,200 deg. C. and cooling sufficiently rapidly gives an extremely fine martensitic structure with high-speed steels. Even pearlitic steels are not in use, since they cost more than Ni:Cr, which they but slightly excel. Use will, in general, be limited to high-speed tools.

(50) Concerning a new chrome tool steel. L.

Guillet. *Revue de Métallurgie*, 1907, pp. 1025-1026. A steel whose analysis shows C 2.18 per cent, Cr 14.88 per cent, Mn 0.71 per cent, Si 0.19 per cent, and P and S traces was accidentally made by adding Cr twice in a ladle. As received it consisted of pearlite and double carbide. It cannot be rolled, and is forged with difficulty. Heat to 950, cool to 850 deg. C. and oil-quench, or heat to 1,050, and cool to 950 deg. C. and oil-quench, when it becomes useful for a cutting tool for steel or iron. It does not warp during quenching.

(51) The densities and specific heats of some alloys of iron. W. Brown. *Sc. Trans., Roy. Dublin Soc.*, vol. 9, ser. 2, 1907, pp. 59-84. Chromium up to 3 per cent added to iron increases specific volume about 0.00034 c.c. for 1 per cent of added Cr. Further addition to 9.5 per cent has no effect. Chromium has very little effect on specific heat when C is relatively high.

(52) Alloy steels for motor car construction. J. A. Mathews, *J. Franklin Inst.*, 1907, vol. 167, pp. 279-397. General résumé of the author's experience.

FROM 1908 TO 1909

(53) The determination of the hardness of the constituents of iron and steel. H. C. Boynton. *Stahl und Eisen*, 1908, vol. 28, No. 1, p. 740. Hardness of pearlite varies but little with the addition of Cr, W or Mn up to 1 per cent. More than this raised the hardness.

(54) Concerning the magnetic properties of a pure iron tested by Dr. Kruesler. E. Gumlich. *Stahl und Eisen*, vol. 28, No. 2, 1908, p. 1430. Removal of gases is difficult. Effects of heating to 1,400 deg. C. on molecular structure noted.

(55) Function of chromium and tungsten in high-speed steels. C. A. Edwards. *J. Iron and Steel Inst.*, 1908, No. 2, pp. 104-132. Case-hardening the nose of a high-speed tool increases cutting speed from 13 to 14.5 per cent. Steels containing more than 3 per cent Cr and 6 per cent W show a critical range beginning at 380 deg. C. In a high-speed tool chromium forms a double carbide with W which imparts high hardness and increases the resistance to tempering.

(56) The special steels in theory and practice. Walter Giesen. *The Iron and Steel Inst., Carnegie Scholarship Memoirs*, vol. 1, 1909, pp. 1-55. Nickel: chromium steels examined for hardness, impact strength, metallography and ability to be case-hardened. Normal Ni:Cr steels may have the following structure: (a) Pearlite and ferrite, (b) pearlite and carbide, (c) martensite and carbide, (d) martensite and gamma iron, (e) martensite and ferrite, (f) gamma iron and carbide, (g) gamma iron. Formation of martensite depends on sum of C, Cr and Ni; the ratio of equivalence of these elements being C 1.68 per cent, Cr 18.5 per cent, Ni 28.7 per cent. Increasing Cr forms carbide. Cr:Ni steels with pearlitic or gamma iron structure can be recommended for industrial or practical use. Chromium steels containing 0 to 8 per cent Cr and 0.5 per cent C, or 0 to 5 per cent Cr and 0.95 per cent C have pearlitic microstructure and differ very slightly from carbon steels. Hardness increases with Cr independently of carbon content; brittleness is less than in plain steels with same carbon. Chromium steels containing 8 to 18 per cent Cr and 0.3 per cent C, or 5 to 12 per cent Cr and 0.95 per cent C are of martensitic or troostitic structure, have high tensile strength and elastic limit, low ductility, high hardness and medium brittleness. Chromium over 25 per cent

with 0.3 per cent C or over 22 per cent with 0.95 per cent C produce very brittle alloys.

(57) Contribution to the study of steels for gears. L. M. Révillon. *Iron and Steel Inst., Carnegie Scholarship Memoirs*, vol. 1, 1909, pp. 161-217. Steels considered are divided into (1) steels containing neither Ni nor Cr; (2) Ni:Cr steels, hardened in oil or water; (3) Ni:Cr steels with high carbon capable of air-hardening; (4) high Ni steels with or without Cr. All steels were heat-treated, and tensile strength, elastic limit, elongation, reduction of area, shock strength and hardness determined. Higher Cr with a well-adjusted Ni content yields the best results with a simple treatment.

(58) Contribution to the study of special ternary steels. A. M. Portevin. *Iron and Steel Inst., Carnegie Scholarship Memoirs*, vol. 1, 1909, pp. 230-362. In steels containing 0.2 per cent C (a) the resistance to shear increases with Cr, but remains below 50 kg.; (b) steels of 7 to 13 per cent Cr have a high resistance, but low contraction on shearing; (c) in steels having more than 13 per cent Cr the resistance to shearing remains within 30 to 35 kg., but contraction increases and elastic limit under shear decreases. In steels containing 0.8 per cent C (a) and with 5 per cent Cr have high resistance and elastic limit in shear, but contraction is low; (b) steels having 7 to 14 per cent Cr have uniform resistance to shear; (c) steels containing over 18 per cent Cr show a decrease in resistance and elastic limit in shear, while contraction increases.

(59) Special steels. Léon Guillet. Abstracted by *Iron Age*, vol. 84, 1909, pp. 916-917, from report read at Fifth Congress of the International Association of Testing Materials at Copenhagen, Denmark, Sept. 7-11, 1909. Tendency of alloying is to raise mechanical strength, simplify thermal treatment and create special anti-friction steels. Analysis, mechanical properties and heat-treatment of one Ni:Cr:V and one Ni:Cr steel are given. Several Cr and Cr:Ni steels can be air-quenched. Anti-friction steels contain Cr 0.42 to 0.54, Ni 2.43 to 2.6 and C 0.33 to 0.62.

DURING 1910

(60) Thermal treatment of special steels. Léon Guillet. *Revue de Métallurgie*, 1910, pp. 489-495. General discussion dividing steels into (1) pearlitic, (2) martensitic, (3) "polyhedrique"—i.e., steels having high percentage of alloy element in solution in gamma iron; (4) carbide steels having a single or double carbide, not necessarily in solution.

(61) Chrome steel permanent magnets. W. Brown. *Sc. Proc., Roy. Dublin Soc.*, new series, vol. 12, 1909-10, pp. 349-353. Results on seven steels giving chemical composition and magnetic moment per gram when glass hard and annealed. Annealing has little effect on magnetic moment; 1.95 per cent Cr, 0.86 per cent C gives the best magnet. Discusses previous investigations.

(62) Some physical properties of 2 per cent chromium steels. H. McWilliams and E. J. Barnes. *J. Iron and Steel Inst.*, 1910, No. 1, pp. 246-267. The forged material was normalized, annealed, quenched in water and drawn at 400 deg. C., 550 deg. C. and 700 deg. C. respectively and tested. Carbon varied from 0.2 per cent to 0.85 per cent in six different steps. A thermal and microscopic analysis is presented.

(63) The A_2 point in chromium steel. Harold Moore. *J. Iron and Steel Inst.*, 1910 No. 2, pp. 268-275.

Critical ranges determined by Carpenter and Keeling's method. Magnetic change point curves also plotted. Ac_1 is progressively raised by Cr. Identity of the lower critical point with magnetic changes proves it to be $Ac_{2,3}$. Occurrence of Ac_2 below Ac_1 means that Fe_3C is insoluble in beta iron.

(64) Concerning two nickel:chrome steels. M. A. Portevin. *Revue de Métallurgie*, 1910, pp. 808-810.

Chemical Analysis	C	Si	S	P	Mn	Ni	Cr	Microhms per c.c.
Steel A.....	0.19	0.18	0.02	0.01	0.44	2.53	0.63	26.2
Steel B.....	0.19	0.17	0.02	0.01	0.53	2.69	0.64	32.2

The slight difference in composition cannot cause such a difference in resistance. In other steels a difference of 3.52 per cent Ni caused similar results. Photomicrographs show very dissimilar structure in A and B, due to the effect of previous thermal treatment both in liquid and in solid state.

(65) Report on the wear of steels and their resistance to crushing. Felix Robin. *Iron and Steel Inst., Carnegie Scholarship Memoirs*, 1910, vol. 2, pp. 1-265. (Cr steels 41, 152, 166.) Double carbide in Cr steels increases wear resistance, especially where the carbide is in numerous grains surrounded by fine martensite, as in annealed steels containing 2 per cent Cr. Cr:W steel is strongest against crushing among Cr, Cr:Ni and Cr:W steels. The straight Cr steel has the greatest interstrain hardness.

DURING 1911 AND 1912

(66) The chemical and mechanical relations of iron, chromium and carbon. J. O. Arnold and A. A. Read. *J. Iron and Steel Inst.*, 1911, No. 1, vol. 83, pp. 249-260, and discussion, pp. 260-268. Brief résumé of several previous investigations; analysis, manufacture and physical properties are listed.

(67) Case-hardening chromium steels. F. Giolitti and F. Carnevali. Abstracted by *J. Iron and Steel Inst.*, 1912, No. 284, p. 595, from *Atti della Reale Accademia delle Scienze di Torino*, vol. 46, pp. 409-432. A 2.3 per cent Cr steel was carbonized using CO, ethylene, and CO and charcoal, giving similar results to carbon steels. Cr causes an increase in the maximum carbon concentration of the carbonized zone.

(68) Contribution to the study of iron:chromium alloys, with special reference to their solubility in acid. Phillip Monnartz. *Metallurgie*, 1912, pp. 161-176 and 193-201. A treatise on solubility.

(69) Relations between the macrostructure and the crystallization of steel. M. N. T. Belarew. *Revue de Métallurgie*, 1912, 647-680. The kind of steel is quite incidental to the relation of crystalline structure to macrostructure.

(70) Various acoustic properties of steel as a function of their temperatures. Felix Robin. *Revue de Métallurgie*, 1912, pp. 413-470. Chromium and Si act more energetically than Mn and Ni in retaining vibrations. In alloy steels the duration of sound is in general raised by Cr.

(71) The corrosion of Ni, Cr and Ni:Cr steels. J. N. Friend, J. L. Bently and W. West. *J. Iron and Steel Inst.*, 1912, No. 1, pp. 249-258. Corroding media, tap water, sea water, hot water and dilute H_2SO_4 may be divided into two groups—acid and neutral. Acceleration tests with H_2SO_4 are misleading. There is an optimum concentration of Cr for resistance to attack. In neutral media corrosion resistance rises with Cr.

(72) Magnetic properties of special steels. O. Boudouard. Abstracted by *J. Iron and Steel Inst.*, 1912, No. 1, vol. 85, p. 575, from (a) *Compt. rend.*, vol. 153, pp. 1475-1478, (b) *Revue de Métallurgie Memoirs*, vol. 9, pp. 294-303. In carbon steels the electric resistance increases with carbon, while in the Cr steels irregularities appear to have no relation to carbon.

(73) The magnetic properties of a variety of special steels at low temperature. J. G. Gray and A. D. Ross. *Trans., Faraday Soc.*, vol. 8, 1912, pp. 115-134. Studies of two steels containing 1 and 4 per cent Cr respectively.

(74) Chromium:vanadium steel tires. Abstracted by *J. Iron and Steel Inst.*, part 1, 1913, p. 665, from *Iron Trade Rev.*, 1912, vol. 51, pp. 1217-1218. Tables showing physical properties and chemical composition of heat-treated Cr:V steels. After 121,000 miles a locomotive still had its Cr:V tires in good condition, while carbon steel tires require turning after 60,000 miles.

(75) Concerning chromium steels. M. Portevin. *Compt. rend.*, No. 153, 1911, pp. 64-66. Reports on hardness and microscopy of two high-chromium steels heated to 1,300 deg. C. and cooled in the furnace.

DURING 1913 AND 1914

(76) On the transformation points and the structure of nickel:chrome steels. Léon Guillet. *Compt. rend.*, No. 156, 1913, pp. 1774-1776. Tabulates sixteen Ni:Cr steels, the best of fifty samples. Shows transformation points on heating and cooling, chemical composition and structure. The addition of Cr to a Ni steel caused effects depending on the percentage of Ni and C.

(77) Differences between the structure and the composition of certain steels. M. Bres. *Revue de Métallurgie*, 1913, pp. 797-808. Report on four Ni:Cr steels having almost identical compositions, but different microstructure and mechanical properties. Different structures were caused by different casting practice and could not be removed by heat-treatment or work, but behaved as steels of their kind after hardening and tempering. These structures correspond perfectly with the corresponding mechanical properties. Control of the factors influencing such special structures would permit making different steels of the same composition.

(78) The magnetism of permanent magnets. Silvanus F. Thompson. *J. Inst. Electrical Eng.*, vol. 50, 1913, p. 217. Includes a bibliography of magnetism which covers many chromium steels.

(79) The corrodibility of nickel, chromium and nickel:chromium steels. J. N. Friend, W. West and J. L. Bently. *J. Iron and Steel Inst.*, No. 1, 1913, vol. 92, pp. 388-398. Nickel steels appear to resist corrosion very well for some time and then fail rapidly. A 20 per cent Cr steel is very resistant to acid corrosion.

(80) New researches upon the transformation points and the structure of nickel:chrome steels. Léon Guillet. *Compt. rend.*, vol. 158, 1914, pp. 412-414. Presents tables for 2 and 4 per cent nickel steels with different percentages of C and Cr, giving transformation points, structure, chemical analysis, hardness and resilience.

(81) High-speed steels. M. Denis. *Revue de Métallurgie*, vol. 11, 1914, pp. 4-94. A study of the cutting properties and their practical utilization.

(82) Studies upon the general properties of high-speed steels. M. Denis. *Revue de Métallurgie*, No. 6, 1914, pp. 569-669. General test methods for high-speed steels and the best treatment which can be applied.

(83) Permanent magnetism of certain chrome and

tungsten steels. M. B. Moir. *Phil. Mag.*, sixth series, vol. 28, 1914, pp. 738-748. Steel containing 8 per cent Cr showed a 5.5 per cent loss, against 2.8 per cent loss for 16 per cent Cr steel, but the former had a higher residual magnetism, so that it remained a stronger magnet.

(84) The magnetic properties of a graded series of chrome steels at ordinary and low temperatures. M. B. Moir. *Phil. Mag.*, vol. 27, 1914, pp. 830-842. Six chromium steels containing Cr 1 to 20 per cent were tested at 15 deg. C. and -190 deg. C. in forged and rolled condition after annealing and after quenching from 900 deg. C. Lowering the temperature diminished the susceptibility for low and increased it for high fields. The magnetizing field at which curves corresponding to 15 deg. C. and -190 deg. C. respectively crossed increased with Cr content up to 12 per cent in annealed specimens and then decreased.

(85) Magnetic habits of alloy steels. J. A. Mathews. *Proc.*, Am. Soc. Testing Materials, vol. 14, 1914, part 2, pp. 50-66. Dwells on chromium steel only as it is the universal magnet steel. Magnetic hardness might be measured by the ratio of residual density and coercive force. Relation of Brinell hardness to magnetic hardness is given.

(86) Chromium:vanadium steel wheels. Abstracted by *J. Iron and Steel Inst.*, 1914, No. 1, p. 372, from *Iron and Coal Trade Review*, 1914, vol. 89, p. 544. Particulars are given of results of different types of tender wheels on the Grand Trunk Railway.

(87) Cr:V rolled steel wheels. Abstracted by *J. Iron and Steel Inst.*, 1914, No. 2, p. 711, from *Iron Age*, vol. 92, p. 1106. In the drop tests, 896,000 ft.-lb. imposed before cracking or breaking; fractured tough and stringy fracture; steel uniformly hard. Analysis Cr 1 per cent, V 0.16 to 0.20 per cent and C 0.55 to 0.65 per cent.

(88) Mayari steel, its properties and uses. The Pennsylvania Steel Co. *Iron Age*, vol. 89, 1914, pp. 69-72. The steel is made with C up to 1.5 per cent. S and P are below 0.04 per cent and Mn is as desired. Nickel averages 1.25 per cent, while chromium runs 0.2 to 0.4 in one grade and 0.4 to 0.7 in the other. It is manufactured in the same manner as a straight carbon steel. It is difficult to weld. Commercial grades and uses are given, also some curves showing effect of heat-treatment.

DURING 1915 AND 1916

(89) The corrosion of high Cr steels, Robert Hadfield. Abstracted by *Iron Age*, vol. 97, 1916, pp. 202-203, from *Faraday Soc.*, 1915D. Compares various steels to high-chromium and stainless steel. Mechanical properties of stainless steel are given. High Cr steels are usually more resistant than most alloy steels and much more so than straight carbon steels.

(90) The thermo-electric properties of special steels. E. L. Dupuy and A. M. Portevin. *J. Iron and Steel Inst.*, 1915, vol. 91, pp. 306-336. Chromium has less influence than nickel.

(91) The effect of chromium and tungsten upon the hardening and tempering of high-speed tool steel. C. A. Edwards and H. Kikkawa. *J. Iron and Steel Inst.*, 1915, No. 2, vol. 92, pp. 6-31. Determines Brinell hardness after various temperings, using a constant rate of cooling. Chromium and carbon cause the greatest hardness, and lower the temperature at which hardening occurs.

Curves of specific gravity vs. tempering temperature and Brinell hardness vs. tempering temperature are similar and show great hardness for highest volume.

(92) Concerning the allotropic transformation and the microstructure of nickel:chrome steel. A. M. Masloff. *Revue de la Soc. Russe de Métal*, vol. 1, pp. 494 and 515, 1915. Abstracted in *Revue de Métallurgie*. Extracts, 1918, pp. 37-44. Chromium retards decomposition of austenite. A low Ni steel with enough Cr can be air-hardened. Cr increases homogeneity and hardness.

(93) Note on the relations between cutting efficiencies of tool steels and their Brinell or scleroscope hardness. J. O. Arnold. *J. Iron and Steel Inst.*, 1916, No. 1, pp. 102-104. Brinell or scleroscope hardness are useless for estimating the thermal stabilities of hardenites, the main cause of lathe efficiency.

(94) Initial temperatures and critical cooling velocities of a chromium steel. C. A. Edwards, J. M. Greenwood and H. Kikkawa. *J. Iron and Steel Inst.*, 1916, pp. 114-140. Steel contained 6.15 per cent Cr, 0.63 per cent C, 0.7 per cent Mn. Chromium imparts the property of self-hardening which in turn is governed by the rate of cooling.

(95) The transformation of special steels at high temperature. R. Honda, K. Tawara and H. Takagi. *J. Iron and Steel Inst.*, 1916, No. 1, pp. 1 and 244-254. Heating, cooling and magnetization curves are taken for the six alloy steels below, and results tabulated.

Steel	C	Si	Mn	P	S	Cr	W	V	Mo
1 D.S.W. steel.....	1.16	2.89	0.4	0.047	0.038	2.74	.....	.....	.....
2 Ultra capitol.....	0.66	0.08	0.08	0.018	0.016	3.43	16.81	.....	.....
3 New capitol.....	0.64	0.05	0.01	0.015	0.012	3.73	14.63	0.011	.....
4 Bohler.....	0.82	0.18	0.26	0.003	0.016	3.71	14.63	0.20	0.17
5 Super-rapid Novo steel	0.59	0.22	0.06	0.028	0.23	2.86	18.81	.....	.....
6 Becker diamond.....	1.05	0.16	0.35	0.009	0.012	.....	3.17	.....	.....

In the cooling curves the critical point remains almost constant but A_3 coincides with A_2 . Cooled from 1,000 deg. C. or higher, the A_3 transformation is displaced partly or wholly to a lower temperature (400 deg. C.).

(96) Manufacture and uses of alloy steels. H. D. Hibbard. *Bull.* 100, Bureau of Mines, pub. 1916, 72 pages. Brief notes on heat, manufacture, use, methods of treatment and physical properties. Steel containing Cr, Cr:Ni, Cr:V and high-speed steels are discussed.

(97) The critical points of self-hardening steels and of the formation of troostite and martensite. M. P. Dejean. *Revue de Métallurgie*, 1917, pp. 641-676 (chromium steels, pp. 661-666). Among self-hardening steels are the following: Cr, Ni:Cr, Cr:W, Ni:Cr:Cu. A series of cooling curves are obtained by varying the initial temperature and rate.

DURING 1917

(98) Some observations relative to the transformation points of special steels. Leon Guillet. *Revue de Métallurgie*, 1917, pp. 676-683. Analysis, transformation points, structure and physical properties of two series of Ni:Cr steels. The first of these steels contains approximately 2 per cent Ni, C 0.15 to 0.34 per cent and Cr 0.06 to 10.25 per cent; the second, C 0.07 to 0.27 per cent, Ni 4 per cent and Cr 0 to 13.87 per cent. Cr has little effect upon the transformation points on cooling between 3 and 5 per cent.

(99) Concerning the transformation of nickel:chrome steels. M. A. Portevin. *Revue de Métallurgie*, 1917, pp. 707-716. This work is divided into (a) methods of thermal analysis, (b) influence of thermal

treatment on transformations, (c) correlation of microstructure. Ar, microstructure and hardness of a Cr:Ni steel are dependent on (1) chemical composition and initial structure, (2) rate of cooling, (3) temperature of heating, (4) pouring conditions.

(100) The penetration of the hardening effect in chromium and copper steels. L. Grenet. *J. Iron and Steel Inst.*, 1917, No. 1, pp. 107-117. Results rather than experimental data. High-chromium steels not containing Cu air-hardened with difficulty. Cr, Cu, Ni or Cu:Cr steels may be air-hardened. Copper does not prevent softening or annealing at high temperatures, but increases the depth of hardening.

(101) Chromium steels for magnets. E. Gumlich. Abstracted by *J. Iron and Steel Inst.*, 1917, No. 1, p. 411, from *Mitteilungen a.d. Physikalisch-Technische Reichsanstalt*. Tungsten having become unobtainable in Germany, chromium was used as a substitute.

(102) The influence of heat-treatment on the electrical and thermal resistivity and thermo-electric potential of some steels. E. D. Campbell and W. C. Dowd. *J. Iron and Steel Inst.*, 1917, No. 2, pp. 251-265. Two chromium steels are included in set. All explanations are advanced in terms of solution theory.

(103) The constitution of the iron:chromium alloys. Ernest Jänecke. *Z. Elektrochem*, vol. 23, 1917, pp. 49-55. Investigation of Fe:Cr alloys by cooling curves and microscope. Equilibrium diagram shows the metals completely soluble in the liquid and partly soluble in the solid state or a ternary system of Fe, Cr and Cr_xFe_y . The eutectic point is 75 per cent Cr, 25 per cent Fe, temperature 1,320 deg. C. The first solid solution is up to 55 per cent Cr and the second from 100 to 85 per cent Cr. Previous investigators used thermit mixtures and formed high-melting AlCr_4 .

(104) Physiochemical properties of Cr:Ni steel. H. J. French. *MET. & CHEM.*, vol. 17, 1917, pp. 473-476.

Properties which may be developed by the heat-treatment of certain chromium:nickel steels are recorded.

(105) Topical discussion on the use of several alloying elements in alloy steel. *Proc.*, Am. Soc. for Testing Materials, vol. 17, part 2, 1917, pp. 5-58, by F. J. Griffiths (chrome:vanadium steel, pp. 33-45). Four Cr:V steels are tabulated, giving different heat-treatments, physical properties and the difference between Ar and Ac. Results obtainable in routine commercial practice are quite uniform.

(106) The rôle of chrome:vanadium steel. R. J. Griffiths. *The Michigan Technic*, vol. 30, No. 3, 1917. A boost for Cr:V steel.

(107) The influence of chromium in steel. R. J. Anderson. *Iron and Coal Trades Rev.*, October, 1917, vol. 95, p. 439. Abstracted by *J. Iron and Steel Inst.*, 1918, No. 1, vol. 97, p. 546. Chromium does not act as a scavenger, nor does it confer soundness. In small amounts it increases tensile strength without reducing ductility; excessive amounts cause brittleness.

DURING 1918

(108) On the magnetic analysis of carbides found in different kinds of steel. T. Ishiwara. *Science Reports*, Tohoku Imperial University, first series, vol. 6, No. 5, 1918, pp. 285-294. The double carbide residue of a Cr steel and high-speed tool steel are paramagnetic, while Fe:Mn, Fe:W double carbides are magnetic and decompose at high temperatures. The decomposition of carbides into their components occurs between 650

and 730 deg. C. Residues show the presence of magnetite. Separation of cementite from eutectoid austenite on tempering begins at about 130 deg. C and ends at 380 deg. C. Temperatures of 130 deg. C., 360 deg. C. and 600 deg. C. correspond to martensite, troostite and sorbite respectively. Residue from quenched specimen contains only a small quantity of cementite, but its amount increases with the tempering temperature until it reaches 360 deg. C.

(109) On the structure of iron:carbon:chromium alloys. T. Murakami. *Science Reports*, Tohoku Imperial University, first series, vol. 7, No. 2, 1918, pp. 219-276 and twenty plates. This investigation forms the subject of the twenty-fourth report of the Alloy Research Institute. The author uses magnetic, thermal and microscopic methods in his work.

(110) Researches upon high-speed steel made at the Harvard Laboratories. M. Yatesevitch. *Revue de Métallurgie*, 1918, pp. 65-115. (Bibliography.) Deals with high-speed steels rather than Cr steels.

(111) Chromium. Samuel H. Dolbear. *Mineral Industry*, vol. 27, for 1918. (Bibliography.). Annual figures relative to price, importation and supplies of chromates and other chromium-containing products.

(112) The metallography and heat-treatment of metals used in airplane construction. F. Grotts. *CHEM. & MET. ENG.*, vol. 19, 1918, Nos. 4 and 5. Studies chromium:nickel steel (p. 195), chromium:vanadium steel (p. 241) and a special chromium steel (p. 246) analyzing 0.24 C, 0.36 Mn, 0.013 S, 0.020 P, 0.30 V and 10.44 Cr.

DURING PART OF 1919

(113) The manufacturing and working of high-speed steel. J. H. Andrew and G. W. Green. *J. Iron and Steel Inst.*, 1919, No. 1, vol. 99, pp. 305-344. Practical application of scientific methods to high-speed steel practice. These steels anneal readily if heated above critical range and slowly cooled through the lower critical point. The steel should not be heated over 1,320 deg. C., best results being obtained using temperatures from 1,300 to 1,320 deg. C. The highest secondary hardness (Brinell 610) is developed by heating between 550 and 600 deg. C. Hot work must destroy carbide envelopes occurring in the form of loops and hocks; an 88 per cent reduction on a 6-in. square ingot is necessary.

(114) The molecular constitution of high-speed steels and their correlation with lathe efficiencies. J. O. Arnold and F. Ibbotson. *J. Iron and Steel Inst.*, 1919, No. 1, vol. 99, pp. 407-435. Twelve per cent V increases efficiency of tool 98 per cent, and it can be used after a water-quench from 1,300 deg. C. Hardness and lathe efficiency are by no means identical terms.

(115) Heat-treating Cr:Ni steel with special reference to impact testing. R. C. Loudonbeck. *Steel Treating Research Soc.*, vol. 11, No. 5, 1919. Izod impact tests plotted against strength, yield point, elongation, reduction of area and Brinell hardness, showing an increase in impact value with a drop in tensile strength (136,000 to 125,000 lb. per sq.in.) and elastic limit (115,400 to 103,000 lb. per sq.in.), while the greater the elongation and reduction of area the greater the impact value. Brinell numbers vary inversely with impact. As a rule the basic steel gave better impact figures with a given set of other physical properties than did the acid steel.

New Variable Speed Power Transmission System

A SPEED control system suitable for a wide variety of uses for which variable speed power transmission is needed has been marketed by the Oilgear Co., of Milwaukee. It consists essentially of a pump which can be adjusted through a wide range of delivery capacity, and a motor driven by the work fluid—oil—received from the pump. The Oilgear variable speed drive receives power from a constant speed source, such as a line shaft, gasoline or oil engine, or constant speed electric motor, and delivers this power at any required speed from zero to a maximum in either direction, at an efficiency at full load of 85 per cent.

An infinite series of definite speed ratios irrespective of variations in load may be obtained, and there are no losses in accumulators, wire drawing through valves, etc. The power used to drive the variable stroke pump is always proportional to the power actually used by the variable speed motor. High torques are obtained at low speeds without additional power input.

The Oilgear variable speed transmission is adapted for such drives as lathes, drill presses, boring machines, etc., and machinery used in textile mills, powder mills, laundries, paper mills, cement plants and rubber mills. It is also admirably adapted to automatically controlled stokers, conveyors, gasoline cranes and excavating machinery, and to many drives where electric motors and gasoline engines are not inherently suited.

MECHANISM

Fig. 1 illustrates the motor end with the motor unit removed and shown to the left. The pump unit is identical except that it is cradled and its axis may be moved to right or left, thereby varying its displacement.

The cylinder barrel of either unit consists of a hub with central bore and five cylinders radiating therefrom. The bore of the hub is fitted closely around a ported pintle and each of the radiating cylinders contains a plunger, operated by a flat steel crosshead (hardened and ground), and delivering the plunger thrust through a roller bearing to a reaction plate on the surrounding driver. These parts are all shown at bottom of Fig. 1. As the cylinder barrel revolves each cylinder in turn registers with one of the ports as the plunger in that cylinder is moved outward, and after passing through a half revolution the same cylinder begins to register with the other port and continues to do so while the plunger is moving inward. Therefore each cylinder draws in a quantity of oil from the upper port and expels the same amount of oil into the lower port. The amount of oil handled by each cylinder at each revolution depends upon the stroke. If the operator sets the stroke at zero, no oil will be pumped. If the pump is at maximum, a large and perfectly steady flow of oil is drawn in through one of the ports and delivered through the other.

Each of these two ports communicates with a lengthwise passage through the interior of the pintle, terminating in a similar port at the opposite end of the pintle inside the case in Fig. 1. This is the motor pintle, and upon it is mounted the motor unit as described above. The oil issuing from one of the ports within the motor cylinder barrel pushes the plungers outward with whatever force may be necessary to compel the motor to rotate, and as each successive plunger reaches its outermost position, it ceases to

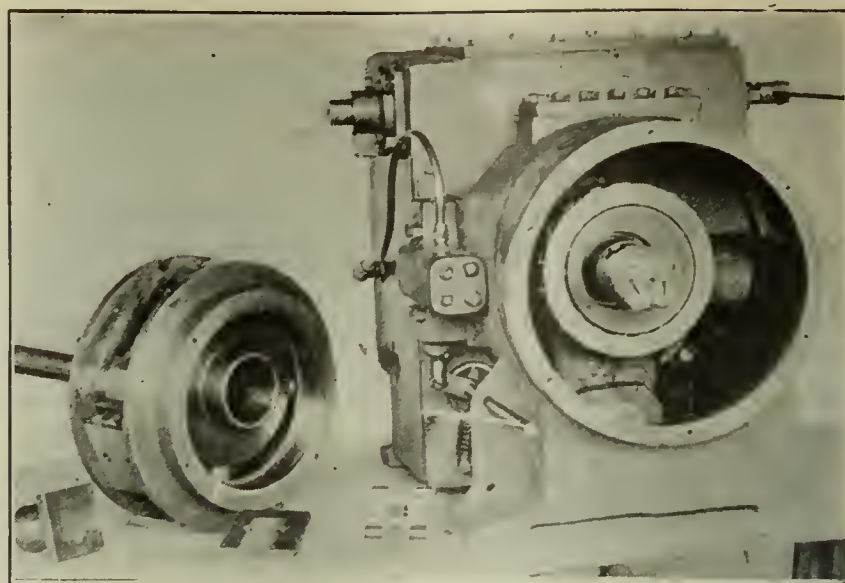


FIG. 1. MOTOR END OF OILGEAR VARIABLE SPEED DRIVE

register with the pressure port, crosses a bridge, and expels the oil into the return or low pressure port during the succeeding half of its revolution. Thus the five motor cylinders combine to return the perfectly steady stream of oil through the low pressure passage to be pumped over again back to the motor.

Besides the positive driving qualities of the Oilgear transmission and its perfect control of speed ratios, there is automatic protection against overload. The speeds selected by the operator are obtained irrespective of changes in load, unless the load becomes excessive, in which case an automatic overload gear relieves the operator of responsibility by preventing him from overloading the machine. The overload gear may be adjusted to any desired maximum load up to the capacity of the machine.

Boiling Linseed Oil With Electric Heat

Difficulties, disastrous fires and explosions have occurred in many cases in connection with the problem of boiling linseed oil, especially when it is used in connection with the production of linoleums and oilcloths.

F. J. Ryan & Co., Wesley Bldg., Philadelphia, Pa., has completed both the installation and test of a new boiling method using electric heat, which besides doing away with the distinct disadvantages of the old method has made possible complete heat and chemical control over a very wide range of temperatures involved.

This installation was made at the works of the Armstrong Cork Co., Linoleum Section, Lancaster, Pa. The installation is of considerable size, having a connected load of 75 kw. and handling batches of 2 tons of material at each heat. In approaching the problem it was necessary to consider the inherent characteristics of linseed oil to build up heat within itself during the oxidation period, and the fact that viscosity changes materially within very narrow temperature range, necessitating definite and exacting control.

The heating method applied is indirect and therefore the temperature of the ribbon is necessarily considerably higher than that desired in the oil. This necessitated a special cooling system to reduce the exterior heat to the normal oil requirement, when stopping the furnace to hold for processing.

General Electric heating units and Leeds & Northrup control are used, while the main furnace body and appliances for operating were constructed at the works of the Lancaster Iron Works, Lancaster, Pa., which is associated with the Ryan company.

Book Reviews

HEAT-TREATMENT OF SOFT AND MEDIUM STEELS.

By *Federico Giolitti*, Bessemer Medalist. Translated from the Italian by E. E. Thum, Associate Editor, *CHEMICAL & METALLURGICAL ENGINEERING*, and D. G. Vernaci, Metallurgical Engineer; 374 pp., 6 x 9; 214 illus. Price \$5. New York: McGraw-Hill Book Co., Inc.

Dr. Giolitti's book is probably unique in its field, in that the author has set himself the task of writing a treatise for the use of practical men which explains, as fully as the present state of metallurgical knowledge permits, the mechanism of the solidification of steel, in order that the reasons for the different heat-treatments described may be truly understood by the reader. In a general way, every one who practices heat-treatment understands that heatings above the critical range and below the solidus promote diffusion of the carbon and other elements in the steel, and hence are the first step necessary in heat-treatment, their function being to substitute homogeneity for its opposite in both forged and rolled steels. We all realize, too, that to retain the homogeneous state attained during this first heating comparatively rapid cooling is essential, and that to relieve the stresses set up and to reduce the hardening due to this rapid cooling a second heating is necessary, generally at a temperature below the critical range.

Of the 360 text pages of the book, the first 101 are devoted to a discussion of the phenomena of solidification and of transformation of the freezing and cooling steel, and an attempt is made to show and explain diagrammatically the reasons for and the extent of the heterogeneities of chemical and physical composition resulting from solidification of the metal and its transformation in cooling through the critical range. The author is not content with diagrams in two dimensions, but soon carries his reader into three, and even into more complicated figures in which by a sort of process of compromise the steels containing four, five or more variables can be reduced to a three-dimension diagram.

This part of the book is very heavy reading and quite beyond the mental grasp of a great many, perhaps a majority, of so-called "heat-treaters"—indeed no one but a thoroughly trained theoretical metallurgist could follow the explanations intelligently. Inasmuch as our present knowledge is still not nearly complete enough to allow numerical values and definite locations to be assigned to these various curves and surfaces, one is tempted to ask oneself if after all the effort to follow all this complicated reasoning has been worth while. Indeed, the author himself is apparently troubled by the same doubts.

Having, in parts I and II, chapters 1 to 10, covered these purely theoretical considerations, the author proceeds, in part III, chapters 11 and 12, to discuss the selection of the heat-treatments best suited to break up the initial heterogeneity of the steel, and to explain somewhat in detail the reasons underlying such selections, these chapters, as indeed is true of all the rest of the book, frequently referring back to discussions contained in the first two sections. Chapter XIII then discusses two groups of phenomena which modify the effects of these heat-treatments that are designed to reduce heterogeneity (for which the author has coined the phrase "preliminary" heat-treatments, as contrasted to the subsequent heatings to lower temperatures, which he styles "final" or "quality" heat-treatments). These two groups of phenomena are those arising during rolling, forging, etc., and those due to solid non-metallic inclusions.

In this chapter we learn the disquieting fact that steels containing certain classes of inclusions cannot be heat-treated in such a way as to make them the equal of metal free from these undesirable parasites. The underlying cause of this is stated to be "the state of oxidation in the system, or better, the oxygen pressure of the non-metallic particles and of the metal respectively, and from the variations which this ratio suffers during crystallization and the subsequent cooling." A series of experiments, the author states, makes this fact practically certain, and for the

description of these experiments one is referred to Italian work and to a forthcoming article in *CHEMICAL & METALLURGICAL ENGINEERING*. It is unfortunate that these data should not have been included in the present volume, as the mere statement of fact leaves the reader who has not read the articles in question unconvinced. Examples are given showing the connection between inclusions and "streaked" or "woody" fractures in transverse test-bars of forged steel. In later chapters this subject is taken up again, when considering transverse strength.

In part IV, chapters 14 to 18 inclusive, the heat-treatment of cast steel is discussed in great detail. Perhaps the most interesting part of these chapters is that which explains the relationship between the primary or dendritic structure and the secondary or network structure of cast steels. It is shown that while the latter structure can be broken up by comparatively simple heat-treatments, the primary or dendritic structure is very persistent and can be broken up only by repeated heatings and coolings. It is shown also that although a fibrous fracture, indicating considerable toughness, is produced in tension specimens by the more simple treatments which break up only the ferrite network, in the impact tests only the specimens that have undergone the more complex treatments designed to break up the dendritic structure show a fibrous fracture.

The arrangement of these tables of tests and heat-treatments is not good, as the reader is constantly forced to refer back a number of pages in order to refresh his memory as to the heat-treatments to which the various specimens in the tables of tests have been subjected. To the metallurgist who is familiar with the heat-treatment of cast steel, too, there appears to be far too wide a gap between the two classes of heat-treatments described—the simple ones that do not affect the dendritic structure, and the complex ones that do. It is by no means clear, and indeed in the reviewer's opinion is not a fact, that recourse need be had to such complicated and drastic treatments to attain this desirable effect.

The very interesting fact is brought out in these chapters that in very low-carbon cast steels the dendritic structure is only slightly developed, so that quite simple heat-treatments suffice to give these steels comparatively good physical properties. Further, it is shown clearly and convincingly that medium-carbon cast steels cooled slowly after the preliminary annealing develop a coarse microstructure and correspondingly poor physical properties, indicating the desirability of more rapid cooling, as in air, oil or water, followed by proper reheating, if the best physical properties are to be attained.

An important discussion in these chapters is that in which it is shown that cast medium-carbon nickel steels develop this coarse microstructure on cooling after the preliminary heat-treatment far less readily than do simple steels, so that an air-cooling of the nickel steel is roughly the equivalent of a quenching of the carbon steel—a fact of great importance in the heat-treatment of castings of large size. Many data are given showing the excellent physical properties that can be obtained with mild nickel steel castings suitably heat-treated.

Unfortunately, though the author does not hesitate to give many pages of data and tests showing the truly remarkable results attained in the Italian plant with which he is connected in the manufacture of these castings, he does not feel at liberty to reveal the exact heat-treatments to which the various castings described were subjected in order to give them these fine physical properties. This seems a most unfortunate omission, as it looks far too much like boosting the goods of a foreign maker in a scientific treatise.

Chapter 18 is devoted to the effect of non-metallic impurities upon the behavior of cast steel in heat-treatment, and we are again reminded that badly made steel does not respond properly to even the most scientific heat-treatment—the explanation, as before, being couched in more scientific language.

Part V, chapters 19 to 22 inclusive, deals with the heat-treatment of rolled and forged steels. Consideration is given to the manner in which preceding hot-work modifies the effect of heat-treatment upon the steel; and the close connection between lamellar structure in rolled steels, which

gives rise to transverse weakness and ingotism in cast steels, is pointed out. The same heat-treatments, therefore, that will eliminate ingotism in cast steel tend to improve the properties of rolled or forged steel, especially when tested transverse to the direction of rolling. Mention is made also of the marked effect of cold-work upon subsequent heat-treatment, due to grain growth during the annealing.

Tables and data are given and discussed showing that forging before heat-treatment is of less value in the case of steels of compositions suited to use as castings than in the case of other compositions not suitable for cast steel. A very interesting section is devoted to the effects of heat-treatment on pieces of steel of large mass, and the author points out the desirability of using for these heavy forgings steels whose transformation points are lowered and whose thermal hysteresis is increased by the use of suitable alloys. In the case of certain of these alloy steels, heavy forgings can be heat-treated without rapid cooling and yet show fine microstructure and good physical properties throughout their cross-section, whereas ordinary steels so treated retain in their inner portions a very coarse microstructure, with correspondingly poor physical properties. This is, of course, of great value in the case of forgings so heavy that they cannot be quenched without liability of cracking.

The last two chapters, in which are considered the effects of heat-treatment upon the longitudinal and the transverse properties of steel, are perhaps the most interesting part of the whole volume.

Data are given to show the desirability of using alloy steels that can be heat-treated without quenching with results practically as good as those obtained by quenching of simple steels, a procedure that enables the steel maker to give first class physical properties to forgings and to castings of such shape and design as to make quenching dangerous. The great difference between the longitudinal and the transverse properties of rolled steels is discussed at length, and the difficulty of so heat-treating rolled and forged steels as to obtain really good transverse properties is emphasized. Mention is made also of the importance of so designing vital parts and so carrying out the forging of them as to prevent their being subjected in service to heavy stresses in a direction transverse to the direction of forging. The reader is again reminded of the virtual impossibility of so heat-treating steel containing certain kinds of inclusions that it will show really good properties when tested transverse to the direction of rolling or forging, and the book concludes with the following paragraph, which at first sight sounds revolutionary, though after carefully reading the whole work its truth appears undeniable:

"It follows that in many cases, and above all when it is impossible to forge the piece in such a way that the working stresses fall in a longitudinal sense, *the rational employment of heat-treated steel castings may present relevant advantages in comparison with steel forgings*, not only from the viewpoint of rapidity of construction but also of resistance to stresses and its immunity from accidental fragility." (The italics are the reviewer's.) To one who, like the reviewer, has preached for years the advantages of real heat-treatment of steel castings for severe service, this paragraph brings a peculiar satisfaction.

The volume includes a brief bibliography of books bearing upon the subject under discussion, and references to other books and articles by the author, some of which give in more detail the discussions necessarily abbreviated in the present volume.

The work of translation has been ably done, so that in no instance has the sense of a paragraph or sentence been obscured. It is embarrassing, however, to the American reader to have the dimensions of castings and forgings given almost in every case in metric figures. With this exception and the above-mentioned fault in the arrangement of some of the tables of heat-treatments and physical properties, the presentation of the data is extremely good.

The work should be of the greatest value to the technically trained metallurgist, and though a good deal of the purely theoretical matter is probably beyond the grasp of the practical heat-treater, yet he too can obtain much most valuable information from the detailed discussions of the various heat-treatments.

JOHN H. HALL.

Recent Chemical & Metallurgical Patents

American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Platinum Substitute.—James B. Grenagle, of Catonsville, Md., has patented an alloy which is claimed to be adapted for use in laboratory apparatus and for other chemical and electrochemical purposes for which platinum is commonly used. The alloy contains 60 to 90 per cent of molybdenum and 40 to 10 per cent of tantalum; it has a melting point above 2,000 deg. C., has a high tensile strength, is ductile and malleable, and is highly resistant to the action of ordinary chemical reagents. (1,385,072; assigned to the Rare Metals Reduction Co., of Baltimore, Md.; July 19, 1921.)

Nitrostarch Explosives.—In the production of nitrostarch, as with other explosives, it is desirable to obtain great strength with a maximum insensibility to blows or friction. It is known that the explosive strength of nitrostarch is not materially decreased by the presence of a limited amount of water, and, in fact, owing to the intense heat produced at the instant of explosion, this water actually serves to increase the volume of gas which is produced. In order to prevent evaporative drying of the wet nitrostarch, Walter O. Snelling, of Allentown, Pa., assignor by mesne assignments to the Trojan Powder Co., of New York, proposes to add a deliquescent inorganic salt such as ammonium nitrate. Such a mixture might contain 50 per cent of nitrostarch, 40 per cent of the deliquescent ingredient and 10 per cent of water. (1,386,437; Aug. 2, 1921.)

Such a mixture may, however, be subject to some hydrolysis with subsequent decomposition and loss of stability. The presence of zinc oxide or hydroxide has been found effective in preventing this hydrolysis and Snelling in a second patent (1,386,438) adds 1 per cent to 5 per cent of such a zinc compound to the explosive mixture.

Another patent by the same inventor relates to the manufacture of nitrostarch explosives without recourse to the usual drying operations. The wet nitrostarch containing as much as 25 per cent of water is treated with a concentrated solution of ammonium nitrate and then centrifuged. In this way it is possible to substitute the ammonium nitrate solution for the water in the nitrostarch. Mixing this product with equal weight of dry ammonium nitrate one obtains a mixture which contains 37.5 per cent of nitrostarch, 56.25 per cent of ammonium nitrate and 6.25 per cent of water. This mixture is sensitive to commercial detonators and forms a highly desirable explosive (1,386,439; Aug. 2, 1921.)

Manufacture of Alum Cake.—Dr. Richard Moldenke, of Watchung, N. J., has recently been granted a patent for an improved method of producing alum cake—i.e., the commercial hydrated aluminum sulphate. It is claimed that the process yields a relatively pure product, free or nearly free from iron, and without an excessive loss of acid. Bauxite, clay or any other mineral containing alumina is finely ground and then mixed with sufficient strong sulphuric acid to form a paste or slurry. This paste is vigorously agitated at a high temperature (500 to 600 deg. F.) in an atmosphere of acid vapor in order to form aluminum sulphate and to prevent hardening into a cake or mass. After the reaction is completed the finely grained product is mixed with the amount of water necessary to make the crystallized aluminum sulphate. Under these conditions, a hot liquid mixture is obtained which can be readily separated from accompanying undissolved sand, clay, iron oxide, silica, etc., by simple filtration or settling. After removal of these insoluble residues, the clear liquid on cooling sets to a hard, crystalline, commercial cake. With care in the operation, this cake is practically free from iron. (1,388,436; Aug. 23, 1921.)

Current Events

in the Chemical and Metallurgical Industries

Organic Chemical Manufacturers Form Association

Manufacturers of organic chemicals on Oct. 29 perfected a trade association after intensive consideration of the subject during two days' meetings in Washington. Dr. Charles H. Herty has resigned as editor of the *Journal of Industrial and Engineering Chemistry* to accept the presidency of the new organization, which is to be known as the Synthetic Organic Chemical Manufacturers' Association of the United States. The purposes of the organization, as set forth in the constitution, are:

To advance the science of organic chemistry by encouraging the manufacture in the United States of all kinds of organic chemicals; to co-operate with the various agencies of the Government of the United States in its efforts to develop, improve and render serviceable a complete organic chemical industry; to promote cordial relations between American concerns and individuals engaged in the production and use of organic chemicals; to afford means for the dissemination of scientific knowledge; to promote the highest scientific and business standards in relation to the industry; and generally to take such collective action as may be proper for the establishment and perpetuation of the organic chemical independence of the United States of America.

The determination to secure Dr. Herty for the presidency of the association was reached late Friday night. Dr. Herty was at the Cosmos Club and had retired when the presence of a committee of manufacturers to wait upon him was announced. He rose to receive the committee and at first was determined not to accept the position offered him. The reasons that actuated him to change his mind are set forth in the following formal statement issued by Dr. Herty:

At last there has been brought together one effective organization of men who, for the past five years, have been developing in this country all lines of manufacture of synthetic organic chemicals. The fine spirit shown throughout the meetings gave assurance of a strong organization which will aid in developing to its maximum efficiency this industry born of the war period and now recognized by all as being of such fundamental importance to the nation. Much progress has been made, but there is a long road ahead before we can hope to give to our country an industry which can worthily meet its every need. Toward that goal we are facing.

The association as organized is thoroughly democratic in character. It follows national lines in this respect, for in the councils of the association the small manufacturer has equal voice with the larger and we all recognize that the success of the industry is closely bound up in the welfare of the small manufacturer. There have been some points of friction in the past between producer and consumer, but I believe that the hearty spirit of co-operation is developed which in the end will assure the future of this industry.

Personally it seems strange to me to be leaving the ranks of the chemists for those of the manufacturers. For six years I have editorially striven to arouse first the chemist and then our people in general to the importance of developing this industry. The idea is now so clear to all that I feel my best efforts can be given to work with the manufacturers on their many problems in the hope of aiding them in the firm establishment of that industry which is so vitally important to this nation that Secretary Hoover, while emphasizing that the main consideration now was the development of this industry for utilization of waste, nevertheless added:

"In these days of the development of forms of warfare that we have to exist under, it is fundamental and vital to us that we should maintain those industries on which we are bound to depend for our very vital existence if we ever come to conflict."

It was stated that the association is in no way a rejuvenation of the Dyes Institute and is not absorbing that organization. The new association is divided into four sections: Dyestuffs, Pharmaceuticals, Intermediates and Fine Organic Chemicals. Each section will have a vice-president, a secretary and an executive committee.

A board of governors, consisting of the president, the four vice-presidents and ten members to be nominated by the sections, will be the administering body of the association. C. N. Turner was selected to be the Dyestuffs vice-president; Herman Seydell, the Pharmaceutical vice-president; S. W. Wilder, the Intermediate vice-president and B. T. Bush, the Fine Organic vice-president. Six other members of the board of governors were chosen as follows: R. S. Burdick, R. C. Jeffcott, August Merz, M. R. Poucher, P. Schleussner and F. P. Summers. The remaining four members, one from each section, will be chosen later.

Dean Cooley Discusses the Problems Facing the F.A.E.S.

During his first visit to the headquarters of the Federated American Engineering Societies since his election to the presidency of the organization, Dean Cooley announced his conclusion that the most necessary thing to do first is to tune up the existing machine so that it may be in the best working order to accomplish the multiplicity of tasks that are before it. Engineers are foremost, he says, in the actual service rendered the public, but the amount of public service they are capable of rendering can be increased immensely if the Federation can co-ordinate and direct the vast energies of the nation's engineers. The public already has been sold the idea of the Federation, Dean Cooley believes, but he thinks much education and hard work will be required before the Federation can be sold to the engineers themselves.

There is scarcely a limit to what engineers can do if they will really work to a common end, says Dean Cooley. Even if they were to limit themselves to efforts to stabilize industries and to eliminate waste, they could perform a national service of first magnitude and indirectly benefit themselves immeasurably, he believes. Only a little progress along these lines would have to be made before unemployment among engineers would disappear, in his estimation.

Dean Cooley points out that it is well understood why engineers, as a whole, have so few collective accomplishments to which they can point. It goes back to the schools, he says, where there is failure to give the engineer a well-rounded education. As a result, he stays within the narrow boundaries of his specialty. With the example of the spirit and point of view of such engineers as Herbert Hoover, Dean Cooley believes there is going to be a general breaking away from the meshes of technicality and that engineers are going to utilize the ability they already possess as economists and business men and become men of affairs.

Priestley Portrait Presented to National Museum

A copy of the Stewart portrait of Joseph Priestley was presented to the National Museum in Washington on Oct. 25 by Dr. Edgar F. Smith on behalf of the American Chemical Society. In making the presentation Dr. Smith told how Priestley, with the help of Washington and Jefferson, did much to stimulate the establishment of chemical industries in this country.

Disposal of British Government Surplus Chemicals

It is reported from London that the Disposal and Liquidation Commission has entered into a contract with Charles Tennant & Co., Glasgow, for the disposal of unsold chemicals and explosives on a commission basis.

More Plants Resuming Operations

Glassware. The American Window Glass Co., Monongahela, Pa., has resumed operations at its local plant after a shut-down for nearly a year. It is said that orders on hand insure continuous production for an indefinite period.

The Thatcher Mfg. Co., Kane, Pa., manufacturer of milk bottles, is increasing the working force at its local plant.

The DuBois Glass Co., Falls Creek, near DuBois, Pa., manufacturer of glass bottles, is making a number of improvements in its plant, including the installation of new equipment, and is said to be planning for a resumption of production at an early date. The works have been closed for many months.

Ceramic. General ware potteries in the eastern Ohio district have increased production to a point of about 75 per cent of normal, the most active schedule attained during the present year. A number of plants are operating at normal.

The National Fireproofing Co. has resumed production at its plant at Keasbey, N. J., for the manufacture of fire-brick, following a shut-down for about eight months past. The plant has been equipped for electric operation and steam power will be abandoned. It is expected that a full working force will be employed at an early date.

The Jackson China Co., Falls Creek, near DuBois, Pa., has resumed operations at its pottery after being closed down since early in the year.

Chemical. The Keeler Chemical Co., Wetmore, Pa., manufacturer of methanol, acetate of lime, etc., is planning for the resumption of production at its plant early in November, after being idle since the first of the year.

Coke. The Mount Pleasant Coke Co., Carpentertown, Pa., has fired 310 coke ovens at its plant, following a shut-down since early in the year.

Steel. The Cumberland Steel Co., Cumberland, Md., has resumed full time production at its local plant, with curtailed working force, following a half-time operating schedule dating from last February.

The Parkersburg Iron & Steel Co., Parkersburg, W. Va., has resumed operations at its local mills after an idleness of a number of months. About 500 men will be employed.

The Alan Wood Iron & Steel Co., Conshohocken, Pa., has resumed operations at its open-hearth department, following a shut-down for a considerable period. Three furnaces at the Ivy Rock plant have been placed in service.

Paper. The Hinde & Dauch Paper Co., Muncie, Ind., has resumed production at its local mill with about sixty operatives, or approximately one-fourth of the regular working force. It is planned to increase the number of employees gradually. The mill has been closed for a number of months.

Miscellaneous. The Viscoloid Co., Leominster, Mass., manufacturer of celluloid products, has adopted a night operating schedule in certain departments of its plant.

The Yaryan Rosin & Turpentine Co., Brunswick, Ga., has resumed full time operations after an extensive curtailment dating from last February.

William M. Burton Chosen as Perkin Medalist

At a meeting of the Perkin Medal Committee of the Society of Chemical Industry, held at the Chemists' Club, Oct. 24, William M. Burton, president of the Standard Oil Co. of Indiana, was awarded the medal for 1921-1922. The formal presentation will be made Jan. 13, 1922.

Mr. Burton's work in the field of pyrolytic distillation of petroleum has brought him international fame. There are now in use in the United States about 2,000 stills in which his patented process is employed, producing in the neighborhood of 1,000,000,000 gal. of gasoline per year, in addition to the gasoline produced normally from crude oil. This amount represents from 20 to 25 per cent of the total gasoline produced in the United States.

Mr. Burton also observed that as a byproduct of the process there was produced an artificial asphalt which was practically identical with Trinidad asphalt from a chemical standpoint and also for practical use. Such asphalt is now widely used for road building, roofing and paving purposes.

The Business Publishers and Editors Meet in Chicago

The National Conference of Business Paper Editors and the Associated Business Papers, Inc., met in annual convention at Chicago on Oct. 24, 25 and 26. The central theme of the convention was the revival of business and what business papers can do to speed it along. The keynote speech for the publishers' convention was given by Mr. James H. McGraw, president of the McGraw-Hill Co., who pointed out that the task of interpreting the world's condition to American business must be assumed by business paper editors and publishers. The outstanding feature of the editors' session was a discussion of the relation between the Department of Commerce and the business papers by F. M. Feiker, assistant to Secretary Hoover. Mr. Hoover had himself hoped to be present to address the conference, but found it impossible to do so. The following telegram was received from him as evidence of his confidence in the business press and the importance of the work of the National Conference of Business Paper Editors:

Pressure of official duties makes it impossible for me to address the members of the National Editorial Conference in Chicago, as I should like to do. I have appreciated the opportunity given me in the monthly meetings we have held together in Washington to express the policies of the Department of Commerce with regard to some of the pressing industrial questions before us. We have indeed great problems yet to solve. I cannot but feel that if these problems are considered as human and not as material questions, we can find their solution. We are dealing with questions of railways, of farms, of shops and of instruments of commerce and industry, but in the background of every person's mind there is the fact that we are dealing not with mechanical things but that we are concerned with the problems of men, women and children. There must be in our discussions of these matters the dominating thought that the better control of economic forces is in fact simply the better comfort of the country. Those several organizations within the Department of Commerce which we have developed and set at work within the past few months are concerned in this spirit, and it is a fine augury of our industrial future to know that the programs and purposes of these various departmental activities have come from our manufacturers, merchants and engineers themselves. The editors of the business press have shown a fine spirit of service. Your opportunity for leadership is unique and unchallenged. Upon you rests in large measure the responsibility of the control of industrial thought and opinion in the detail of the industrial, economic and technical problems which confront us. I wish your conference every success in carrying forward your high and constructive purposes.

The editors presented a résumé of conditions in the following basic industries: Iron and steel, railroads, marine, automotive, textiles, electrical, construction industries, mining, leather and agriculture. In general they indicated a slight improvement in business and an optimistic outlook. All felt that the bottom had been reached and that business is on the upward trend. No more hopeful picture of any industry was painted than of agriculture, which is generally supposed to be in the dumps.

At the election of officers James H. McGraw was chosen president of the Associated Business Papers. The editors elected the following group: C. J. Stark, *Iron Trade Review*, president; H. C. Parmelee, *CHEMICAL & METALLURGICAL ENGINEERING*, vice-president; W. W. Macon, *Iron Age*, secretary and treasurer. The following comprise the executive committee: A. I. Findley, *Iron Age*; V. E. Carroll, *Textile World*; S. O. Dunn, *Railway Age*; Harry Hilman, *Inland Printer*; James H. Stone, *Shoe Retailer*, and C. A. Moffat, *Druggists' Weekly*.

Leather Manufacturers Vote Against Cod Oil Tax

The board of directors, New England Shoe and Leather Association, Boston, Mass., has adopted resolutions protesting against the imposition of a tax on Newfoundland cod oil. It is held that this is essentially a raw material, requires no protection and that any tax will raise unnecessarily the cost of leather and leather products.

Meeting of Chicago Section A.C.S.

Friday, Oct. 21, was the occasion of the second monthly meeting of the Chicago Section of the American Chemical Society. With the increased interest in so many industries in hydrogen-ion concentration it was particularly timely that Dr. Paul E. Klopsteg of the Central Scientific Co. should speak at this meeting on the practical aspects of electrometric methods in chemistry. As a physicist of note, his work in co-operation with Dr. Wendt in the development of apparatus has been of distinct service not only to the research laboratory, but of still more importance to many scientifically controlled industrial operations.

Following the paper by Dr. Klopsteg, Dr. Wendt led a brief discussion on the method of operating the apparatus exhibited. Dr. Hale of Michigan, speaking for the Chemical Foundation, made some rather startling revelations concerning the extent of German competition in the dye manufacturing and consuming industries. Dr. H. E. Howe, who was a visitor, spoke briefly on the aims of the National Research Council.

The group meetings following the main address were enthusiastically carried forward on the following subjects:

Groups 1 and 2 (Laboratory Methods). Subject: The Electrolysis of Lead Tartrate Solutions. Leader: V. H. Gottschalk, of the Western Electric Co.; Subject: Determination of Free Alkali in Soap. Leader: M. L. Sheely, of the Armour Soap Works.

Group 3 (Synthesis). Subject: Synthesis of an Organic Arsenic Compound. Leader: H. C. Cheetham, of Northwestern University.

Group 4 (Biologic). Subject: Animal Biologic Derivatives. Leader: David Klein, of the Wilson Laboratories.

Hearings on River and Harbor Pollution Legislation

Drastic legislation in an effort to prevent pollution of waters in rivers and harbors probably will be recommended to the House of Representatives in the near future. This may be judged from the attitude of members of the House Committee on Rivers and Harbors during the course of the hearing on bills intended to prevent pollution of waters. John I. Tierney, representing the Manufacturing Chemists' Association, appeared before the committee and urged that before a step was taken which would interfere greatly with a large number of manufacturing plants the Secretary of Commerce be requested to conduct a scientific investigation as to the causes of water pollution. He told the committee that the discharges from chemical plants had very little effect on animal and vegetable life. He thought chemical manufacturing plants are being blamed in some cases for damage done by acid waters from coal mines.

While witnesses for the bill were able to show actual and material damage caused by the indiscriminate discharge of petroleum sludge from tank-ships, they were admittedly without specific data as to the damage done by the discharges of waste materials into streams from manufacturing plants. Mr. Tierney called the attention of the committee to the fact that the witnesses had presented no actual data showing that chemical waste had caused damage. He declared that Congress owes it to the industry not to interfere with the operation of its plants until properly qualified engineers should have made a study of the problem.

The committee may attempt to give some protection to manufacturing plants in the bill it will report, but apparently it is bent upon pressing legislation at this time which will affect materially the interests of all industries which discharge waste into streams.

French Imports of German Potash Cause Concern

Prominent men in the French potash industry express much concern over the large importations of potash from Germany. Despite the duty of 30 fr. per ton on chloride of potassium, German salts can be sold cheaper than the French product. The matter has been reported to the government.

Measurement of Color in Industry

At the regular monthly meeting of the Delaware Section of the American Chemical Society, held in Wilmington on Wednesday evening, Oct. 19, Dr. A. H. Pfund of Johns Hopkins University spoke on "Measurement of Color as Applied to Industrial Needs." The speaker's first work along this line was on lithopone paints. Practically all the so-called white paints have an outstanding tint, and by means of multiple reflection he has been able to accentuate this tint and to measure it.

In ordinary colorimetry and photometry the sensibility cannot be greater than that of the unaided human eye, and it has been found that the average physiological sensibility is only about 2 per cent. This, of course, is not accurate enough for quantitative work. The speaker pointed out that any color can be expressed absolutely by the three factors: brightness (or reflection coefficient), saturation and dominant hue. The first two are ratios or percentages, and the third is a definite wave-length. In order to express colors in this manner there must be marked improvement in the sensibility of the colorimeter.

Working along this line, Dr. Pfund has been successful in developing a differential tintometer. So far he has studied more particularly the comparison of two dyed skeins in order to check the dye-tester's judgment. The two samples are mounted at the ends of a track upon which slides a small nitrogen-filled electric bulb. Light from the two samples is reflected through a colorimeter tube to an eye-piece. The light source is moved along the track until the brightness of the two halves of the colorimeter field appears the same. By twisting one sample and thus increasing the reflection from it, the saturation or "strength" of the two samples is equalized. Then the two samples are interchanged. If they really are the same, the field will not be affected, but if they are not the same, there will be a marked difference. This device doubles the sensibility of the human eye.

In order to compare the dominant hues of the two samples, advantage is taken of the fact that the human eye is most sensitive to a certain hue in the purple. Color screens are introduced into the eye-piece so that, regardless of the actual hue of the sample, the light reaching the eye is purple. Here again the sensibility is doubled by interchanging the two samples. The color screens consist of an exceptionally ingenious arrangement of wedges, by which any desired wave-length can be transmitted or absorbed. The great sensibility of this differential tintometer was shown by a demonstration in which skeins that had been judged "O. K." by an expert dye-tester appeared to be markedly different when compared in the instrument.

Confer on Muscle Shoals

Following a conference on Muscle Shoals in Washington Oct. 24 among the Secretary of War, the Secretary of Commerce, Brigadier General Harry Taylor, W. B. Mayo and Colonel J. W. Worthington, Secretary Weeks declared that definite progress is being made and that the spread between the estimates of the Army engineers and the Ford engineers on the cost of the completion of the Wilson dam and the construction of dam No. 3 has been narrowed materially. Secretary Weeks stated that no bargaining was attempted at this conference, as that would be done between Mr. Ford and himself shortly after he has looked over the project personally, but his attitude indicated plainly that he is much more favorably impressed with the proposition in its present form than at any previous time.

Secretary Weeks left Washington Oct. 25 on his Southern trip and his plans included a personal inspection of the Wilson dam and the nitrate plants. Shortly after his return to Washington he expects to "get down to figures" with Mr. Ford.

German Company to Resume Manufacture of Fertilizers

The Badische Anilin und Sodafabrik announces that it will resume the manufacture of nitrogenous fertilizers in about three months.

Personal

Dr. V. L. BOHNSON has been promoted to an assistant professorship in general chemistry at the University of Wisconsin, Madison, Wis.

CHARLES FRÉMONT, who was awarded the Bessemer Gold Medal of the British Iron and Steel Institute, began to contribute to French technical literature in 1890. He is best known abroad through his researches in metallurgy and the strength of metals, especially iron and steel, and the apparatus invented by him for testing steel by shock. Besides the Bessemer Medal, he has also been awarded (in 1920) the great gold medal bearing Prony's effigy, by the French Société d'Encouragement pour l'Industrie Nationale, two great gold medals by the Société des Ingenieurs Civils de France (in 1897 and 1898), and over thirty prizes by the French Academie des Sciences and the Société d'Encouragement. M. Frémont is ingénieur-constructeur, chief of the mechanical laboratory of the French Ecole Nationale Supérieure des Mines, member of the Commission des Méthodes d'Essai des Matériaux de Construction in the French Ministry of Public Works, etc.

FEDERICO GIOLITTI arrived in the United States on Oct. 20.

Dr. WILLIAM J. HALE of the Dow Chemical Co. spoke before the Mining Congress on "Protecting American Industry."

WHITNEY S. HAMNETT, who was for twelve years with the Pittsburgh Testing Laboratory, eight of which were as manager of the Dallas (Tex.) branch and the last two as Eastern manager of the company at New York, has resigned, and has become associated with J. E. Dockendorff & Co., New York, American agent for two manufacturers of aluminum in Switzerland.

Dr. H. B. HART has been appointed research chemist for the Eagle-Picher Lead Co., Joplin, Mo.

W. LEE LEWIS, director of chemistry of Northwestern University, addressed the Chicago Chemists Club on Oct. 25 on "Joaquin Miller, the Poet of the Sierras."

E. P. MATHEWSON has gone to Burma, via Continental Europe. He expects to remain several months in the Far East studying metallurgical practice at the mill and smelter of the Burma Corporation.

W. R. OGLESBY, formerly with E. I. du Pont de Nemours & Co., is now vice-president of the American Food Products Corporation, New York City.

H. C. PARMELEE was a guest at the Chicago Chemists Club last week.

EDGAR F. SMITH addressed the American Mining Congress banquet in Chicago on Oct. 21.

C. E. WATTS, Steelton, Pa., chemist of the coke-oven department at the local plant of the Bethlehem Steel Co., was tendered a farewell dinner on Oct. 13 at Folger's Inn, Dauphin, Pa., by executives and associates at the works, on the occasion of his departure to West Virginia to take up work at the Bethlehem company's mines in that district.

The National Conference of Business Paper Editors, which recently met at Chicago, elected the following officers for the ensuing year: C. J. Stark, *Iron Trade Review*, president; H. C. Parmelee, CHEMICAL & METALLURGICAL ENGINEERING, vice-president; W. W. Macon, *Iron Age*, secretary-treasurer. The following comprise the executive committee: A. I. Findley, *Iron Age*; V. E. Carroll, *Textile World*; S. O. Dunn, *Railway Age*; Harry Hilman, *Inland Printer*; James H. Stone, *Shoe Retailer*, and C. A. Moffat, *Druggists' Weekly*.

The executive committee of the National Safety Council elected the following vice-presidents for the National Safety Council: David S. Beyer, Liberty Mutual Insurance Co., Boston, vice-president for service to members; B. F. Tillson, New Jersey Zinc Co., Franklin, N. J., vice-president for industrial safety; F. A. Davidson, Dwight P. Robinson Co., New York City, vice-president for sectional activities; C. B. Scott, Bureau of Safety, Chicago, vice-president for local

councils; David Van Schaack, Aetna Life Insurance Co., Hartford, Conn., vice-president for public safety; W. E. Worth, Chicago Safety Council, secretary and treasurer. W. H. Cameron, formerly secretary-treasurer of the National Workmen's Compensation Service Bureau, New York City, was elected executive secretary of the National Safety Council. Sidney J. Williams was re-elected chief engineer of the Council. C. W. Price, formerly general manager, will assist the National Safety Council as a special consultant in public safety. The executive committee approved the organization of a Drop Forge Section and a Petroleum Section by the companies in its membership interested in more intensive accident prevention activities in those two groups of industries.

Obituary

JESSE PETERSON, seventy-one years old, a fiber products manufacturer, died in Lockport, N. Y., on Oct. 22 of heart disease. Mr. Peterson was one of the first fiber manufacturers in America and organized the United Industrial Fiber Company in 1889.

CHARLES W. WHITLEY, vice-president of the American Smelting & Refining Co., New York, and in charge of the company's plants in the United States, died on Oct. 9.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, Oct. 31, 1921.

The chemical industry during the past week was quite active and buying orders reached the market in good volume. On some commodities producers had to withdraw and wait for revised prices. Some of the largest alkali plants have gradually reduced their overhead and are reported working at capacity. The Solvay process plant of the Allied Chemical & Dye Corporation reported a rapid rise in demand for its products and this has caused production in all the company's departments to approach normal levels. Other leading plants have increased working capacity and it seems probable that the turn of the year will find the chemical industry on a stronger footing than at any time since the recent depression. Consumers have come into the market with greater interest and frequently desired to increase standing contracts.

The threatened railroad strike has at last been averted. It cannot be truthfully said that this unsettled condition has been the cause of a revival of active trading, but it has helped the market along to some extent, as consumers feared being left with empty shelves and those who had been accustomed to the hand-to-mouth method of buying were eager to buy well in advance. Market prices have reflected the marked increase of buying operations and in some instances the spot market was held at a war-time premium. Forward shipment business has also shown an increased interest.

The export trade is showing signs of improvement. Importations of English and German chemicals have not had a tendency to weaken standing quotations. Imported bleaching powder and prussiate of soda attracted considerable attention. Increased sales and inquiries were noted on sal ammoniac and cyanide of soda and prices were advanced accordingly. A better demand was also recorded on sulphuric and oxalic acids.

CHEMICALS

Dealers were offering spot *acetate of soda* at 4c. per lb., but might shade prices a trifle on firm round lot business. Leading manufacturers were asking up to 4½c. for prime goods and quoted lesser quantities at 4¼c. per lb. The

demand for this product has not been very active and business has passed for small lots only. Sales of spot *bichromate of soda* were reported at 8@8½c. per lb. It is possible that an odd lot might be picked up at 7½c., but the greater portion of dealers were above this figure. Offerings around the trade were not heavy and the tone of the market appeared very firm at the close. *Solid caustic soda* is attracting considerable attention at \$4.10 per 100 lb., and large dealers were not inclined to quote below this figure at any time during the week. Quotations were generally heard at \$4.10@4.15 per 100 lb. for standard brand goods. *Spot caustic potash* has continued quite active all week, with sales reported up to 6c. per lb. for the imported 88-92 per cent. Large dealers are asking 6@6½c. for this product and it is very doubtful if shipment material can be placed below 6c. in any direction. Offerings on spot were not heavy, as most of the imported shipments have been practically sold upon arrival. The firm tendency that has been so prevalent in the *prussiate of soda* market has not let up and sales have been made at 14½@14¾c. per lb., with some sellers asking the outside figure in the late trading. Spot material is very scarce and the tone all around seems to be for higher prices.

Shipments are quoted firm at 14¼@14½c. per lb. Consumers are purchasing light *soda ash* in single bags at \$2.10@2.15 per 100 lb. Sales of barrels are reported at \$2.45@2.50 per 100 lb. Offerings were not heavy and numerous orders were booked for less than carload lots. Prices on *camphor* have been advanced by American refiners and the market closed in a very firm condition with buyers showing an increased interest. At the close prices were heard at 85@90c. per lb. Prices on *carbonate of copper* are quoted higher in some first-hand quarters, where sales are reported at 22c. per lb. In other directions a shade under this price can be done, but the tone of the market is decidedly stronger. *Spot formaldehyde* has been offered in the open market down to 11c. per lb. by second hands. The general range is from 11@12c. per lb. depending upon the quantity and seller. This product has not met with any active interest and first-hand competition has become keener for the small passing business. Prices on *oxalic acid* became somewhat firmer during the latter part of the week after a period of severe competition which brought the market down to 13c. per lb., the lowest figure recorded in the past few years. This price was still named by manufacturers at the close f.o.b. works, but spot material was quoted at 15c. per lb. Buyers were very cautious in buying quantities owing to the unsettled conditions for this product. Manufacturers of domestic *sulphide of soda* are meeting competition with the imported material and offer the 60-62 per cent, fused, at 4¾c. per lb. in carload quantities. The broken variety is quoted at 5c. per lb. in round lots and 5½c. in smaller portions. Crystals continue scarce, with 3½c. per lb. quoted for domestic material.

COAL-TAR PRODUCTS

There has been a substantial improvement noted in the entire list of coal-tar products during the past week and leading producers reported a more active demand than at any time this year. Consumers in many cases are requesting that some of their forward shipments be anticipated. Intermediate producers are more cheerful and feel that after a long depression of the most severe nature business is finally beginning in earnest. There were reports that orders were received from sources that were entirely out of the buying market for the past year. The active movement brought out the fact that spot material in resale hands is extremely low and that most of these products have been lying around for some time and are of an inferior quality. Prices in general have not changed to any marked extent and are not closely adhered to on firm business. The dye-stuff field has witnessed the greatest gain in the coal-tar products industry, as the textile business has recovered much of its lost ground. Business was particularly good in dimethylaniline, para phenylenediamine and phenol. Some resale *benzene* sold at 38@40c. per gal., but consumers found it extremely difficult to obtain any round quantities at this level. Refiners are turning down all offers for immediate business and are quoting only future shipments.

The St. Louis Market

ST. LOUIS, Mo., Oct. 27, 1921.

Trading in the chemical and drug markets for some time past has shown a consistent gain and during the past week a tremendous increase has been noticed, but it is the general opinion that the major part of this increase is only artificial, due to the present railroad situation. However, it is apparent that buyers are anticipating their requirements for a longer period than heretofore but nevertheless proceeding cautiously. The general trend of the market is very firm and weak holders are practically eliminated. The market as a whole is assuming a more normal and firmer position.

The market on *caustic soda* has not changed and is still moving normally at the prevailing price of \$4 per 100 lb., basis 73 to 75 per cent solid, f.o.b. point of production. The *soda ash* market remains slow with price unchanged from last week. *Bicarbonate* and *sal soda* have not changed.

Acetphenetidin is commanding a better position since most of the second-hand lots on the market have been cleared away. *Ammonia water*, 26 deg., is one of the stable articles and moves through regular channels throughout the year. The heavy demand for *ammonium sulphate, pure granular*, which was reported in our last letter continues at the present time. *Bismuth salts* continue to move in an unusually large quantity and are in greater demand. *Bromides* are showing some increase. *Caffeine* is on the road to recovery in spite of the fact that competition is still very keen. *Carbon bisulphide* is moving in a large way. *Ether* is increasing in inquiries and demand. *Glycerine* is in good demand at 14c., in 500-lb. drums. The *copperas* market continues along routine lines with no change in price. *Glycerophosphates* are on a better movement. A regular trade in *hypo* continues. Jobbers should bear in mind that the season for *creosotes* and *guaiacols* is approaching and should be prepared to meet the demand by carrying good stocks. The *iodides* are moving beyond manufacturers' expectations and orders of large volume are being placed. *Phenolphthalein* demand is above normal. *Saccharine* continues to move in a moderate way. *Salicylates* have improved considerably and, this being a seasonable article, buyers should not hesitate to order liberal quantities. Sales of fairly large proportions have been reported on *sodium benzoate*, although the season for this article is virtually over. *Strychnine salts* were reduced by manufacturers, *alkaloid* now being quoted at \$1.45 for crystals and \$1.35 for powdered and the *sulphate*, crystals and powdered, at \$1.15.

Manufacturers of heavy mineral acids report a general increase in activities and are very optimistic regarding the future. *Citric acid* demand is normal. *Acid tartaric* and *cream of tartar* are rather slow. Factors report a good increase in inquiries and demand for *pyrogallie acid*.

Castor oil is in strong demand with a price of 12½c., showing an increase of ½c. over previous report. *Linseed oil* suffered a drop during the preceding days, going as low as 68c., basis raw oil ex-warehouse. The demand is for spot and in small quantities. *Turpentine* remains steady at 79c. in single barrels and 75c. in 5-bbl. lots ex-warehouse.

Lithopone remains firm at 6½c., in less than carlots, and 6c. in carlots, with market getting stronger. Shipments have been good during the last ten days owing to the attempt of users trying to provide against the pending labor trouble. The market on *floatated barytes* has not changed, price \$23 per ton. The demand for this item shows an increase due to the pending railroad strike.

The Iron and Steel Market

PITTSBURGH, Oct. 28, 1921.

The United States Steel Corporation has taken the lead, promptly followed by independents, in reducing prices of standard section rails from \$45 per gross ton for bessemer rails and \$47 for open-hearth to \$40 for either description. About 1,500,000 tons of rails had been contracted for by the steam railroads for 1921 delivery, and about 1,000,000 tons had been taken out, the prospect being that the balance would be carried over to 1922. A reduction was in order for one time or another, as the old prices were those of the Industrial Board schedule of March 21, 1919, and all other steel products are now much below that schedule.

In most finished steel lines a slight tapering off in demand

is noticed in the past week, but a distinct exception is tubular goods, which show improved demand as to both oil country goods and standard pipe. In most trade circles there is a disposition to account for the change, after a period of three months of rather steadily increasing demand, on the ground that buyers are waiting for lower cost steel in connection with prospective freight rate reductions, which would lower the cost of steel and presumably the price, at the same time reducing the freight on the steel, paid by the buyer. The difficulty in accepting this explanation is that buying of steel products has been described right along as being of the hand-to-mouth character, and as rate reductions are unlikely to occur before about Jan. 1, if even on that date, it is difficult to see how there could be much postponement of buying such as would otherwise be in process. Perhaps a more natural explanation would be that steel demand has now recovered from its extreme depression, due to the necessity of liquidating stocks, and is now in normal relation to the character and volume of business the country is transacting, while the usual year-end dullness in the steel market is beginning to show itself.

STEEL PRICES

There have been no really important changes in finished steel prices for several weeks. There has been a sort of backing and filling in various branches of the trade, which in the general average has indicated no decided change toward softness or firmness. Tubular goods prices were formally reduced by the lists of Sept. 16, and these prices are now being shaded somewhat. Wire products were advanced Sept. 12, while the advance is not holding in all cases. Sheets were advanced \$5 a ton in September. The advance is holding in black and galvanized, but not in blue annealed. A second advance, \$5 a ton, has been announced by the majority of independents, but it is not actually effective, and the tone of the market is perhaps not as good as if the advance had not been attempted. Bars in small lots seem to be a shade firmer, but not in large lots. Shapes are reported firmer and plates weaker.

With the steel market in this somewhat unstable condition, with possibilities of demand being somewhat less active in the next few weeks, with freight rate reductions in near-by prospect, and with the showing that at present prices and wage rates and an operation at one-third of capacity, the Steel Corporation in September had earnings of \$15 a ton, against earnings averaging \$10 a ton in 1912 and 1913 with an operation of 88 to 90 per cent, the balance of probability is plainly that steel prices will tend to sag in the next few weeks rather than advance.

MILL OPERATIONS

Production of steel ingots appears to be at a rate nearer 40 per cent than 35 per cent of capacity, against an average of about 32 per cent in September and a dip under 20 per cent at the middle of July. Operation at rail, plate, shape and bar mills are under a 35 per cent rate on the whole, while the lighter products show a better operation, tin mills going at about 50 per cent, sheet mills at 65 to 85 per cent and pipe mills at 50 to 80 per cent.

PIG IRON AND COKE

Extreme dullness continues in the pig-iron markets and prices are not overly firm. It is improbable that prices can avoid yielding when coal, coke and limestone freight rates are reduced. The recent reduction in iron ore freight rates has not been reflected, as the furnaces had large piles of ore already and were anxious to liquidate, irrespective of the precise time of the freight rate reduction, which would affect fresh supplies. The market remains quotable, although now largely nominal, at \$20 for bessemer, \$19.25 to \$20 for basic and \$21 for foundry, f.o.b. valley furnaces.

Connellsville coke shows a slightly easier tone, prices remaining at approximately the cost of production. The balance is slightly against the coke operators, as they have been showing slightly more avidity in resuming operations than have the blast furnaces. The market is quotable as follows: Spot furnace, \$3.25 to \$3.50; contract furnace, \$3.40 to \$3.50; spot foundry, \$4.25 to \$4.75, per net ton at ovens.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots	Less Carlots
Acetic anhydride.....lb.	—	\$0.40 — \$0.45
Acetone.....lb.	\$0.12½ — \$0.12½	.13 — .13½
Acid, acetic, 28 per cent.....100 lbs.	2.75 — 3.00	3.25 — 3.50
Acetic, 56 per cent.....100 lbs.	6.00 — 6.25	6.50 — 7.00
Acetic, glacial, 99½ per cent, carboys, 100 lbs.	10.75 — 11.00	11.25 — 11.50
Boric, crystals.....lb.	.12½ — .13	.13½ — .14
Boric, powder.....lb.	.13 — .13½	.14 — .14½
Citric.....lb.	—	.45 — .47
Hydrochloric.....100 lb.	1.25 — 1.50	1.60 — 1.75
Hydrofluoric, 52 per cent.....lb.	.12 — .12½	.12½ — .13
Lactic, 44 per cent tech.....lb.	.09½ — .10	.10 — .12
Lactic, 22 per cent tech.....lb.	.04½ — .05½	.06 — .07
Molybdic, C.P.....lb.	3.25 — 3.50	3.60 — 4.00
Muriatic, 20 deg. (see hydrochloric).....lb.	—	—
Nitric, 40 deg.....lb.	.06½ — .07	.07 — .07½
Nitric, 42 deg.....lb.	.06½ — .07	.07½ — .07½
Oxalic, crys. tals.....lb.	.14 — .14½	.15 — .16
Phosphoric, 50 per cent solution.....lb.	.13 — .13½	.14 — .18
Picric.....lb.	.20 — .25	.27 — .35
Pyrogallol, resublimed.....lb.	—	1.75 — 1.90
Sulphuric, 60 deg., tank cars.....ton	—	11.00 — 12.00
Sulphuric, 60 deg., drums.....ton	—	13.00 — 15.00
Sulphuric, 66 deg., tank cars.....ton	17.00 — 18.00	—
Sulphuric, 66 deg., drums.....ton	21.00 — 22.00	22.50 — 23.00
Sulphuric, 66 deg., carboys.....ton	—	—
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	21.00 — 22.00	—
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	23.00 — 23.50	24.00 — 24.50
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	31.00 — 32.00	33.00 — 34.00
Tannic, U. S. P.....lb.	—	.75 — .85
Tannic (tech.).....lb.	.45 — .48	.50 — .55
Tartaric, imported crystals.....lb.	—	.26 — .27
Tartaric acid, imported, powdered.....lb.	—	.27½ — .28½
Tartaric acid, domestic.....lb.	—	—
Tungstic, per lb. of W.O.....lb.	—	1.10 — 1.20
Alcohol, Ethyl.....gal.	—	4.70 — 5.00
Alcohol, Methyl (see methanol).....gal.	—	—
Alcohol, denatured, 188 proof.....gal.	—	.37 — .38
Alcohol, denatured, 190 proof.....gal.	—	.35 — .36
Alum, ammonia, lump.....lb.	.03½ — .03½	.04 — .04½
Alum, potash, lump.....lb.	.03½ — .04	.04½ — .04½
Alum, chrome lump.....lb.	.10 — .11	.11 — .12½
Aluminum sulphate, commercial.....lb.	.01 — .02	.02½ — .02½
Aluminum sulphate, iron free.....lb.	.02½ — .02½	.03 — .03½
Aqua ammonia, 26 deg., drums (750 lb.).....lb.	.07½ — .07½	.08 — .08½
Ammonia, anhydrous, cyl. (100-150 lb.).....lb.	.30 — .32	.33 — .35
Ammonium carbonate, powder.....lb.	.07 — .07½	.08 — .09
Ammonium chloride, granular (white salammuniac).....lb.	.07 — .07½	.07½ — .07½
Ammonium chloride, granular (gray salammuniac).....lb.	.07 — .07½	.07½ — .07½
Ammonium nitrate.....lb.	.07½ — .07½	.07½ — .08½
Amylacetate tech.....gal.	—	2.40 — 2.70
Arsenic oxide, (white arsenic) powdered lb.	.05½ — .06	.06½ — .06½
Arsenic, sulphide, powdered (red arsenic) lb.	.11 — .11½	.12 — .13
Barium chloride.....ton	46.00 — 47.00	48.00 — 50.00
Barium dioxide (peroxide).....ton	.20 — .21	.22 — .23
Barium nitrate.....lb.	.07½ — .08	.08½ — .09
Barium sulphate (precip.) (blanc fixe) lb.	.04 — .04½	.04½ — .05
Bleaching powder (see calc. hypochlorite).....lb.	—	—
Blue vitriol (see copper sulphate).....lb.	—	—
Borax (see sodium borate).....lb.	—	—
Brimstone (see sulphur, roll).....lb.	—	—
Bromine.....lb.	.27 — .28	.28½ — .30
Calcium acetate.....100 lbs.	2.00 — 2.05	—
Calcium carbide.....lb.	.04½ — .04½	.05 — .05½
Calcium chloride, fused, lump.....ton	23.50 — 24.00	24.50 — 25.50
Calcium chloride, granulated.....lb.	.01½ — .02	.02½ — .02½
Calcium hypochloride (bleach'g powder) 100 lb.	2.35 — 2.40	2.50 — 3.25
Calcium peroxide.....lb.	—	1.40 — 1.50
Calcium phosphate, tribasic.....lb.	—	.15 — .16
Camphor.....lb.	—	.85 — .90
Carbon bisulphide.....lb.	.06½ — .06½	.07 — .07½
Carbon tetrachloride, drums.....lb.	.10½ — .10½	.11 — .12
Carbonyl chloride, (phosgene).....lb.	—	.60 — .75
Caustic potash (see potassium hydroxide).....lb.	—	—
Caustic soda (see sodium hydroxide).....lb.	—	—
Chlorine, gas, liquid-cylinders (100 lb.) lb.	.08 — .09	.09½ — .10
Chloroform.....lb.	—	.40 — .43
Cobalt oxide.....lb.	—	2.00 — 2.10
Copperas (see iron sulphate).....lb.	—	—
Copper carbonate, green precipitate.....lb.	.21 — .22	.22½ — .23
Copper cyanide.....lb.	—	.50 — .62
Copper sulphate, crystals.....lb.	.05 — .05½	.05½ — .06
Cream of tartar (see potassium bitartrate).....lb.	—	—
Epsom salt (see magnesium sulphate).....lb.	—	—
Ethyl Acetate Com. 85%.....gal.	—	1.00 — 1.10
Ethyl Acetate pure (acetic ether, 98% to 100%).....gal.	—	.95 — .95
Formaldehyde 40 per cent.....lb.	.11 — .11½	.11½ — .12½
Fusel oil, ref.....gal.	—	2.65 — 3.00
Fusel oil, crude.....gal.	—	1.50 — 1.75
Glauber's salt (see sodium sulphate).....lb.	—	—
Glycerine, C. P. drums extra.....lb.	—	.14 — .15
Iodine, resublimed.....lb.	—	3.50 — 3.60
Iron oxide, red.....lb.	—	.10 — .20
Iron sulphate (copperas).....ton	18.00 — 19.00	20.00 — 23.00
Lead acetate.....lb.	—	.10½ — .12½
Lead arsenate, paste.....lb.	.09 — .09½	.10 — .11
Lead nitrate.....lb.	—	.15 — .20
Litharge.....lb.	.07½ — .08	.08½ — .09
Lithium carbonate.....lb.	—	1.40 — 1.50
Magnesium carbonate, technical.....lb.	.08 — .08½	.09 — .10
Magnesium sulphate, U. S. P.....100 lb.	2.50 — 2.75	—
Magnesium sulphate, technical.....100 lb.	—	1.10 — 1.75
Methanol, 95%.....gal.	—	.66 — .68
Methanol, 97%.....gal.	—	.70 — .72
Nickel Salt, double.....lb.	—	.12 — .12½
Nickel salt, single.....lb.	—	.14 — .14½
Phosgene (see carbonyl chloride).....lb.	—	—
Phosphorus, red.....lb.	.40 — .41	.42 — .45
Phosphorus, yellow.....lb.	—	.30 — .35
Potassium bichromate.....lb.	.10½ — .11	.11½ — .11½

	Carlots	Less Carlots
Potassium bitartrate (cream of tartar)..... lb.	\$.25 — .28	\$0.25 — \$0.28
Potassium bromide, granular..... lb.	.14 — .20	.14 — .20
Potassium carbonate, U. S. P..... lb.	.20 — .21	.22 — .25
P. tassium carbonate, 80-85%..... lb.	.04 — .04	.05 — .06
P. tassium chlorate, crystals..... lb.	.08 — .08	.08 — .12
Potassium cyanide..... lb.	.26 — .28	.26 — .28
Potassium hydroxide (caustic potash)..... lb.	.06 — .06	.06 — .08
Potassium iodide..... lb.	.20 — .25	.20 — .25
Potassium nitrate..... lb.	.07 — .07	.08 — .09
Potassium permanganate..... lb.	.18 — .19	.20 — .22
Potassium prussiate, red..... lb.	.28 — .29	.29 — .30
Potassium prussiate, yellow..... lb.	.20 — .20	.21 — .22
Rochelle salts (see sodium potas tartrate).....		
Salammoniac (see ammonium chloride).....		
Salt soda (see sodium carbonate).....		
Salt cake (bulk)..... ton	20.00 — 22.00	20.00 — 22.00
Silver cyanide..... oz.	1.35 — 1.38	1.35 — 1.38
Silver nitrate..... oz.	.45 — .47	.45 — .47
Soda ash, light..... 100 lb.	2.10 — 2.15	2.20 — 2.60
Soda ash, dense..... 100 lb.	2.35 — 2.40	2.45 — 2.70
Sodium acetate..... lb.	.04 — .04	.04 — .05
Sodium bicarbonate..... 100 lb.	2.00 — 2.25	2.50 — 2.75
Sodium bichromate..... lb.	.08 — .08	.08 — .08
Sodium bisulphate (nitre cake)..... ton	5.00 — 5.25	5.50 — 6.50
Sodium bisulphite powdered, U.S.P..... lb.	.04 — .05	.05 — .06
Sodium borate (borax)..... lb.	.05 — .06	.06 — .07
Sodium carbonate (sod. soda)..... 100 lb.	1.75 — 1.90	2.00 — 2.25
Sodium chloride..... lb.	.07 — .07	.08 — .08
Sodium cyanide..... lb.	.27 — .28	.28 — .30
Sodium fluoride..... lb.	.11 — .12	.12 — .14
Sodium hydroxide (caustic soda)..... 100 lb.	4.10 — 4.15	4.20 — 4.75
Sodium hyposulphite..... lb.	.03 — .03	.03 — .03
Sodium nitrite..... lb.	.06 — .07	.07 — .07
Sodium peroxide, powdered..... lb.	.25 — .26	.27 — .30
Sodium phosphate, dibasic..... lb.	.04 — .04	.04 — .05
Sodium potassium tartrate (Rochelle salts)..... lb.	.21 — .24	.21 — .24
Sodium prussiate, yellow..... lb.	.14 — .14	.15 — .15
Sodium silicate, solution (40 deg.)..... 100 lb.	1.00 — 1.15	1.25 — 1.40
Sodium silicate, solution (60 deg.)..... lb.	.02 — .02	.03 — .03
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	1.50 — 1.75	2.00 — 2.25
Sodium sulphide, fused, 60-62 per cent (cone.) lb.	.04 — .05	.05 — .05
Sodium sulphite, crystals..... lb.	.03 — .03	.04 — .04
Strontium nitrate, powdered..... lb.	.12 — .13	.13 — .20
Sulphur chloride, red..... lb.	.05 — .05	.05 — .06
Sulphur, crude..... ton	18.00 — 20.00	18.00 — 20.00
Sulphur dioxide, liquid, cylinders extra..... lb.	.08 — .08	.09 — .10
Sulphur (sublimed), flour..... 100 lb.	2.25 — 3.10	2.25 — 3.10
Sulphur, roll (brimstone)..... 100 lb.	2.00 — 2.75	2.00 — 2.75
Tin bichloride, 50 per cent..... lb.	.18 — .19	.19 — .20
Tin oxide..... lb.	.37 — .38	.37 — .38
Zinc carbonate, precipitate..... lb.	.16 — .16	.17 — .17
Zinc chloride, gran..... lb.	.09 — .09	.10 — .11
Zinc cyanide..... lb.	.42 — .44	.45 — .47
Zinc dust..... lb.	.11 — .11	.11 — .12
Zinc oxide, XX..... lb.	.07 — .07	.08 — .09
Zinc sulphate..... 100 lb.	3.00 — 3.25	3.30 — 3.50

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude..... lb.	\$1.15 — \$1.20	\$1.15 — \$1.20
Alpha-naphthol, refined..... lb.	1.25 — 1.30	1.25 — 1.30
Alpha-naphthylamine..... lb.	.27 — .30	.27 — .30
Aniline oil, drums extra..... lb.	.17 — .20	.17 — .20
Aniline salts..... lb.	.24 — .26	.24 — .26
Anthracene, 80% in drums (100 lb.)..... lb.	.75 — 1.00	.75 — 1.00
Benzaldehyde U.S.P..... lb.	1.35 — 1.45	1.35 — 1.45
Benzidine, base..... lb.	.90 — 1.00	.90 — 1.00
Benzidine sulphate..... lb.	.75 — .85	.75 — .85
Benzoic acid, U.S.P..... lb.	.60 — .65	.60 — .65
Benzoate of soda, U.S.P..... lb.	.52 — .55	.52 — .55
Benzene, pure, water-white, in drums (100 gal.)..... gal.	.27 — .32	.27 — .32
Benzene, 90%, in drums (100 gal.)..... gal.	.25 — .28	.25 — .28
Benzyl chloride, 95-97%, refined..... lb.	.25 — .27	.25 — .27
Benzyl chloride, tech..... lb.	.20 — .23	.20 — .23
Beta-naphthol benzoate..... lb.	3.50 — 4.00	3.50 — 4.00
Beta-naphthol, sublimed..... lb.	.70 — .75	.70 — .75
Beta-naphthol, tech..... lb.	.31 — .34	.31 — .34
Beta-naphthylamine, sublimed..... lb.	1.75 — 1.85	1.75 — 1.85
Cresol, U. S. P., in drums (100 lb.)..... lb.	.16 — .17	.16 — .17
Ortho-cresol, in drums (100 lb.)..... lb.	.25 — .27	.25 — .27
Cresylic acid, 97-99%, straw color, in drums..... gal.	.70 — .80	.70 — .80
Cresylic acid, 95-97%, dark, in drums..... gal.	.65 — .70	.65 — .70
Cresylic acid, 50%, first quality, drums..... gal.	.45 — .50	.45 — .50
Dichlorobenzene..... lb.	.06 — .09	.06 — .09
Diethylaniline..... lb.	1.10 — 1.20	1.10 — 1.20
Dimethylaniline..... lb.	.60 — .65	.60 — .65
Dinitrobenzene..... lb.	.23 — .27	.23 — .27
Dinitrochlorobenzene..... lb.	.20 — .25	.20 — .25
Dinitronaphthalene..... lb.	.30 — .35	.30 — .35
Dinitrophenol..... lb.	.35 — .40	.35 — .40
Dinitrotoluene..... lb.	.25 — .30	.25 — .30
Dip oil, 25%, car lots, in drums..... gal.	.30 — .35	.30 — .35
Diphenylamine..... lb.	.60 — .70	.60 — .70
H-acid..... lb.	1.05 — 1.15	1.05 — 1.15
Meta-phenylenediamine..... lb.	1.15 — 1.20	1.15 — 1.20
Monoethylaniline..... lb.	.12 — .14	.12 — .14
Monoethylaniline..... lb.	1.65 — 1.70	1.65 — 1.70
Naphthalene crushed, in bbls..... lb.	.06 — .08	.06 — .08
Naphthalene, flake..... lb.	.06 — .08	.06 — .08
Naphthalene, balls..... lb.	.08 — .09	.08 — .09
Naphthionic acid, crude..... lb.	.70 — .75	.70 — .75
Nitrobenzene..... lb.	.12 — .15	.12 — .15
Nitro-naphthalene..... lb.	.30 — .35	.30 — .35
Nitro-toluene..... lb.	.15 — .17	.15 — .17
Ortho-amidophenol..... lb.	3.00 — 3.10	3.00 — 3.10
Ortho-dichlor-benzene..... lb.	.15 — .20	.15 — .20
Ortho-nitro-phenol..... lb.	.75 — .80	.75 — .80
Ortho-nitro-toluene..... lb.	.15 — .20	.15 — .20
Ortho-toluidine..... lb.	.20 — .25	.20 — .25
Para-amidophenol, base..... lb.	1.40 — 1.45	1.40 — 1.45
Para-amidophenol, HCl..... lb.	1.70 — 1.80	1.70 — 1.80
Para-dichlorobenzene..... lb.	.12 — .15	.12 — .15
Paranitroaniline..... lb.	.77 — .80	.77 — .80
Para-nitrotoluene..... lb.	.80 — .85	.80 — .85
Para-phenylenediamine..... lb.	1.70 — 1.75	1.70 — 1.75
Para-toluidine..... lb.	1.25 — 1.40	1.25 — 1.40
Phthalic anhydride..... lb.	.40 — .50	.40 — .50

Phenol, U. S. P., drums..... lb.	.09 — .12	.09 — .12
Pyridine..... gal.	2.00 — 3.50	2.00 — 3.50
Resorcinol, technical..... lb.	1.50 — 1.60	1.50 — 1.60
Resorcinol, pure..... lb.	2.00 — 2.25	2.00 — 2.25
Salicylic acid, tech., in bbls..... lb.	.18 — .20	.18 — .20
Salicylic acid, U. S. P..... lb.	.19 — .22	.19 — .22
Salol..... lb.	.60 — .70	.60 — .70
Solvent naphtha, water-white, in drums, 100 gal..... gal.	.25 — .28	.25 — .28
Solvent naphtha, crude, heavy, in drums, 100 gal..... gal.	.14 — .16	.14 — .16
Sulphanilic acid, crude..... lb.	.27 — .30	.27 — .30
Tolidine..... lb.	1.30 — 1.35	1.30 — 1.35
Toluidine, mixed..... lb.	.43 — .45	.43 — .45
Toluene, in tank cars..... gal.	.25 — .28	.25 — .28
Toluene, in drums..... gal.	.28 — .31	.28 — .31
Xylidines, drums, 100 gal..... lb.	.40 — .45	.40 — .45
Xylene, pure, in drums..... gal.	.40 — .45	.40 — .45
Xylene, pure, in tank cars..... gal.	.45 — .45	.45 — .45
Xylene, commercial, in drums, 100 gal..... gal.	.33 — .35	.33 — .35
Xylene, commercial, in tank cars..... gal.	.30 — .30	.30 — .30

Waxes

Prices based on original packages in large quantities.

Bayberry Wax..... lb.	\$0.19 — \$0.20	\$0.19 — \$0.20
Beeswax, refined, dark..... lb.	.24 — .25	.24 — .25
Beeswax, refined, light..... lb.	.28 — .30	.28 — .30
Beeswax, white pure..... lb.	.36 — .40	.36 — .40
Candelilla wax..... lb.	.24 — .25	.24 — .25
Carnauba, No. 1..... lb.	.46 — .47	.46 — .47
Carnauba, No. 2, North Country..... lb.	.24 — .24	.24 — .24
Carnauba, No. 3, North Country..... lb.	.14 — .15	.14 — .15
Japan..... lb.	.21 — .22	.21 — .22
Montan, crude..... lb.	.04 — .05	.04 — .05
Paraffine waxes, crude match wax (white) 105-110 m.p..... lb.	.03 — .03	.03 — .03
Paraffine waxes, crude, scale 124-126 m.p..... lb.	.02 — .02	.02 — .02
Paraffine waxes, refined, 118-120 m.p..... lb.	.03 — .03	.03 — .03
Paraffine waxes, refined, 125 m.p..... lb.	.03 — .03	.03 — .03
Paraffine waxes, refined, 128-130 m.p..... lb.	.03 — .03	.03 — .03
Paraffine waxes, refined, 133-135 m.p..... lb.	.04 — .04	.04 — .04
Paraffine waxes, refined, 135-137 m.p..... lb.	.05 — .05	.05 — .05
Stearic acid, single pressed..... lb.	.09 — .09	.09 — .09
Stearic acid, double pressed..... lb.	.10 — .10	.10 — .10
Stearic acid, triple pressed..... lb.	.11 — .11	.11 — .11

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl..... 280 lb.	\$5.45 — 5.50	\$5.45 — 5.50
Rosin E-I..... 280 lb.	5.55 — 5.75	5.55 — 5.75
Rosin K-N..... 280 lb.	6.10 — 6.75	6.10 — 6.75
Rosin W. G.-W. W..... 280 lb.	7.00 — 7.25	7.00 — 7.25
Wood rosin, bbl..... 280 lb.	6.25 — 6.25	6.25 — 6.25
Spirits of turpentine..... gal.	.82 — .82	.82 — .82
Wood turpentine, steam dist..... gal.	.80 — .80	.80 — .80
Wood turpentine, dest. dist..... gal.	.78 — .78	.78 — .78
Pine tar pitch, bbl..... 200 lb.	6.50 — 6.50	6.50 — 6.50
Tar, kiln burned, bbl. (500 lb.)..... bbl.	10.00 — 10.00	10.00 — 10.00
Retort tar, bbl..... 500 lb.	10.00 — 10.00	10.00 — 10.00
Rosin oil, first run..... gal.	.35 — .35	.35 — .35
Rosin oil, second run..... gal.	.37 — .37	.37 — .37
Rosin oil, third run..... gal.	.44 — .44	.44 — .44
Pine oil, steam dist., sp.gr., 0.930-0.940..... gal.	1.90 — 1.90	1.90 — 1.90
Pine oil, pure, dest. dist..... gal.	1.50 — 1.50	1.50 — 1.50
Pine tar oil, ref., sp.gr. 1.025-1.035..... gal.	.46 — .46	.46 — .46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla..... gal.	.35 — .35	.35 — .35
Pine tar oil, double ref., sp.gr. 0.965-0.990..... gal.	.75 — .75	.75 — .75
Pine tar, ref., thin, sp.gr., 1.080-1.060..... gal.	.35 — .35	.35 — .35
Turpentine, crude, sp. gr., 0.900-0.970..... gal.	1.25 — 1.25	1.25 — 1.25
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990..... gal.	.35 — .35	.35 — .35
Pinewood creosote, ref..... gal.	.52 — .52	.52 — .52

Solvents

73-76 deg., steel bbls. (85 lb.)..... gal.	\$0.37 — .37	\$0.37 — .37
70-72 deg., steel bbls. (85 lb.)..... gal.	.35 — .35	.35 — .35
68-70 deg., steel bbls. (85 lb.)..... gal.	.34 — .34	.34 — .34
V. M. and P. naphtha, steel bbls (85 lb.)..... gal.	.23 — .23	.23 — .23

Fertilizers

Ammonium sulphate, bulk and d. bags..... 100 lb.	\$2.70 — 3.00	\$2.70 — 3.00
Blood, dried, f.o.b., N. Y..... unit	4.00 — 4.00	4.00 — 4.00
Bone, 3 and 50, ground, raw..... ton	30.00 — 32.00	30.00 — 32.00
Cyanamide, f.o.b. works..... unit	4.50 — 4.50	4.50 — 4.50
Fish scrap, dom., dried, f.o.b. works..... unit	2.90 — 3.00	2.90 — 3.00
Nitrate soda..... 100 lb.	2.35 — 2.45	2.35 — 2.45
Tankage, high grade, f.o.b. Chicago..... unit	3.00 — 3.10	3.00 — 3.10
Phosphate rock, f.o.b. mines, Florida pebble, 68-72 p.c..... ton	4.50 — 6.50	4.50 — 6.50
Tennessee, 78-80 p.c..... ton	8.00 — 9.00	8.00 — 9.00
Potassium muriate, 80 p.c..... ton	37.50 — 40.00	37.50 — 40.00
Potassium sulphate..... unit	1.15 — 1.20	1.15 — 1.20

Crude Rubber

Para-Upriver fine..... lb.	\$0.21 — .21	\$0.21 — .21
Upriver coarse..... lb.	.11 — .12	.11 — .12
Upriver caucho ball..... lb.	.11 — .12	.11 — .12
Plantation—First latex crepe..... lb.	.15 — .15	.15 — .15
Ribbed smoked sheets..... lb.	.15 — .15	.15 — .15
Brown crepe, thin, clean..... lb.	.15 — .15	.15 — .15
Amber crepe No. 1..... lb.	.17 — .17	.17 — .17

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls..... lb.	\$0.10 — \$0.10	\$0.10 — \$0.10
Castor oil, AA, in bbls..... lb.	.11 — .12	.11 — .12
China wood oil, in bbls. (f.o.b. Pac. coast)..... lb.	.13 — .13	.13 — .13
Cocanut oil, Ceylon grade, in bbls..... lb.	.09 — .09	.09 — .09
Cocanut oil, Cochin grade, in bbls..... lb.	.10 — .10	.10 — .10
Corn oil, crude, in bbls..... lb.	.10 — .10	.10 — .10
Cottonseed oil, crude (f. o. b. mill)..... lb.	.07 — .07	.07 — .07
Cottonseed oil, summer yellow..... lb.	.09 — .09	.09 — .09
Cottonseed oil, winter yellow..... lb.	.09 — .10	.09 — .10

Linseed oil, raw, ear lots (domestic).....	gal.	67	—	68
Linseed oil, raw, tank cars (domestic).....	gal.	62	—	63
Linseed oil, in 5-bbl lots (domestic).....	gal.	70	—	71
Olive oil, Denatured.....	gal.	\$1.15	—	\$1.20
Palm, Lagos.....	lb.	.07	—	.07½
Palm, Niger.....	lb.	.06½	—	.06¾
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.08	—	.08½
Peanut oil, refined, in bbls.....	lb.	.11½	—	.11¾
Rapeseed oil, refined in bbls.....	gal.	.85	—	.87
Rapeseed oil, blown, in bbls.....	gal.	.92	—	.94
Soya bean oil (Manchurian), in bbls, N. Y.....	lb.	.09	—	.....
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.07½	—	.....

FISH

Light pressed menhaden.....	gal.	\$0.40	—	.....
Yellow bleached menhaden.....	gal.	.42	—	.....
White bleached menhaden.....	gal.	.44	—	.....
Blown menhaden.....	gal.	.48	—	.....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$24.00	—	30.00
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	20.00	—	24.00
Barytes, crude, 88% @ 94% ba., Kings Creek.....	net ton	10.00	—	12.00
Barytes, floated, f.o.b. St. Louis.....	net ton	23.00	—	24.00
Barytes, crude, first grade, Missouri.....	net ton	7.00	—	.....
Blanc fixe, dry.....	lb.	.04	—	.04½
Blanc fixe, pulp.....	net ton	45.00	—	55.00
Casein.....	lb.	.07	—	.10
Chalk, Precipitated, domestic, extra light.....	lb.	.04½	—	.05
Chalk, Precipitated, domestic, light.....	lb.	.04	—	.04½
Chalk, Precipitated, domestic, heavy.....	lb.	.03½	—	.04
Chalk, Precipitated, English, extra light.....	lb.	.04½	—	.05
Chalk, Precipitated, English, light.....	lb.	.04½	—	.05
Chalk, Precipitated, English, dense.....	lb.	.04	—	.04½
China clay (kaolin) crude, f.o.b. mines, Georgia.....	net ton	6.50	—	8.50
China clay (kaolin) washed, f.o.b. Georgia.....	net ton	9.00	—	10.00
China clay (kaolin) powdered, f.o.b. Georgia.....	net ton	13.00	—	20.00
China clay (kaolin) crude f.o.b. Virginia points.....	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points.....	net ton	13.00	—	20.00
China clay (kaolin), imported, lump.....	net ton	12.00	—	20.00
China clay (kaolin), imported, powdered.....	net ton	25.00	—	30.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	net ton	5.00	—	7.50
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27.00	—	30.00
Fullers earth, f.o.b. Mines.....	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Pa.....	net ton	15.00	—	18.00
Fullers earth, powdered, f.o.b. Fla.....	net ton	18.00	—	.....
Fullers earth, imported, powdered.....	net ton	24.00	—	27.00
Graphite, Ceylon lump, first quality.....	lb.	.06	—	.07
Graphite, Ceylon chip.....	lb.	.04½	—	.05
Graphite, high grade amorphous crude.....	lb.	.00¾	—	.02½
Kieselguhr, f.o.b. mines, Cal.....	per ton	40.00	—	.....
Kieselguhr, f.o.b. N.Y.....	per ton	61.00	—	.....
Magnesite, calcined.....	per ton	66.00	—	70.00
Pumice stone, imported.....	lb.	.03	—	.40
Pumice stone, domestic, lump.....	lb.	.05	—	.05½
Pumice stone, domestic, ground.....	lb.	.06	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore.....	net ton	.....	—	10.00
Quartz (acid tower) 1½ @ 2 in., f.o.b. Baltimore.....	net ton	.....	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	.....	—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange fine.....	lb.	.68	—	.70
Shellac, orange superfine.....	lb.	.80	—	.82
Shellac, A. C. garnet.....	lb.	.58	—	.60
Shellac, T. N.....	lb.	.68	—	.70
Soapstone.....	ton	12.00	—	15.00
Sodium chloride.....	long ton	12.50	—	13.00
Talc, paper-making grades, f.o.b. Vermont.....	ton	11.00	—	18.00
Talc, roofing grades, f.o.b. Vermont.....	ton	8.50	—	13.00
Talc, rubber grades, f.o.b. Vermont.....	ton	11.00	—	18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	7.50	—	11.00
Talc, imported.....	ton	30.00	—	40.00
Talc, California talcum powder grade.....	ton	18.00	—	25.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	per ton	\$50.00	—	.....
Carborundum refractory brick, 9-in. { less than carlot	1,000	1250.00	—	.....
Chrome brick, f.o.b. Eastern shipping points.....	net ton	52- 55	—	.....
Chrome cement, 40-45% Cr ₂ O ₃	net ton	30- 32	—	.....
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in car lots, f.o.b. Eastern shipping points.....	net ton	33- 35	—	.....
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	35- 40	—	.....
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	30- 35	—	.....
Magnesite brick, 9-in. straight.....	net ton	65- 70	—	.....
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	77	—	.....
Magnesite brick, soaps and splits.....	net ton	98	—	.....
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	40- 42	—	.....
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	42- 45	—	.....
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	35- 38	—	.....

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00	—	\$225.00
Ferrocchrome per lb. of Cr. contained, 6-8% carbon, carlots.....	lb.	.11	—	.....
Ferrocchrome per lb. of Cr. contained, 4-6% carbon, carlots.....	lb.	.11	—	.12
Ferromanganese, 76-80% Mn, domestic.....	gross ton	60.00	—	63.00
Ferromanganese, 76-80% Mn, English & German.....	gross ton	59.00	—	60.00
Spiegelisen, 18-22% Mn.....	gross ton	25.00	—	27.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.25	—	.....
Ferrosilicon, 10-15%.....	gross ton	38.00	—	40.00
Ferrosilicon, 50%.....	gross ton	60.00	—	65.00
Ferrosilicon, 75%.....	gross ton	130.00	—	135.00
Ferrotungsten, 70-80%, per lb. of contained W.....	lb.	.40	—	.45
Ferrouanium, 35-50% of U, per lb. of U content.....	lb.	6.00	—	.....
Ferrovandium, 30-40% per lb. of contained V.....	lb.	4.25	—	4.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content.....	net ton	\$8.00	—	\$10.00
Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃	ton	24.00	—	26.00
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard.....	ton	24.00	—	26.00
Coke, foundry, f.o.b. ovens.....	net ton	4.25	—	4.50
Coke, furnace, f.o.b. ovens.....	net ton	3.25	—	3.50
Coke, petroleum, refinery, Atlantic seaboard.....	net ton	12.00	—	13.00
Fluorspar, gravel, f.o.b. mines, New Mexico.....	net ton	15.00	—	.....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	20.00	—	22.00
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01½	—	.01¾
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	.20	—	.21
Manganese ore, chemical (MnO ₂).....	net ton	50.00	—	55.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.55	—	.60
Monazite, per unit of ThO ₂ , c.i.f. Atlantic seaport.....	unit	30.00	—	.....
Pyrites, Spanish, fines, c.i.f. Atlantic seaport.....	unit	.12	—	.12
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.13	—	.13
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.11	—	.12
Rutile, 95% TiO ₂ per lb. ore.....	lb.	.15	—	.....
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	2.75	—	3.00
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	3.00	—	3.25
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	1.25	—	1.75
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.25	—	2.50
Vanadium pentoxide, 99%.....	lb.	12.00	—	14.00
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1.00	—	.....
Zircon, washed, iron free, f.o.b. Pablo, Florida.....	lb.	.04½	—	.15

Non-Ferrous Metals

New York Markets

	Cents per Lb
Copper, electrolytic.....	13.00
Aluminum, 98 to 99 per cent.....	24.50 @ 25.00
Antimony, wholesale lots, Chinese and Japanese.....	5.00 @ 5.25
Nickel, ordinary (ingot).....	41.00
Nickel, electrolytic.....	44.00
Monel metal, shot and blocks.....	35.00
Monel metal ingots.....	38.00
Monel metal, sheet bars.....	40.00
Tin, 5-ton lots, 8 raits.....	28.00
Lead, New York, spot.....	4.70 @ 4.75
Lead, E. St. Louis, spot.....	4.45 @ 4.50
Zinc, spot, New York.....	5.05 @ 5.10
Zinc, spot, E. St. Louis.....	4.675

OTHER METALS

Silver (commercial).....	oz.	\$0.71½
Cadmium.....	lb.	1.00-1.25
Bismuth (500 lb. lots).....	lb.	1.50 @ 1.55
Cobalt.....	lb.	3.00 @ 3.25
Magnesium (f.o.b. Philadelphia).....	lb.	1.25
Platinum.....	oz.	82.00
Iridium.....	oz.	150.00 @ 170.00
Palladium.....	oz.	55.00-60.00
Mercury.....	.75 lb.	38.00-39.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled.....	20.50
Copper bottoms.....	28.00
Copper rods.....	19.00 @ 19.75
High brass wire.....	15.75
High brass rods.....	13.25
Low brass wire.....	17.25
Low brass rods.....	17.25
Brazed brass tubing.....	25.00
Brazed bronze tubing.....	29.75
Seamless copper tubing.....	19.50
Seamless high brass tubing.....	18.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current	Cleveland	Chicago
Copper, heavy and crucible.....	9.50 @ 10.00	9.25	9.50
Copper, heavy and wire.....	9.00 @ 9.25	8.50	8.50
Copper, light and bottoms.....	7.50 @ 8.00	7.50	7.25
Lead, heavy.....	3.25 @ 3.50	3.25	3.25
Lead, tea.....	2.25 @ 2.35	2.25	2.25
Brass, heavy.....	4.25 @ 4.50	4.50	5.00
Brass, light.....	3.25 @ 3.50	3.25	3.50
No. 1 yellow brass turnings.....	4.00 @ 4.25	4.25	4.50
Zinc.....	2.00 @ 2.25	2.00	2.25

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ½ in. and larger, and plates ½ in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes.....	\$2.88	\$2.88	\$2.88
Soft steel bars.....	2.78	2.78	2.78
Soft steel bar shapes.....	2.78	2.78	2.78
Soft steel bands.....	3.42	3.48	3.48
Plates, ½ to 1 in. thick.....	2.88	2.88	2.88

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

TUSCALOOSA—Members of the industrial committee of the local Chamber of Commerce are perfecting plans for the establishment of a local paper mill, to specialize in the manufacture of bond, kraft and other papers.

California

SAN FRANCISCO—Technion, Inc., manufacturer of composition of tiling, wainscoting, etc., has established a new plant at 524 Gough St., and plans for extensive operations. Alexander R. Balm is president, and J. W. Rowell, vice-president and production manager.

Georgia

COLUMBUS—The Southern Cotton Oil, Ninth Ave., is said to be planning for the rebuilding of its plant, recently partly destroyed by fire.

Illinois

CHICAGO—The American Tar Products Co., 208 South La Salle St., has commenced the erection of its proposed new local plant, to be equipped for the production of tar and tar byproducts.

Louisiana

ABBEVILLE—The Peoples' Sugar Refinery, Rose Hill, near Abbeville, is planning for the rebuilding of its local sugar mill, destroyed by fire, Oct. 13, with loss estimated at about \$300,000, including machinery.

Maryland

BALTIMORE—The Chesapeake Paper Board Co., Key Highway and Baltimore & Ohio R.R., will soon commence the enlargement of its plant to provide approximately double the present output, or about 100,000 lb. of material every 24 hours. The machinery installation is estimated to cost in excess of \$50,000. An extension will be constructed to the power house. J. S. Smith is president.

BALTIMORE—The American Sugar Refining Co. has filed plans for the erection of another building at its new plant now in course of erection at Woodall and Clements Sts. It will be 1-story, 55 x 107 ft. Stone & Webster, Inc., 120 Broadway, New York, has the building contract.

BALTIMORE—The Patuxent Clay Products Co., 206 Water St., recently incorporated with a capital of \$1,000,000, is having plans prepared for the erection of a new local plant to cost about \$150,000, for the manufacture of hollow tile and other burned clay products. The company is headed by Herbert W. Holmes and Harry Hanna.

Massachusetts

LEOMINSTER—The Viscaloide Co., manufacturer of celluloid products, has awarded a contract to Wiley & Foss, Central St., Fitchburg, Mass., for the construction of a 3-story plant addition on Lancaster St., 40 x 50 ft. A. S. Paton is president.

SALEM—The Atlantic Refining Co., 3144 Passyunk Ave., Philadelphia, Pa., manufacturer of oil products, is planning for the erection of a new local plant on Jeffers Ave. New England headquarters are at 248 Boylston St.

Michigan

CADILLAC—R. J. Teetor, Muskegon, Mich., is completing plans for the erection of a new 1-story and basement foundry, 75 x 100 ft., at Cadillac. Frank D. Chase, Inc., 645 Michigan Ave., Chicago, Ill., is architect and engineer.

ANN ARBOR—The University of Michigan, S. W. Smith, secretary, University Hall Bldg., has preliminary plans under way for the erection of a new chemical laboratory at the institution, estimated to cost about \$75,000.

Missouri

ST. LOUIS—The République Photographie Corp., Kansas City, Mo., has acquired property totaling about 6 acres at St. Louis, to be used as a site for the erection of a new plant for sensitized photographic paper manufacture. Preliminary plans are under way. E. B. Fish is president.

ST. LOUIS—The St. Louis Lead & Oil Works, International Life Bldg., will break ground at once for the erection of a new power house at its plant on Manchester St.

New Jersey

CAMDEN—Fire, Oct. 19, destroyed a portion of the plant of the Camden Copper Works, Second and Royden Sts., with loss estimated at about \$11,000.

NEWARK—The Celluloid Co., 290 Ferry St., manufacturer of celluloid products, has awarded a contract to Enstice Bros., 40 Clinton St., for the erection of a new 1-story and basement building, 73 x 240 ft., at Westcott and Niagara Sts., estimated to cost about \$200,000.

JERSEY CITY—Fire, Oct. 15, destroyed a portion of the plant of the C. A. Woolse Paint & Color Co., 500 Grand St. An official estimate of the loss has not been made.

TRENTON—Fire, Oct. 21, destroyed a portion of the plant of the Enterprise Rubber Co., Enterprise Ave., manufacturer of rubber products, with loss estimated at about \$25,000. John McCue is head.

New York

NIAGARA FALLS—The American Motorists' Refining Co., has construction under way on a new oil refinery on a 30-acre tract of property recently acquired in the northern section of the city.

ROCHESTER—The Pennsylvania Glass Sand Co., Lewiston, Me., is reported to be planning for the immediate erection of a new local mill, to be equipped for grinding feldspar, etc., estimated to cost about \$45,000, to be 1-story, 50 x 130 ft.

BUFFALO—The Standard Mirror Co., 155 Harrison St., has plans under way for the erection of a new 1-story building at its plant, 60 x 120 ft. Bids will be asked at once. Colson & Hudson, Dun Bldg., are architects.

North Carolina

SALISBURY—The American Foundry Co. is completing plans for the erection of a new 1-story foundry, 60 x 120 ft., for the production of iron and other metal castings. Thomas G. Shelton is manager.

MICAVILLE—The Carolina Feldspar Co., Box 1025, Asheville, N. C., is planning for extensive developments and operations at its properties in the vicinity of Micaville, to include the grinding and pulverizing spar and kindred products. F. Frazier Glenn is president and general manager, address noted.

BURLINGTON—The Chamber of Commerce is developing plans for the establishment of a new local plant for the manufacture of terra cotta specialties, drain tile and other burned clay products. J. V. Mann is secretary.

Ohio

BARBERTON—The receivers for the Portage Rubber Co. have offered the plant and property to F. A. Seiberling, former head of the Goodyear Tire & Rubber Co. and now president of the Lehigh Tire & Rubber Co., New Castle, Pa., for a consideration of \$1,000,000, or \$250,000 in excess of the amount Mr. Seiberling has tendered for the works. If the sale is consummated, the plant will be operated in conjunction with the New Castle works.

YOUNGSTOWN—The Paul J. Kalman Co., 22 West Munroe St., Chicago, Ill., manufacturer of steel products, is planning for the early erection of a new steel fabricating plant, 400 x 420 ft., at Youngstown, estimated to cost close to \$200,000 with equipment.

Pennsylvania

KITTANING—The Templeton Limestone Co., with plant at Templeton, near Kittanning, has construction under way on the

rebuilding of its crusher building and power house, 30 x 60 ft., and 25 x 25 ft., respectively, recently destroyed by fire. The work is estimated to cost about \$50,000. W. L. Snyder is superintendent.

KANE—Fire, Oct. 18, destroyed a building of the Nansen Chemical Co., Nansen, near Kane, with loss estimated at about \$25,000.

PHILADELPHIA—The Pennsylvania Sugar Co., North Penn St., has acquired the property at 1015-21 North Penn St., adjoining its works, from the J. W. Paxson Co., for a consideration said to be \$145,000. The site is improved with a 3-story factory and other buildings, and will be used by the new owner in connection with its plant.

WILLIAMSPORT, PA.—C. A. Reed & Co., Willow and Laurel Sts., manufacturer of paper products, has awarded a contract to Charles W. Feil & Co., South and Willow Sts., for the erection of its proposed new 4-story plant, 70 x 100 ft., estimated to cost \$100,000.

PHILADELPHIA—The Philadelphia Paper Mfg. Co., Mixon St., Manayunk, has filed plans for the erection of a new building at its plant 100 x 180 ft., estimated to cost about \$30,000.

Tennessee

CHATTANOOGA—The Ocoee Copper Co., 1135 Volunteer Life Bldg., has plans under way for the erection of a new plant at Ducktown, near Chattanooga, estimated to cost about \$200,000. J. I. Carter is president. L. R. Hope, Ducktown, is engineer.

MEMPHIS—G. N. Shepardson is considering plans for the rebuilding of his local potash manufacturing plant, recently damaged by fire with loss of about \$23,000.

CHATTANOOGA—The Cities Brick Co., Curtain Pole Road, has preliminary plans under way for the erection of an addition to its plant.

Texas

BEAUMONT—The Magnolia Petroleum Co., Dallas, Tex., is planning for the rebuilding of the portion of its gasoline plant recently destroyed by fire with loss reported in excess of \$300,000.

BRECKENRIDGE—The laboratory building and other structures at the plant of the Mystic Gasoline Co., were destroyed by fire, Oct. 4, with loss estimated at about \$14,000.

West Virginia

BELLE—The Belle Alkali Co. has awarded a contract to the Korns-Thomas Contracting Co., First National Bank Bldg., Huntington, W. Va., for the erection of additions in its plant, including improvements and alterations in the present works, estimated to cost about \$300,000. D. W. Stubblefield is manager.

SUTTON—The Sutton Chemical Co. has acquired a large tract of property, totaling about 5,000 acres in the vicinity of Wolf and Stoney Creeks, to be used for certain raw material supply for the local plant.

PRINCETON—The Princeton Brick Co. has plans under way for extensions and improvements in its plant. Additional machinery will be installed.

STAR CITY—The new plant of the Star Glass Co., 93 Washington St., Morgantown, W. Va., to be erected at Star City, will total about 75,000 sq. ft. of manufacturing area, and is estimated to cost about \$200,000. Construction will be commenced at once. H. J. Wagoner is secretary and treasurer.

Capital Increases, Etc.

THE UNITED STATES TURPENTINE & ROSIN Co., Mobile, Ala., has filed notice of increase in capital from \$3,000,000 to \$6,000,000.

THE STANWOOD RUBBER Co., Newark Ave., Elizabeth, N. J., has been taken over by a reorganization committee and receivership, operative for about a year past, has been terminated. The new company proposes to issue bonds for \$175,000 and stock for \$651,000, and will operate the local plant. A consideration of \$360,000 was given for the property.

THE MARTIN LEATHER Co., Fifth and Spruce Sts., Wilmington, Del., has filed notice of increase in capital from \$700,000 to \$1,500,000.

A stockholders' committee is perfecting plans for the reorganization of the **BUTTERWORTH-JUDSON CORP., Doremus Ave., Newark, N. J.,** manufacturer of chemicals, dyes, etc. The committee is composed of Chellis A. Austin, chairman; William A. Bradford, and Thomas L. Chadbourne.

New Companies

THE IVA-LITE CORP., Boston, Mass., has been incorporated with a capital of \$250,000, to manufacture glass products of various kinds. Robert T. Russell is president; and M. S. MacDonald, 175 Cypress St., Newton, Mass., treasurer.

NOEPEL & BLAIR, INC., Boonton, N. J., has been incorporated with a capital of \$25,000, to manufacture leather products. The incorporators are Charles W. Blair, I. J. and Jacob E. Noepel, 65 Harrison St., Boonton.

THE GWYNED CLAY PRODUCTS CO., Wilmington, Del., has been incorporated under state laws with a capital of \$125,000, to manufacture hollow tile, firebrick and other burned clay products. The company is represented by the Delaware Charter Co., 904 Market St., Wilmington.

THE BORG CORPORATION, New York, N. Y., has been incorporated with a capital of \$100,000, to manufacture shellac, glue and kindred products. The incorporators are F. C. Leubuscher, J. W. Suling and J. C. Skinner. The company is represented by Leubuscher & Suling, 258 Broadway, New York.

THE MOTOR CITY SOAP CO., Detroit, Mich., has been organized under state laws to manufacture soaps and affiliated products. The incorporators are James L. and F. Cowan, and Ira Snyder, 5715 Third Ave., Detroit.

THE CHICAGO DRUG & CHEMICAL MFG. CO., 2201 West Roosevelt Road, Chicago, Ill., has been incorporated with a capital of \$50,000, to manufacture chemicals and chemical byproducts, drugs, etc. The incorporators are David Rish, Max Karno and Benjamin Michelson.

THE HUDSON VALLEY PORTLAND CEMENT CO., New York, N. Y., has been incorporated with a capital of \$100,000, to manufacture cement. The incorporators are H. W. Davey, M. S. Reeve and E. F. Mack, Jr. The company is represented by Hyman Dominitz, 152 West 42d St.

THE MOUNTAIN LIME CO., Los Angeles, Cal., has been incorporated with a capital of \$500,000, to manufacture lime and affiliated products. The incorporators are V. C. Hickson, W. J. Little and T. P. Lamb. The company is represented by Randal, Bartlett & White, 605 California Bldg.

THE M. & S. SHELLAC CO., Newton, Mass., has been incorporated with a capital of \$3,600, to manufacture shellac, varnish and kindred products. Thomas J. Mitchell is president; and Isidor Slotwick, 87 Congress St., Chelsea, Mass., treasurer.

THE SATISFACTO PRODUCTS CO., New York, N. Y., has been incorporated with a capital of \$25,000, to manufacture chemicals and chemical byproducts. The incorporators are O. W. Sample, H. Gerbitz and T. J. Ward. The company is represented by M. A. Barney, 154 Nassau St., New York.

THE HARDMAN PRODUCTS CO., Caldwell, N. J., has been incorporated with a capital of \$50,000, to manufacture rubber products. The incorporators are J., Herbert V. and L. N. Hardman, 29 Elizabeth St., Caldwell.

THE MAXWELL PAINT CO., Philadelphia, Pa., has been incorporated with a capital of \$10,000, to manufacture paint, varnish, etc. H. C. Middletown, Jr., Moorestown, N. J., is treasurer.

THE DORADIAN OIL CO., El Dorado, Ark., has been incorporated with a capital of \$125,000, to manufacture petroleum products. The incorporators are F. N. Fisher, A. J. Falls and Benjamin R. Henderson, all of Memphis, Tenn.

THE TUCAN CLAY PRODUCTS CO., Chicago, Ill., has been incorporated with a capital of \$250,000, under Delaware laws, to manufacture clay products. The incorporators are C. W. Smith, J. N. Fulton and J. M. Fitzpatrick, Chicago. The company is represented by the Colonial Charter Co., Ford Bldg., Wilmington, Del.

THE ASBESTOS PRODUCTS MFG. CO., Hoboken, N. J., has been incorporated with a capital of \$10,000, to manufacture asbestos goods of various kinds. The incorporators are William D. Crumpton, Frank Richl and Elwood J. Wilson, 1021 Grand St., Hoboken.

THE MAGNUS CHEMICAL CO., Brooklyn, N. Y., has been incorporated with a capital of \$90,000, to manufacture chemicals and chemical byproducts. The incorporators are W. M. and W. J. Campbell, and E. Magnuson. The company is represented by Henry Amerman, 233 Broadway, New York.

THE WYATT RUBBER CO., 233 East 22d St., Baltimore, Md., has been incorporated with a capital of \$50,000, to manufacture

rubber products. The incorporators are Charles M. Reckord and Francis J. Hamill.

THE A. B. HURST CO., Kendall, Fla., has been incorporated with a capital of \$25,000, to manufacture starch and affiliated products. A. B. Hurst, is president; W. T. Tomlinson, vice-president; and John B. Hurst, secretary, all of Kendall.

THE PINE TREE PULP CO., Gardiner, Me., has been incorporated with a capital of \$100,000, to manufacture paper-pulp and affiliated products. J. Harold Machette is president and treasurer. Robert K. Eaton, Gardiner, represents the company.

THE LAWLOR-McCORMICK CO., New Brunswick, N. J., has been incorporated with a capital of \$50,000, to manufacture coal-tar byproducts and affiliated specialties. The incorporators are Joseph J. Lawlor, William J. Lawlor and Clifford J. McCormick. The company is represented by Neilson & Hamilton, New Brunswick.

THE LIBERTY GLASS CO., Wilmington, Del., has been incorporated under state laws, with capital of \$200,000, to manufacture glass products. The company is represented by the Capital Trust Co., Dover, Del.

THE APEX COLOR CO., Providence, R. I., has been incorporated with a capital of 100 shares of stock, no par value, to manufacture colors, dyes and kindred products. The incorporators are Herbert J. Humphres, and Clifton I. Munroe, Providence; and Ogden R. Lindsley, Central Falls, R. I.

THE WELLSTAN OIL CO., New York, N. Y., has been incorporated with a capital of \$200,000, to manufacture oil products. The incorporators are Charles Newburg, Anthony N. Roderink and Randolph S. Barrie, New York. The company is represented by the United States Corporation Co., 65 Cedar St.

THE EXCELSIOR LEATHER CO., New York, N. Y., has been incorporated with a capital of \$30,000, to manufacture leather products. The incorporators are W. and E. Fried, and E. Tucker. The company is represented by Abraham Karp, 350 Broadway.

KERR, WILSON & CO., INC., Roanoke, Va., has been incorporated with a capital of \$250,000, to manufacture tannin extracts for leather working, dye products, etc. George A. Kerr is president; Walter F. Wilson, vice-president; and J. Calvin Moss, secretary-treasurer, all of Lynchburg, Va.

THE AMERICAN COBALT PRODUCTS CO., Jersey City, N. J., has been incorporated with a capital of \$1,500,000, to manufacture cobalt compounds and affiliated products. The company is represented by the Corporation Trust Co., 15 Exchange Pl., Jersey City.

Manufacturers' Catalogs

THE K-B PULVERIZER CO., INC., New York, N. Y., has issued a folder on the Pulver-burner.

THE PIRON COAL DISTILLATION SYSTEMS, New York, N. Y., in Bulletin 1 illustrates and describes coke and gas oven byproduct plants and distillation recovery systems.

C. G. BUCHANAN CO., INC., New York, calls attention to Bulletin 13, on Type "C" Buchanan crushing rolls. On page 2 is given a brief history of the original and first introduction of rolls. This in itself would probably be of little interest to the average reader, but the data given on the large capacity and the comparatively small amount of power required to operate these early and imperfect machines must be of keen interest to any one who is not thoroughly familiar with the use or possibilities of rolls as a crushing device for medium fine crushing. This company has endeavored to make clear the limitations of rolls in regard to size of pieces that rolls can economically handle and the reduction that can be made in a single pass, and convenient tables and diagrams are given on pages 8 and 10. Simple tables of capacities are given on pages 12 and 13, enabling the users of rolls to determine quickly the size, speed and number of rolls to be used for accomplishing any given amount of work.

THE EAGLE-PICHER LEAD CO., Chicago, Ill., has issued an attractive booklet on Eagle-Picher Products. A "Lead Tree" chart is given showing the comprehensiveness of the company's operations; composition and use of white lead, blue lead, litharge, red lead and orange mineral, etc.; a list of metal products which find most general use in the lead-consuming industries; and specifications of lead pipes, traps, roof flanges and lead bottles and specialties.

New Publications

PROBLEMS FOR RESEARCH TRAINING. By Research Committee, H. A. Shoule, chairman. 30 pp. Sciencetech Club, Indianapolis, Ind.

This little pamphlet addressed to the members of the scientific and technical faculties of Indiana colleges and universities lists 175 different research problems awaiting solution in the fields of botany, chemistry, engineering and physics. These problems, for the most part, have been suggested by active professional men who are appreciative of the actual needs of the industries they represent.

OIL FLOW IN PIPE LINES. By R. S. Danforth. Ten charts and two pages of instructions. Published by King Knight Co., San Francisco, Cal. Price \$3.

A series of charts for use in solving oil-pumping problems have been prepared by the author using the formulas and method of computation explained in a previous bulletin, "Friction Pressure Loss in Oil Pipe Lines" published by the Kinney Manufacturing Co., of Boston, Mass.

THE AMERICAN ACADEMY OF ARTS AND SCIENCES has issued a booklet on "The Potential of the Thallium Electrode and the Free Energy of Formation of Thallous Iodide," by Grinnell Jones and Walter Cecil Schumb.

THE UNIVERSITY OF ILLINOIS has issued bulletins on "Investigation of Warm-Air Furnaces and Heating Systems," by A. C. Willard, A. P. Kratz and V. S. Day; "The Functions of the Engineering Experiment Station of the University of Illinois," by Charles Russ Richards, and "Some Conditions Affecting the Usefulness of Iron Oxide for City Gas Purification," by William A. Dunkley.

THE IOWA STATE COLLEGE has issued a bulletin on "Effects on Concrete of Immersion in Boiling Water and Oven Drying," by W. J. Schlick.

THE FEDERAL POWER COMMISSION has issued a booklet on Rules and Regulations as amended by Order No. 11 of June 6, 1921, governing the administration of the federal water power act, with copies of the act, of amendment thereto, and of orders Nos. 1 to 11 inclusive.

Coming Meetings and Events

ACADEMY OF POLITICAL SCIENCE will hold its forty-first annual meeting at the Hotel Astor, New York City, Nov. 4 and 5.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its seventy-fourth meeting at Toronto, Canada, Dec. 27 to 31, 1921.

AMERICAN CERAMIC SOCIETY will hold its twenty-fourth annual meeting at St. Louis, Feb. 27 to March 2, 1922.

AMERICAN GAS ASSOCIATION will hold its third annual convention in the Congress and Auditorium Hotels, Chicago, the week of Nov. 7. More than 100 manufacturers will exhibit their latest gas-burning appliances.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its annual winter meeting at Baltimore, Md., Dec. 6 to 9. Headquarters will be at the Southern Hotel and the sessions will be held in the Engineers' Club.

AMERICAN IRON AND STEEL INSTITUTE will hold its twentieth general meeting at the Hotel Commodore, New York City, on Friday, Nov. 18.

INDUSTRIAL COST ASSOCIATION will hold its second national conference at Pittsburgh, Pa., Nov. 2-4, with headquarters at the William Penn Hotel.

INDUSTRIAL RELATIONS ASSOCIATION OF AMERICA is holding its annual convention at the Waldorf-Astoria, New York, Nov. 1-5.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stettens Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

The following meetings are scheduled to be held in Rumford Hall, the Chemists' Club, New York: Nov. 11—American Chemical Society (in charge), Society of Chemical Industry, American Electrochemical Society, Société de Chimie Industrielle, joint meeting; Nov. 18—American Electrochemical Society, regular meeting; Dec. 2—Society of Chemical Industry, regular meeting; Dec. 9—American Chemical Society, regular meeting.

CHEMICAL & METALLURGICAL ENGINEERING

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Number 19

The Arms Conference And Chemical Warfare

CHEMICAL warfare is certain to come in for an exhaustive discussion at the Conference on the Limitation of Armament, which opens this week in Washington. It is admitted generally that the universal recognition of gas as a proper weapon would make it possible for armaments to be limited to a far greater extent than would be the case otherwise. Without discounting in any way its effectiveness as a weapon of offense, gas is coming to be regarded as one of the most potent of the weapons of defense.

An indication of the recognition of the importance of chemical warfare in any discussion of armaments is the selection of General AMOS A. FRIES, head of the Chemical Warfare Service of the Army, as a member of the technical staff of the American delegation. Further recognition of the chemical industry is had in the appointment of Dr. EDGAR F. SMITH, president of the American Chemical Society, as representative of the scientific and professional element, and of WILLIAM S. CULBERTSON, the Tariff Commissioner who has dealt principally with chemical tariff problems.

If an effort is made at the conference to prohibit the use of gas in warfare, it is believed it will be prompted by a desire to see the United States stripped of a weapon which she is in a position to use to greater advantage than any other country. The United States has ample supplies of all the raw materials used in chemical warfare. In this she has an advantage over any other country. With proper development in time of peace she would have industries equipped for immediate conversion to gas warfare purposes. In addition to these advantages, the United States is separated from possible powerful enemies by oceans. By the use of gas, our defense could be greatly strengthened. Even with gas in the infancy of its development, it is very generally recognized by military authorities that it makes the landing of troops from overseas so difficult that no attempt would be made to land them directly on our shores.

Another point, frequently lost sight of, is the fact that gas can be limited in its use against non-combatants to the same extent that other weapons of warfare are limited. The most frequently used argument against gas is that non-combatants suffer along with combatants. But we may point out that this applies to all weapons used in the recent war and does not constitute an argument against chemical warfare, since its possibilities of destruction can be confined to certain areas with almost the same exactness as would apply to other weapons. In that connection, however, it may be stated that military authorities do not expect great concern for civilian populations in future wars. The means of warfare have changed to such an extent that discrimination between combatants and non-combatants is growing increasingly difficult.

It is expected that the American delegation will advocate the retention of chemical warfare since the Congress of the United States has approved on several occasions the use of gas in warfare and has set up within the Army the most pretentious chemical warfare service in the world.

The Blight of Finance On Technical Enterprises

THE old-fashioned merchant is passing away. He used to be very much of a person. He ruled his affairs and his employees as well as his junior partners with patriarchal firmness; but he knew his business. He was likely to be a gentleman in what we call the American sense of the word—that is, he was polite in his mind and in his heart, rich in sympathy and gifted with understanding. Often, indeed, he was a man of distinguished culture and a person of taste. He took a reasonable pride in his high station, but still more seriously did he consider and live up to his obligations.

The old-fashioned manufacturer is a later creation, but he, too, is passing. He knew the business end of his industry and he had an understanding of its technology, so far as the old rule-of-thumb methods may be called technology. He also was an important person in the community in which he lived; a little more addicted, perhaps, to whimsical opinions as a substitute for wisdom; but that followed his rule-of-thumb technology, which was not even supposed to be understandable. He was a good citizen and an independent thinker, according to his lights.

These men are passing away, because both commerce and industry are passing over into the hands of bankers. The development of great corporations which have replaced private and personal ownership has placed bankers and lawyers in command. They select directors, chairmen of the boards and presidents. In many industries we find men in control who cannot look or even think beyond the balance sheet. And since accounts are only records of past performances, they cannot see ahead. They are ignorant of the technology of the industries which they direct, and as for the science which underlies the technology they are no better informed than so many hod-carriers. We do not say this of all men in industry, but we do affirm it in relation to so large a number as to threaten our national welfare in industry.

Let's follow out a frequent process: Imagine please, a product greatly needed which is worked out after long and tireless investigation, and the inventor, a scientific man, is associated with a business man who grows in understanding as the venture develops. The demand for the product is so great that they need money for extensions. Their bank of deposit will deal only on their notes, and they want to fund their floating debt and to double or treble their capacity. So they go to the investment banker. At this point the sound

economies which they have always practiced are likely to get a severe jolt. The more money they need the more welcome they are. The broker plans a bond issue, a preferred stock issue and common stock eruption of about the current value per share of German marks. The banker keeps an inordinate share of preferred and common stocks as commissions, but it is a good thing, and the two old boys go on working and planning and directing the corporation's affairs with an unwieldy board of directors, strangers to the business, and hopelessly ignorant. The banker appoints his favorite firm of public accountants to balance the books and with that he feels secure. "The books," he declares cheerfully, "tell the whole story." He can understand the balance sheet; and that is all that he can understand. One director gets his favorite insurance broker appointed, and another places his son-in-law in the office. But the two old boys stick to their jobs and all goes so well that the common stock begins to have value, and we read the quotations in the newspapers. It looks like a good buy.

Then comes the chance for amalgamation, consolidation and a new stock issue. Why not? If grocers buy both flour and sugar, then a consolidation of sugar and flour industries is a proposal of the sort that appeals to the banking eye. It will save duplication of sales force and fill up freight cars to sell more sugar and flour together than of either commodity alone. And in a reorganization there are more commissions which are pleasant to consider. So this particular industry is tied up with something else—"related," as the bankers say—and the consolidation makes it so big that the stockbrokers begin to talk about it. The two old boys cannot see it; they don't know these other lines of business that are coming in; they say they are too old to learn new tricks and so they are bought out because they are not progressive. Then the banker takes hold for fair. He wants a good administrator as president and as likely as not he will get a man who has succeeded in developing a string of 5 and 10 cent stores and will expect him to manufacture this particular product which requires at every step in the process trained, scientific control. "He's got a good business head," says the banker, "and that's what we want here."

True, the new administrator knows the 5 and 10 cent business down to the ground, and the very fact that he has succeeded in it is his worst quality. You can't fool him in the 5 and 10 cent store business but you can put all sorts of foolish notions over on him about this new business, because he does not understand it fundamentally. Little wrong guesses turn out to be thundering mistakes. He is lost in his job because he is befogged with ignorance, and genius itself can't see through a fog. So there is danger ahead. He brings fog and mud instead of a clear vision ahead and a well-thought-out road of progress. Then old Uncle Trouble and Aunt Agony come and settle down as members of the family.

The remedy is easy if it can only be got into the minds of investment bankers. They don't know how to seek information. Their business is that of super-treasurer of the corporations they organize and they do not play the game straight. They do not give value received in honest study and in getting information and in constructive thought in return for what they get out of it. They want the big profits without contributing enough real work. This is their minor fault. Their major fault is that they put the wrong men into ad-

ministration. That is due to their inexcusable ignorance, which they can remedy by study and work. They don't study enough or know enough. If they haven't got the time to learn, or the educational backing to make themselves familiar with the business, they should leave well enough alone—or at least they should learn how to seek advice. It is easy enough to take advice—the difficulty lies in finding out where to get it.

A Notable Movement

In Metallurgical Education

A DEFINITE educational movement for the benefit of the "man at the fire" is one of the fundamental aims of the American Society for Steel Treating. Not only is this aim stated in the constitution of the society, but the national officers bear this responsibility in mind. This in turn is doubtless due to a constant urge from the membership, voiced through the officers of the thirty-one local sections, or chapters, so called. All the directors realize that the phenomenal growth of the society has risen from a desire on the part of the skilled heat-treater to acquire some technical and theoretical information on his daily work. This desire must not be disappointed; otherwise the decline of the society will be as rapid as its rise.

A most pretentious effort in educational lines is sponsored by the important chapter at Chicago. Over a year ago they induced the president of Lewis Institute to provide facilities for an evening course in metallurgy, and secured the services of Professor JOHN F. KELLER, of Purdue, to direct the work. Several specialists also volunteered to lecture on certain phases of heat-treatment. This effort proved such a gratifying success that now two separate courses are offered, one on heat-treatment and the other on metallography of iron and steel, each extending over four months, and meeting for three hours two evenings each week.

Such a program is obviously not beyond the resources of many of our technical colleges, and it appears to be one well worthy of imitation. However, other local sections, notably those at New Haven, New York and Bethlehem, did not wait to perfect a working arrangement with some progressive school, but have laid out a well-considered program to occupy the regular monthly meetings; a program which will cover certain branches of the art in a systematic manner, each meeting to be addressed, in not too technical language, by an undoubted authority in his subject. The New Haven chapter demonstrated last year that such a series of meetings was very popular with the members. Knowing that the new president of the society, P. H. GILLIGAN, is a New Haven man, it is unnecessary to remark that his influence will undoubtedly support those members who desire to perform some service for brothers less fortunate in their technical education.

Nor should such meetings be devoid of interest to the skillful metallurgist. One has only to read Professor TYNDALL'S fascinating lectures to know that it is possible to instruct both the expert and the layman. Of course, there are few Tyndalls, but now and then the feat so easy for him, so difficult for others, is attained; witness Dr. JOHN A. MATHEWS' masterful address recently given in New York on "What Is Steel?" Commonplace facts stated with precision and interpreted with that discrimination which comes unbidden from many years' experience gives not only instruction to the tyro but a new perspective to the specialist.

Foundations of Trade Unionism

THE very familiar question of which came first, the chicken or the egg, has a sort of parallel in this matter of trade unionism. Is a shop union because the employees are union men, or are the employees union men because the shop is union? Sometimes an employer finds he can't get employees unless he signs the scale and sometimes a man can't get a job unless he has a union card. In branches of the building trades these cards frequently cost \$100 to \$200 apiece. Sometimes, and fortunately more frequently, the shop is "open" and there is no question about unionism. The employer picks out the best men to employ, and a man gets a job if he is good enough.

The question of which is cause rather than effect has been brought prominently before the public by the advertising which the "check-off" in the bituminous coal industry received last week through the granting of an injunction against coal operators using this system. The check-off, instituted a couple of decades or so ago, is a sort of automatic unionism. The scale signed by the operators requires that they deduct from each man's pay his initiation fee, fines and monthly dues and remit in lump sum to the local division of the United Mine Workers. Thus upon accepting employment a man automatically becomes a member of the union, so far as supporting it financially is concerned. If the man is not a good union man, disposed to strike when told, etc., the union can employ to educate him in unionism the funds he helps to provide.

As a system this is very efficient. All that is necessary is to get the scale signed and the rest will usually take care of itself. If there are non-union mines whose competition interferes with the operation of union mines the funds can be employed to unionize those mines, putting them in the same boat with the rest. If when a scale settlement time comes around the men want an increase in wage rates which the operators cannot afford to pay with the existing price of coal, all that is necessary is to fail to agree. Thereupon there is what is called "a cessation of mining" rather than a strike; coal becomes scarce and advances in price, and the operators are then able to pay the advance in wages. The coal operators cannot agree with one another to close their mines in order to improve the market, as that would be a violation of the Sherman law, but there is no law preventing them from disagreeing with the United Mine Workers. It is purely incidental that thereby the union mines all become idle. It is wrong to agree, but all right to disagree, and the public takes (or pays) the consequences.

It is curious, decidedly curious, indeed, that the check-off has existed so long in the bituminous coal industry and in but few other isolated instances. This is no fault of Mr. GOMPERS, for upon the granting of the injunction against the check-off last week Mr. GOMPERS promptly arose to record his protest not merely against Judge ANDERSON'S injunction on union activities in the non-union West Virginia coal field, but against the check-off injunction as well. He "could not see" why a judge interferes with the practice, the decision being "part and parcel of the attempt to repress and subdue labor." Mr. GOMPERS would find his work easier in his declining years if the check-off were made universal. He repeats his threat of the past two years, which the public will heed even less than formerly, that if his

variety of trade unionism is not encouraged the workers will adopt something worse, meaning bolshevism, etc. Mr. GOMPERS ought to have something more interesting to say by this time.

If the bituminous miners will not pay their dues except by having the money taken out of their pay, there is prospect that one of the three great monopolies that have been holding up the American people will have its power lessened. The two others are the railroad unions and the unions in the building trades.

Congress Fears Cupidity In the Chemical Industry

OUR Washington correspondent transmits this week a news item which we commend to all leaders, particularly business leaders, in the chemical industry. We have been preaching in season and out the advisability of continuing research in all our technological industries and the necessity of keeping our chemical industries in the hands of men who appreciate its technical requirements. We have consistently deplored the tendency to curtail research and have pointed out the danger of allowing our great chemical industries to fall into the hands of business men and financiers whose only yardstick is the immediate dollar and with whom success can be reflected only in the balance sheet. If practical evidence were needed to support the wisdom of our contentions, it can be found in the impression prevailing in Congress today "that the banking interests have gained the upper hand in many chemical activities and that there is a tendency to eliminate research and experimentation in the interest of greater profit." In this attitude of mind Congress will scarcely look with favor on claims of the chemical industry for tariff protection. Hitherto the House has been persuaded to recommend unusual measures for the protection of the chemical industry, but favorable consideration cannot be expected if the impression is permitted to persist that men of technical vision are being superseded by business men who look more to immediate profits than to a stabilized industry. We have all gladly joined in the effort to educate Congress to an appreciation of the importance of chemistry in our national welfare, but nobody will rally to the defense of those whose cupidity leads them to exploit a great industry. Steps should be taken immediately to set Congress right in this matter, particularly by those whose actions are responsible for the prevalent impression.

One of the great needs of American chemical industry today is a spirit of unity and solidarity through all the elements that go to make up the whole. It will not prosper if here and there through the ranks are short-sighted individuals in positions of power who consider only their own immediate welfare and make no contribution to the general good. Chemical industry as a whole is going to profit by whatever consideration it gets at the hands of Congress, and it is unfair for a few who are without vision to jeopardize the prospects of success of those who are broad-minded and far-seeing. It may be well to remember that a successful chemical industry requires the attention of chemists. It cannot be fully comprehended by bankers, promoters, stockbrokers, and so-called successful business men, and it is quite evident that Congress has been educated to a point where it realizes this fact, and will look with disfavor upon a chemical industry controlled by such elements.

British Chemical Industry

FROM OUR LONDON CORRESPONDENT

LONDON, Oct. 14, 1921.

THE slow but steady improvement in the chemical trade which developed after the holidays and which, it was expected, would continue after the coming into operation of the safeguarding of industries act has not been maintained, and at the time of writing the demand is not so active. While it cannot be said that markets have received a setback, business is not yet of a stable nature in spite of occasional evidence of considerable and somewhat spasmodic improvement. The prospect of gradual stabilization has been upset by the sudden depreciation of German currency, which has been sufficient almost to neutralize the operation of the safeguarding of industries act in regard to depreciated exchanges, in so far as it affects German imports.

ANOMALIES OF THE KEY INDUSTRIES ACT

The official list of articles chargeable with duty under the key industries act is a formidable document of seventy-three pages, and its importance to the fine chemical industry is demonstrated by the fact that this section covers fifty pages and includes about 2,500 substances, including those protected by the dyestuffs act and marked "D." While it was scarcely to be expected that this act could be operated without serious disorganization and criticism, it is already apparent that the dissatisfaction and inconvenience caused will be more severe than was expected, and not only the technical press but also the daily press is giving prominence to anomalies and complaints mainly in view of the fear of additional unemployment. The principal complaint is that numbers of articles are included which have no real relation to key industries and so give the measure a more broadly fiscal character. In addition, there is the usual unfortunate tendency of customs officials at first to interpret the letter rather than the spirit of the act. Thus importations of toy magic lanterns and eyes in dolls' heads are held up as being optical glassware, the small carbon rods used in pocket batteries are considered to be arc lamp carbons and even electric lamps containing tungsten wire originally supplied by British manufacturers cannot at present be re-imported. A joint conference is to be organized by the London Chamber of Commerce and the Chemical and Dyestuffs Traders Association with the idea of formulating an authoritative case to be laid before the government. Meanwhile the only other activity to be noted is increased advertising by the firms whose products are being protected, often accompanied by announcements of price reductions as an additional bait to the shy purchaser.

LESSONS OF THE OPPAU EXPLOSION

Nothing authoritative has yet been published in regard to the cause of the disaster at the Badische Co.'s works, but discussion of its probable effect on the nitrogen industry and theories as to its origin are rife. It is generally assumed that decomposition or overheating of ammonium nitrate or a mixture of ammonium sulphate and nitrate, either from external causes or through acidity and consequent decomposition, resulted in the ultimate explosion of the products in store and as a result there is some apprehension in regard to stocks of similar commodities at various factories here and on the Continent. There is a close

analogy between this explosion and that of a large quantity of potassium chlorate which occurred at the United Alkali Works near St. Helens in 1899. At that time potassium chlorate had not been known to explode and yet by reproducing the conditions during the fire prior to that explosion it was conclusively shown that when molten and struck a glancing blow with a piece of wood on a brick floor potassium chlorate would explode violently with the utmost regularity. The Claude process for ammonia synthesis continues to make headway and it is rumored that the British group intends ultimately to consolidate its interests by controlling Norwegian production and has in fact already acquired certain water powers from which the cyanamide industry in that country obtains its supply.

GENERAL DESPONDENCY PREVAILS REGARDING THE FUTURE

In spite of the belated legislation, it is freely predicted that the British chemical industry will ultimately revert practically to its pre-war status and importance. An exception is made of the heavy chemical industry, but it is realized that apart from state-supported key industries the chemical industry of Great Britain must in the future as in the past depend largely upon the efforts of the merchants and traders and that these must be placed in a position to maintain to the fullest extent the export and foreign trade, British manufactured goods being necessarily left to find their own level in the face of external competition. In the same way, the future of the chemist is gradually becoming an acute problem, particularly the future of those whose attainments and achievements are below the average or insufficient to warrant their retention in normal work and progress. Probably the junior chemist who lags behind in the race will have to swallow his pride and become a process-foreman or a salesman, and it is not unusual to find men with commercial ability who have become successful travelers, utilizing their technical knowledge somewhat in the way that was practiced by the representatives of German dyestuffs firms before the war. The depression in trade has also militated against the work of unifying chemical and scientific societies, which was initiated by the Federal Council, it being impossible at the moment to attract the funds for a central home. There is still so much jealousy and rivalry among the various societies that none of them can reasonably be expected to show the way without exciting suspicion. Mining engineers have succeeded in getting together and there is still the possibility that through the medium of bodies like the Chemical Industry Club or the Radium (Chemists) Lodge, the foundations can be laid for a better understanding and at any rate for the provision of a common meeting house and library. The lessons learned by the visitors to the United States and Canada are receiving due publicity and it is recognized that the organization of the American Chemical Society excels in its influence not only among chemists but on the American press and public. Meanwhile the Society of Chemical Industry appears to be going through a transition period and many changes are foreshadowed, mainly as regards policy. The crux of the matter is still that of publicity, and in addition members are clamoring for further departures from tradition and the provision of improved meetings and incidentally better entertainment than that which was afforded by the recent annual dinner.

Recent Developments in the Sulphuric-Acid Industry--I

New Methods and Equipment for the Production of Sulphur Dioxide, Precipitation of Flue Dust and Introduction of Nitrogen Oxides in Chamber Process Are Reviewed in the First of an Important Series of Articles

By ANDREW M. FAIRLIE
Consulting Chemical Engineer

ALL of the important processes for the manufacture of sulphuric acid could formerly be comprised under two general heads: the chamber process, and the contact or catalytic process. The chamber process has itself been considered by some as a kind of catalytic process, but generally it has not been so classified. The distinctive features of the chamber process have been the use of oxides of nitrogen, and of lead chambers, in combination. The recent development of processes which use no chambers, but still use oxides of nitrogen, has upset the former simple classification. These new processes certainly are not chamber processes, nor are they contact processes in the narrower meaning of the term as applied to sulphuric-acid manufacture. A new classification is therefore proposed, and inasmuch as these new processes all use oxides of nitrogen, they are grouped with the chamber process under the general head "nitration processes," leaving the contact processes as they were, in a group by themselves.

This series of articles is based on a lecture delivered by the author before the Franklin Institute of the State of Pennsylvania in the spring of 1921. It is the purpose here, as in the original lecture, to confine attention to nitration processes only, discussing the developments, since 1914, in equipment and appliances, in plant design and construction, and in plant operation. As this discussion is by nature a review, no special claim is made to presenting novelties. Many of the features described herein have appeared in the technical literature and are more or less familiar. Here we concentrate the attention, however, on developments relating to a single industry, and correlate these developments with one another. The descriptions of the devices and inventions considered are brought as nearly as possible up to date, and an opportunity is afforded, with the aid of the illustrations, to contrast or compare them.

RAW MATERIALS FOR SULPHUR DIOXIDE

Prior to 1895 most of the sulphuric acid made in this country was made directly from sulphur, or, as it is commonly called, brimstone. Then during a period of twenty years brimstone was largely supplanted by pyrites. Since 1914, however, the use of sulphur as a raw material for acid making has rapidly increased, and by 1918 the percentage of acid made from sulphur, based on the total acid made in this country, was 48 per cent.

The restrictions on importations of Spanish pyrites during the war, coupled with the extraordinary demand for sulphuric acid for the production of high explosives, gave the brimstone industry an opportunity to regain to a large extent the supremacy, as a raw material for the manufacture of sulphuric acid, which it had enjoyed

TABLE I. QUANTITIES OF SULPHURIC ACID PRODUCED IN THE UNITED STATES FROM DIFFERENT RAW MATERIALS, FOR 1914, 1917 AND 1918

	Tons 50 Deg. Bé. Acid			Per Cent of Total		
	1914	1917	1918	1914	1917	1918
From brimstone.....	100,000*	2,350,000	3,580,000	2.6	32.6	48.0
From pyrite:						
Spanish pyrite....	1,900,000	1,650,000	570,000	50.0	22.9	7.6
Domestic pyrite, including "coal brasses" and pyrrhotite.....	600,000	850,000	950,000	15.8	11.8	12.7
Canadian pyrite...	300,000	500,000	550,000	7.9	6.9	7.5
From roasting zinc ores.....	500,000	1,300,000	1,200,000	13.2	18.1	16.1
From waste gases at copper smelters.	400,000	550,000	600,000	10.5	7.7	8.1
Totals.....	3,800,000	7,200,000	7,450,000	100.0	100.0	100.0

* Approximate.

prior to 1895. Table I shows approximately the extent to which brimstone supplanted pyrites in the manufacture of sulphuric acid during the years 1917 and 1918, as compared with the year 1914.

Since the close of the war Spanish pyrites has again become available, and manufacturers are confronted with the problem, At what price per unit of sulphur contained is pyrites cheaper than brimstone, with the latter at a given price? The answer to this question cannot be found in a comparison of the cost of burning a given weight of sulphur from brimstone with the cost of burning the same weight of sulphur from pyrites. The use of pyrites for the manufacture of acid involves additional costs, as compared with brimstone, beyond the burner room. The costs of removing flue dust, of washing sediment out of tanks, towers and chambers, of acid and niter lost in washing operations and of additional niter required, the increased depreciation of chamber plant, the increase in maintenance expense, the decrease in production capacity of chamber plant, with consequent increase in cost per ton of acid for fixed charges, must all be considered. The answer to the question must be sought, then, in a comparative statement of the cost of a ton of acid made (a) from pyrites, and (b) from brimstone.

BURNER EQUIPMENT

The transition from pyrites to brimstone necessitated a change in burner equipment at many plants. Where burners for lump pyrites had been in use, the change was simple and consisted merely in installing pans in the place of the grate bars. Plants equipped with fines burners installed brimstone burners of one of the well-known mechanical types, such as the Glens Falls horizontal rotary burner, or the Vesuvius, or vertical cylindrical, burner.

*Compiled from data given by A. E. Wells and D. E. Fogg in "The Manufacture of Sulphuric Acid in the United States," Bull. 184, U. S. Bureau of Mines, pp. 23, 24.

The latter part of 1919 saw the first successful attempt to make sulphuric acid from copper converter gas. This was done at the plant of the Tennessee Copper Co., at Copperhill, Tenn., and followed close upon the heels of a rather remarkable improvement in blast-furnace practice, whereby the quantity of blast-furnace gas lost into the atmosphere was reduced to a very small percentage. The combination of the more complete recovery of the blast-furnace gas with the utilization of the converter gas increased the percentage of sulphur made into acid, based on total sulphur volatilized at the Copperhill plant, from about 70 per cent to upward of 92 per cent. For the past two years the sulphur fume nuisance has practically been eliminated at Copperhill.

Fig. 1 shows the former smoky condition of the plant

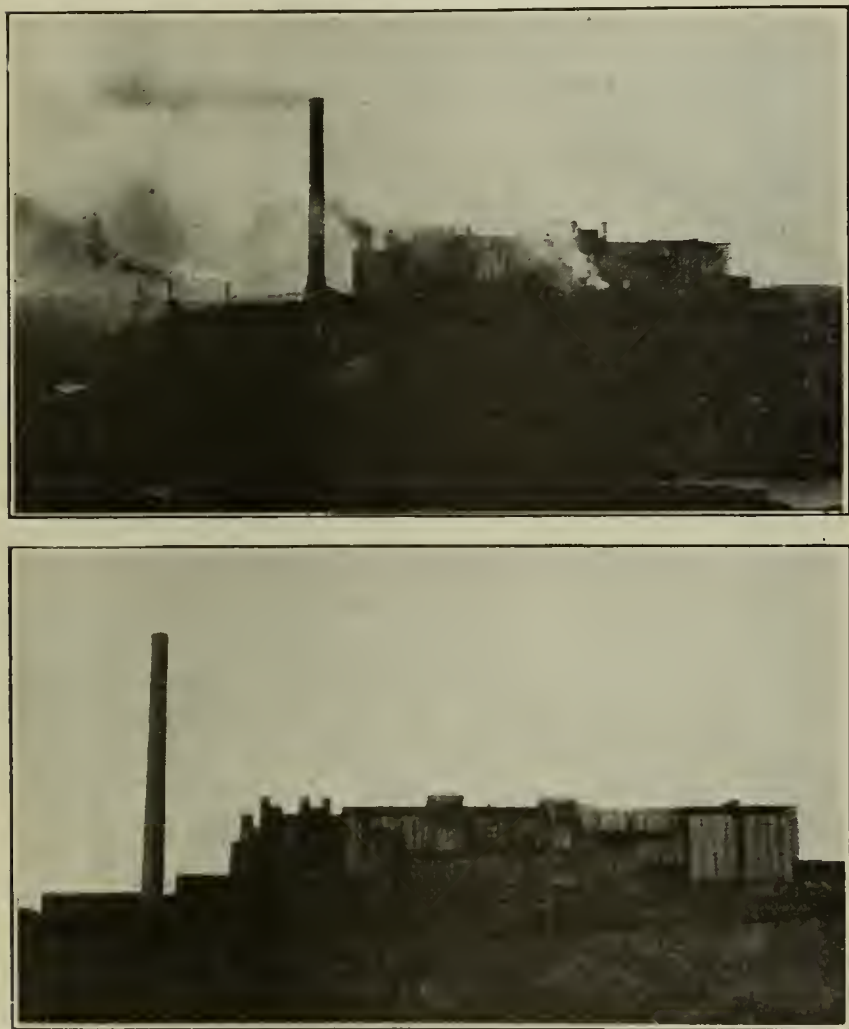


FIG. 1. CHAMBER PLANT OF TENNESSEE COPPER CO., COPPERHILL, TENN., SHOWING CONTRAST BETWEEN FORMER PARTIAL, AND LATER COMPLETE, CONDENSATION OF SULPHUROUS FUMES TO SULPHURIC ACID

of the Tennessee Copper Co. as compared with its present appearance, and clearly indicates the improvement in sulphur recovery efficiency.

The converter gas is blown into the same hot gas flue as the blast-furnace gas, and no attempt is made to keep separate the gases from the two sources. The gases mix in the brick flues, and the introduction of the converter gas has involved no serious complication in operating methods at the acid plants. The successful use of converter gas at Copperhill indicates that sulphuric acid can easily be made from converter gas alone wherever there is a sufficient number of converters in operation to insure an uninterrupted supply of gas.

DUST PRECIPITATION

Flue dust does not concern the acid maker who burns brimstone. Those who burn pyrites, however, or who

make acid as a byproduct of roasting zinc or copper ores or of copper-smelting operations, experience much trouble and expense from the dust coming over with the gas from the burners, roasters or furnaces. At some plants the burner or furnace gas carries, in addition to the dust (fine particles of the furnace or burner charge), metallic fumes, consisting of volatilized metals or metallic compounds, more or less condensed and consisting of very finely divided particles almost as hard to precipitate as the gas itself. The proportion of fume, however, is always small in comparison with the particles of burner or furnace charge, commonly called flue dust, and most acid makers would be content to put up with the fume problem if they could only be rid of the dust.

Various types of mechanical precipitators for flue dust have been briefly described in the recent bulletin by Wells and Fogg.² The same authors have referred to the use of the Cottrell electrical methods for precipitating flue dust from acid-plant gas. In the Cottrell precipitators the gases pass between two electrodes, one of which is grounded, while the other is under a high voltage, 40,000 to 60,000 volts. Two different types of Cottrell dust precipitators have been installed: the pipe treater and the plate treater. In the pipe treater, the grounded electrodes are vertical pipes and the charged electrodes are wires, one of which is suspended vertically in the center of each pipe. The gases may ascend or descend through the pipes, satisfactory distribution of the gas through all the pipes being possible in either case.

In the plate treater the grounded electrodes are parallel plates of steel or sheet iron suspended vertically and arranged parallel to the side walls of the gas flue. Between these plates the charged electrodes are suspended, and the gases either pass horizontally or rise vertically between the parallel iron or steel plates. The first installation of the plate treater had chains for the charged electrodes. More recently narrow strips of steel have been substituted for the chains, and, it is said, have been found more satisfactory. The treaters are designed to electrify the dust or condensed fume particles as the gases pass between the electrodes, so that the electrified dust or fume may be precipitated, chiefly on the grounded electrode. Means for vibrating the electrodes for the removal of accumulated dust may be provided, and the flue is preferably constructed with a hopper-shaped bottom to facilitate the removal of dust. Spare units of Cottrell treaters should always be installed, provided with suitable dampers so that when necessary to clean or repair one unit the gases can be shut off from such unit and passed through the others without interrupting plant operations.

INSTALLATIONS OF ELECTRICAL TREATERS

The initial experiments for the precipitation of dust by the Cottrell process from the hot gases of a sulphuric-acid plant were conducted at the Cleveland plant of the Grasselli Chemical Co. The commercial installations which have been installed include two treaters for the Baugh Chemical Co., Canton Works, Baltimore, Md., two treaters for the General Chemical Co., Delaware Works, and one treater each for the National Zinc Co., Kansas City, Kan., and the Grasselli Chemical Co., Cleveland, Ohio. Some of these treaters are at present not in operation due to burning brimstone in lieu of dust-forming ores. The apparatus used in each case

²Op. cit., pp. 74-75.

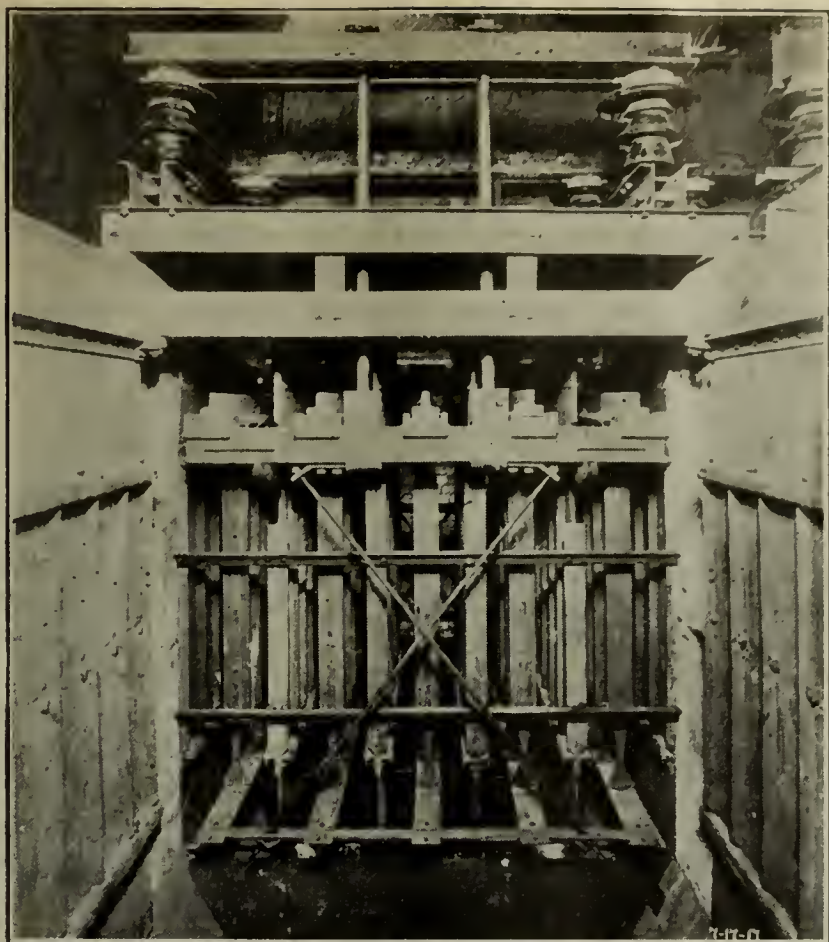


FIG. 2. INTERIOR VIEW OF COTTRELL DUST PRECIPITATOR, PLATE TYPE, FOR CLEANING HOT GASES FROM PYRITES BURNERS

consists of two horizontal chambers in parallel, with dampers in the inlet and outlet gas connections of each.

In the first plate treaters installed for the precipitation of dust from acid-plant gases the plates were too thin and were not ribbed sufficiently to prevent buckling in the hot gas. Trouble was also experienced in the method of supporting the discharge electrodes in the hot gases due to failure of the insulators and steel supporting beams. These difficulties, it is claimed, have been overcome by hanging the discharge electrodes on cast-iron beams and by using heavier plates with more substantial ribbing. These cast-iron beams are in turn suspended on steel tension rods passing through the roof of the flue, from which they are insulated electrically by fused silica bushings. The rods are hung from a steel framework outside the precipitator carried on tapered corrugated porcelain insulators 24 in. high.

EFFICIENCY TEST ON COTTRELL PRECIPITATOR

The right to the electrical precipitation process as applied to cleaning the gases from pyrite burners throughout the United States, with the exception of six of the far Western States, is owned and controlled by the Research Corporation, 25 West 43d St., New York City. Although plate treaters have been installed by this company at one chamber plant operating on pyrites fines, no numerical data on the efficiency of these treaters in precipitating dust are available. Efficiency tests have been made, however, on the improved type of plate treater installed at a contact sulphuric-acid plant in the East, and the data in Table II, obtained from one such test, have been furnished by the courtesy of the Research Corporation.

During this efficiency test the amount of sulphur burned out of the ore per burner per day was 9,350 lb., and as there were six burners the total sulphur burned was 56,100 lb. per day, equivalent, at 95 per cent sulphur recovery, to about 210,000 lb. of 60 deg Bé. acid. Since

TABLE II. RESULTS OF EFFICIENCY TEST ON COTTRELL DUST TREATER, PLATE TYPE

Dust and Elements in the Dust	Pounds Precipitated	Percentage Precipitated	Pounds Not Precipitated	Percentage Not Precipitated
Dust.....	1,700.00	98.94	18.25	1.06
Soluble iron.....	14.45	83.24	2.95	16.76
Arsenic.....	70.00	24.21	218.00*	75.79
Lead.....	262.00	81.59	59.00*	18.41

The partial analysis of the precipitated dust was as follows:

	Per Cent
Sulphur.....	4.17
Soluble iron.....	0.85
Lead.....	15.40
Arsenic.....	4.11
Acidity.....	5.98
Total.....	30.51

The remainder of about 70 per cent was assumed to be chiefly oxides of iron.

* This weight is evidently considered to be present in the hot gas as volatilized metallic fume, not as dust.

18.25 lb. of dust, 2.95 lb. of soluble iron, 218 lb. of arsenic and 59 lb. of lead escaped precipitation by the Cottrell apparatus, those amounts of impurities would be contained in the 210,000 lb. of 60 deg. acid, if chamber acid had been made from the gas, instead of contact acid. The percentage of impurities in the 210,000 lb. of acid would then have been:

	Per Cent
Dust ³	0.0087
Soluble iron ⁴	0.0014
Arsenic ⁴	0.1037
Lead ⁴	0.0284

It is interesting to note that the arsenic was the least efficiently precipitated, due, no doubt, to the fact that it was present in the gas chiefly as uncondensed fume, and not as dust.

The cost of such a Cottrell installation for cleaning the hot gases from pyrites burners capable of burning 30 tons of sulphur per day is given by the Research Corporation as about \$60,000. The gas volume produced by the burning of the tonnage of sulphur stated would be about 20,000 cu.ft. of gas per minute, at 1,000 deg. F. The operating cost is small. Power consumption would be 1.5 kw. for the entire installation, and the only operating labor required would be an occasional inspection by the plant electrician, and labor once a week to remove the dust from the treater.

The Research Corporation states that a 90-day test on such an installation, while treating a volume of gas of from 17,000 to 22,000 cu.ft. per minute at a temperature of from 800-1,000 deg. F., with a temperature drop through the installation of about 100-125 deg. F., has shown a dust removal of 99 per cent continuously. Fig. 2 shows the interior of a Cottrell precipitator for cleaning hot gases from pyrites burners, and Fig. 3 is a photograph of the electrical equipment employed.

SCREEN TYPE OF ELECTRICAL TREATERS

A modification of the Cottrell treater for the precipitation of dust from hot gases has been developed by R. B. Rathbun, of the American Smelting & Refining Co. The main feature of this modification, on which patents are pending, is the use of sheets of iron screen, with diamond-shaped or square meshes about 2 in. wide, placed transverse to the direction of flow of the gases, and parallel to each other, with an intervening space of about 6 in. between adjacent screens, instead of the

³Total solids in the gas at the temperature at which the gas was cleaned.

⁴Probably present as a vapor at the temperature at which the gas was cleaned.

iron plates of the treater advocated by the Research Corporation. In some instances the wire screen has been replaced by expanded metal having diamond-shaped meshes of the desired width. Midway between the sheets of screen, or of expanded metal, as the case may be, wires are suspended vertically—about 6 in. apart across the width of the flue, with alternate rows of wires staggered. The screens are the grounded electrodes, and the wires the charged electrodes. This type of treater may be called the "screen treater," to distinguish it from the Cottrell treaters of the Research Corporation. High voltage is used, as with the Cottrell treaters.

The screen treater offers the apparent advantages over the Cottrell plate treaters, (a) that the grounded electrodes are placed transverse to the direction of gas

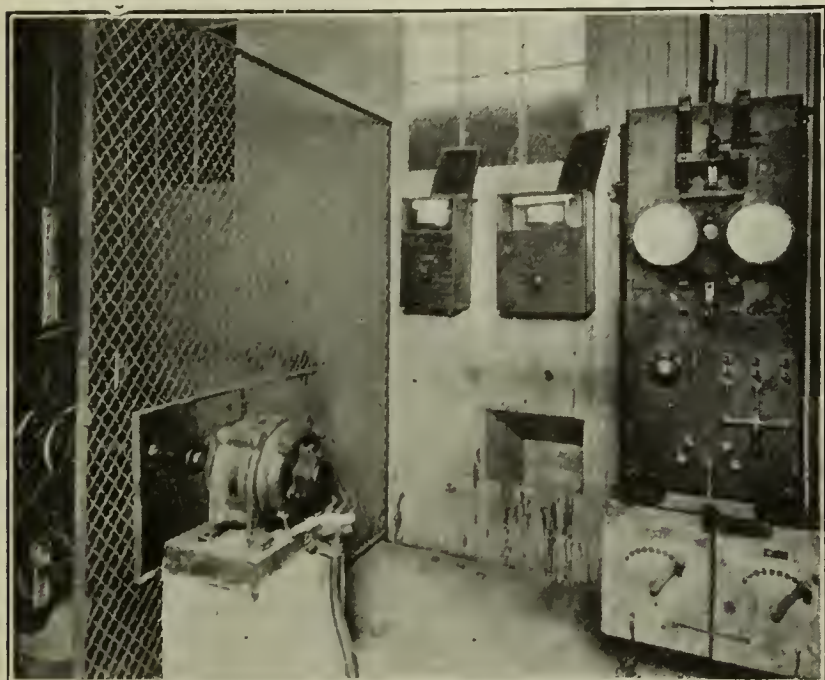


FIG. 3. ELECTRICAL EQUIPMENT FOR USE WITH COTTRELL ELECTRICAL PRECIPITATION PROCESSES

flow instead of parallel thereto; and (b) that the screens themselves, without any electrical equipment, are of a form adapted for the precipitation of dust. From time to time the screens and wires are jarred to shake off adhering dust, and during the operation of jarring or tapping, the gases are diverted into another flue. In some cases the efficiency of the screen treater seems to have been improved by injecting a finely divided spray of sulphuric acid, at intervals, into the gas stream, and this spray lodges temporarily on the screens and wires. The screen treater is said to be in successful use at some of the plants of the American Smelting & Refining Co. for the precipitation of dust from the gases of lead-smelting furnaces, where the temperature of the gas is in the neighborhood of 400 deg. F.

The burner or furnace gases of an acid plant are, of course, much hotter than this, and the results of the application of the screen treater to gases of a temperature of 800-1,000 deg. F. will be awaited with interest.

After leaving the dust chamber, or the electrical treater, as the case may be, the hot gases pass first to the niter potting equipment, if any, and then into the Glover tower.

NITRATION EQUIPMENT

On account of the inconvenience caused by the accumulation of niter cake in the hot gas flues, there has been a tendency of late, where niter pots are used, to install these outside of the flues, and fire them with

coal. In some cases, where the gases are not hot enough to "cook" the niter efficiently, outside pots are a necessity, if pots are used at all. The coal expense has been found to amount to from 1c. to 4c. per ton of 60 deg. acid produced, and this expense is less than the losses incurred in shutting down the entire plant in order to clean niter cake out of choked gas flues. The coal fired pots have, too, proved very efficient in facilitating a quick "catching" of the process, in starting a new plant, or in starting up after a temporary shut-down.

SPRAYING NITER SOLUTION INTO CHAMBER

At some plants nitration is effected by spraying a solution of nitrate of soda through atomizing nozzles located in the lead top of the front chamber. The strength of solution used is different at different plants, but at any one plant it should not vary appreciably. Some plants use solutions as low as 13 deg. Bé., others as high as 25 deg. Bé. A solution which is too weak may result in low drips and weak acid in the front chamber, while too strong solutions may not afford sufficient flexibility in controlling the supply of niter to the best advantage. The admission of nitrate solution into the front chamber results in the formation of sulphate of soda in the acid, and in many cases this is objectionable. Failure to maintain close inspection of the atomizing efficiency of the spraying nozzles may result in streams of liquid solution falling into the acid in the pan of the front chamber, with subsequent formation of liquid nitric acid, followed by undue corrosion of the bottom lead of the chamber. Where the acid is allowed to flow from the front chamber to other chambers, this corrosion may spread throughout the entire plant.

At times when it is desired to operate the chambers at a capacity much below normal, the temperature of the front chamber may be too low to vaporize the atomized niter solution, and liquid solution may fall to the bottom of the chamber. At such times, too, the burner gases may not be hot enough to cook properly the niter in pots located inside the hot gas flue; and in such cases the outside coal-fired pots are very desirable. Spraying niter solution into the front chamber has the advantage that it is a labor-saving device. Under certain conditions it is a more desirable method of nitration than potting. Other means of nitration, such as feeding nitric acid or nitrosulphuric acid into the Glover tower, are well known.

NITRATION BY OXIDIZED AMMONIA GAS

During the war a development of the attempts to use atmospheric nitrogen for the manufacture of nitric acid, either by the cyanamide process or by modifications of the Haber process, was a successful catalytic method of oxidizing ammonia gas to oxides of nitrogen, by passing the former through incandescent platinum gauze. In the early stages of the development of this method the platinum catalyzer was electrically heated; later this external heat was found to be unnecessary. This catalytic method of oxidizing ammonia gas has been fully described by Parsons⁵ and by Perley.⁶

Information received by the author indicates that equipment for oxidizing ammonia gas has been installed

⁵Charles L. Parsons, "Commercial Oxidation of Ammonia to Nitric Acid," *J. Ind. Eng. Chem.*, vol. 11, p. 541 (June, 1919).

⁶George A. Perley, "The Commercial Oxidation of Ammonia," *J. Ind. Eng. Chem.*, vol. 12, p. 5 (January, 1920); and p. 119 (February, 1920).

at several sulphuric-acid plants in England and at one plant at least in the United States, and that the nitration of the chamber process has been effected by this means. The installation in the United States referred to was at the plant of the Ammo-Phos Corporation, a subsidiary of the American Cyanamide Co., at Warners, N. J. This equipment was installed in 1916, and has been referred to by Pranke,⁷ who gives a tabulated statement as to the efficiency of the electrically-heated catalyzers.⁸ No data are available as to the actual cost of operating this equipment, as compared with operating the usual sulphuric-acid plant niter-potting equipment, and even if such data were available, it would have to be taken into account that this particular installation was at the plant of a company which is itself a manufacturer of the raw material, and others who would have to purchase the ammonia might find themselves in a less favorable position.

The catalyzers developed by the Government at Nitrate Plant No. 1, Sheffield, Ala., dispensed with the equipment for electrically heating the platinum gauze, and it is claimed that the oxidizing efficiency of the improved catalyzers has been brought up to 95 per cent and higher. Costs for operating labor are very much less with the ammonia oxidation equipment than with niter-potting equipment. Over a period of 22 years, according to The Barrett Co., of New York City, nitrogen as ammonia has cost slightly more per unit than nitrogen as nitrate of soda; but if ammonia can be bought on a sliding scale on an approximate parity with prevailing prices for nitrogen as nitrate of soda, the cost of the raw material should not be an important factor.

FACTORS TO BE CONSIDERED IN SUBSTITUTING AMMONIA OXIDATION FOR NITER POTTING

For those acid manufacturers who are contemplating a change from niter potting to ammonia oxidation, some of the important features to consider are:

1. First cost of plant, as compared with cost of niter-potting equipment.
2. Comparative costs of maintenance of plant.
3. Comparative rate of depreciation of plant.
4. Relative cost of raw materials per unit of nitrogen contained.
5. Comparative efficiency, in producing oxides of nitrogen, of ammonia oxidation apparatus versus niter pots.
6. Comparative cost of operating labor.
7. Comparison of freedom from interruptions, in service, of the two types of equipment.
8. Ability to obtain an adequate and unfailing supply of ammonia, delivered in the quantities and at the times required, to insure uninterrupted operation of the ammonia oxidation apparatus after having once installed it. (The maintenance of a niter-potting equipment as a reserve should not be considered.)
9. Probability of wastage of liquid ammonia and of ammonia gas, through leaks and spills, as compared with wastage of nitrate of soda.
10. Actual arrangements, ascertained by inquiry of the ammonia dealers, which it is possible to make in this country for the purchase of ammonia, either as sulphate or as liquor, over a period of years.

Atlanta, Ga.

(Part II will be published in a subsequent issue.)

Corrosion Protective Action of Certain Colloidal Solutions

BY WILBERT J. HUFF*

IN CONNECTION with an investigation concerning the causes and prevention of after-corrosion in the bores of firearms, information was obtained upon corrosion beneath oil films. It appeared advisable to supplement this information with additional experiments and to present the whole.

Oils of many types are universally employed for the temporary protection of bright iron and steel surfaces and have, in general, proved adequate. Nevertheless, repeated examples have shown that ordinary oil coatings may fail almost completely. The circumstances surrounding such failures are generally interesting and sometimes puzzling. The writer recently received the complaint that the physical condition of the workman appeared to influence the protective action of petrolatum, for polished steel surfaces packed beneath a coating of this by one workman corroded more frequently than similar surfaces packed by another. The corrosion sometimes traced finger prints. Rifle parts handled by persons afflicted with gout are said to corrode in spite of careful cleaning and oiling.

MECHANISM OF CORROSION UNDER OIL FILMS

In a paper¹ already published the writer has shown that ordinary oils alone possess no value for the protection of the bores of firearms against after-corrosion following use. Oil films are permeable to water vapor and their anti-corrosive action rests upon the preferential wetting of the metal by the liquid oil which thus interposes a non-conducting film between liquid water and the metal. In the absence of contact between the liquid water and the metal, corrosion cannot occur. The discharge of the firearm deposits a water-soluble compound (potassium chloride) over the bore surface. Exposed to a rather high humidity, this compound deliquesces beneath ordinary oil and so forms a corrosive aqueous film in direct contact with the metal.

This mechanism applies to many cases of corrosion beneath oil films. A water-soluble salt (sodium chloride) is an important part of perspiration residues, hence the finger prints. The excretion of perspiration is dependent upon physiological conditions which vary to some extent from worker to worker, hence the personality factor.

Corrosion under oil caused by corrosive water-soluble compounds presents very important problems. A vast number of manufacturing, assembling and packing operations involve handling, with the concomitant danger of salty perspiration residues. Moreover, similar forms of corrosion may be expected where iron or steel surfaces are exposed to finely divided salts carried mechanically through the air (a common condition near the ocean and in the presence of certain manufacturing operations) or where such surfaces are exposed to certain volatile water-soluble compounds.

A second serious menace presented by such water-soluble compounds is their ability to form corrosive

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¹A paper read at the semi-annual meeting, New York City, Sept. 8, 1921, and published by permission of the American Chemical Society.

*Research chemist, Pittsburgh Experiment Station, Bureau of Mines.

²Huff, W. J., "The Cause and Prevention of After-Corrosion on the Bore Surfaces of Firearms," *J. Ind. Eng. Chem.*, September, 1920, vol. 12, p. 862.

⁷E. J. Pranke, "Development in Nitric-Acid Manufacture in the United States Since 1914," *CHEM. & MET. ENG.*, vol. 19, p. 395 (Sept. 25, 1918).

⁸See American Fertilizer Hand Book, 1920, p. D-3.

liquid films at humidities which may be much below that humidity at which clean iron and steel corrode.¹

Were all the surfaces upon which the water-soluble compound is deposited accessible, the prevention of such corrosion would be a relatively simple matter. Such surfaces can be given a thorough preliminary washing with water, followed by wiping. They may then be oiled with safety. Drying by evaporation following the use of tap water is not to be recommended, since such water contains salts which would thus be deposited upon the metal surfaces. Unfortunately, the bright surfaces of many assembled parts are so inaccessible that it is impossible to wipe them dry.

Experiments given below show that the water may be absorbed into a suitable emulsion. Such emulsions are almost ideal agents, for they are non-corrosive and may be readily forced over very inaccessible surfaces.

Six plates 2.5 x 3 x 0.2 cm. were cut from the same piece of steel and machined to a uniform surface. They were all carefully washed with soap and water, a hot 10 per cent solution of sodium carbonate, distilled water, alcohol and finally ether, in the order given. They

TABLE I. ANTI-CORROSIVE ACTION OF CERTAIN EMULSIONS WHEN AN EXCESS OF THE EMULSION IS IN CONTACT WITH THE STEEL

Plate No.	Medium	Change in Weight	
		First Exposure Two Days	Second Exposure Five Days
1	Ammonium oleate plus water	Gain 0.5 mg.	No change
2	Ammonium oleate plus water	Loss 0.1 mg.	Loss 0.1 mg.
3	Water-oil emulsion	Gain 0.1 mg.	Loss 0.3 mg.
4	Water-oil emulsion	Gain 0.2 mg.	No change
5	Distilled water	Loss 12.5 mg.	Loss 28.3 mg.
6	Distilled water	Loss 12.5 mg.	Loss 27.1 mg.

were then carefully weighed. Two were suspended in distilled water, two in an emulsion of ammonium oleate two parts and water one hundred parts, and two in an emulsion of one volume of the above ammonium oleate solution with one volume of neutral transformer oil (sp.gr. 0.855 at 15.5 deg. C.). The depth of immersion and the access of light and of air were identical in all three systems.

Throughout both exposures, plates 1, 2, 3 and 4 maintained their initial polish. Table I shows that bright steel surfaces may be left in contact with an excess of either emulsion safely for many days. After the second exposure all six plates were immersed in their respective solutions for an hour, then exposed to a laboratory atmosphere for twenty-seven days. At the end of that time all adhering material was removed and the change in weight determined.

The loss of weight of plates 1 and 2 was due to the formation of iron oleate, which was readily loosened, leaving the luster of the surface somewhat dimmed. The slight loss of weight of plates 3 and 4 was due to the formation of a trace of iron oleate. Under the conditions of Table II the emulsion containing oil is much to be preferred to the ammonium oleate-water emulsion. This may be due to the lower concentration of free oleic acid in the adhering film.

A comparison of the results shown in Tables I and II for plates 1, 2, 3 and 4 shows that a large amount of water may, under some conditions, aid in preventing attack. The chief loss in the conditions of Table I to give these of Table II is water, since the soap, oleic acid and oil are only slightly, if at all, volatile, and it will be shown below that the possible loss of free ammonia in itself is probably not of much consequence.

The anti-corrosive properties of ammonium soap solution shown above are apparently not unusual, for sodium

and potassium soaps in distilled water likewise prevent corrosion. This is true even in the presence of an excess of oleic acid. It is possible that other emulsions superior to the ammonium soap solutions studied could be prepared by the aid of other soaps.

Although not specially investigated, observations indicated that these soap solutions and emulsions hold their anti-corrosive properties in the presence of low concentrations of corrosive salts. However, it is not safe to allow the concentration of such salts to rise while the mixture is in contact with iron and steel surfaces, for by evaporation, concentrations can be reached at which corrosion results. Thus a piece of steel immersed in a solution of potassium chloride (1 per cent) containing a sodium soap (about 2 per cent), then exposed to evaporation, gave characteristic pitting rust so often noted in salt corrosion. A second piece immersed in a solution of the same soap (about 2 per cent) in distilled water, then exposed to evaporation, remained perfectly bright under analogous conditions.

The protective action of the soap solutions and emulsions can hardly be due to their alkalinity, for the ammonium soap solution used in the above experiments retained its anti-corrosive properties after air had been blown through it for several days to drive out any ammonia which might have been formed by hydrolysis. A better explanation suggests the preferential coating of the metal surface by the colloid or oil, resulting in the formation of a non-conducting film. This preferential coating action probably explains the anti-corrosive action of oils to which certain peptizing agents

TABLE II. ACTION OF CERTAIN EMULSION RESIDUES WHEN ALLOWED TO EVAPORATE IN CONTACT WITH STEEL

Plate No.	Medium With Which the Plate Was Initially Coated	Change in Weight
1	Ammonium oleate, plus water.....	Loss 2.8 mg.
2	Ammonium oleate plus water.....	Loss 2.5 mg.
3	Oil-water emulsion.....	Loss 0.3 mg.
4	Oil-water emulsion.....	Loss 0.4 mg.
5	Distilled water.....	Gain 0.1 mg.
6	Distilled water.....	Gain 0.5 mg.

have been added. Exposed to the atmosphere, under certain conditions, such a mixture takes up sufficient water to form an emulsion, the aqueous phase of which dissolves the corrosive compound. The use of such oil-peptizing mixture is not, however, entirely satisfactory, since the supply of compound may be relatively large or the rate of supply of moisture from the atmosphere relatively small, thus permitting the formation of a concentrated electrolyte which may not emulsify readily, but may instead remain in contact with the metal at some point and so cause corrosion. A somewhat more satisfactory expedient is to use an emulsion containing considerable water, thus insuring a low concentration of salt in the aqueous phase. Here, again, the expedient is not ideal, for the vapor pressure of the aqueous phase may endanger a portion of the metal not protected by actual contact with the oil or colloid. Moreover, a low atmospheric humidity may so concentrate the emulsion that this may break and deposit a corrosive residue in contact with the metal.

At present it is believed that thorough washing with water, followed immediately by a careful rinsing with a suitable emulsion and lastly by a coating of oil, is the best treatment available for the temporary protection of inaccessible bright steel surfaces.

Chemical Research Laboratory,
Pittsburgh Experiment Station,
Bureau of Mines.

Nitrogen in Carburized Steels

Nitrogen Plays a More Important Role in Everyday Metallurgy Than Is Generally Supposed—Many Commercial Carburizers Introduce Considerable Amounts of This Element—Micrographic Methods for the Detection of Nitrogen Compounds Worked Out and Described

BY W. E. RUDER AND G. R. BROPHY
Research Laboratory, General Electric Co.

THE presence of nitrogen in steel under certain conditions has been recognized for forty years, although little attention was paid to its effect until 1905, when Braune and later Strauss studied its effect in quantities greater than those ordinarily found in commercial practice.¹ Since the revival of interest in the effect of nitrogen, due to the study of its marked influence upon the ductility of electric arc welds, its presence in at least two other important conditions has been suggested. Lieutenant Wheeler² and Knight³ have advanced a most plausible theory that nitrogen is the active agent in the hardening and erosion of gun liners. Brophy and Leiter⁴ demonstrated that case-hardening by the cyanide process is largely a nitroge-nizing rather than a carburizing process.

The work reported in this paper is a continuation of this latter investigation and deals with the introduction of nitrogen by solid carburizers such as are largely used commercially, and the effect of various elements often found in alloy steels.

ETCHING FOR NITROGEN

The presence of nitrogen may frequently be detected by the nitride needles which are quite characteristic,

¹Comstock and Ruder, "The Effect of Nitrogen on Steel," *CHEM. & MET. ENG.*, vol. 22, p. 399 (1920).

²Wheeler, "Nitrogen in Steel and the Erosion of Guns," *Mining and Metallurgy*, No. 160, April, 1920.

³Knight and Northrup, "Notes on the Effect of Nitrogen on Steel," *CHEM. & MET. ENG.*, vol. 23, p. 1107 (1920).

⁴*Trans., Am. Soc. Steel Treathers*, March, 1921, *CHEM. & MET. ENG.*, vol. 23, p. 968.

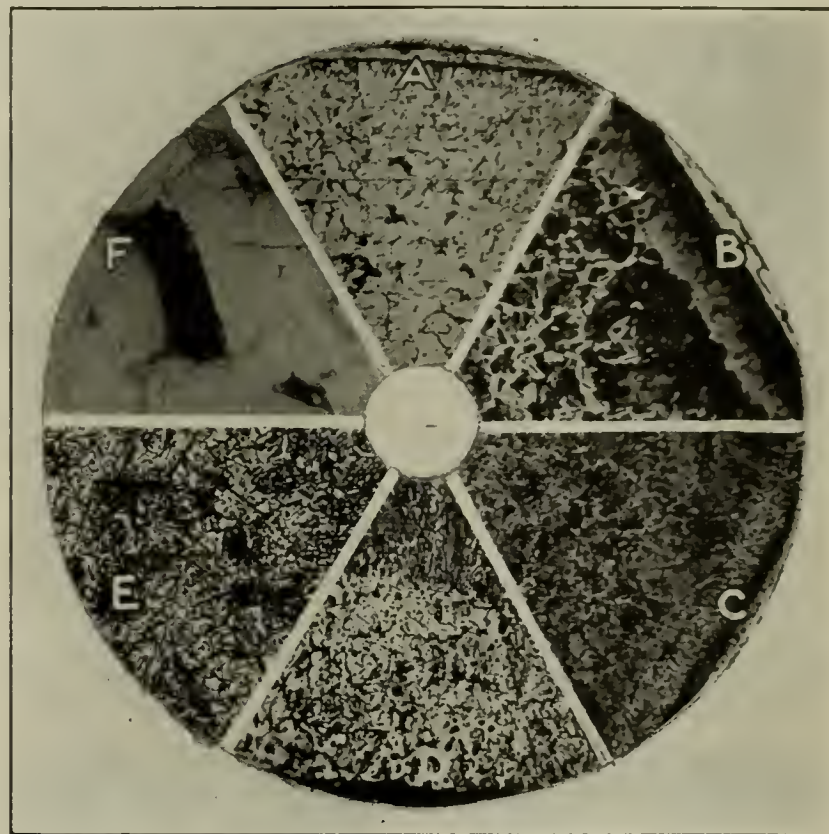


FIG. 2. EFFECT OF HEATING CARBON STEELS IN CHARRED LEATHER

A and F, electrolytic iron at 100 and 400 dia. respectively.
B and E, 0.50 C steel at 100 and 400 dia. respectively.
C and D, 0.90 C steel at 100 and 400 dia. respectively.

but when it is present as a solid solution in the ferrite or as a eutectoid (possibly between FeN and Fe) its presence may easily be overlooked. In the latter form it resembles an imperfect form of pearlite.

Heat-tinting gives a clue to its presence when dissolved in the ferrite, as ferrite grains containing dissolved nitride color much more rapidly than pure ferrite.

In order to distinguish between nitrogen patches and pearlite a $\text{CuCl}_2 + \text{HCl}$ reagent was developed which has given excellent results. This has already been briefly described⁵. The sample is polished in the usual manner, after which it is washed and dried carefully with a soft cloth. Stead's (phosphorus) reagent has been found to have about the right proportions of Cu and HCl and since it is one usually found in all metallographic laboratories is recommended for use. The proportions are 2.5 g. CuCl_2 , 10 g. MgCl_2 , 6.25 c.c. HCl and 250 c.c. $\text{C}_2\text{H}_5\text{OH}$. Just enough hot water is used to dissolve the MgCl_2 and CuCl_2 . The surface of the sample is covered with the reagent, and as soon as a copper deposit shows on the surface the sample is washed, dipped into hot water and dried with a single blast of compressed air. The washing and drying must be performed rapidly or there is danger of discolora-

⁵*CHEM. & MET. ENG.*, vol. 22, p. 403 (1920). Wheeler, "Nitrogen in Steel," discussion by W. E. Ruder, *Mining and Metallurgy*, April, 1920.



FIG. 1. PURE IRON AFTER HEATING WITH SIX COMMERCIAL CARBURIZERS. ETCHED WITH HNO_3

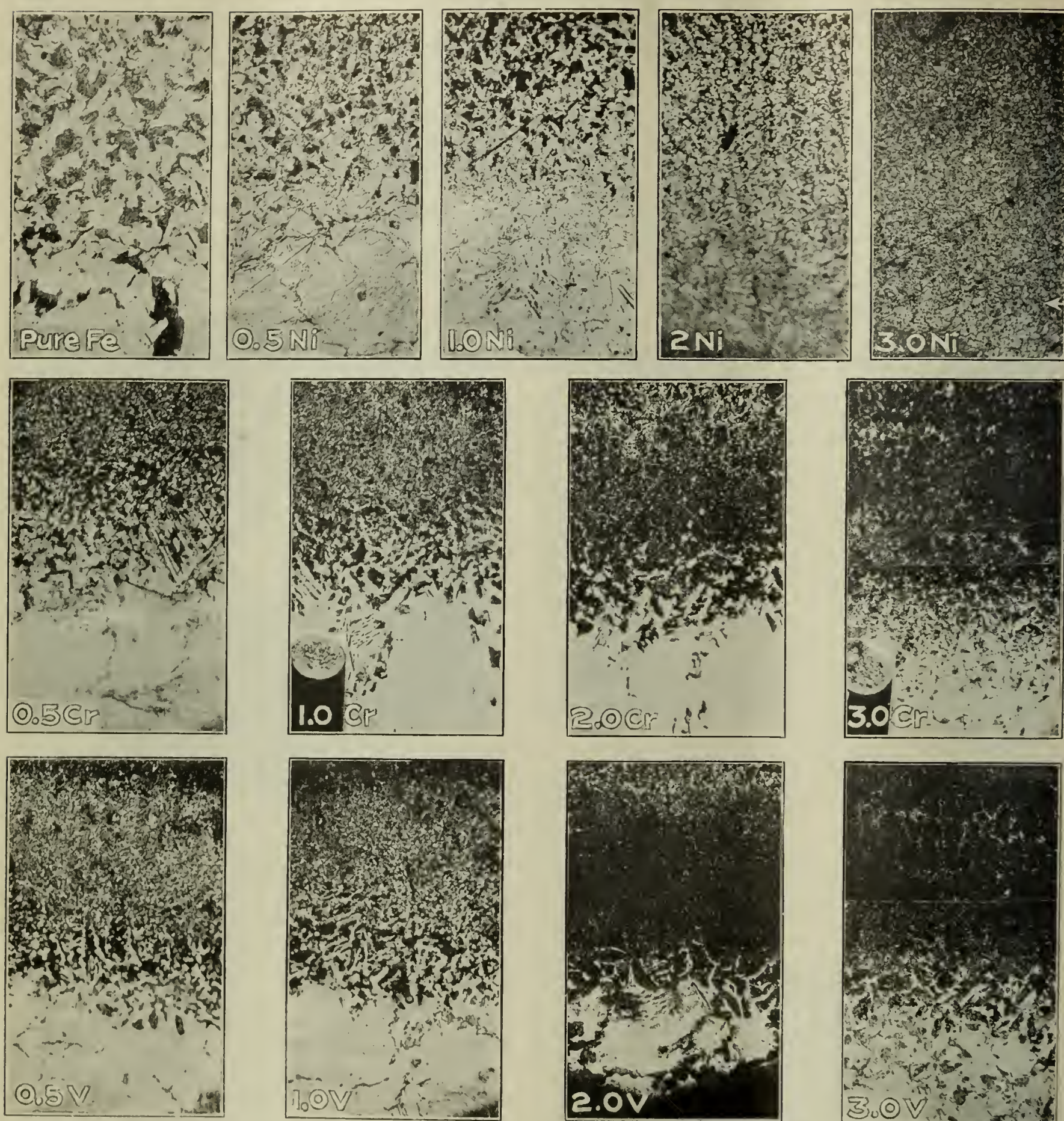


FIG. 3. MICROSTRUCTURE OF CYANIDED ALLOY STEELS. ETCHED WITH HNO_3 . $\times 200$

tion, leading to erroneous conclusions. The etching solution must not be permitted to dry on the surface—more solution should be added if the deposit is slow in forming.

When properly etched the ferrite is covered with copper, the cementite remains bright and the pearlite is also white. The nitride needles and the white (nitride?) hard constituent of the eutectoid patch are black. On further etching the pearlite also becomes copper plated, but the cementite remains white and the nitride etches out and, in appearance, remains dark. If the sample has been previously etched with nitric or picric acid, it should be repolished before applying this reagent.

Comstock⁶ finds that the use of an additional reagent aids in making the distinction more certain. He suggests boiling the specimen for 10 to 30 minutes in a reagent, 10 g. KOH and 1 to 4 g. $\text{K}_3\text{Fe}(\text{CN})_6$, dissolved in 100 c.c. of water. With this treatment cementite is blackened, pearlite and sorbite are turned brown and the "massive" nitride constituent is unchanged or at most slightly stained. In our experience this latter treatment has rarely been found necessary.

It is to be noted that this use of a cupric reagent is distinctly different from other applications of this versatile metallographic reagent. It has been used for

⁶Discussion, "Nitrogen in Steel," *Mining and Metallurgy*, No. 160, April, 1920.

the detection of phosphorus, nickel, cobalt, tin, antimony, silicon, carbon and oxygen when present in solid solution.⁷ In such cases it owes its value to the fact that solid solutions of these elements in iron are electro-positive to pure iron and remain white while copper is deposited on pure ferrite. In the case of the nitrogen compounds the action is more positive, as they are actually attacked by the reagent and blackened. Heat-tinting colors nitrogen areas first, in this resembling the action of other elements such as phosphorus. Oxygen existing in solid solution or around the grain boundaries is also distinguished from nitrogen, which often exists in the same position, by the fact that oxygen areas remain white, while nitrogen areas turn dark.

NITROGEN INTRODUCED BY CASE-HARDENING

Many case-hardening operations, especially cyaniding, introduce varying amounts of nitrogen. It has been shown that the hardness was largely due to nitrogen and not alone to the 0.30 per cent C introduced, which is not sufficient to cause the hardness found. The action of N_2 , as far as our experiments have gone, is very much like that of carbon, and the resulting structures are very much alike. The copper reagent makes a clear distinction, but does not photograph well. However, after some experience nital etching is sufficiently good, as the forms of patches and needles are characteristic. The patch and needle structure are formed best after annealing.

Case-hardening appears to consist of two distinct elements: (1) Nitrogenizing—the most important hardening element in cyaniding, whether the molten, gas or cyanamide process is used—and (2) carburizing—when solid or gaseous carburizer are used which do not contain too much of the nitrogen-bearing “energizers.”

COMMERCIAL CARBURIZERS

Nitrogenous materials are very often added to commercial carburizers on the assumption that they aid in the penetration of the carbon. We know now, however, that this is not the case. The effect is one of additional hardness, due to combined nitrogen. This nitrogen penetrates deep into the specimen, and nitrogen needles are found inside the case proper. The brittle-

⁷Stead, *Engineer*, vol. 111, p. 627 (1921).

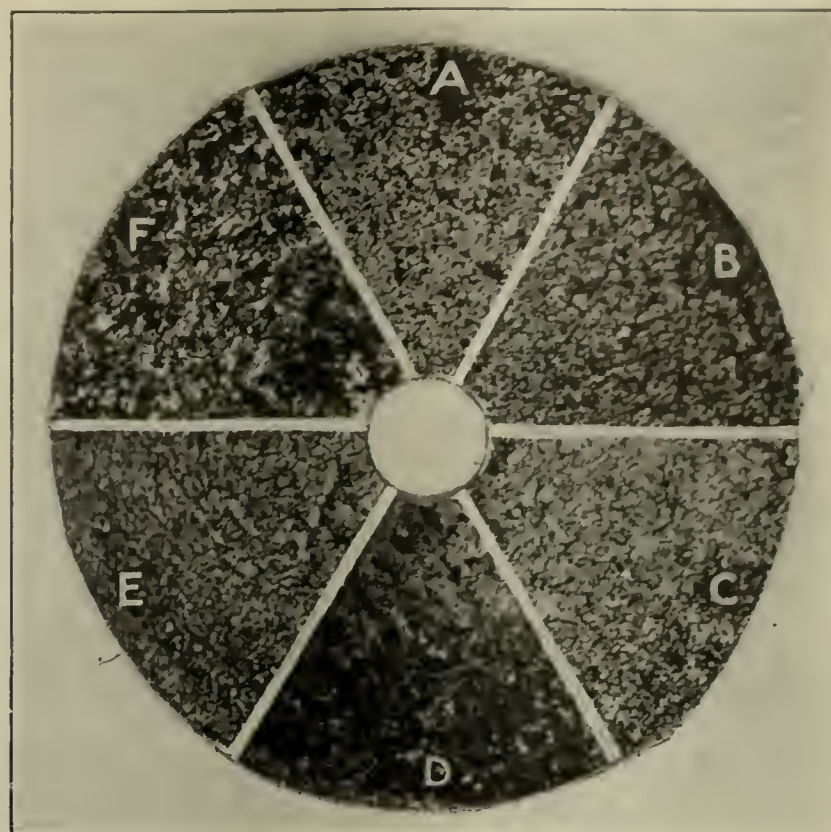


FIG. 5. MICROSTRUCTURE OF COMMERCIAL STEELS AFTER CYANIDING. ETCHED WITH HNO_3 . $\times 200$

- A, 1.5 per cent Ni steel.
- B, 3.5 per cent Ni steel.
- C, 0.5 per cent Cr steel.
- D, 1.0 per cent Cr steel.
- E, 0.25 per cent V steel.
- F, 0.50 per cent V steel.

ness caused by this nitrogen may well be the cause of numerous and perplexing cases of exfoliation.

Through the courtesy of several well-known manufacturers of carburizing compounds, samples were obtained and carbonless iron rods were carburized in them. Resulting structures are shown in Fig. 1. Each section represents a different brand of carburizer. A and B are very high in N, being obtained with green bone and leather, respectively; C and D have small amounts of N and E and F are entirely free of N. All of these micrographs are of spots in the “needle zone” of the case which is at the boundary between case and core. A and B, at 200 diameters, are practically pure nitrogen cases obtained with green bone and leather, respectively. In C and D, at 500 diameters, attention is called to the “angular” shape of the pearlite; it is also not well laminated. These points, particularly the former, are characteristic of pearlite which

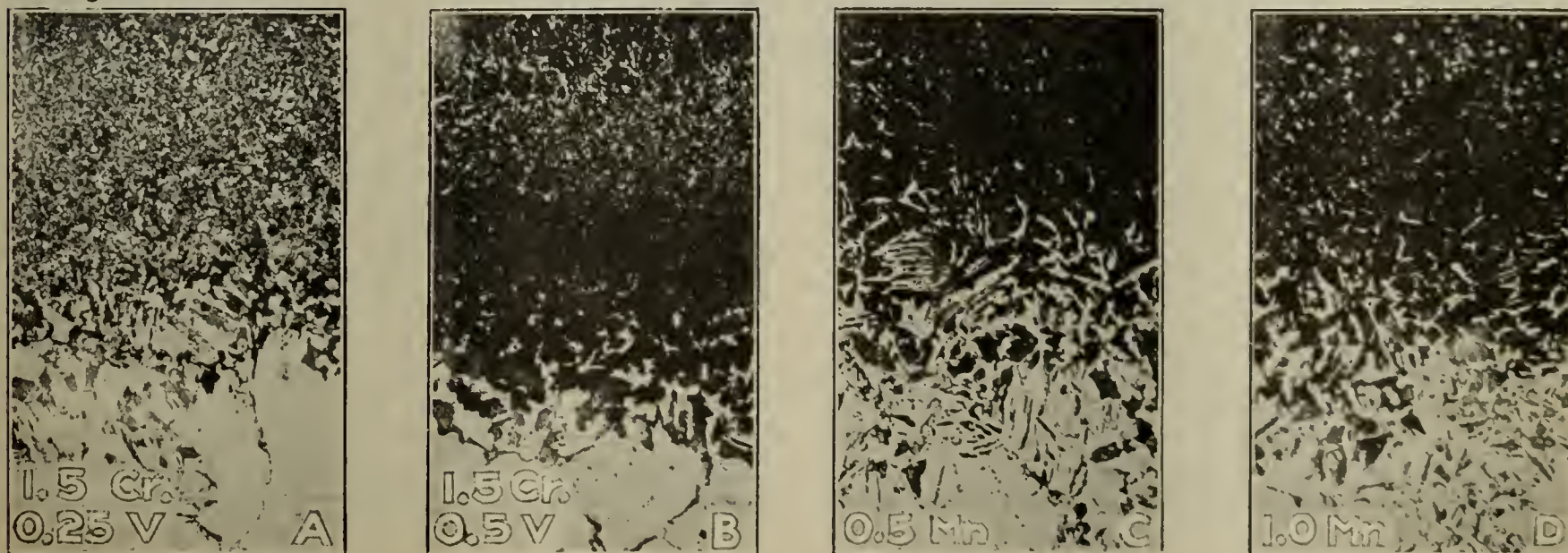


FIG. 4.

A and B, microstructure of cyanided Cr-V steels. $\times 200$. C and D, microstructure of cyanided manganese steels. $\times 200$.

contains nitrogen. The needles in the ferrite are unmistakable. *C* to *F* are of higher power (500 diameters) than *A* and *B*, to bring out the structure of the pearlite.

DETECTION OF NITROGEN IN CARBON STEELS

Small amounts of nitrogen in the presence of considerable carbon are difficult to detect micrographically. Its effect upon the structure and form of the pearlite is, however, quite marked. (See Figs. 2*E* and 6.)

A series of steels were packed in the same container in charred leather and heated to 900 deg. C. for 3 hours and cooled slowly. As has been shown, heating in charred leather introduces a large quantity of nitrogen as well as carbon in the steel. Fig. 2*A* is of carbonless, hydrogen fused, electrolytic iron, swaged to $\frac{1}{4}$ in. rod, copper plated to prevent carbon penetration and treated as above. The dark patches are nitride patches, numerous needles occurring between. The structure of the patch is shown in detail in micrograph 2*F*. There is a certain resemblance to pearlite; but the dark areas are not truly laminated and are more angular and surrounded by the characteristic hard, white border. It is interesting to note here that copper-plating prevents the penetration of carbon, but not of nitrogen. This may account for the fact that copper-plating often fails to prevent hardening of the steel. If no nitrogen is present in the carburizer used, the copper will prevent any hardening.

Micrograph 2*B* shows a 0.50 C steel treated as above except with no copper-plate.

Numerous needles appear between the grains of pearlite for about $\frac{1}{16}$ in. in from the surface. On the surface is a light-colored constituent which looks like decarbonized metal, but decarbonization under these conditions is not likely to occur. Micrograph 2*E* shows a higher power of this border. The pearlite has lost its laminated structure and a hard, white constituent like "massive" cementite and numerous needles are found.

Fig 2*C* shows a 0.90 C steel after treatment. The border is not as wide as in the 0.50 C steel, and no needles appear among the pearlite grains. 2*D* is a higher power of this border. It has more of the hard, white constituent and hardly any pearlite or nitrite patches.

It appears, therefore, that as the percentage of carbon increases the penetration of nitrogen decreases and that the nitrogen tends to hold the carbon in solution, forming a hard, white constituent resembling cementite. This confirms the experiments of Andrew,⁸ who found that N suppressed and lowered the Ar₁ point and of Wheeler,⁹ who found that white cast iron showed no penetration of N when heated in ammonia. There is, therefore, great danger from brittleness involved in the use of nitrogen-bearing carburizers for treating medium and high carbon steels.

ACTION OF NITROGEN ON NICKEL STEELS

Carbonless iron alloys were prepared containing various amounts of nickel. These were swaged to $\frac{1}{4}$ -in. rods, and cyanided for 3 hours at 800 deg. C. to study the effect of nickel on the penetration and metallographic appearance of nitrogen. (Fig. 3.) In the case of an alloy containing 0.5 per cent Ni the penetration is deep (0.060 in.), the Ni having offered prac-



FIG. 6 COMPARATIVE STRUCTURE DEVELOPED BY NITROGEN-BEARING CASE (TO LEFT) AND NITROGEN-FREE CASE (TO RIGHT). NITAL ETCHING. $\times 350$

Three per cent nickel steel, above.
Three per cent chromium steel, middle.
Three per cent vanadium steel, below.

tically no resistance to the penetration of nitrogen, which occurs in the characteristic patches and needles. The carbon of this case is no higher than 0.30 per cent, but the case was much harder than this amount of carbon would account for. The nitrogen has refined the grain of the case to a great extent compared to the large coarse grain of the center, shown in lower part of micrograph.

In the 1 per cent Ni steel the patches of nitride do not occur as deeply, but the area in which needles

⁸T. H. Andrew, *J. Iron and Steel Inst.*, vol. 86, p. 210 (1921).

⁹See footnote 2.

occur is wider, the needles more numerous and the grain is finer. The "penetration" is the same as in 0.5 per cent Ni.

At 2 per cent Ni fewer patches occur and very few needles are seen, but the grain refinement occurs to the same depth as before.

At 3 per cent nickel no patches or needles are seen. Judging by first appearance, there has been no penetration, but on close scrutiny a great difference is seen between the grain size of the case and core. This case is the same thickness (0.060 in.) as in the three preceding examples. The line of change is indicated by the arrow. (Fig. 3, top row, right.)

Nickel, therefore, up to 3 per cent appears to have no effect upon the penetration of nitrogen. The grain size decreases with increasing nickel, as might be expected. The change in metallographic appearance—that is, disappearance of needles and large dark patches—is partly due to this reduction in grain size, but examination under high power discloses an entire change in structure, like that in Fig. 7D of the carbon series, indicating that the nickel increases the solubility of the ferrite for nitrogen and what carbon there is present.

CHROMIUM STEEL

This series was made up, treated just as described in the nickel series, and shown in the middle row of Fig. 3. The penetration is about the same as with nickel. The concentration is greater, however, in all cases and may be due to the greater affinity of Cr for carbon or nitrogen or both. With 2 per cent Cr a decided network appears, increasing in width with increased Cr content. Chromium appears to increase both the penetration and concentration of nitrogen as well as carbon.

VANADIUM STEEL

This element is more active than chromium. The concentration is greater and the hyper-eutectoid zone wider with 3 per cent vanadium than with 3 per cent chromium. (Fig. 3, lower row.) Inserts show photographs of fractures of these three series, the depth of penetration being the same in all regardless of amount or kind of special element.

CHROMIUM-VANADIUM STEEL

A combination of these elements gives the expected result, both penetration and concentration being high. (Fig. 4A and B.)

MANGANESE STEEL

The absorption of nitrogen is high in manganese iron alloys, and of all steels worked with, these are the most brittle after cyaniding. (Fig. 4C and D.)

COMMERCIAL STEELS

Fig. 5 shows various alloy steels containing carbon and cyanided as described above. The carbon has not prevented the special element from exerting its effect.

CARBON CONTENT OF CYANIDED CASES

Analyses of the outer 0.010 in. of the rods shown in Fig. 3, containing 3 per cent Cr, 3 per cent Ni and 3 per cent V respectively, showed 0.34 per cent C in the Cr alloy, 0.24 per cent C in the Ni alloy and 0.39 per cent C in the V alloy, certainly much too small an amount alone to account for the structure shown or hardness obtained.

The difference in structure with nital etching between carburized (no nitrogen present) and cyanided

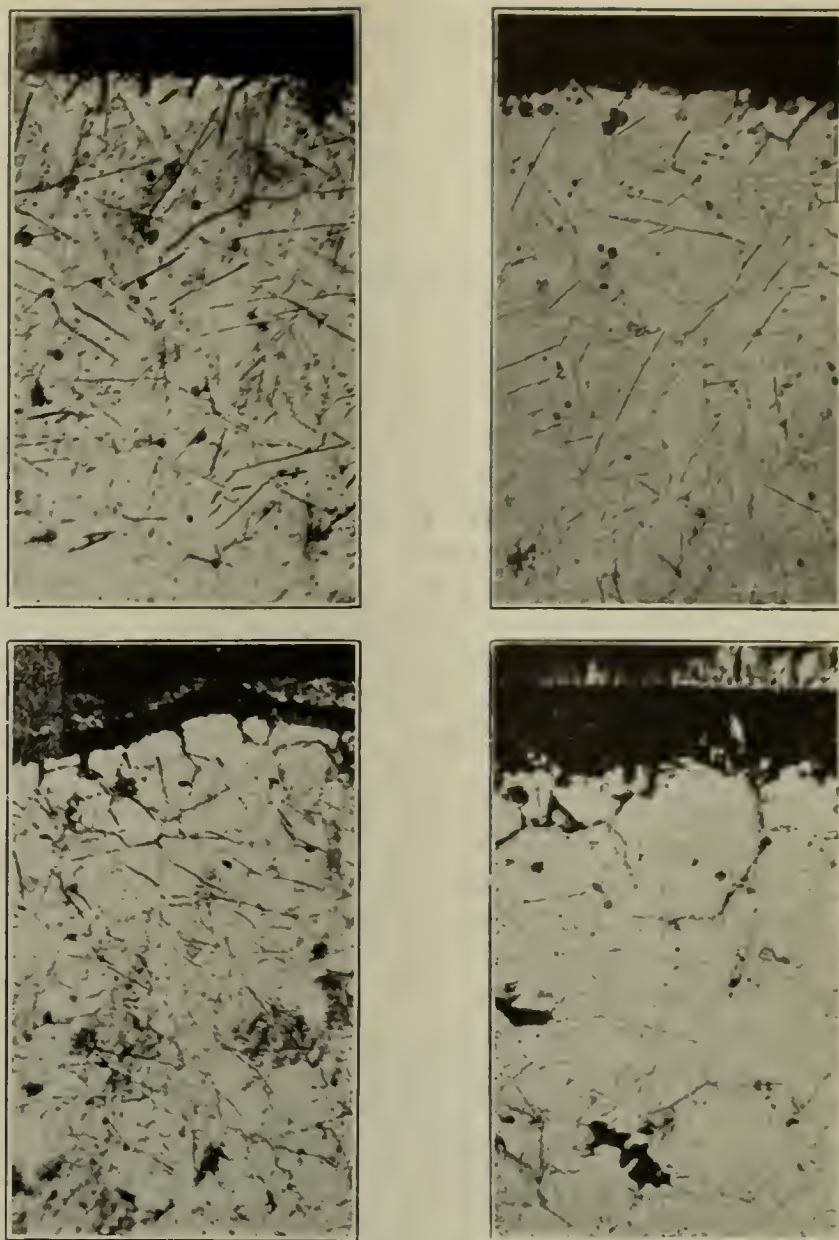


FIG. 7. STRUCTURE CAUSED IN PURE IRON BY PURE AMMONIA (LEFT) AS COMPARED TO THAT DUE TO COMMERCIAL AMMONIA (RIGHT). $\times 200$
Annealed at 450 deg. C., above, and at 650 deg. C., below.

cases is shown in Fig. 6. The carburized cases are about five times the depth of the cyanided case. The section shown is in the eutectoid zone.

CARBON IN NITROGENIZED IRON (NH_3)

Many investigators have assumed that the dark areas herein referred to as "eutectoid" patches must of necessity contain carbon. Strauss first suggested this in working with pure iron treated in ammonia, assuming that the C came from pyridin existing as an impurity in the ammonia. In order to investigate this further two rods of pure iron were treated in tank ammonia and in pure NH_3 . The tank (commercial) ammonia did show a wider black border than the pure ammonia (see Fig. 7), but even with the pure ammonia a distinct black border of "eutectoid" structure was found. It appears that the carbon, if present, does associate itself with this "eutectoid" constituent, but that the presence of C is not necessary to its existence.

SUMMARY

Nitrogen plays an important rôle in case-hardening and greatly reduces the ductility of pieces so treated. Cyaniding is effective in introducing nitrogen, but certain commercial solid carburizers introduce nitrogen to a harmful extent. Nitrogen is not unlike carbon in its micrographic appearance and its action in the presence of added elements such as Cr, V, Ni and Mn, but its micrographic occurrence may be distinguished by the use of Stead's CuCl_2 reagent, used as described.

Schenectady, N. Y.

Legal Notes

BY WELLINGTON GUSTIN

Pearse Patent Held Anticipated and Void by District Court

In the case of the Chipman Chemical Engineering Co., Inc., vs. the Reade Manufacturing Co., the United States District Court for New Jersey held Pearse patent No. 873,680, dated Dec. 10, 1907, void for lack of novelty. Complainant had charged that the patent had been infringed by defendant and asked for an injunction, which was denied. (270 Fed., 679.)

Complainant was in the business of spraying railway tracks with a liquid weed killer by means of the device made under the patent in suit, and during the year 1918 it used 281,320 gal. of liquid on such railways as the Chicago & Northwestern, Lehigh Valley, Baltimore & Ohio, Illinois Central, Southern Pacific, Pennsylvania and others. Defendant was in the same business many years prior to the entrance into it of the complainant.

Complaint was infringement of the fifth and eighth claims of the patent. The fifth claim by analysis consists of three parts—the tank, a discharge device and a means for using pressure. Its eighth claim, in addition to the discharge device, consists of a nozzle pipe with a series of nozzles connected therewith, each containing an independent valve controlling the passage of liquid therefrom. Defendant asserts there is no novelty in either of these claims. Various earlier patents are cited, and Bradford patent No. 803,090, for a hand-car device for destroying weeds along the railroad, the court said, appeared to be a complete anticipation of the patent in suit.

Sale of Goods Before Organization of Company

The Circuit Court of Appeals of the United States, Fifth Circuit, was unable to decide the rights of the parties on questions of law in the case of Bickmore Nitrating Cotton Co. against the Covington Cotton Oil Co. (271 Fed., 80) and remanded the case for a new trial.

The Nitrating company brought suit to recover damages for breach of a contract for the sale and further delivery to it by the Cotton Oil company of 500 bales of cottonseed linters. Defendant admitted the execution of the contract and that plaintiff had lost profits in the amount claimed as damages, but defended on the ground that it was induced to enter into the contract by false and fraudulent representation of plaintiff's financial responsibility, in that it was at the time of the contract a corporation fully organized, with a paid-in capital stock of \$5,000; and that at the discovery of the true facts, defendant elected to, and did, rescind the contract.

The contract was negotiated through a broker who was uncertain whether plaintiff's manager stated the amount of the paid-in capital stock was \$5,000 or \$10,000. There was much conflict in the evidence between the parties in the issues involved. The court held that the difference of \$5,000 as alleged in the answer, and \$10,000 as given in the evidence as to the amount of capital stock paid in, was no material variance, the gist of the defense being false representation.

It appears that the Nitrating company was only in

process of organization at the date of the contract. Its organization meeting had not then been held, according to all the evidence. Plaintiff admitted that only \$500 of its capital stock had been paid in at the time of organization, and that no more than that had been paid in at the time of the negotiations of sale.

Plaintiff was given judgment in the trial court and sought to defend that judgment on the appeal by contending that proof that no capital stock, or a less amount than \$10,000, had been paid in was of no avail, since defendant rescinded the sales contract on the ground that the representation to it was that plaintiff's capital stock had been paid in to the amount of \$10,000.

However, the court pointed out that defendant's letter rescinding the sale did not lay as much stress upon the amount of the capital stock as it did upon the circumstances that there was no capital stock paid in, no corporation organized and no financial responsibility behind plaintiff's obligations.

The court said it could not be well argued that defendant was seeking to save itself from a losing bargain, since it was shown that the price of the linters as sold had not advanced, and were afterward sold to others at the same price as to plaintiff.

On the dispute as to the facts, the court said a new trial was necessary.

Trader May Announce in Advance Circumstances Under Which He Will Refuse to Sell

In a recent suit by the Andrew Jergens Co. against William A. Woodbury Distributors, Inc., for infringement of its claimed rights to the exclusive use of the name "Woodbury" and the registered trade-mark, consisting of a reproduction of a neckless head, upon dermatological preparations and toilet articles, the District Court of the United States for Delaware laid down the rule that the charge that complainant does not come into court with "clean hands" is not a defense which must be pleaded (271 Fed., 45).

As a counterclaim to the suit defendant stated certain facts to show that it was entitled to use the word "Woodbury" or "Woodbury's," together with the "neckless head," on certain toilet articles and preparations, and charged:

"That plaintiff . . . has threatened to and did refuse to deal with, or to sell its products, the products of plaintiff, to dealers . . . and the like, who dealt with defendant, and did otherwise intimidate dealers . . . and the like, into declining to deal with defendant."

The court said the rule to be applied to this proposition is to the effect that a trader or manufacturer may, in the absence of an intent to create or maintain a monopoly, freely exercise his own discretion as to parties with whom he will deal, and that he may announce in advance the circumstances under which he will refuse to sell.

Further the defendant likewise charged:

"That plaintiff . . . has threatened to and did refuse to deal with . . . trade journal publishers, . . . who dealt with defendant. . . ."

The court says this charge is too vague, indefinite and uncertain to show a cause of action in the defendant against the plaintiff. It may mean no more than that plaintiff declined to advertise in trade journals carrying the advertisements of the defendant, and if so, without further facts, it was acting within its rights by such refusal.

The Relation of the Chemical Engineer to the Manufacture and Application of Automobile Finishes*

Some Chemical Engineering Developments in the Paint and Varnish Industry Which Have Resulted From the Demand for the Large-Scale Manufacture and Application of Automobile Paint, Enamel and Varnish Products

BY C. D. HOLLEY, PH.D.

Director of Research, Acme White Lead & Color Works

LESS engineering, particularly chemical engineering, has been devoted to the paint and varnish industry than to any of the other modern industries of similar magnitude. As late as the beginning of the present century, at which time many of us were just beginning our professional careers, it would have been very difficult to have cited or discussed any engineering feature connected with the paint or varnish industry that was worthy of mention. Perhaps some will be inclined to challenge this statement and point to certain of the industries whose products are used in the manufacture of oils and colors, but I refer primarily to the paint and varnish industry in itself.

A late start oftentimes results in increased progress, and this is particularly true of the paint industry. It has outgrown many of its rule-of-thumb methods and procedures and is now using some genuine engineering in the manufacture of paint, enamel and varnish products and in their application.

The rapid developments in the automobile industry, especially as related to quantity production, have necessarily had their effect on the manufacture of paints and varnishes and have been perhaps the most potent influence in the development of this industry from an engineering standpoint.

Although the paint industry is frequently considered as separate from the varnish industry, both are closely connected and in the larger plants they are in fact regarded as separate departments of the same industry. The modern paint and varnish plant compares favorably as to size with the representative plants of other industries. The larger plants have a daily production capacity of 10,000 gal. or better of varnish and 12,000 to 20,000 gal. of paints and enamel products.

In the manufacture of the ordinary types of paint, of which house paint is a typical example, the liquid or

vehicle is essentially raw linseed oil, and the procedure of combining the pigments and the oil is rather elementary. In automobile finishes raw linseed oil as such is but little used, the vehicle being always in the nature of a varnish or grinding japan—i.e., composed of heat-treated oils, fused resins, metallic driers and volatile thinners, of the kinds and in the quantities the manufacturer considers necessary.

After the gums and oils have been "run" on the fire for the requisite length of time, which varies with the character of the products used and the requirements, the kettles are removed from the fire and allowed to cool until the temperature has dropped sufficiently to



FIG. 2. ALLOWING KETTLES TO COOL PRIOR TO ADDING THE VOLATILE THINNERS

permit the addition of the volatile thinners. In Fig. 1 is shown the older but still common type of varnish stack under which the gums are melted with no attempt to recover volatilized fumes. The kettles shown in Fig. 2 are being cooled in the open air. A portion of the melting and cooling room in a modern plant equipped with recovery apparatus is shown in Fig. 3. After the varnish has been thinned and is cool it is run through a press or a centrifugal clarifier and stored to age.

GRINDING PIGMENTS AND COMBINING WITH VEHICLE

The grinding of the pigments with the varnish vehicle for automobile coatings is accomplished in several types of mills. The mill most commonly used is the flat stone mill, 20 in. in diameter, the stones being water-cooled.

Recently a new type of mill has come into use. This is shown in Fig. 4. It resembles the previous type of mill, but instead of the rolls touching each other, each roll which is of granite is bedded individually in a half round block of granite, the contact between the roll and its bed furnishing the grinding surface.

After the enamel has been ground in the form of a



FIG. 1. THE OLD TYPE OF VARNISH-MAKING INSTALLATION

*Abstracted from a paper presented before the Detroit Meeting of the American Institute of Chemical Engineers, June 20, 1921.



FIG. 3. PORTION OF MELTING AND COOLING ROOM IN A MODERN VARNISH PLANT

paste, it is thinned by the addition of the requisite varnishes and volatile thinners and then strained to free it from dirt particles or else run through a clarifier. Clear varnishes, baking japans and auto coatings containing pigments of low specific gravity such as carbon or lampblack pigments are now handled by means of a clarifier.

USES FOR CENTRIFUGAL CLARIFIERS

Centrifugal clarification permits the paint manufacturer to prepare many of his automobile coatings free from dirt particles, small "liver" formations and any coarse pigment particles and therefore enables the user to obtain a smooth, uniform finish, free from specks or spots without having to rub down the coats. This treatment also enables the automobile manufacturer to keep the varnish and enamel coatings in his dipping tanks and collecting tanks continually freed from particles that would speck the surface. It has been the experience of one manufacturer that prior to the installation of such a system more than half of his finished product was returned by the inspectors for further rubbing down and afterward it was reduced to less than 5 per cent. It is very generally conceded that the introduction of centrifugal clarification in connection with modern application devices, such as the

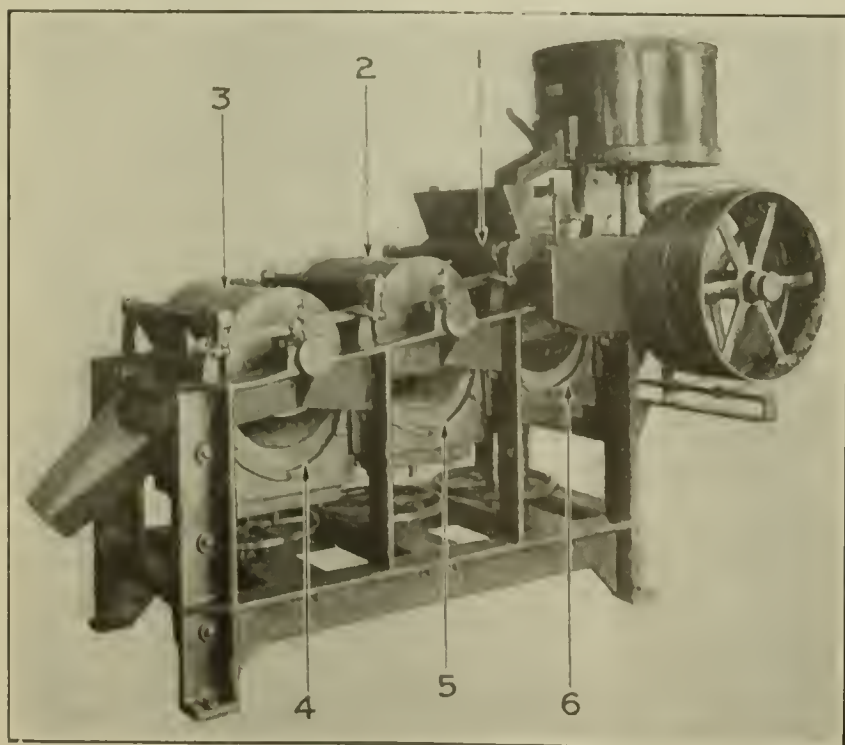


FIG. 4. THREE-ROLL MILL FOR GRINDING PIGMENTS
1, 2, 3—Hard granite rolls, 4, 5, 6—Half-round hard granite beds leaded in cast iron.

use of the "floc," has resulted in a saving of more than 80 per cent in labor costs for finishing, to say nothing of the elimination of wastage. Fig. 5 shows a typical installation of a clarification system.

The pigment materials used in varnish manufacture or the technique of combining the vehicles with the pigments have not been discussed in detail, as these are well known and do not present any engineering practice worthy of mention in the present limited treatment of the subject.

FUME COLLECTION

There is, however, one feature in connection with the varnish industry that deserves special attention. Varnish making is a very old industry and the varnish maker has been content to go about his business without bothering himself about any chemical engineering requirements. Recently he has changed his mind, because in several instances he had his choice of closing down permanently, moving his plant at a heavy financial

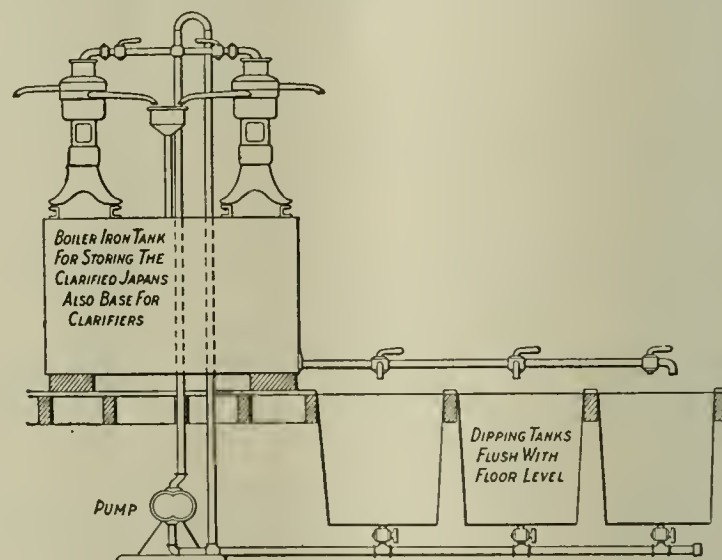


FIG. 5. DIAGRAM SHOWING INSTALLATION OF CENTRIFUGAL CLARIFIERS

loss, or getting out of his trouble by resorting to the services of a chemical engineer.

Most varnish plants were built either in a manufacturing section or in the outskirts of the cities away from the residential sections, but with the growth of the cities, many of these plants have found themselves surrounded by residences, the occupants of which object to the large volumes of fumes emitted from the varnish stacks. From 10 to 25 per cent of the weight of the varnish gums used is driven off in the melting of the gums. These products of decomposition pass up the varnish stacks and are disseminated in the air in quantities that sometimes reach several thousand pounds daily.

This has necessitated the installation of an efficient fume control system whereby these fumes can be condensed as they leave the kettles or be made to enter into a chemical combination and thereby be eliminated. This has required some really ingenious chemical engineering practice, as the problem was not an easy one to solve, because of the physical and chemical nature of the fumes and because of the fact that the gums are "run" in the varnish kettles at nearly their flash point; any undue disturbance in the equilibrium of the gases in the kettle often meant a bad fire. Two views of recovery apparatus are shown in Figs. 6 and 7. These installations have proved quite successful, affording usable byproducts, and in several instances have permitted a 50 per cent reduction in the insurance premiums and, not least, have permitted the varnish maker



FIG. 6. THINNING RECOVERY APPARATUS

to continue the manufacture of his products undisturbed by the authorities.

APPLICATION OF AUTOMOBILE FINISHES

The systems of finishing and the methods of application developed by the automobile industry have a very close relation to modern engineering practice. There are many variations in details in the leading automobile plants depending on the experience of the finishers in charge, on the production schedule as related to the floor space available, on the price allowed for the job and especially on the labor- and time-saving devices installed. The last named have resulted from the research of chemical and other engineers.

Possibly no two devices have done so much toward reducing the cost of auto coatings as the "spray" and the "floc." Their introduction and use have accomplished wonders in the automobile industry in the way of quantity production, and due credit should be given the chemical engineer in bringing about the results obtained. The amount of work that can be accomplished by the spray over hand brushing varies considerably, depending upon the nature of the parts and the conditions under which the work is done. It is conservatively estimated that it does the work from a minimum of twice as fast and ranging from this figure up to seven times as fast as can be done by an experienced brush hand. It is used for applying the undercoatings on bodies, quite generally for all chassis work and more or

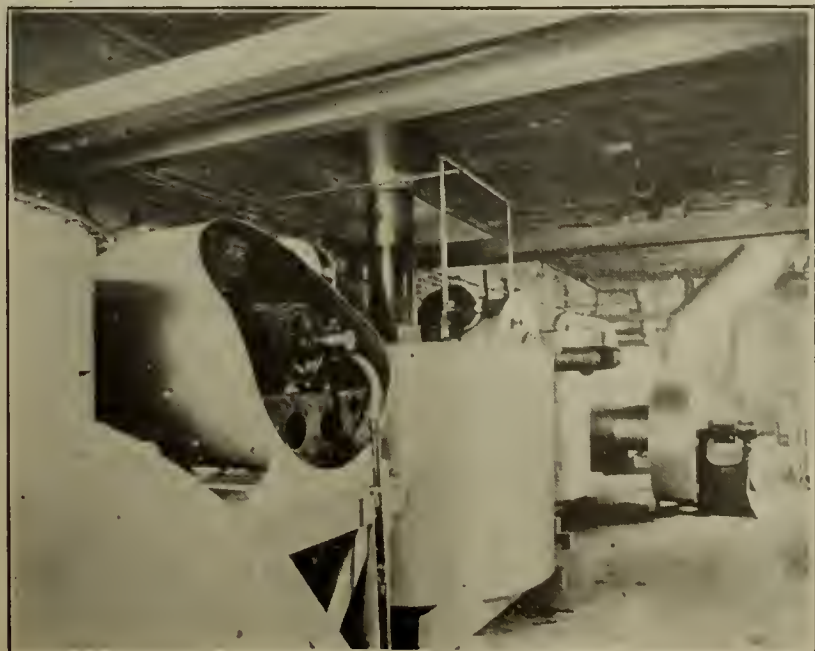


FIG. 7. VARNISH FUME RECOVERY APPARATUS

less on the wheel jobs. The "floc" is used for flowing on the finishing coats and in some instances the color coats on bodies and can be used on fenders and hoods as well. On open body work the cost of application has been reduced to 30 to 40 per cent of the previous cost.

DIPPING, BAKING AND DRYING

The application of baking japans by dipping and then baking at comparatively high temperatures was well understood before the automobile industry became a commercial factor. Generally the parts dipped were quite small and could therefore be easily handled. When the automobile plants went into quantity production, the application of baking japans to fenders, hoods and other parts together with the subsequent baking operations required extensive installations. Our present-day procedures are the result of extensive engineering research. Much ingenuity has been expended in labor-saving devices for dipping and protecting the dipped articles from dust while draining and then conveying them mechanically through the ovens. An intermittent conveyor and a dip used for fenders are shown in Fig. 8.

The time of baking has been shortened by systematic temperature control. The dangers of the old direct gas-fired oven with which there was always a risk that a burner might go out, fill the oven with gas and the

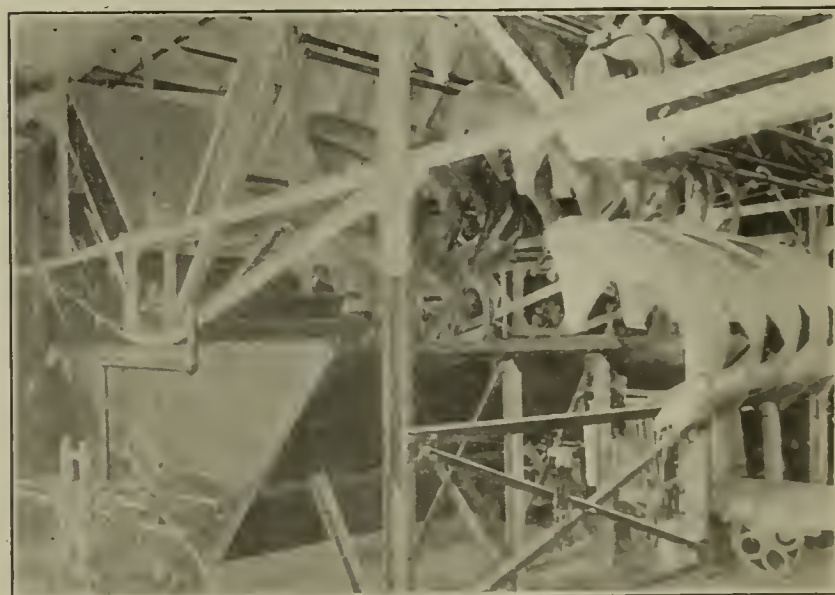


FIG. 8. DIPPING AUTOMOBILE FENDERS PRIOR TO ENTERING BAKING OVENS

mixture explode with disastrous consequences from ignition with another burner have been eliminated. The indirect method of heating in which each burner is inclosed in a separate combustion box with a separate vent from the oven is reasonably safe and does not contaminate with soot and other foreign particles the articles being baked. More recently electric baking ovens have come into extensive usage. I shall hold no brief for either the gas or the electric. Each have their advantages and disadvantages. There is still room for considerable improvement; in the larger baking installations the temperature is not as uniform as desirable throughout the cross-section of the oven to get maximum production. Much has already been done to overcome this trouble, and it appears to be only a question of time when a closer uniformity will be obtained.

The drying time of a paint, enamel or varnish varies with atmospheric conditions and, since it does vary, it necessarily follows that there must be at least one definite condition under which the coating in question will dry most rapidly and successfully. Moreover there are many different coatings to be dried and each coating contains different proportion of oxidizable oils.

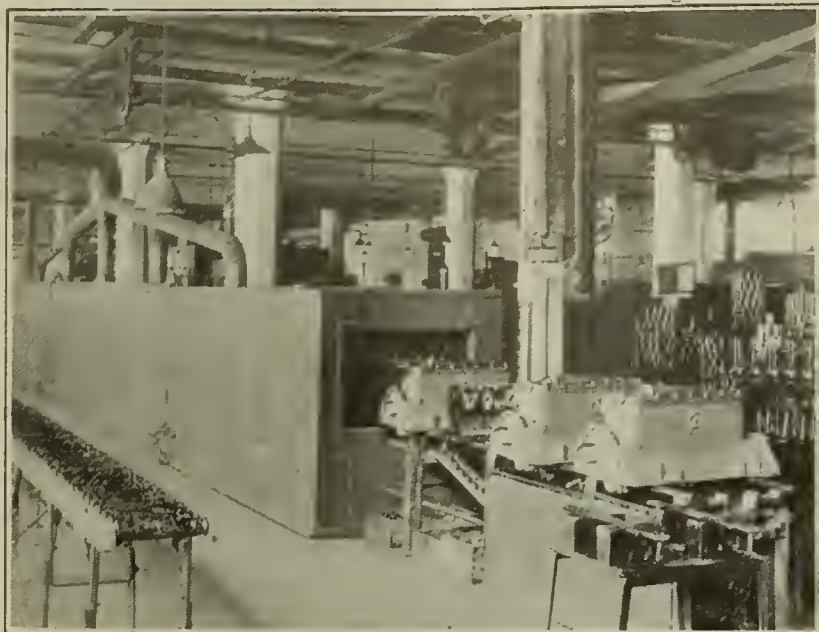


FIG. 9. EXIT OF GAS-HEATED OVEN FOR AUTOMOBILE ENGINE PARTS

This, then, is the problem that confronted the automobile engineer and the engineers who have been developing the artificial drying systems.

When artificial drying was first considered, it was the general belief that moisture would retard rather than hasten the drying process. Investigation has proved the contrary, that definite percentages of moisture in conjunction with the heat materially increased the rate of drying over that obtained by the same degree of heat alone. The most successful method of controlling the humidity is by the so-called dew point control, which operates on the principle that the amount of moisture which air can carry at saturation is dependent on the temperature of the air. For instance, having determined that a humidity of 42 per cent at 120 deg. F. is required, it is found that this corresponds to an absolute humidity of $14\frac{1}{2}$ grains per cubic foot, which is the amount present in a cubic foot of saturated air at 90 deg. F. (dew point), and therefore the humidity control device is set at 90 deg. F., the current of air then being raised to 120 deg. F. after passing through the humidifier.

Considerable difficulty was at first experienced in obtaining uniform results with the light colors such as the light blues, yellows, grays and whites. These colors frequently showed marked variation under artificial drying from that obtained by ordinary air drying. More recent developments have proved that by varying the humidity these troubles can be overcome. For example, a light blue job dried at 130 deg. F. with 35 per cent humidity had a greenish overcast, whereas another body with the same varnish, at the same temperature but at a humidity of 45 deg, dried to exactly the same color as an air-dried job. I have cited these instances to show that the artificial drying of an enamel or varnish requires engineering skill.

CONCLUSION

In conclusion I wish to state that the paint maker and the paint engineer have co-operated whole-heartedly with the automobile and equipment engineers, and to meet the requirements of the various installations I have discussed has been no easy undertaking. It has meant the developing of enamels and varnishes of entirely different characteristics especially as regards their physical properties. The accomplishing of this has been of very material benefit in placing the paint and varnish industry on a more scientific basis.

Detroit, Mich.

Practical Applications of Electrometric Control

Dr. Paul E. Klopsteg, addressing a recent meeting of the Chicago Section of the American Chemical Society, cited the increasing number of important industrial applications for electrometric methods of measurement and control. This is particularly true in the case of hydrogen-ion determinations, the value of which has been recognized in scores of industrial processes. In the sugar industry, for example, one of the serious problems is the clarification of the raw juice before evaporation is started. This is accomplished by adding lime water to the juice and careful neutralization with CO_2 or SO_2 . The hydrogen-electrode method has been successfully used in controlling this process. In the sirup and sugar industry, two other problems have been successfully solved with the hydrogen electrode. One of them was the determination of acidity caused by fermentation in molasses and sirups. In this instance an indicator is of little use, because of the color and opacity of the sirup. In the preparation of glucose from starch, the neutralization of the acid with which the starch is digested can be satisfactorily controlled electrometrically.

The acidity of plant and fruit juices, both as regards actual acidity and total available acidity, is easily measured by similar methods. Work of this sort has been done by some of the large canning companies which are also studying the effect of fruit juices upon the cans, using the hydrogen electrode in their investigations.

The Bureau of Standards some years ago investigated the effect of H-ion concentration upon deposits obtained in metal plating baths and demonstrated the importance of this factor. In addition to these applications Dr. Klopsteg referred to problems in a number of other industries, of which the following is a partial list:

In the baking industry, fermentation takes place only within certain limits of p_H and there is an optimum value of acidity.

In filtration problems, especially of gelatinous material, there is a particular hydrogen-ion concentration at which the volume occupied by the material is a minimum. The same considerations apply to some problems of gelatin manufacture.

In the leather industry, the actual acidity in the various tanning processes is the controlling factor affecting practically all of the important properties of the finished leather.

Much of the recent progress in the manufacture of dentifrices has come about through the discovery that the actual acidity of toothpaste is an important factor in determining the effect of the paste on the teeth.

In the textile industry, hydrogen-electrode control has been exercised for wool-scouring liquors, in cloth finishing, and in the application of dyes.

Alsatian Potash Mines Returned to France

The Colmar Court of Appeal has delivered a judgment in the case of the Alsatian potash mines by which they are definitely returned to France. A business man, M. Koch, bought certain mining rights from the German company just before the mines were sequestered by the French Government. Later M. Koch claimed only 0.6 per cent of the rights he had acquired, but the tribunal of Mulhouse awarded M. Koch the whole area. The French Government appealed and the Colmar Court of Appeal awarded M. Koch 0.6 per cent of the mines and returned the remainder to France.

Radium Production in America—II*

Electroscopic Analysis of Radium-Bearing Products—Preparation of Standard Samples Used in the Standardization of the Electroscopes—Description of the Apparatus and Methods of Operation

By H. D. d'AGUIAR

THE electroscopic laboratory is of primary importance in a radium production plant. Without accurate determinations from this laboratory the work in the plant can never be anything but guesswork; whereas when it is functioning properly the progress of the work at each stage is accurately known. In a laboratory, such as this, where determinations of radioactivity are constantly being made, it is imperative that all samples of active matter be kept sealed in order to prevent possible radioactive contamination by the escape or spilling of radioactive material. The presence in the laboratory of highly active samples such as the sulphates and carbonates resulting from the different stages of the extraction process and samples from the crystallizing laboratory, or tubes of radium, will vitiate the measurements made.

All the chemical and manipulative work on the various samples received should be performed in a portion of the laboratory separate from that where the measurements are made, so that any accident causing the escape of emanation or the spilling of radium-bearing material shall not cause the contamination of the laboratory. While the errors of measurement caused by the escape of emanation are largely temporary, the continual escape of emanation will result in the walls becoming active due to the products of slow decay derived from the emanation.

It will be necessary so to plan the work of the laboratory that the determination of radium content of ores, sand tails and similar materials, by means of the alpha electroscope, will not be taking place at a time when tubed radium for estimation by gamma ray is present in the laboratory. Neither can tubed radium be present when readings are being made with the emanation electroscopes used for determining the strength of carbonates, sulphates or the samples of dissolved crystals and mother liquors.

ALPHA RAY DETERMINATIONS

The apparatus for these determinations is a small electroscope provided with a scale and a microscope by which the rate of fall of the leaf can be timed. One electrode extends through the case, terminating in an insulated handle, while the other passes through the amber insulation at the bottom of the head into a metal chamber below the head. This chamber is provided with a door permitting the samples to be measured to be introduced and removed easily. The container for the samples is made by providing a circular disk of metal about $\frac{1}{16}$ in. thick having a circular opening in the center about $\frac{3}{4}$ or 1 in. in diameter, with a metal tray into which the disk fits firmly, thus forming a space for the samples of a fixed area. This container

can be readily taken apart for cleaning after each determination. As the alpha rays have no penetration, even a cigarette paper stopping their passage, the principal point to be observed is that a definite area of the sample and standard be exposed, and not that a definite weight be used.

The electroscope may be charged with batteries or by a static charge generated with an ebonite rod or amber. Charging with a battery, however, is always preferable. A battery of about 300 v. potential will be required. The metal casting of the electroscope is grounded, as is one pole of the battery, while the other is attached to the charging arm of the electroscope. Upon turning this against the leaf holder and switching on the current, the leaf system will be charged. When so charged the fall of the leaf is watched through the microscope and the time required for it to fall a definite number of divisions on the scale is recorded with a stop watch. A record is made of the time in seconds and of the number of divisions. From these figures the number of divisions which the leaf will fall is calculated and recorded as the natural leak of the instrument in divisions per hour.

METHOD OF OPERATION

The standard ore, on which the amount of uranium has been determined by chemical analysis, is placed in the sample holder, carefully leveled and all particles removed from the surrounding metal by means of a small piece of cotton. The holder is handled as little as possible, only the edges being touched with the fingers. The sample prepared, it is placed in the chamber of the electroscope and the door closed. The electroscope is then charged and the time required for the leaf to fall through the same space as was selected for the determination of the natural leaf is taken. The standard is then removed, the holder cleaned and freed from any trace of ore by wiping with small bits of cotton. The sample of the unknown ore which is to be analyzed is then placed in the holder in the same manner. It is placed in the electroscope and the time taken for the leaf to pass through the same divisions as were selected for the standard is recorded. The same holder must be used for the three readings. Example:

Time required for the leaf to fall 10 divisions on the scale = 480 seconds.

$480 \div 10 = 48$ seconds per division.

3,600 seconds in 1 hour; divided by 48 = 75 divisions per hour = natural leak of the instrument used.

With the standard (say 3 per cent uranium oxide) the time required for leaf to fall 10 divisions = 120 seconds.

$(3,600 \times 10) \div 120 = 300 - 75$ (natural leak) = 225 divisions per hour.

With the unknown sample the time required for leaf to fall 10 divisions = 100 seconds.

$(3,600 \times 10) \div 100 = 360 - 75$ (natural leak) = 285 divisions per hour.

Therefore: $225 : 285 :: 3 : x$; and $x = 3.52$ per cent.

*For Part I see CHEM. & MET. ENG., vol. 25 No. 18, 1921, p. 825

The radium-uranium ratio in unaltered ores being a constant and 8 lb. of uranium oxide being equivalent to 1 mg. of radium, it is necessary only to know the total weight of the ore analyzed to compute the radium content in milligrams.

The control analysis on the sand tails is made in the same manner. The sample of the tails as received at the laboratory is dried over night (or until dry) in a drying oven at 105 deg. C. The sample is then ground in an agate mortar, if necessary, to reduce it to about the same grain size as the standard used. The determination is then made immediately and the results are reported to the plant for guidance in the dissolving work.

DETERMINATIONS BY EMANATION METHODS

The determination of radioactivity by the emanation method is used for samples of sulphates, carbonates, dissolved crystals and mother liquors.

The electroscope used for emanation determinations consists of the usual electroscope head mounted on an air-tight container, of about 10 liters capacity, provided with adjustable legs for leveling, a circular spirit level being mounted on the top of the head. The container is fitted with two gas-tight stop-cocks located on opposite sides of the container. One is placed near the top and the other near the bottom of the container. The head screws on and the joint is gas tight. The electrode extends through the amber insulation at the bottom of the head and is long enough to reach nearly to the bottom of the container. It is preferable to have the bottom of the container removable to facilitate cleaning should the electroscope become contaminated.

STANDARDIZATION

Before determinations can be made it is necessary to standardize the electroscope by means of emanation from a known quantity of radium. A small tube of radium containing about 1 mg., which is in equilibrium and has been carefully estimated by gamma comparisons with a standard tube, is opened and dissolved carefully in sulphate-free water containing about 1 per cent barium chloride and hydrochloric acid. This solution is then made up to volume in a 1-liter volumetric flask with dilute acidified barium chloride water and constitutes the standard stock solution. A quantity of this stock solution equivalent to about 1 microgram of radium is accurately pipetted off and diluted to 1 liter with acidified barium chloride water in a second volumetric flask. Several portions (one for each electroscope to be standardized) are pipetted off and transferred to tall aspirating bottles of about 250-c.c. capacity. The portions pipetted should be equivalent to about 40 millimicrograms of radium. The radium solution in the aspirating bottles is then diluted to about 100 c.c. with dilute acidified barium chloride water. The bottles are marked with the exact amount of radium they contain. These are the standardizing solutions. Each standard is then de-emanated by attaching it to an air pump. The air passing through the radium solution is drawn from outdoors and the air and emanation drawn off and passing through the pump are also passed outdoors by an outlet pipe through the wall. By so aspirating vigorously for 20 minutes all the emanation is removed. The intake-cock is then closed and the pump permitted to create a strong vacuum in the bottle. When this is done, the outlet stop-cock is closed and the exact time noted and recorded on the bottle.

Each bottle is treated in the same way. The bottles are permitted to stand for at least 3 days and 20 hours before being used for standardizing. The radium comes into equilibrium with the emanation in 30 days, the half period being 3.85 days—that is, one-half the total emanation is formed in 3 days and 20 hours. Therefore, knowing the exact time at which the radium was totally de-emanated and the time at which the emanation is again separated from the radium and transferred to the electroscope for standardization or measurement purposes, the fraction formed in the elapsed period of time can be definitely calculated from tables prepared by actual determinations throughout a period of 30 days. The accompanying table gives the constants of growth and decay which are used in calculating the amount of emanation formed for any intermediate period.

GROWTH AND DECAY OF RADIUM EMANATION

T = time. X = fraction of emanation remaining after time, T . Y = fraction of equilibrium amount formed in time T .

T	X	Y	T	X	Y
0	1.0000	0.0000	5 days	0.4066	0.593
1 hr.	0.9925	0.0075	6 days	0.3396	0.660
2 hrs.	0.9851	0.0149	7 days	0.2837	0.716
3 hrs.	0.9777	0.0223	8 days	0.2369	0.763
4 hrs.	0.9704	0.0296	9 days	0.1979	0.802
5 hrs.	0.9632	0.0368	10 days	0.1653	0.834
6 hrs.	0.9560	0.0440	11 days	0.1381	0.861
7 hrs.	0.9489	0.0511	12 days	0.1153	0.884
8 hrs.	0.9418	0.0582	13 days	0.0963	0.903
9 hrs.	0.9347	0.0653	14 days	0.0805	0.919
10 hrs.	0.9277	0.0723	15 days	0.0672	0.932
11 hrs.	0.9208	0.0792	16 days	0.0561	0.943
12 hrs.	0.9139	0.0861	17 days	0.0469	0.953
13 hrs.	0.9071	0.0929	18 days	0.0392	0.960
14 hrs.	0.9003	0.0997	19 days	0.0327	0.967
15 hrs.	0.8936	0.1064	20 days	0.0273	0.972
16 hrs.	0.8869	0.1131	21 days	0.0228	0.977
17 hrs.	0.8803	0.1197	22 days	0.0191	0.980
18 hrs.	0.8737	0.1263	23 days	0.0159	0.984
19 hrs.	0.8672	0.1328	24 days	0.0133	0.986
20 hrs.	0.8607	0.1393	25 days	0.0111	0.988
21 hrs.	0.8543	0.1457	26 days	0.0093	0.990
22 hrs.	0.8479	0.1521	27 days	0.0078	0.992
23 hrs.	0.8416	0.1584	28 days	0.0065	0.993
1 day	0.8353	0.1647	29 days	0.0054	0.994
2 days	0.6977	0.3023	30 days	0.0045	0.995
3 days	0.5827	0.4173	40 days	0.0007	0.999
4 days	0.4868	0.5132	50 days	0.0001	0.999

Example: If the emanation formed by the standards, or by any sample, is transferred to the electroscope 3 days and 20 hours after sealing, the fraction of the equilibrium amount of emanation formed will be:

Value of X for time t (3 days) = 0.5827.
Value of X for time T (20 hours) = 0.8607.
Therefore $X = 0.5827 \times 0.8607 = 0.5015$.

Standardizations are never made with standards which have not reached the half period, and it is even preferable to use standards which are in equilibrium.

METHOD OF OPERATION

About 1 hour before the time at which it is desired to transfer the emanation from the standard to the electroscope the apparatus is thoroughly de-emanated by drawing air from outdoors through the container of the electroscope by means of the air pump. The container is kept under a slight vacuum by opening the inlet tap only half way, while the outlet to the pump is opened fully. After 10 minutes the pump is cut off and when air has passed in sufficient amount to bring the pressure in the container to normal the inlet tap is closed. The electroscope is then charged, either with the battery or with the ebonite rod, and the natural leak of the instrument is determined by timing the fall of the leaf over the full scale and recording the value obtained in divisions per hour. The pump is then turned on and the outlet tap of the electroscope is opened. The inlet tap remains closed, thus creating a strong vacuum in the container. The vacuum is carried as far as is possible with the pump at hand. A manometer is attached to the inlet tap and the same vacuum is applied for every determination. When evacuated, the taps are closed, the pump and manometer are detached, and the

delivery tube of a drying bottle containing dry calcium chloride is attached to the inlet tap. The other tube of the drying bottle, which reaches to the bottom of the bottle, is attached to the delivery tube of the sample bottle containing the standard. The other tube of the standard bottle, which dips into the liquid, is attached to the pipe delivering air from outdoors. The stop-cock of the delivery tube of the standard bottle is opened and inlet tap of the electroscope container is partly opened. When the two vacuums balance the air inlet stop-cock on the standard bottle is slightly opened, thus permitting the vacuum to be filled and drawing the emanation from the standard bottle into the electroscope container. When the vacuum is filled, as shown by the ceasing of the bubbles at the end of the tube of the standard bottle which dips into the liquid, the inlet tap of the electroscope is immediately closed. The electroscope containing the emanation is then allowed to stand for 3 hours. At the end of this time it is charged and the time required for the leaf to fall is taken with a stop watch and recorded. This done, the electroscope is immediately attached to the air pump and the emanation removed by drawing air from outside through it exactly as was done previous to taking the natural leak. The drying bottle is also de-emanated in the same way. The drying bottle should be refilled with fresh calcium chloride after using two or three times. The standard is again de-emanated and sealed and put aside for future standardizations. The electroscope should be restandardized regularly once a month. The standards can be used over and over providing none of the liquid splashes beyond the stop-cocks during transfer of the emanation to the electroscope.

The time required for the leaf to fall is converted into divisions per hour and the divisions per hour of the natural leak are subtracted. Thus the following facts are obtained for each electroscope: (a) Natural leak in divisions per hour. (b) Millimicrograms in standard used. (c) Divisions per hour for standard.

Where the standard used is not in equilibrium, the divisions per hour for the standard are recorded as being produced by the fractional equivalent of emanation formed in the time which the standard has stood since de-emanation and sealing. Thus if the standard contains 40 millimicrograms of radium and has stood 3 days and 20 hours since sealing, when the emanation formed is transferred to the electroscope, because in that time one-half the equilibrium amount of emanation will be formed, the divisions per hour for the standard are recorded as having been produced by 20 millimicrograms of radium in equilibrium.

PREPARATION OF SULPHATE SAMPLES FOR ANALYSIS BY THE EMANATION METHOD

The samples of sulphates as received at the laboratory are sent to the section of the laboratory where the chemical work is done. Here they are first dried in an oven at 105 deg. C. The dried sample is ground finely in an agate mortar. One gram is then accurately weighed and ground together with 3 g. of a mixture containing 20 per cent ammonium chloride, 30 per cent barium chloride and 50 per cent lampblack. This mixture is transferred to a small iron crucible. The last traces of the mixture are removed from the mortar by means of a small bit of tissue paper and added to the mixture in the crucible. It is then covered with an iron lid, placed in a muffle furnace and roasted at a temperature of 1,050 deg. C. for 1½ hours. The crucible

is removed and cooled. It is carefully opened and the contents removed to a small beaker containing dilute hydrochloric acid and barium chloride. The crucible is carefully washed out with dilute acidified barium chloride water and the washings are added to the main solution in the beaker. The solution is then diluted to about 50 c.c., carefully boiled for 10 minutes, and filtered into a tall 250-c.c. sample bottle. The residue of carbon on the filter paper is washed with dilute acidified barium chloride water. The residue on the paper is then mixed with another 3 g. of the lampblack mixture and the roasting repeated. This is to insure the complete reduction of all sulphates to sulphides. The mixture when cool is dissolved in dilute acid barium chloride water, filtered and added to the main solution in the sample bottle. The solution should now measure about 100 c.c. The ground-glass stopper carrying the closure cocks and aspirating tube is then carefully inserted and the sample de-emanated by aspirating as were the standards. Fifteen minutes of aspiration is sufficient. The air inlet tap is then closed and the pump allowed to create a vacuum in the bottle. When this is done, the tap is closed and the time noted.

ANALYSIS OF SULPHATE AND CARBONATE SAMPLES BY THE EMANATION METHOD

Each sulphate sample bottle when de-emanated and sealed is delivered to the section of the laboratory having charge of the electroscopic work. They are allowed to stand for 3 or 4 days before estimation. When ready for estimation, the natural leak of the electroscope is taken and the emanation from the sample transferred to the container of the electroscope in the same manner as the emanation from the standards. The emanation is allowed to stand in the electroscope chamber for 3 hours. The leaf is then charged and the time of fall recorded with a stop watch. The calculation of the results is made in the following manner:

From the standardization it is known that

Time of fall of the leaf for 20 millimicrograms = 300 divisions per hour.

The natural leak of the instrument = 75 divisions per hour.

Therefore the rate of fall due to the standard = 225 divisions per hour.

Time of fall for natural leak taken just before introducing the sample = 8 minutes, which = 75 divisions per hour.

Time of fall for sample = 60 seconds.

So 60 seconds = 600 divisions per hour minus the natural leak of 75 divisions per hour = 525 divisions per hour for the sample.

Therefore $225 : 525 :: 20 : x$

$x = 46$ millimicrograms.

As the sample has stood (for example) 3 days and 20 hours, the factor as determined from the table is 0.50.

$46 \div 0.50 = 92$ millimicrograms of radium per gram of sulphates.

Or, $(454 \times 92) \times 1,000,000 = 0.0417$ mg. of radium per lb. of sulphates.

The electroscopic laboratory is usually furnished with the total weight of sulphates and the percentage of moisture which they contain by the analytical laboratory, so that the calculation of the number of milligrams in the entire lot is easily made from these figures.

The samples of carbonates as received at the laboratory are sent to the chemical section of the laboratory, where they are first dried at a temperature of 105 deg. C. The dried material is then thoroughly mixed. A 1-g. sample is then weighed off and dissolved in dilute hydrochloric acid containing barium chloride. The solution is boiled carefully, cooled somewhat and then filtered into a tall 250-c.c. sample bottle. If the sample

does not dissolve to a perfectly clear solution, the residue, which will consist mainly of unconverted sulphates, is incinerated in a small iron crucible, mixed with 3 g. of the lampblack reduction mixture, reduced in the muffle furnace and prepared for estimation exactly as described under the procedure for sulphates. In such cases there will be two samples for each determination, one representing the soluble portion of carbonate, and the other the insoluble portion or sulphate present. The samples so prepared are allowed to stand for 3 to 4 days. The emanation formed is then transferred to the electroscope and estimated just as was done with the sulphate samples.

The radioactivity is figured in the same way. The milligrams of radium found in the carbonate portion of the sample plus those in the insoluble or sulphate portion give the total activity of the material.

The insoluble portion is an index of the completeness of the carbonation process and should always be very small when the work has been properly carried out.

OTHER ANALYSES

The samples of the gelatinous silica press cakes submitted for analysis are prepared for analysis by the chemical section of the laboratory in the same manner as the samples of sulphates. It will usually be necessary to take a 2-g. sample for analysis.

The samples of dissolved crystals will be received at the laboratory marked with the volume of the sample and the volume of the liquid which each sample represents. The samples in 200- to 250-c.c. capacity volumetric flasks are prepared for determination by the chemical section of the laboratory. The operator preparing the sample will have to judge what fraction of 1 c.c. of the original sample or how many c.c. to pipette off for analysis and base his judgment on the usual radium content of the different fractions of dissolved crystals with which he is dealing and so proportion his samples that they will represent 60 millimicrograms or so as a maximum. This amount of the sample which has been made to definite volume is then pipetted into a sample bottle and made up to about 100 c.c. with dilute acidified barium chloride water. This sample is then de-emanated, sealed and delivered to the electroscopic section for estimation after standing 3 or 4 days. The results are computed to milligrams per c.c. and the amount present in the total volume of liquor is also reported.

Samples of the mother liquors from the different fractions in the crystallizing laboratory will be received stating the volume of the mother liquor which they represent. These are prepared for estimation by the chemical section in the same manner as the samples of dissolved crystals. As they are weaker in radium content, a correspondingly larger sample will be taken for analysis. The samples are then de-emanated, sealed and sent to the electroscopic section, where they are estimated after standing for 3 to 4 days.

All volumetric flasks, beakers, sample bottles and other containers used for containing the samples in any of the chemical manipulations are invariably washed thoroughly with water and then with dilute acidified barium chloride water before using. This is to insure freedom from any sulphate. Any water containing sulphates in solution would immediately vitiate the results by precipitating radium-barium sulphate. A stock solution containing 15 per cent barium chloride and 15 per cent concentrated hydrochloric acid is kept on hand

and about 100 c.c. per liter of this solution is added to all the water used in preparing samples for analysis. Under no circumstances should an untreated distilled water be used.

GAMMA RAY DETERMINATIONS

The electroscope used for gamma ray determinations is a small electroscope provided with a microscope and is similar to the one used for alpha ray determinations except that it has no chamber for holding samples. The electroscope is mounted on a long board provided with a metal track. A sample holder is made which slides along the track so that it may be set and held at a fixed distance from the electroscope by means of a lock nut. The varying of the distance is necessary, as the samples examined will be of widely different strengths, and samples of high radioactivity will have to be set at a longer distance from the electroscope so that the fall of the leaf will not be too rapid to time accurately. A large lead screen about $\frac{1}{4}$ in. thick is mounted between the electroscope and the sample holder to cut off all alpha and beta rays.

The determinations are made in the following manner: The tubes of radium will be received at the laboratory marked with their number indicating the fraction from the crystallizing laboratory which they represent and which will also be an indication of their probable radium content, and with the time at which they were tubed and sealed. The tube to be estimated is kept in a lead container made for the purpose and located in another room at some distance from the electroscope. The natural leak of the instrument is then taken by charging the leaf with the battery or an ebonite rod and timing the fall over the whole scale or over half the scale. The result is recorded in divisions per hour. A standard tube of radium is then laid on the sample holder and the time required for the leaf to fall over the same portion of the scale as was selected for the determination of the natural leak is recorded with the stop watch. The standard tube is then removed and replaced in the container where tubes under estimation are kept and the tube to be estimated is placed in the sample holder, being careful not to change its distance from the electroscope. The rate of fall for the unknown tube is then determined in the same manner and over the same portion of the scale. This done the time is noted and the tube is returned to the container. The calculation is then made as follows:

Natural leak for 10 divisions on the scale = 480 seconds = 75 divisions per hour.

Standard tube (10 mg.) requires 120 seconds = 300 - 75 (natural leak) = 225 divisions per hour for the standard.

Unknown tube requires 40 seconds = 900 - 75 (natural leak) = 825 divisions per hour.

Therefore $10 : 225 :: x : 825$ and $x = 32.2$ mg.

When the tubes estimated are not in equilibrium, the result so obtained is divided by the factor equivalent to the age of the tube reckoned from the time of tubing to the time of making the reading. Thus if 3 days and 20 hours has elapsed from the time the tube was sealed until the time it was read, the factor will be 0.50 and the number of milligrams as found in the above example are divided by this factor. Thus $32.2 \div 0.50 = 64.4$ mg. of radium in equilibrium.

The final readings are made on the tubes when they have reached equilibrium. They are then ready for such disposal as the producing company may wish to make of them.

New York City.

Electric Smelting of Iron Ore

BY FRANK HODSON

President Electric Furnace Construction Co., Philadelphia

A STATEMENT was made at a recent meeting of the officers of the American Mining Congress in Washington by Charles W. Potts, mine operator, of Bearwood, Minn., that "Present known reserves of high-grade iron ore, based upon constantly expanding requirements of the steel industry, will be exhausted in twenty years, and the merchantable grades of iron from the great mines of Minnesota will be, at the present rate of depletion, practically exhausted within the next fifteen years unless new discoveries are made."

The tremendous significance of this rapid depletion of native high-grade iron ore has not yet been fully realized, but a glance at the capital invested in iron and steel and kindred industries and its importance nationally will make anyone see the gravity of the situation. As in the olden days the possessors of metals ruled the world, so today control of iron is inseparably linked with world leadership. If, as Mr. Potts states, our available high-grade iron ore will be depleted in twenty years, is there also not a grave danger of our position today in the world's markets passing, unless the vast deposits of iron sands and low-grade ores in this country are properly exploited? Other countries—China, Japan, Brazil, India—with cheap labor, have immense deposits of iron ore. They have water power available and already are installing large smelting furnaces operated electrically for reducing the iron ores.

COMMERCIAL FEASIBILITY OF ELECTRIC SMELTING OF LOW-GRADE IRON ORE

The electric smelting furnace—using cheap water-generated power—will very probably in the next few years open up a vast supply of iron ore at present considered almost worthless. Immense deposits of iron sands and low-grade ores occur in the Atiron-dacks, on the Pacific Coast and in many other parts of the country. These ores are at present useless, as they cannot be economically treated in the ordinary standard blast furnace. Most of these deposits are in places where power is, or could be generated very cheaply; the ore can be concentrated and smelted into iron by specially designed electric furnaces.

The one thing essential after the financial backing is obtained is the selection of the right type of equipment for the work. Many previous attempts to smelt these ores electrically have failed, owing to wrong or no proper technical advice. A recent issue of *The Foundry* stated there are no less than seventy so-called "direct" processes for making steel direct from ore. Some of these are feasible under certain conditions, but they should not be attempted except on advice from disinterested metallurgists who have had practical electric smelting experience. These "direct" and "secret" processes to give steel direct from ore are the snag that has sunk many promising ventures.

There are several known and proved processes for electric iron smelting, chief of which is the Swedish Electrometall process. Already twenty-seven large installations, with a total capacity of 100,000 kw., are running or under construction in various parts of the world. This type of electric smelter uses the gases generated in the melting zone to preheat and partly

reduce the charge; it does not attempt to make steel direct, but in several cases the product is being tapped out into metal mixers or open hearth furnaces and from there into finishing electric furnaces. Dr. Stangfield in his report on the commercial feasibility of electric smelting of iron ores in British Columbia, writes:

"In Sweden the Electrometall type of electric smelting furnace has proved very satisfactory for the production of low-silicon pig iron. This is, as far as I am aware, the only type of electric furnace that has ever attained commercial success in the production of pig iron from ores. If a permanent smelting plant were being erected, the Swedish type of furnace would be selected."

Considerable publicity has been given recently to what was termed a recent Japanese discovery that iron sand and low-grade ores could be smelted and made into steel. There is nothing new in this invention; as long ago as 1907 John T. Jones, of Iron Mountain, Mich., had devised a similar process for treating low-grade ores. H. A. Greaves and H. Etchells, English scientists and inventors of the successful "Greaves-Etchells" electric steel furnace, also brought out a process a few years ago, in which black iron sand was passed down a rotating tube or kiln and from there to a finishing electric furnace. The ore in this tube is preheated and partly reduced by the gases given off in the electric furnace, and finished steel from sand and has repeatedly been made by their process.

A French inventor, Monsieur Basset, uses a similar method, but in his case external or additional heat is applied to the ore proceeding through the preliminary tube.

ADVANTAGES OF ELECTRICALLY MADE PIG IRON

As long as high-grade ore is available and coke reasonable in price, these electric processes of ore reduction cannot hope to compete with the standard blast furnace in anything but charcoal iron—or iron of special analysis. With the falling off in available supplies of high-grade ore and the generation of cheap electric power from water power, the electric smelters will come into their own. They can undoubtedly make iron superior in quality to that made in the standard blast furnaces. Very thorough tests made in Sweden and England with this electrically made pig iron also proved that by its use in the open-hearth furnaces considerable time could be saved in the steel-making operations. Actual figures have not been published, but in a number of cases that came directly under the writer's notice the saving in time per heat of steel was between 1½ and 3½ hours.

Although, therefore, the initial cost of electric pig iron may still be somewhat higher than ordinary blast-furnace pig iron, yet considerations such as that mentioned above and the extreme purity of the electric iron do not make the difference in first cost as large as would at first appear.

The electric smelter can also economically handle a very large proportion of turnings, borings and cheap scrap in its charge—material that is not suitable except in small proportions in the standard blast furnace.

In places like the Pacific Coast, where good ore is available near cheap, water-generated electric power and where at present most of the coke, pig iron or

steel has to carry heavy freights from the East, there is a splendid opening for someone with vision ahead to put down electric smelters and steel plant.

COMMERCIAL FEASIBILITY OF ELECTRICALLY MADE STEEL

Probably the future method of making even cheap steels will be to take hot blast-furnace metal, either from electric or standard blast furnaces, directly into a large metal mixer where additions of ore, cheap borings and turnings could be added, from there to a bessemer converter, where the metal would be given a partial blow only, and the deoxidizing and finishing off would be done very quickly in a series of electric furnaces.

In the process outlined there would be practically no loss of heat in the whole operation, the addition of ore and cheap scrap in the form of borings, etc., in the mixer would cause a thermic reaction and generation of heat, the bessemer operation would add more heat, and all that the electric furnace would have to do would be to deoxidize, adjust temperature and, where necessary, refine or make additions of alloys. The writer is confident this process would make the cheapest steel in the world.

Ceramics as a Byproduct of Coal Mining in Sweden

BY J. W. BECKMAN

AT A recent meeting of the Chemical Society of Sweden C. Crouquist showed that Sweden has a very ancient coal industry as well as a well-established clay industry. In Skane, the southernmost province of Sweden, coal has been mined ever since the fifteenth century. In those early days the coal was brought out for domestic use only, and from small seams, and it was not until 200 years later that active commercial mining operations took place. The coal veins that had been mined were very thin and the larger mining operations forced the abandoning of the early workings, finding wider veins. These were discovered at Höganäs, which place has since developed into a large industrial center.

The coal is of a more recent formation than that occurring in England and Germany and is found at depths from 10 to 100 m. The thickness of the coal seams vary from 30 to 60 cm. In between the coal seams there are clays and carboniferous slates. These clays have to be mined simultaneously with the coal to make it economical and feasible to bring it out.

The ash content of the coal varies from 5 to 50 per cent and more. It is free from sulphur and phosphorus and has all the characteristics of "sub-bituminous" coal. The railroads and industries of Sweden use the best qualities, although they are also used to some extent for domestic heating. The low grades are used as a source of energy at Höganäs and for the burning of clay products.

The clay-products manufacture is now the main operation at Höganäs. The clay, originally a waste product, has become of prime importance, and the quality of the products produced from it has become famous not only in Sweden but in many other countries. Firebricks, paving bricks, common building bricks, chemical ware, acid-proof bricks, terra cotta products, sewer pipes, sanitary ware and household articles are all being made. These products are pro-

duced in a simple way. The carbonaceous shales are piled in the open and set on fire. They burn completely, leaving a dense well-burned chamotte which is very desirable for the manufacture of pressed brick and other clay products.

The company operating the works at Höganäs also operates an electric furnace plant at Trollhättan, where alundum and carborundum are produced, and these products are used here as elsewhere in the manufacture of highly refractory bricks. Electrodes are also a product of this plant, their manufacture being virtually a ceramic industry, though utilizing different raw materials.

The accumulation of a large quantity of low-grade coal prompted one of the engineers of the Höganäs company to experiment for the purpose of finding a use for this material. He worked out a simple process for the reduction of iron ore at a low temperature by means of these inferior coals, producing a very pure iron sponge, well adapted, on account of its purity, to the manufacture of high-grade steels.

At the present time about 7,000 kw. is generated at the mine from low-grade coals. This energy is used by the industry itself and is also supplied to the adjacent countryside, and this power plant acts as a standby for one of the hydro-electric companies.

The total annual capacity of the plant is 450,000 tons of coal, 200,000 tons of clay, 150,000 tons of firebrick, 400,000 tons of sewer pipes, 7,000 tons of electrodes, 12,000 tons of iron sponge, as well as considerable quantities of other products.

Beckman & Linden Engineering Corporation,
San Francisco, Cal.

Switzerland as a Market for American Goods

American manufacturers and exporters are overlooking an important field for business development in Switzerland, says American Trade Commissioner H. Lawrence Groves in a special survey of the markets of that country published recently by the Bureau of Foreign and Domestic Commerce of the Department of Commerce.

In his report published as a convenient handbook of Switzerland, the Trade Commissioner calls special attention to the increased importance of that country as a financial and a commercial center. He says that Switzerland, located in the heart of Europe, is essentially an industrial nation, almost entirely lacking in raw materials. Consequently, its many industries are dependent on foreign countries for supplies of raw materials as well as for many semi-manufactured and finished products. In his opinion, supplying these commodities is of sufficient importance to merit much more intensive consideration than heretofore accorded on the part of our exporters.

The report is devoted to Switzerland exclusively. It reviews the country's industries, finances, natural resources, markets, etc. Conspicuous facts in its foreign trade are mentioned specifically. There is also information about advertising, credit and transportation agencies, and other similar trade factors.

The complete report is known as Special Agents Series 210—"Switzerland—A Commercial and Industrial Handbook." Copies can be purchased at 40c. each, from the Superintendent of Documents, Government Printing Office, Washington, D. C., and from the district and co-operative offices of the Bureau of Foreign and Domestic Commerce.



ENAMELED STEEL PLANT OF PFAUDLER CO., ROCHESTER, N. Y.

Enameled Steel Manufacture

Development of Glass-Lined Steel Containers—French Plate Glass First Employed—Enamel and Industrial Application Research Involved—Fabricating and Finishing the Steel—Mixing and Firing the Enamel—Erection and Auxiliary Departments

BY CHESTER H. JONES

THE origin of the glass-lined tank or sheet steel enameled container may properly be traced to the need for large containers in the brewing industry, where many sanitation difficulties were encountered in the preparation and storage of malt liquors. At the time the Pfaudler Co. decided to manufacture enameled tanks for this purpose there was no idea of producing the present-day complicated constructions such as steam-jacketed kettles, vacuum pans, etc. These have come as a development from the time when all enamels on containers of any size were applied to cast iron.

Preparatory to undertaking the manufacture of large brewery tanks a comprehensive investigation was carried out. Enamelers were consulted and it was found that the formulas extant were simply the product of rule-of-thumb experiments. These formulas reposed in the memories of individual enamelers rather than in written scientific data. One well-known class of enamel was made originally by taking ordinary rock chips from a granite quarry, grinding them to a powder and fusing to the metal to produce granite ware. Other methods were quite as crude, making conditions difficult for the manufacture of vessels of any size.

The first attempt was made with a cast-iron tank which went into a specially built furnace in 1887. At the end of the heat the door was opened, revealing a melted mass of cast iron. With this failure and since all formulas purchased from so-called scientific enamelers had failed, the company made a radical departure from the accepted methods and started to experiment with sheet steel.

In the process of this research French plate glass was first used as a basic enamel material. The plate was imported from France, broken up, the fragments ground to a fine powder and fused to the steel vessel. This was fairly successful and marked the origin of the glass-lined tank. The high cost of the imported plate caused the company to turn to the purchase of French bottle glass from the leading perfume manufacturers in the United States. This method was employed in the actual manufacture of glass-lined tanks for about fifteen years, during which time experiments to find other methods were continued and the organization was developed. Real scientific handling of the problem from the standpoint of the present state of the art began in 1908, and since that time the methods have been developed to the most modern stage of production. Research in the truly advanced interpretation still continues.

RESEARCH LABORATORY

The first building in evidence on entering the plant of the Pfaudler Co., at Rochester, N. Y., houses the research and control laboratory and is shown in Fig. 1. The work involved here requires a staff of ceramists, chemists and metallurgists, for the metal to be enameled must be studied in relation to the metallurgical properties which affect the ceramic properties of the coating, and the chemist must discover the chemical values best suited to the use of both. The building contains all the departments of this work, including chemical laboratory; balance room equipped, besides the balances, with a Thwing instrument for determining the expansion co-



FIG. 1. VIEW OF RESEARCH LABORATORY

efficient of glass; photographic dark room, and micro-metallographic laboratory.

The furnace room for testing is equipped with a two-crucible furnace for studies in enamel composition, and a large semi-muffle furnace. Here is also a drier for the pebbles. All of these are heated with gas fuel with draft furnished by low-pressure air. The grinding room is equipped with large and small pebble mills and is adjacent to a well-stocked enamel-compounding room. The welding experimental laboratory has, with other apparatus, an electric-welding outfit, made by the General Electric Co. The latest development here is the furnishing of an industrial application room for studying the application of enameled ware in relation to the materials in the many industries where it goes to make up the process equipment.

FABRICATING THE STEEL

The first step in the production of enameled steel is the shaping of the vessel from the steel sheet. The raw material arrives at the factory in flat rectangular or circular steel sheets varying in thickness from $\frac{3}{4}$ in. to $\frac{1}{4}$ in. or less. The dished heads for tanks are formed from the circular sheets on three hydraulic presses after previous heating in a coal-fired reverberatory furnace. Views of these pieces are shown in Figs. 2 and 3. Fig. 2 is a partial view of the steel layout room, while Fig. 3 is one of the stock rooms with the above-mentioned hydraulic presses showing in the background. Two overhead traveling cranes run the length of the fabricating department.

Bending rolls of various sizes are employed to form the circles for large vats from the flat plate. Some of these pieces appear in the left foreground of Fig. 2. The ends are welded to form a complete ring after rolling. Bevel shears cut bevels on the two edges for welding.



FIG. 2. VIEW OF STEEL LAYOUT ROOM

The welding department is furnished with twenty-four oxyacetylene welding stations and sixteen one-man electric welding units. Each welding station is isolated by separating with hanging sheets of loose canvas which confine the sparks of hot metal to one locality and at the same time do not interfere with the moving about of large pieces along the floor. The top of each compartment is open, permitting access to traveling cranes.

The acetylene gas is manufactured in a separate building in four units. The generators feed to a common main for conveyance to the welding stations. The oxygen is purchased from the Linde Co., arriving in steel bottles. These are placed in the acetylene generator house and likewise connected to a common main for the welding station.

GRINDING AND FLANGING

After the welding the surplus metal at the joint is removed by grinding. Fig. 4 shows a movable emery wheel equipment for such work on the interior of tanks. Rings which make up the sides of large sectional tanks or in cases where the cover must be bolted or riveted



FIG. 3. STEEL STOCK ROOM

must next be run through the flanging machine, one of which appears on the left in Fig. 5. The equipment is made to special design of the Pfaudler Co. It will turn the cold metal to an angle of 90 deg. with the side, and flange one edge of a ring or both edges simultaneously.

Following this operation the rings are trued in a rotary shear. The flanges are subsequently punched on machines which pierce ten holes at one operation.

SAND BLASTING

Before the enamel coating is applied, it is essential that the steel surfaces be thoroughly cleaned. Fig. 6 shows the operation in one of the six large sand blast rooms. The blasting equipment consists of blowers, excess dust removers and sand-conveying and storage equipment.

The sand-blast treatment is sufficient, since it removes grease, rust, oxide and all other foreign matter. At the same time a fine surface is given to the steel for the enameling operation.

The enamel is prepared and applied by both the wet and the dry process. There are in general four different coatings used depending upon the service to which the ware is to be subjected. One is supplied for the

malt industry only; the dairy, soft drink and pharmaceutical trade use another type; the third enamel is designed to resist all and any degree of acidity, and finally a special coat is used which is more decorative and while not compounded to combat acid has a reasonable resistance to it.

Raw materials ordinarily used are ground sand, quartz, feldspar, borax, cryolite, fluorspar, sodium and potassium compounds, and clay. The method of melting French plate glass onto the steel sheet has long been abandoned and the constituents which go to make up a glass as mentioned above are made in the form of a powder. The required proportions of each for a definite enamel are mixed, smelted together, and ground wet in ball mills to form a slip which may be applied to the steel surface with spraying machines.

The basis of all enamels is SiO_2 , which is obtained in the ground sand, quartz or feldspar. Borax or anhydrous boric acid (B_2O_3), like silica, is an essential

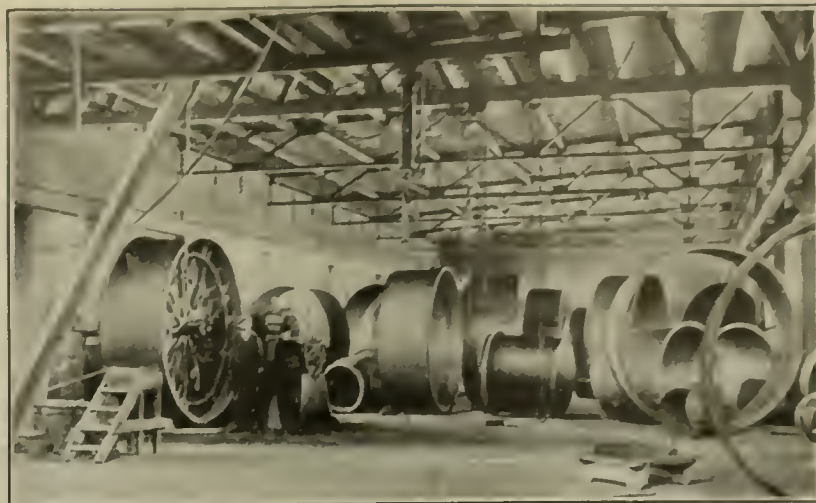


FIG. 5. FLANGING MACHINE

this operation a flocculating agent such as magnesium sulphate, clay or borax is added to increase the viscosity of the slip.

Ordinarily wet enamels are sprayed on the heavy pieces through the medium of a portable air spray nozzle guided by the hand of the operator. Chemical plant ware may be treated by the dry process, or dusting. In this case the metal surface is wetted and the dry powdered frit dusted on where it adheres to the water film. The dusting method has the decided advantage over the wet process in the production of acid-resisting wares, for no raw materials are added to the frit. These raw materials in an enamel lower the acid resistance, for while an enamel is a glassy coating it is not a solid glass and becomes less solid with the addition of raw materials which may not completely fuse with the frit during the brief operation of burning the enamel to the steel.

FURNACE ROOM

The equipment for burning enamel to the steel consists of a total of seven furnaces, four of which are the open type, two complete muffle type and one vertical furnace of special design used for firing small articles that would involve waste of heat if treated in the large furnaces. This furnace consumes oil for fuel, the remainder burning coke. Natural draft is obtained by high stacks. One of the larger furnaces with door raised appears in Fig. 7.



FIG. 6. SAND BLASTING



FIG. 4. GRINDING WELDED JOINTS

constituent of enamel with the possible exception of acid-proof enamels. Those enamels which contain no borax are much more difficult to apply to the metal. Cryolite functions in the mix as both a flux and an opacifier. Fluorspar is also an active flux. Barium carbonate of a pure grade produces finished coats of high luster and density, and gives the easy fusibility of lead without the poisoning feature attending the use of the latter. The action of zinc oxide is similar to that of barium carbonate. Sodium and potassium salts are active fluxes, the nitrate of soda being most frequently used.

The raw materials for making the frit are mixed by hand or in revolving drums. Thorough mixing by machinery is the more advisable, especially in making white enamels where the quality is inversely proportional to the length of time spent in obtaining a thorough melt. Fine grinding and mixing as accomplished by ball mills insure a uniform fusion product with the shortest time in the melting furnace. Five Abbé pebble mills and four special rotary smelters comprise the glaze room apparatus.

The enamel mixture is melted and fined in the smelting furnace until no lumps of unfused or undissolved material can be detected in the string of glass drawn from the melt. On cooling, the frit from the furnace is broken up and ground wet in pebble mills. During

Muffle furnaces are employed largely for burning light wares, especially the light enamels, while the heavier steel pieces are fired in the open type. The temperatures range from 1,500 to 2,000 deg. F. The temperature in any one firing depends on the enamel. Hoskins pyrometers record the temperatures of each furnace. The combustion chambers are constructed from silica brick, while the burning chamber is firebrick throughout. All doors are made up of firebrick blocks and steel and are operated by compressed air, as seen in Fig. 7.

ENAMEL APPLICATION ROOM

Adjacent to each battery of furnaces is one enamel application room. The coated ring or tank is picked up by a traveling charging crane and placed in the open-type furnace, where it is revolved on a turntable while burning. Two of these charging machines are operated by electric current, while others have air lift for the vertical movement and electric drive for the lateral operation. The muffle furnaces are served by power tongs, which pick the pieces from tables moving on industrial tracks along the front of the battery and place them within the burning chamber in each case. Pieces are also served to these tongs by an overhead electric crane paralleling the industrial track just mentioned. Part of one of the traveling tables is seen in the lower right in Fig. 7. The overhead crane is operated from a floor station near the furnaces.

The special upright circular kiln noted above is charged through split doors in the top and is equipped



FIG. 7. ENAMELING FURNACE

with two firing holes located in the side near the bottom. The waste gases from all furnaces is conducted through waste heat boilers in the power plant. The charging cranes were all designed by the company's engineers.

ERECTING DEPARTMENT

The burned wares next go to the erecting department, where assembly is made and packing accomplished in accordance with the customer's specifications. Fig. 8 shows a corner where tanks of certain sizes are built up. The department has six one-man electric welding stations which operate mainly in attaching the jackets to jacketed pans and tanks. One section is given over



FIG. 8. ASSEMBLY FLOOR

to detail assembly of sprays, motor and gear brackets, agitating mechanisms, etc. A portable electric welding station is operated in fastening the various details to the main body at this location. All surfaces are inspected and tested for enamel perfection and the mechanical devices are given operating trial before shipment.

POWER HOUSE

All the steam needed is furnished from three Wickes waste heat boilers. Two Worthington feed-water pumps and a Cochrane feed-water heater complete the boiler room equipment. Power is generated in one Nordberg engine connected to a Western Electric Co., 250-kw., 230-v., direct-current generator and one Westinghouse unit 200-kw., 230-v., direct-current machine. There are five Ingersoll-Rand steam-driven air compressors, three of which furnish air for the sand-blast plant and two supply air for operating furnace doors and tongs. A six-panel switchboard controls the electrical apparatus. All the power consumed in the plant is generated in this department.

AUXILIARY OPERATIONS

Other departments of the plant include a large machine shop, with planers, lathes and drill presses, which is supplemented by repair stations located throughout the various process departments; complete woodworking plant; stores department; hospital and first aid stations; painting shop for coating the unenameled portions of the apparatus; large-scale development of the laboratory department for research in applications to the industries, and finally the factory offices, engineering department and drafting rooms.

CONCLUSION

The plant is conveniently located for shipment of raw materials and products over the Erie Barge Canal, the New York Central, and Buffalo, Rochester & Pittsburgh railroads. It is well arranged for flow of process and ideally located for the health and morale of the working forces. The product is widely marketed to the food, pharmaceutical, dairy, beverage and other chemically-controlled industries.

The company through its research department has made a special study of these industries, with a view to meeting their requirements and developing the equipment accordingly.

Further continuous investigation must obtain to meet new needs in the rapid present-day development of scientifically operated industrial plant processes.

Firefoam Protection of Extra-Hazardous Risks in Manufactories

BY DUNCAN M. PATTERSON, M.E.

IN RECENT YEARS—that is, during the war—the fire protection interests have been confronted with many new forms of extra-hazardous risks, requiring other means of protection than water.

TYPICAL FIRE RISKS WHERE WATER PROTECTION IS INSUFFICIENT

Of these risks, the manufacture of dyes is perhaps the most prominent. Many of the coal-tar derivatives used in this industry are flammable liquids lighter than water. It is obvious that water would be useless for extinguishing fires started in such materials.

The paint industry is another business where the same peculiar hazards are encountered, while varnish manufacturing has even greater hazards than ordinary paints.

In varnish factories the gums and resins, together with the solvents used, are melted together in kettles over coal fires, and it is not uncommon for this to get so hot that the mixture boils over the sides and immediately ignites. In addition to this, the varnish is usually aged in large numbers of tanks 3 to 4 ft. in diameter, crowded together in floors of buildings, where a fire in one tank, caused either by a spark of static electricity igniting the fumes or from some external

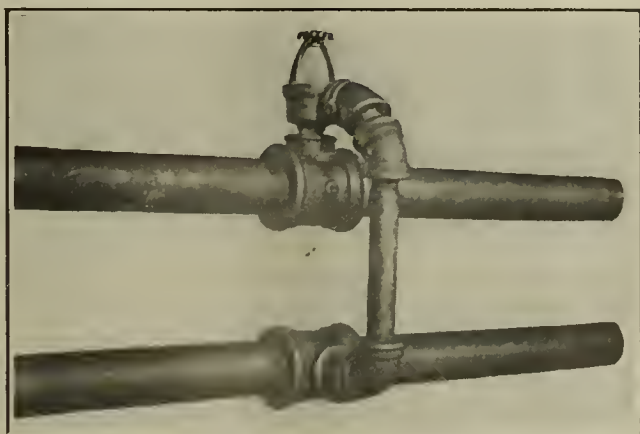


FIG. 1. FOAMITE SPRINKLER HEAD

source, would set fire to the whole room, with the result that hundreds of gallons of burning varnish would be spread over the floor.

In the rubber business solvents are used to make the rubber cement and for preparing the "friction" holding the rubber lining of hose to the cotton jackets, so that in nearly every rubber plant there is one room containing quantities of carbon bisulphide or other solvents for rubber, making an extremely bad hazard.

In linoleum factories we have the oxidizing room, where the linseed oil is treated.

In furniture factories it is becoming the general practice to varnish by dipping the article repeatedly in vats of varnish and drying the piece between successive coats. This means that in such plants there is risk that the whole factory may be set afire, in which case the use of the ordinary water sprinkler could accomplish nothing.

Nearly all the manufacturers of automobiles today adopt this practice for enameling fenders and other parts of the bodies. The parts are hung on a slow moving endless chain. The parts when clean and dry dip down into a bath of enamels, then move on, the excess enamel draining off, and pass through a heated

oven, the source of heat being steam coils or electricity. This cycle is repeated several times before they are removed in the finished condition.

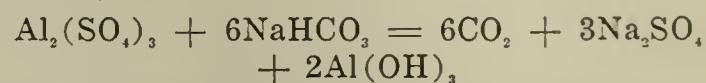
These vats of enamel are kept warm and, of course, the drying ovens are full of the fumes of the solvent being dried out of the enamel, so that a fire in one vat may ignite the whole series.

The above are merely a few of the most prominent hazards of the kind under discussion. It will be apparent that no matter how well a manufacturing plant may be otherwise protected against fire, such, for instance, as the well known automatic sprinkler system, hose stations, soda-and-acid extinguishers, the whole plant is menaced by these "powder magazines" in one part of the plant.

AUTOMATIC FIREFOAM SPRINKLER SYSTEM

Such risks must be protected by a medium which will exclude the air from the burning liquid in the manner which the well-known Firefoam system does in tanks of the large oil companies, and this is now possible by means of a special form of automatic Firefoam sprinkler system.

The system requires two solution tanks and two separate systems of piping, as the foam is produced by the reaction between an acid solution, aluminum sulphate, and a basic solution of sodium bicarbonate, to which the foaming ingredient known as Foamite is added. The reaction is:



The combination produces sodium sulphate, an inert salt, aluminum hydrate, a gelatinous material which stiffens the foam, and free carbon dioxide, which is held by the combined action of the gelatinous aluminum hydrate and the Foamite in the form of a mass of minute bubbles or foam.

This foam is projected on the burning object, completely covering it and excluding the air, while the bubbles, as they gradually break, liberate carbon dioxide, which inhibits combustion.

The foam produced is equal to eight times the combined volumes of the two solutions from which it was produced, so that 1 gal. of each solution will produce 16 gal. of fire-smothering foam. It will be seen that the foam is extremely light, having a specific gravity of approximately one-eighth that of water, and consequently is lighter than the lightest of coal-tar or petroleum products. It will, therefore, float on the surface of these, cutting off the air supply upon which the combustion depends, and will not sink down and float the liquids over the premises as will water.

The foam, being a mass of bubbles, should be created at the point when it is to be used; for, while quite tough and durable, it should be subjected to as little compression or agitation as possible, and it is not desirable to force the foam, after its creation, through lengths of pipe, around sharp corners or through small orifices.

SOLUTIONS MIXED AT SPRINKLER HEAD

The Foamite sprinkler head (Fig. 1), which is of the well-known Grinnell type, is therefore designed so that the two chemicals mix in the particular head or heads over the fire and are simultaneously released upon the fusing of the strut by the heat of the fire.

The two streams of chemical solutions then are thoroughly mixed by the peculiar construction of this head,

and the resulting foam showers down over the fire below.

The source of supply of solutions may be any variation of the standard approved sprinkler practice, such as gravity or pressure tanks, but there must be separate tanks and separate pipes, as the solutions must not mix except at the head.

Owing to the corrosive nature of the acid solution, the tank containing this must be either of wood of special construction, or of lead-lined steel.

For the same reason the Firefoam automatic sprinkler system is preferably of the dry pipe type, to avoid the expense of lead-lined pipe throughout for the acid line.

The usual practice is to use the dry pipe system and ordinary piping in the building, the only lead-lined pipe being that at the tanks in constant contact with the acid solution.

For the same reason the system should be thoroughly washed out after use with water, and, where possible, the basic solution is washed out through the acid line

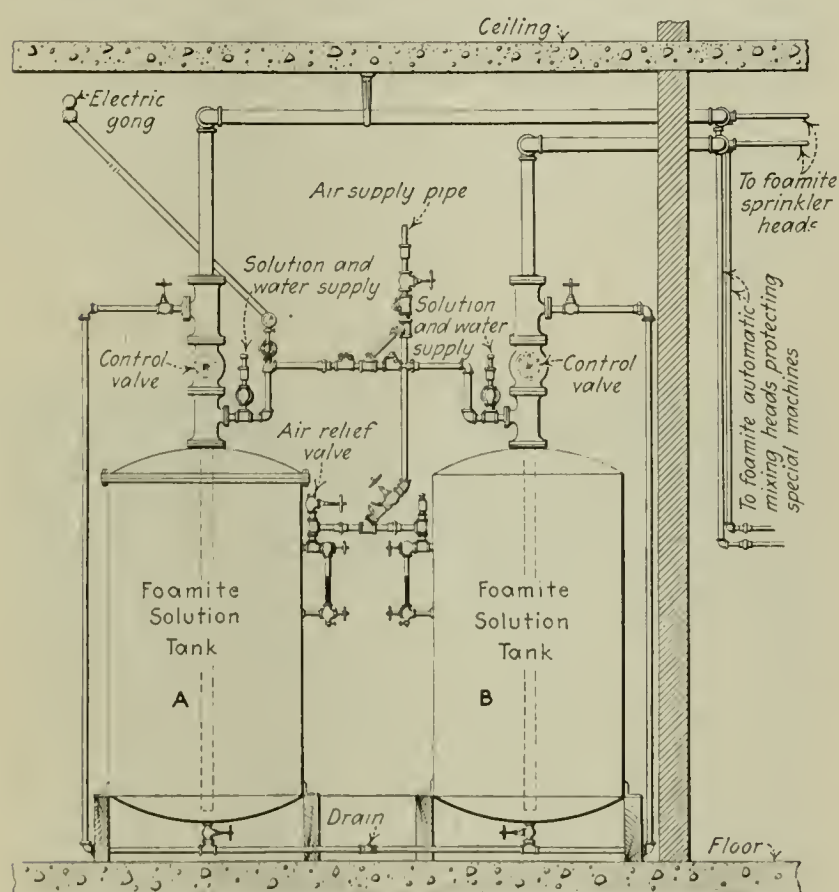


FIG. 2. DIAGRAM OF VALVELESS SYSTEM

by means of a cross-connection at the end of each pair of lines, so the basic solution remaining in the basic line will be washed into the acid line and neutralize any of the acid solution which might remain in the latter after both had been drained back to their respective solution tanks.

The ordinary dry pipe valve, lead-lined up to the seat, may be used for the acid line, and the ordinary dry pipe valve for the basic line.

Installations of any size permitted by the fire insurance interests may be installed by using the accelerator valve in particularly large systems.

For small systems what is known as the valveless system may be used, which in its simplest form is shown in Fig. 2.

The solution tanks are filled two-thirds full of the chemical solutions, and air pressure built up to the pressure required to deliver the solutions to the heads.

The same pressure will also be built up in the pipe lines through the check valves, which have a small ori-

fice through them. This compensates for any minor leaks in the air piping, but the orifices are so small that they will not compensate when a sprinkler head is released. When this occurs, the unbalanced pressure in the solution tanks forces the solution up and out of the sprinkler heads.

There are a number of other methods which may be used in addition to those described, and a careful survey of the conditions with all the engineering data is required to devise the proper installation for any conditions. It will be seen, however, that this new application of Firefoam offers a means not only of reducing these extra-hazardous risks to a point where they are no greater than those of an ordinary fire, but also, by eliminating these special hazards, of reducing the risk on the whole plant, so that the lowest rate should be obtained on the latter.

Foreign Trade of Germany in 1920

The Federal Statistical Bureau of the German Ministry of Economics furnishes an itemized statement of Germany's foreign trade during the twelve months of 1920. The figures do not include reparations deliveries under the terms of the Treaty of Versailles.

The itemization of Germany's foreign trade for 1920, presented in the *Monatliche Nachweise*, is given in the accompanying table:

Articles	Imports, Double Centners*	Exports, Double Centners
Agricultural, animal, and vegetable products, including foodstuffs.....	65,625,129	14,095,778
Animal and vegetable spinning materials and manufactures thereof, including human hair, prepared feathers, fans, and hats.....	871,597	782,698
Brooms, brushes and sieves.....	2,602	24,829
Caoutchouc goods.....	20,611	31,132
Chemical and pharmaceutical products, including dyes and dyestuffs.....	2,656,364	26,324,611
Clay goods.....	549,473	3,823,766
Glass and glassware.....	138,954	1,184,284
Goods prepared from bones, wood, cork, and other plant dissection.....	70,989	1,286,938
Leather and leather manufactures, including furs and goods made from animal waste.....	168,012	99,777
Machines, vehicles, and electrotechnical products....	81,413	6,726,116
Metals:		
Coarse, and manufactures of.....	5,294,219	18,478,827
Precious, and manufactures of.....	163	2,530
Mineral and fossil raw materials, and mineral oils....	111,398,942	118,479,877
Paper and pulp, and manufactures of.....	800,729	2,770,938
Stones and other minerals (excepting clay) and fossil material, manufactures of.....	236,292	3,184,214
Wax (prepared), paraffin, and related products, including soap, and other fatty substances, oils, and wax manufactures.....	411,890	81,991
Wickerwork and goods plaited from plants, excepting spinning fibers.....	10,337	46,312
All other articles.....	28,545	671,461
Total.....	188,366,261	198,096,079

*1 double centner = 220.46 lb.

Formula for Strength of Rope

At the Bureau of Standards laboratories tests have been made that have resulted in a formula quickly determining the strength of rope.

For three-strand regular lay manila rope from $\frac{1}{2}$ to $4\frac{1}{2}$ in. in diameter, the following computation will give the breaking load of the rope: The average breaking load in pounds equals 5,000 multiplied by the diameter of the rope in inches, multiplied by the diameter of the rope increased by 1.

This will give, of course, the average maximum weight that the rope will hold, but the working load that may be applied with proper safety and precaution would be considerably less than the load given by the formula.

Other data on rope are contained in the Bureau of Standards Technologic Paper 198, by A. H. Stang and L. R. Strickenberg, which has just been issued.

Superpower System for the Boston-Washington Region

THE United States Geological Survey has just published Professional Paper 123 (255 pages) embodying the report of W. S. Murray and others on the Superpower System for the region between Boston, Mass., and Washington, D. C.

Congress has appropriated during the fiscal year 1921 the sum of \$125,000 "For the survey of power production and distribution in the United States, including the study of methods for the further utilization of water power and the special investigation of the possible economy of fuel, labor and materials resulting from the use in the Boston-Washington industrial region of a comprehensive system for the generation and distribution of electricity to transportation lines and industries, and the preparation of reports thereon." An additional sum of \$26,000 was contributed by thirty-six corporations and individuals, representing utilities and industries in the superpower zone. The work was promptly organized and an engineering staff was selected by Mr. Murray, consulting engineer, of New York City, who was appointed by the Secretary of the Interior to head this engineering study. The investigation was begun on July 1, 1920, and completed within a year. Some of the principal facts brought out in the report are presented in the following paragraphs.

THE SUPERPOWER ZONE

The "superpower zone" may be described as lying between the thirty-ninth and forty-fourth parallels of latitude and extending from the coast approximately 150 miles inland, embracing parts of the States of Maine, New Hampshire, Vermont, New York, Pennsylvania, Delaware and Maryland and all of the States of Massachusetts, Rhode Island, Connecticut and New Jersey. Within this zone is concentrated one-fourth of the population of the United States, and within it are operated, most of them independently, 315 electric utilities, 18 railroads and 96,000 industrial plants.

The superpower zone has relatively small hydro-electric resources and maximum industrial-power requirements. Fortunately some of the best coal deposits in the country lie near this great industrial territory, and a prime economic purpose should be so to conjoin the hydro-electric supply of power to the steam-electric supply as to produce a maximum of energy for a minimum investment of capital and a minimum operating expense, and at the same time to conserve the rapidly disappearing cheap fuels of the Appalachian coal fields.

The superpower system comprehends also a plan of power production that includes the generation of electricity by steam at tidewater and on inland waters where a sufficient quantity of condensing water can be obtained, and also the utilization of all hydro-electric power that may be economically obtainable from rivers within the zone or within transmission distance of it. The electric power so generated will be co-ordinated through a system of inter-connected transmission lines, the potentials of which will be on the order of 220,000 and 110,000 volts.

PRESENT POWER PLANTS IN THE SUPERPOWER ZONE

Under the present independent operation of the electric utilities and the manufacturing industries in the superpower zone the existing power plants are numerous and small. The average capacity of the 558 elec-

tric-utility plants now in operation in the zone is 7,900 kw., and that of the steam-electric plants 10,000 kw., while the hydro-electric plants average only 2,800 kw. Out of the 96,000 industrial establishments in the superpower zone 76,000 use power, and each of these isolated plants averages about 350 hp. Under the superpower system, by contrast, the number of power stations required to supply the entire zone in 1930 will be only 273, of which 218 will belong to the existing electric utilities. The capacity of the base-load steam plants will range from 60,000 to 300,000 kw. In none of these plants will there be installed a turbo generator having a capacity of less than 30,000 kw.

LOCATION OF POWER STATIONS AND LOAD CENTERS

The new power stations and load centers will be so located with reference to the existing electric-utility plants that are to be incorporated in the system as to insure the maximum aggregate economy in power generation and transmission. A prime object to be attained in the superpower plan is the maximum economic utilization of existing generation and transmission equipment. In the early stages, while the superpower system is taking form, existing electric-utility capacity will predominate. Indeed, in 1930, as much as 31 per cent of the total superpower capacity will be contained in plants belonging to the present electric-utility companies.

The fundamental information required for the determination of the mechanical power-supply equipment and fuel used by all the industries necessarily had to be procured from the Bureau of the Census, if for no other reason because time would not have permitted its independent compilation. The analysis of this information showed that in 1919 the equivalent of 9,311,440,000 kw.-hr. was developed by prime movers operated by the industries themselves and that 3,338,800,000 kw.-hr. was purchased. It further shows that it would have been economical to shut down 4,008,200 hp. of prime movers and purchase energy to the amount of 5,623,800,000 kw.-hr., which would have made a total of 8,962,600,000 kw.-hr. purchased in 1919. The saving in coal thus effected would have been 13,502,100 tons—71 per cent of the coal used by the industries for producing power, or 25 per cent of all the coal used by the industries.

REDUCING COST BY INTERCONNECTING SYSTEMS

In general it has been found that industrial establishments which require 500 hp. or less can economically purchase energy. Only those that need more than 500 hp. and that have special requirements for heat can generate their own power economically, and even these should have central-station connections to take up irregularities of load. The efficiency of power production by isolated industrial plants is precluded from any considerable improvement by their necessarily small average capacity.

A careful study of the power requirement for industrial establishments in the superpower zone has been made and has shown that by 1930 an annual saving of \$190,000,000 can be made to the industries themselves above the fixed charges against an investment of \$185,000,000 for the motor equipment necessary to utilize the power.

Of great interest is the economic relation established between the joint use of steam and water power. It is shown that steam and water power can be so combined

as to yield annually \$69,550,000 on an increased investment of only \$44,838,000. Here is exemplified one of the prime advantages of superpower production, costs being reduced by means of the interconnecting system which permits the highest economy in steam-produced power together with the maximum use of water power.

HYDRO-ELECTRIC POWER

The construction of a hydro-electric plant is economically justified if it produces its power at a cost less than that of a steam-electric plant of the same capacity. With maximum development of water power, however, the hydro-electric energy available within the superpower zone will amount to less than 20 per cent of the total electric power required in 1930.

Of especial importance in determining the location and capacity of the new water-power plants for the zone is the economy attained by the development of rivers beyond their primary power. The principal rivers which can contribute water power to the superpower zone are the Potomac, Susquehanna, Delaware, Hudson and Connecticut. It is proposed to utilize power from these rivers in 1930 to the following extent:

River	Capacity, Kw.	Output (Millions of Kw.-Hr.)	Investment	Production Cost (Mills per Kw.-Hr.)
Potomac.....	200,000	950	\$22,000,000	3.36
Susquehanna.....	185,000	1,230	28,000,000	3.22
Delaware.....	350,000	1,250	51,500,000	5.95
Hudson.....	150,000	900	38,350,000	5.84
Connecticut.....	165,000	760	29,000,000	5.45

The water powers of Niagara and St. Lawrence rivers are within transmission distance of the superpower zone, but on account of the time required for construction on the St. Lawrence and of the treaty restrictions concerning the use of the water at Niagara Falls the power from these sources has not been considered available in the zone prior to 1930.

The reproduction cost of the 451,500 kw. of existing hydro-electric capacity within the zone is \$87,127,000. The new hydro-electric capacity which should be installed by 1930 will bring the total capacity up to 1,501,500 kw., of which the old plants will represent 30 per cent. In 1930 the total hydro-electric investment will be \$245,977,000, of which the old plants will represent 35 per cent.

RECOMMENDED PROCEDURE

The order in which the superpower steam-electric and hydro-electric power plants and transmission systems should be constructed must depend (1) on the present industrial demand for energy that cannot be satisfied because of the difficulties of the local electric utilities in financing extensions; and (2) on the future demand for energy that will result from the more economical generation of power under the superpower system. Many of the economies incident to superpower operation will be effected through the interconnection of existing plants and systems, and these economies should be increased as new power plants and interconnections are added.

By keeping in mind the two conditions, it is believed that the quickest return will be obtained by following in chronologic sequence the order of procedure as follows:

1. The construction of a steam-electric plant near Pittston, Pa., to supply a part of its energy to the Anthracite division of the superpower zone and the remainder to the Metropolitan division, particularly New Jersey.

2. The construction of a steam-electric plant near Sunbury, Pa., to supply a part of its energy to the Anthracite division, a part to the Reading load center, and the remainder to Philadelphia.

3. The construction of hydro-electric plants on Delaware and Susquehanna rivers to supplement the steam plants indicated above.

4. The progressive development of the Hudson River projects to meet the growth of energy requirement at the Schenectady, Utica, Poughkeepsie and Pittsfield load centers.

5. The construction of a steam-electric plant near Boston to supply the Boston, Lowell and Newburyport load centers.

6. The construction of a steam-electric plant near New Haven to supply the New Haven, Bridgeport, Waterbury and Norwich load centers.

7. The partial construction of the first hydro-electric plant in the development of Potomac River as soon as the power demands of the Baltimore and Washington load centers require additional plant capacity.

Plant capacities are not stated above, as they cannot be finally determined except by further and more detailed study of local conditions combined with regional demands. The load growth at all the centers, however, will make it imperative to provide new plant capacity at an early date, so that the construction of additional plants must be started promptly after the plants that will yield the greatest return have been built.

ADVANTAGES OF SUPERPOWER ENERGY

The market for superpower energy will be furnished by the electric utilities, the industries and the railroads. The estimated requirement for energy supplied through the electric utilities for municipal, private, industrial and railroad purposes in 1930 is 31,000,000,000 kw.-hr. This energy could be supplied by a co-ordinated power system at an annual cost of \$239,000,000 less than by an unco-ordinated system such as is now in use. This amount represents the net saving after the necessary fixed charges on total capital expenditure have been deducted. The total investment in generating and transmission facilities for the superpower system will be \$1,109,564,000, of which \$416,346,000 will represent the value of existing facilities to be incorporated into the system.

A study of the 96,000 manufacturing establishments operating within the superpower zone shows that by 1930, through the maximum economical use of purchased electric energy, they can save \$190,000,000 annually above the fixed annual charges against a capital investment of \$185,000,000 to provide the motor equipment necessary to receive and use the necessary electric power.

The combined capital investment necessary for the electric utilities and the industries as of 1930 therefore amounts to \$1,294,564,000, and this total investment will yield annually above the fixed charges the sum of \$429,000,000, or 33 per cent on the amount of the investment.

Within the superpower zone there are 36,000 miles of railroad measured as single track—that is, including each track of main lines, yards and sidings. Of this total about 19,000 miles can be profitably electrified, so as to yield by 1930 an annual saving of \$81,000,000 as compared with the cost of operation by steam. The capital expenditure necessary to electrify the 19,000

miles would be \$570,000,000, and the average return upon the investment would therefore be 14.2 per cent.

Studies of the operations of each load center have shown that a large quantity of coal could have been saved had superpower facilities been available in 1919. On comparing the coal rates of power production in 1919 with those of the superpower system and applying the difference to the load that will exist in 1930 we find that the coal saved annually under the superpower system may be estimated as follows:

	Short Tons
Electric utilities.....	19,149,000
Heavy-traction railroads.....	10,210,000
Manufacturing industries.....	20,625,000
Total.....	49,984,000

COAL SAVING BY CHEMICAL AND METALLURGICAL INDUSTRIES IN SUPERPOWER ZONE

Of the total quantity of coal to be saved by the superpower system, chemical and metallurgical industries would contribute the following savings:

Industry	Coal Saved in Short Tons	Industry	Coal Saved in Short Tons
Dyeing and finishing.....	34,500	Gas, illuminating and heating.....	163,000
Steel works and rolling mills	1,035,000	Petroleum refining.....	49,000
All other iron and steel products.....	1,124,400	All other chemicals.....	586,000
Tanning, currying and finishing of leather.....	10,000	Cement.....	94,000
Paper and wood pulp.....	390,000	Clay products.....	97,400
Coke, except gas-house coke	51,000	Glass products.....	27,500
Explosives.....	52,000	Metals, non-ferrous.....	199,000
		Metal products, non-ferrous	112,000
		Total.....	4,024,800

Synopsis of Recent Chemical & Metallurgical Literature

Alcoholic Fermentation as a Source of Glycerine.—In 1780 Scheele obtained glycerine by the saponification of fats with lead oxide. In 1823 Chevreul proved that glycerine is an integral part of fats in the form of an ester of the fatty acids. This has been confirmed by Pelouze and since then glycerine has been prepared commercially by saponification of fats in soap plants. During the war, due to the scarcity of fats, researches were started to prepare glycerine synthetically or by fermentation. As early as 1873 Friedel and Silva succeeded in preparing glycerine synthetically, but up to now the process has not been an industrial success. The fermentation method at first used by Pasteur has been more successful, and Dr. K. Schweizer gives in the August, 1921, issue of *Chimie et Industrie* a lengthy description of the industrial preparation of glycerine by alcoholic fermentation.

After reviewing the work of Pasteur, Laborde, Ehrlich, Rossi, Neuberg and Kerb, he outlines the facts and hypotheses concerning the intermediate products formed during alcoholic fermentation and then describes the changes in normal alcoholic fermentation which are necessary for the manufacture of glycerine as the main product. Among the methods used for the realization of these changes he gives the following:

Reduction of Trioses. Since it is known that glycerine can be obtained by the reduction of glyceric aldehyde and dioxyacetone and since these substances are supposed to be formed as intermediate products during the conversion of sugar into alcohol, it seemed logical to expect that the addition of a reducing agent during fermentation would increase the yield of glycerine. The greatest practical difficulty was to find a yeast which would function in the presence of the large quantities of salts constituting the reducing agent.

However, by the use of a yeast prepared from molasses, and a great excess of sodium sulphite, it was possible to obtain 21.3 g. glycerine from 100 g. sugar.

Change of the Reaction of the Fermentation Medium. This is best realized by introducing given quantities of sodium carbonate in the fermentation medium shortly after fermentation started. Twenty to 25 kg. of glycerine can thus be obtained per 100 kg. of sugar.

Blocking the Formation of Acetaldehyde During Fermentation. This is best realized by using sodium sulphite, which acts not only as an alkaline reagent but also as an antiseptic for the harmful bacterias resulting from the fermentation in alkaline medium. About 23 kg. of glycerine is obtained per 100 kg. of sugar.

The author then describes the method used for the extraction and purification of the formed glycerine. He concludes by suggesting that instead of starting with sugars, which are expensive, there will soon be a possibility of preparing glycerine by using hydrolyzed sawdust and waste sulphite liquor from paper mills.

Hardening of Tool Steel.—Shipley N. Brayshaw presented a paper recently before the Sheffield Association of Metallurgists and Metallurgical Chemists, and abstracted in *Iron and Coal Trades Review*, upon an ordinary carbon tool steel containing about 0.8 per cent of tungsten and about 0.2 per cent of chromium, with a change point at 738 deg. The work was mainly for the purpose of determining the effect of various heat-treatments by means of test-bars and test-cutters. Some of the cutters were badly broken; others were fairly sound; even of the sound ones some were good and some were bad so far as their strength was concerned. Yet when each group was examined it was shown that there was a clear relation between the previous heat-treatment and the behavior on hardening. The results from the whole series of 102 cutters were reasonably consistent with scarcely half a dozen exceptions; furthermore, the results were in general accord with those obtained from the test-bars before and after hardening.

It was found that for the steel in question there was a range of temperature of somewhere about 715 to 725 deg., within which with prolonged soaking the steel reached a condition which was remarkably favorable to satisfactory hardening, as was shown by the non-occurrence of hardening cracks and the fact that taps and screw gages could be hardened without change of pitch.

Mr. Brayshaw made a proposal for a standard hardening test for the purpose of ascertaining the degree of liability of a given steel to crack in hardening. He believed that the hardening of steel could be brought completely under control provided it were reasonably sound and not objectionable in analysis. Such a simple test would show whether the steel was liable to hardening cracks or not, and the degree of liability would be indicated.

Separation of Lime From Dolomite.—H. G. Schurecht, in the July *Journal of the American Ceramic Society*, publishes an exhaustive study of "The Separation of Lime From Dolomite." Magnesium carbonate in dolomite is decomposed by calcining for 1 hour at 800 deg. C. Calcium carbonate is not completely decomposed until after calcination at 960-1,040 deg. C. for 1 hour.

By adding sufficient sulphuric acid to milk of dolomite to react with the lime present, a bulky precipitate of magnesium hydroxide is formed which may be partly separated from the finer calcium sulphate by screening through a 120-mesh sieve. The residue on the screen contains about 68.3 per cent magnesium oxide and represents about 50 per cent of the original CaMgO. The best results by flotation were obtained by removing the fine material from the raw dolomite and then calcining at 920 deg. C. Wood creosote flotation oil No. 400 was found best suited for this separation. The concentrates removed by flotation, however, represent only 25 per cent of the dolomite originally treated. By leaching and screening treatment it is possible to obtain a product containing about 80 per cent MgO. This is superior to the Canadian magnesite in MgO content. By an elutriation treatment it is possible to obtain a residue containing over 85 per cent MgO and representing about 30 per cent of the original dolomite.

Current Events

in the Chemical and Metallurgical Industries

Tariff to the Fore Again

With the tax bill practically out of the way, the Senate is concentrating its interest on tariff matters. The extent to which the chemical industries are to receive protection practically will be decided during the next few weeks. The thing which is militating most against high rates on chemicals is an impression on Capitol Hill that the chemical industries have been unusually prosperous under existing rates of duty. There is also an impression that the banking interests have gained the upper hand in many chemical activities and that there is a tendency to eliminate research and experimentation in the interest of greater profits. One of the principal reasons which influenced the House committee to recommend unusual measures for the protection of the chemical industry was the very evident need of incurring large expense in research so that the new American industries might compete successfully with the long-established chemical concerns in other countries. There is an idea that many of the former leaders in the industry who built up pretentious activities, despite the lack of protection, and who had the vision to incur large expense in experimentation study, are being crowded aside by interests who are more concerned in quick profits than in the permanency of the industry.

Fertilizer Freight Rates Discussed

A reduction of 25 per cent in the freight rate on fertilizer was urged at a hearing in Washington Nov. 2 before the traffic executives of the Southern railroads. J. W. White of Atlanta, chairman of the traffic committee of the National Fertilizer Association, and John I. Tierney, Washington representative of that organization, appeared in behalf of the fertilizer industry. They contended that the fertilizer industry had reduced its prices to the point of actual loss in its effort to be helpful in the general return to more normal prices. The fertilizer used in 1921 was 59 per cent of the amount used in 1920. One of the principal causes for this decline in fertilizer use was held to be freight rates, which have contributed nothing to the liquidating process. As a result of the reduced use of fertilizer, the cotton crop is 7,000,000 bales less than would have been the case had the fields been properly fertilized, the railroad executives were told.

National Research Council Publication on Research Chemicals

Timely information with regard to research chemicals is contained in a publication being distributed gratis by the National Research Council. The pamphlet contains a list of manufacturers, as well as an alphabetical list of the several thousand of the rarer chemicals. The pamphlet also contains a list of biological stains and indicators and another list of hydrogen ion indicators. The work follows the lines of "British Research Chemicals," published by the Association of British Chemical Manufacturers.

Standardization of Paving Brick

Elimination of excess varieties and styles in paving brick is to be considered at a meeting Nov. 15 in Washington under the auspices of the Secretary of Commerce. The meeting is to be open to all interested. A preliminary survey of the situation is being made by a committee of paving brick manufacturers and a report will be submitted setting forth the facts as to the volume of the manufacture in the various sizes and styles of bricks now in use.

Chamber of Commerce Establishes Natural Resources Department

Half of the difficulties of the natural resource industries would disappear if the public were well educated in their problems. This is the opinion of W. DuB. Brookings, the head of the Natural Resources Production Department of the Chamber of Commerce of the United States. This department is preparing a very active program in an effort to render constructive service to the raw material industries. In that connection it was pointed out that this work is supplementary to that of the various trade associations. It is believed, however, that this nation-wide organization of business men can render great assistance to the industries and to the public by conducting a campaign of education intended to enlighten the public on the vital problems of natural resource activities.

The organization of the natural resources department is just being perfected. An advisory committee has been named of which C. S. Keith, the president of the Central Coal & Coke Co. of Kansas City, is chairman. The other members of the advisory committee are: J. H. Ross, president, Exchange Supply Co., Winter Haven, Fla.; J. E. Spurr, Editor, *Engineering and Mining Journal*, New York; Christy Payne, president, Peoples & Hope Natural Gas Cos., New York; E. T. Meredith, former Secretary of Agriculture, Des Moines, Iowa; Sidney J. Jennings, vice-president, United States Smelting, Mining & Refining Co., Boston, Mass.; R. V. Norris, mining engineer, Wilkes-Barre, Pa.; Van H. Manning, American Petroleum Institute, New York, and William H. Davis, president, Midcontinent Oil & Gas Association, Bartlesville, Okla.

It is the opinion of Mr. Brookings that nothing is of more importance in this day with its tendencies toward federal regulation of business than to obtain for the natural resources industries a high degree of public confidence. This, he believes, can be obtained if the public knows the real facts in regard to these industries.

American Field Service Fellowships for French Universities

The Society for American Field Service Fellowships for French Universities will offer for open competition among graduates of American colleges and other suitably qualified candidates a number of fellowships, not to exceed twenty-five, for the purpose of encouraging advanced study and research in French universities during 1922-23. The fellowships, of the annual value of \$200 and 10,000 francs, are granted for one year and are renewable for a second year. They may be awarded in thirty-one fields of study, including chemistry, engineering, geology, mathematics, physics.

Fellows will be required to sail to France not later than July 1 of the year in which the award is made, to matriculate in a French university for the following session, and to pursue studies in the field of science designated in their awards.

Applications should reach the secretary of the society not later than Jan. 1, 1922. Application blanks and full information as to qualifications, etc., may be obtained from the secretary, Dr. I. L. Kandel, 522 Fifth Ave., New York City.

Sterling Chemical Laboratory, Yale University

With the awarding of the contract for the erection of the new chemical laboratory at Yale University, New Haven, Conn., to the Thompson-Starrett Co., 49 Wall St., New York, it is proposed to commence work immediately on the structure. The new laboratory, to be known as the Sterling Chemical Laboratory, is estimated to cost \$2,000,000.

Congress of Industrial Chemistry at Paris

The first Congress of Industrial Chemistry was opened on Monday, Oct. 10, at the National Arts and Crafts Conservatoire, M. Dior, the Minister of Commerce, presiding. Many distinguished scientists and chemical experts attended, including Mme. Curie and Sir William Pope. Dr. Frederick Cottrell and Dr. Mackall represented the United States. Paul Kestner, president of the Société de Chimie Industrielle, opened the proceedings with an account of the work of the society and outlined the subjects which would come within the range of the conference.

Sir William Pope lectured on the future of organic chemistry, with special reference to the advantages which France and Britain might derive from their tropical possessions. He was presented by M. Dior at the conclusion of his lecture with the gold medal of the French Society.

Great interest was taken in the public lecture given at the Sorbonne by Georges Claude on his method of obtaining synthetic ammonia. The lecture was illustrated both by lantern slides and experiments, M. Claude actually producing synthetic ammonia in the hall. This manufacture, he said, as carried out at the Montereau works, where pressures up to 1,000 atmospheres are used, is incomparably less dangerous than might be supposed, since by reason of the high pressures employed the parts of the apparatus used in the Claude process are so small that an explosion, as proved by experience, does no damage. Moreover, the ammonium salt (ammonium chloride) produced by the French methods is non-explosive, so no disasters similar to that of Oppau need be feared.

Lectures were also given by M. Matignon, professor at the Collège de France, on the state and development of the nitrogen industries and by M. Gall on the French cyanamide industry.

Henri Le Chatelier, member of the Institute of France, lecturing on chemical analysis, emphasized the necessity of supplementing laboratory experiments by experiments in the industrial field and pleaded for an improved system of teaching chemical analysis and for some standardization of methods of analysis.

An exhibition of applied chemistry was held in connection with the conference.

Plants Resuming Operations Growing in Number

Glassware.—The F. C. Wheaton Co., Millville, N. J., manufacturer of druggists' glass specialties, has resumed operations at its plant, effective Oct. 31, placing its furnace, the largest in south Jersey, in service.

The Potomac Glass Co., Cumberland, Md., has resumed production with a full operating force, totaling about 250 workers, following a shut-down since July.

The Hazel-Atlas Glass Co., Wheeling, W. Va., manufacturer of fruit jars, etc., has placed an additional tank in service at its Clarksburg, W. Va., works, effective Oct. 31, giving employment to about 200 additional employees and bringing operations up to a point of approximately 28 per cent of the full quota of 850 workers that are employed in normal times.

The Whitall-Tatum Co., Millville, N. J., manufacturer of druggists' glassware, has placed a new amber glass tank in operation at its Glasstown works, giving employment to additional workers. The lamp department at the works has been started up at full capacity.

The American Window Glass Co., Belle Vernon, Pa., has resumed operations at its local plant, following a six-months shut-down. It is said that orders on hand insure capacity production for some months to come.

Paper.—The International Paper Co., 30 Broad St., has increased production at its mills to about 700 tons of paper per day, or close to 60 per cent of capacity. A total of eleven mills are now operating and it is planned to resume at other mills at an early date.

The Dryden Pulp & Paper Co., Montreal, Que., is now operating at capacity, with the sulphite mill producing about 70 tons of material a day, the kraft paper mill about 13 tons daily, and the paper board mill running at close to capacity.

Rubber.—The Mason Tire & Rubber Co., Kent, Ohio, is

operating at full capacity, with three shifts. The output totals about 11,000 casings a week.

The Boston Woven Hose & Rubber Co., Boston, Mass., is now operating at close to 70 per cent of normal, with the hose-manufacturing department, comprising about 20 per cent of the total output at the works, producing at 75 per cent of normal. The tape, heel, tube and matting departments are increasing their operating schedules. Effective Nov. 1, wages at the mill have been reduced 5 to 15 per cent, with the average labor reduction at 10 per cent.

Oil.—The Sinclair Consolidated Oil Corporation, 45 Nassau St., New York, operating refineries in Indiana, Kansas and Oklahoma, will place all plants on a capacity basis of production at once.

Coke.—The H. C. Frick Coke Co., a subsidiary of the United States Steel Corporation, has placed 350 coke ovens in blast at its plants at Calumet, Southwest and Hostetter, Pa., closely following the resumption of operations at the Continental No. 1 and York Run plants of the company, totaling 600 ovens, on Oct. 24. This total of 950 ovens will give employment to over 1,200 men. The ovens have been banked since last spring. It is planned to place 300 ovens at the Brownsville, Pa., works in operation at an early date.

Steel.—The Superior Sheet Steel Co., Canton, Ohio, is operating at full capacity, with eight mills in service.

The Cumberland Steel Co., Cumberland, Md., has agreed with operatives at the plant for production on a two-shift, full-time basis, each shift to work three 10-hour days a week. The men have accepted a wage reduction of 10 per cent.

The Tyler Tube & Pipe Co., Washington, Pa., has resumed operations at its plant. Orders on hand are said to insure continuous production throughout the fall and winter.

Iron.—The Reading Iron Co. is arranging for the immediate resumption of its Keystone blast furnace, Reading, Pa., with a weekly output totaling 2,000 tons.

Chemical.—The Solvay Process Co., Syracuse, N. Y., is now operating at close to normal pre-war production at its Solvay works, manufacturing soda ash and its derivatives. Early in the summer the plants were on a 40 per cent capacity basis.

Lower Freight Rates Sought for Pottery Products

Representative pottery interests at Trenton, N. J., and vicinity are formulating plans to bring about an early readjustment and lowering of freight rates on commodities entering into the manufacture of sanitary pottery, including clay, feldspar, flint, etc. It is held that these materials are now defraying more than their just proportion of the transportation burden of the country and that a reduction in rates will stimulate greatly business in the sanitary ware line. A committee has been appointed to compile data and carry out the details of the movement. M. D. Warren, traffic manager of the Chamber of Commerce, Trenton, will act as chairman of the committee; other members include: Charles Brian, general manager of the Paper Makers' Chemical Co., Easton, Pa.; George Dyer, representing the Sanitary Potters' Association, Trenton; John Manor, Golding Sons' Co., East Liverpool, Ohio; A. C. Hoffman, Trenton Potteries Co., Trenton; L. L. Lee, Star Porcelain Co., Trenton; F. W. Walker, secretary, Beaver Falls Art Tile Co., Beaver Falls, Pa.; and Charles Donnelly, United States Potters' Association, Pittsburgh, Pa.

A.S.M.E. Meeting to Stress Elimination of Industrial Waste

Elimination of industrial waste will be stressed at the annual meeting of the American Society of Mechanical Engineers to be held in New York City, Dec. 5 to 9. The report of the Committee on Elimination of Waste in Industry of the American Engineering Council will provide the basis for the discussion, which will emphasize the engineering phases of the waste problem. The A.S.M.E., in arranging its annual meeting program, follows the recommendations of the committee that each technical society give intensive treatment to the report.

Personal

ALLEN ABRAMS has resigned as research associate from the research laboratory of applied chemistry at the Massachusetts Institute of Technology to become chief chemist for the Cornell Wood Products Co., Cornell, Wis.

Dr. CHARLES BASKERVILLE, College of the City of New York, gave an interesting address recently on the subject of chemical research, before a joint meeting of the Rhode Island Branch of the American Chemical Society and the Providence Engineering Society, at Brown University, Providence, R. I.

Dr. CHARLES H. HERTY has resigned as editor of the *Journal of Industrial and Engineering Chemistry* of the American Chemical Society to accept the presidency of the newly organized Synthetic Organic Chemical Manufacturers Association.

ALBERT HIRSCH has been appointed general sales manager of the Atriken Chemical Works, New Brunswick, N. J.

GEORGE E. HOFFMAN of the Trenton Potteries Co., Trenton, N. J., gave an interesting address on the subject of "Fine Pottery Manufacture" before the members of the Rotary Club, Allentown, Pa., at their noon-day meeting, Oct. 21.

JOHN F. MILLER of Pittsburgh, vice-president of the Westinghouse Air Brake Co., Pittsburgh, has been elected an alumni trustee of the College of Wooster, Wooster, Ohio, filling an unexpired term in the class of 1922. Mr. Miller graduated from the college in 1881.

WILLIAM WHISTLER MILLS, for five years assistant chief chemist of the Pittsburgh Crucible Steel Co. at its Midland, Pa., works, has been added to the faculty of the College of Wooster, Wooster, Ohio, as instructor in chemistry. Mr. Mills resigned from the Pittsburgh Crucible Steel Co. in 1919 to take up graduate work at Ohio State University, Columbus, Ohio, which he completed last June with the degree of Master of Science.

OLIVER C. RALSTON has been promoted from the position of superintendent of the Mining Experiment Station of the Bureau of Mines, Seattle, Wash., to assistant chief metallurgist with headquarters at Berkeley, Cal. He will also act as superintendent of the Pacific Experiment Station of the Bureau of Mines.

EDWIN R. THEIS, formerly chemist for the American Leather Co., Cincinnati, Ohio, has joined the staff of the department of leather research, College of Engineering and Commerce, University of Cincinnati, as research chemist.

The members of the technical staff of the American delegation to the Conference on the Limitation of Armament who were selected for their industrial and scientific knowledge are: Dr. Edgar F. Smith, president of the American Chemical Society; General C. C. Williams, Chief of Ordnance; General Amos A. Fries, Chief, Chemical Warfare Service; General George O. Squier, Chief, Signal Corps; William S. Culbertson, United States Tariff Commission; Dr. S. W. Stratton, Director, Bureau of Standards; J. H. Dellinger, Chief, Radio Investigations, Bureau of Standards; L. W. Austin, Radio Specialist, Navy Department. The other members of the technical staff are specialists in international law, international relations, or in army and navy operations.

Obituary

JOHN BOYD DUNLOP, Dublin, Ireland, known as the inventor of the pneumatic rubber tire, died on Oct. 24. He was eighty-one years old.

WILLIAM H. PRICE, secretary of Griffith & Turner, Baltimore, Md., fertilizer manufacturers, died recently at the age of sixty-six years.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, Nov. 7, 1921.

Chemical activity continued to show increased signs of improvement and conditions in most directions were of a decidedly favorable character. The discontinuance of the proposed railroad strike did not have a bad effect on the demand for the more important commodities.

Buyers are more eager to anticipate their standing contracts and are covering requirements a month or two in advance. This condition was more pronounced last week than at any time during the year. Consumers that have accustomed themselves to small quantity buying have again been picking up large quantities of odd resale material from the spot market and the tendency of values has remained quite firm throughout the list.

Heavy importations of chemicals were noted during the week. These undoubtedly were shipments ordered a month or two ago and had no disastrous effect on spot quotations, as the bulk of this material is going directly to various consuming interests. Domestic producers have found it extremely difficult to keep up with the increasing demand, and efforts are being made to expand operations as much as possible.

Among the outstanding features of the week was the sudden rise of barium chloride. Prussiate of soda, cyanide of soda and caustic potash were items that attracted considerable attention from large consumers and the market has shown a gradual advance during the entire week. Prussiate of soda and barium chloride closed higher for shipment from abroad. Solid caustic soda and soda ash remained steady, with a tendency to advance. Oxalic acid still feels the pinch of keen competition existing among producers, and quotations were lower at the close. Bichromate of soda has ruled steady, with orders reported in larger volume. Consumers of muriate of potash have shown more interest at the recently reduced figures. Bleaching powder has also shown a regular steady outlet, although large quantities were recently imported from Germany.

CHEMICALS

Spot prices for imported 88-92 per cent caustic potash were a trifle firmer during the latter part of the week. Importations have been quite heavy, but consumers seem to be constantly in the market for additional quantities. While several sellers quoted the market at 6½c. per lb., the majority of holders named 6¼c. as their lowest figure. Shipment material was obtainable at 5¾c. per lb. Importers of calcined carbonate of potash, 80-85 per cent, quote 4½c. per lb. for spot material. There are not as many offerings around the market as were noted a week ago and it is understood that some large sellers are very low on supplies. The 85-90 per cent test is quoted at 4¾c. per lb., while the 99 per cent U.S.P. is quoted at 15c. per lb. Foreign powdered chlorate of potash is offered for shipment at 5¼c. per lb. c.i.f. New York. Some sellers demanded as high as 5¾c. The spot market is somewhat unsettled on imported material, with sellers asking 6½@7½c. per lb. for the powdered and 8c. for the crystals. Manufacturers of domestic chlorate quote the market unchanged at 12c. per lb. f.o.b. works. Importers offered muriate of potash on the basis of \$37@37.50 per ton of 80 per cent KCl, c.i.f., New York. Buyers are showing a keener interest in the new prices and considerable business has been reported. Yellow prussiate of potash is moving in a small way at 20½c. per lb. The general quotation heard among leading factors is 20½@21½c. per lb., depending upon quantity. The red variety is inactive and sellers quote the market at 28c. per lb.

There has been no departure from the upward tendency of yellow prussiate of soda during the past week. Buyers are eager to pay higher prices for spot material, but offerings are very scarce. Sales at the close were reported at 14¾c. per lb. In some places as high as 15c. was named for spot ma-

terial. Shipments were quoted at 14½c. per lb. for November-December. *Bichromate of soda* sold at 8c. per lb. during the beginning of the week and was fractionally higher at the close. A carload lot was reported sold at 7½c., but this was an inside transaction and did not represent the general range. Quotations were around 8½c. per lb. for standard brand goods. The demand is showing a moderate improvement with consumers more eager to follow the market activity. Sales of solid *caustic soda* have been made at \$4.10@4.20 per 100 lb. for standard material. A good inquiry was experienced for less than carload quantities. Producers have received numerous orders for large lots, but claim to be entirely sold out for prompt shipment. Buyers of *amyl acetate* are covering actual requirements in the market, but are not inclined to extend commitments at the present time. Producers quote the market for commercial at \$2.40@\$2.70 per gal., the price varying according to quantity and sellers.

Dealers of crude *fusel oil* quote the market at \$1.50@\$1.60 per gal. The imported material has sold at about the same figures as the domestic, although an occasional stray lot has been found at a concession. It is stated that prices abroad are higher than those prevailing in the open market. The refined grade is quoted by producers at \$2.60@\$3 per gal. Odd lots have been sold through dealers down to \$2.40 per gal., but in most instances, this material was not up to specifications. There was some improvement noted in the call for *arsenic*, and prices ranged from 6@6½c. per lb. for the white, powdered material. Some sellers of *nitrite of soda* were fractionally higher in their views and quoted the spot market at 7@7½c. per lb. Buyers, in general, were interested only in small quantities and were not eager to pay over 6½c. per lb. Closing prices for domestic *oxalic acid* at the works were somewhat lower and producers were quoting 12½c. per lb. Dealers reported sales ex-store at 13½@14c. per lb. The market is still feeling the influence of strong competition from first-hand interests.

COAL-TAR PRODUCTS

Reports from various steel factories of more pronounced activity put a brighter aspect on existing conditions for *benzene* and consumers feel more reassured about supplies. Coke-oven operations showed another gain, but this will not be reflected in the *benzene* market for at least another month. The spot market was practically bare of supplies, with quotations on odd lots heard at 40c. per gal. The intermediate market is showing decidedly improved signs of activity owing to the improved condition of the dye field and sales are more numerous in various quarters. The demand for *cresylic acid* is not very active, but the market seems to be holding its own at 65c. per gal. for the 95 per cent and 70c. for the 97-99 per cent. A round lot sale of the 95 per cent was reported at slightly under the quoted figure, but most sellers are adhering to the regular price. Activity in *naphthalene flakes* continued to a moderate extent, but the balls were somewhat dormant. Prime white flakes sold at 6¼@7½c. per lb. Makers ask up to 8½c. per lb., but most business is going to jobbers at the lower figures. Buying in *phenol* for domestic consumption increased to a considerable degree and some large-quantity sales were made at 9½c. per lb. Odd lots at lower prices were occasionally offered around the market, but the quality is known to be of an inferior grade. Official Government resellers ask 12c. per lb. Selling in *para-phenylenediamine* has been fairly active at \$1.70@\$1.75 per lb. Inquiries at the close of the week were being recorded in good volume. Makers of *dimethylaniline* ask 45c. per lb. and upward. Resale stocks are practically unheard of around the market and first hands are the controlling influence on prices. Sales of *aniline oil* at 18c. per lb. were made in several directions during the week. The market seemed to be strengthening up somewhat and sellers are maintaining prices. Stocks of *beta-naphthol* are still quite heavy and no real snap to trading has been witnessed on this commodity in the past few months. Makers quote down to 34c. per lb., but according to various rumors have placed business well under the resale price of 32c. per lb. Prices of *H acid* in some directions were under the quotation of \$1.10 per lb. which prevailed generally.

The Chicago Market

CHICAGO, Nov. 4, 1921.

Viewing world markets over the last century and a half in relation to present commodity prices, it is noted we are on the down grade of a major commodity price cycle covering a 40- to 50-year period similar to the condition following the Napoleonic wars and the Civil War. Looking at the minor 3- to 5-year cycle, however, commodity prices show a straight precipitous drop beginning in July of last year and reaching a bottom near the middle of 1921. In other words, the curve of average commodity prices has not only been checked but actually moved upward. Chemicals, being essential raw materials of basic industries, follow very closely the average price of other commodities and vary with the industrial movements. It may be safely predicted that regardless of the possible lower prices of chemicals 10 years from now the immediate trend will be upward.

This trend is clearly shown by Chicago prices during the past fortnight. Stocks on hand are lighter, and while prices on the average have not risen to any great extent they remain very firm at present levels. Furthermore a good volume of business is enjoyed by most firms. Speculators are beginning to accumulate stocks with expectation of higher figures. Clearing of the skies on the railroad situation is removing the cause for immediate haste in purchasing. The next large movement should be upward regardless of pessimistic opinions which exist in some quarters.

INDUSTRIAL CHEMICALS

Caustic soda is very firm. Supplies are nearly depleted and prices are 4½c. for the ground 76 per cent and 4½c. for the solid. *Soda ash* is moving well, with firm price at \$2.60 per 100 lb. for material in cooperage. *Potash alum* is also in good demand, with a price of 5½c. per lb. for the lump and 6½c. for the powdered. *Sal ammoniac* remains quiet, with supplies available at 7½@7¾c. per lb. for the white granular 98-100 per cent. *Carbon tetrachloride* is in brisk demand and 10¾c. per lb. the lowest figure quoted. *Formaldehyde* is still quiet, with 12c. per lb. as the prevailing figure and a possibility of some shading. *Glycerine* remains unmoved in price and without apparent demand. Refiners are asking 14¼@14½c. per lb. for the large drums.

LIST MOSTLY UNCHANGED

The rest of the list remains about as usual. *Caustic potash* continues firm and unchanged in price, with supplies available at 6½c. per lb. for the 88-92 per cent grade. *Potassium bichromate* is quoted at 13@13½c. per lb. and the *soda* at 9½c. for single casks. A decline of 2c. per lb. was noted in some quarters on *potassium permanganate*, and U.S.P. crystals of foreign origin are now available at 21c. for small lots. *Bicarbonate of soda* is offered at \$2.60 per 100 lb. for single barrels. *Sodium fluoride* is not so active, but prices are unchanged at 11@12c. per lb., according to quantity. *Zinc sulphate* is quiet at 3½c. per lb. for the tech. cryst. in single barrel lots.

ACIDS

Acid prices remain as quoted in last letter with nominal demand. Supplies are plentiful and are said to be moving well. *Acetic acid* is firm with supplies of the 28 per cent available at \$2.65@\$2.75 per 100 lb. and glacial at \$10.25@\$10.75. *Oxalic acid* is in fair demand at 17c. per lb. *Citric* and *tartaric acids* are very quiet with domestic makers apparently in control of the market. *Hydrochloric acid* is quiet and unchanged as to price.

VEGETABLE OILS

Linseed oil is moving in a fair way with no large transactions noted. The boiled oil is offered at an increased price of 76c. per gal. and the raw at 74c.

NAVAL STORES

Turpentine is in a firm position, according to a prominent factor, and higher prices can be expected. This material was offered today at 86½c. per gal. for small quantities in drums.

The Iron and Steel Market

PITTSBURGH, Nov. 4, 1921.

The tapering off in demand for steel products generally has now developed a decidedly quiet market. Buying has not ceased, but it is materially decreased in volume, and it lacks snap entirely. While various causes are assigned for the dullness, including in particular the alleged prospect that freight rates will be reduced in the near future, the more rational view seems to be that the dullness is a reflection of the season of the year. The iron and steel market is normally dull in December and January, unless it has previously acquired great momentum, and in a generally dull period the seasonal dullness is likely to begin especially early.

It is obvious that existing ideas or impressions as to the state of business generally and of the prospects are rather vague. "Business" is commonly spoken of as a homogeneity, which it is not. The total volume of business, measured by bank clearings, bank debits, freight ton-mileage on the railroads, and similar general indices, is really fairly large. The character of the activity, however, is not such as to produce a large demand for steel. In what is called by the very general term "building" there is a rather high stage of activity, but the building is chiefly of garages and dwelling houses, which do not require much steel. The same amount of money invested in power plants, factories and skyscrapers would produce a much larger tonnage of steel demand. Again, the railroads are receiving and spending a great deal of money, but the outgo is chiefly against payrolls, not against rails, bridges, buildings, rolling stock and other improvements.

STEEL PRICES

The American Steel & Wire Co. (Steel Corporation) has been soliciting contracts from regular customers on the ground that a second price advance, following that of Sept. 12, is to be made, the September advance having been to 2.60c. for plain wire and \$2.90 for nails. The Youngstown Sheet & Tube Co., which alone among the important independents did not advance its prices in September, has this week made the advance. By other independents there has been some selling lately at the old prices, and it is not certain that a second advance can be made generally effective.

In attempting a second step in advancing prices on sheets the market has slipped a trifle on the first step. Three weeks ago independents began formally announcing a second advance of \$5 a ton, following that in September, which raised black sheets from 2.75c. to 3c., but instead of the market becoming established at 3.25c. sales have been made in the past week at less than 3c., and even 2.75c., the minimum of the market this year, has been quoted in some isolated cases.

In bars, shapes and plates there is a more competitive market than a few weeks ago, in that some mills, formerly committed to slightly advanced prices, have receded from that position and are meeting competition when the tonnage involved is important. Prices generally are in the neighborhood of 1.60c. for bars and shapes and 1.55c. for plates.

Tin plate prices have continued unsettled and may become still more unsettled. The McKeesport Tin Plate Co., with a 44-mill plant, has made an agreement with its tonnage men whereby the men accept a 20 per cent wage reduction and the company guarantees full operation of the plant to Jan. 1.

PIG IRON AND COKE

The pig-iron market continues very dull, expectations recently entertained of an improvement being wholly disappointed. In some quarters the lack of buying is attributed to expectation on the part of buyers that freight rates will be reduced, but the hand-to-mouth buying that has characterized the market for many months could hardly be affected by such expectations, and it is more reasonable to assume that actual consumption has decreased or will decrease. Quotable prices are unchanged, but are becoming more or less nominal: Bessemer, \$20; basic, \$19; foundry, \$21, f.o.b. valley furnaces, with \$1.96 freight to Pittsburgh.

Connellsville coke is somewhat softer, by the double influence of continued light demand and softer conditions in coal. Spot furnace is \$3.25@3.35, contract furnace about \$3.40 and spot foundry \$4.25@4.75, depending on brand.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots	Less Carlots
Acetic anhydride.....lb.	—	\$0.40 — \$0.45
Acetone.....lb.	\$0.12½ — \$0.12¾	.13 — .13½
Acid, acetic, 28 per cent.....100 lbs.	2.75 — 3.00	3.25 — 3.50
Acetic, 56 per cent.....100 lbs.	6.00 — 6.25	6.50 — 7.00
Acetic, glacial, 99½ per cent, carboys, 100 lbs.	10.75 — 11.00	11.25 — 11.50
Boric, crystals.....lb.	.12½ — .13	.13½ — .14
Boric, powder.....lb.	.13 — .13½	.14 — .14½
Citric.....lb.	—	.45 — .47
Hydrochloric.....100 lb.	1.25 — 1.50	1.60 — 1.75
Hydrofluoric, 52 per cent.....lb.	.12 — .12½	.12½ — .13
Lactic, 44 per cent tech.....lb.	.09½ — .10	.10½ — .12
Lactic, 22 per cent tech.....lb.	.04½ — .05½	.06 — .07
Molybdic, C.P.....lb.	3.25 — 3.50	3.60 — 4.00
Muriatic, 20 deg. (see hydrochloric).....	—	—
Nitric, 40 deg.....lb.	.06½ — .06¾	.06¾ — .07
Nitric, 42 deg.....lb.	.06¾ — .07	.07 — .07½
Oxalic, crystals.....lb.	.12½ — .13	.13½ — .14½
Phosphoric, 50 per cent solution.....lb.	.13 — .13½	.14 — .15
Picric.....lb.	.20 — .25	.27 — .35
Pyrogallol, resublimed.....lb.	—	1.90 — 2.00
Sulphuric, 60 deg., tank cars.....ton	—	11.00 — 12.00
Sulphuric, 60 deg., drums.....ton	—	13.00 — 15.00
Sulphuric, 66 deg., tank cars.....ton	17.00 — 18.00	—
Sulphuric, 66 deg., drums.....ton	21.00 — 22.00	22.50 — 23.00
Sulphuric, 66 deg., carboys.....ton	—	—
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	21.00 — 22.00	—
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	23.00 — 23.50	24.00 — 24.50
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	31.00 — 32.00	33.00 — 34.00
Tannic, U. S. P.....lb.	—	.75 — .85
Tannic (tech.).....lb.	.45 — .48	.50 — .55
Tartaric, imported crystals.....lb.	—	.26 — .27
Tartaric acid, imported, powdered.....lb.	—	.27½ — .28½
Tartaric acid, domestic.....lb.	—	—
Tungstic, per lb. of W.O.....lb.	—	1.10 — 1.20
Alcohol, Ethyl.....gal.	—	4.70 — 5.00
Alcohol, Methyl (see methanol).....	—	—
Alcohol, denatured, 188 proof.....gal.	—	.37 — .38
Alcohol, denatured, 190 proof.....gal.	—	.35 — .36
Alum, ammonia, lump.....lb.	.03½ — .04	.04 — .04½
Alum, potash, lump.....lb.	.03½ — .04	.04½ — .04½
Alum, chrome lump.....lb.	.10 — .11	.11½ — .12½
Aluminum sulphate, commercial.....lb.	.01 — .02	.02 — .02½
Aluminum sulphate, iron free.....lb.	.02½ — .02¾	.03 — .03½
Aqua ammonia, 26 deg., drums (750 lb.).....lb.	.07½ — .07¾	.08 — .08½
Ammonia, anhydrous, cyl. (100-150 lb.).....lb.	.31 — .32	.33 — .35
Ammonium carbonate, powder.....lb.	.07 — .07½	.08 — .09
Ammonium chloride, granular (white sal ammoniac).....lb.	.07 — .07½	.07½ — .07¾
Ammonium chloride, granular (gray sal ammoniac).....lb.	.07 — .07½	.07½ — .07¾
Ammonium nitrate.....lb.	.07½ — .07¾	.07¾ — .08½
Amylacetate tech.....gal.	—	2.40 — 2.70
Arsenic oxide, (white arsenic) powdered lb.....lb.	.06 — .06½	.06½ — .07
Arsenic, sulphide, powdered (red arsenic) lb.....lb.	.11 — .11½	.12 — .13
Barium chloride.....ton	63.00 — 64.00	65.00 — 66.00
Barium dioxide (peroxide).....lb.	.20 — .21	.22 — .23
Barium nitrate.....lb.	.07½ — .08	.08½ — .09
Barium sulphate (precip.) (blanc fixe) lb.....lb.	.04 — .04½	.04½ — .05
Bleaching powder (see calc. hypochlorite).....	—	—
Blue vitriol (see copper sulphate).....	—	—
Borax (see sodium borate).....	—	—
Brimstone (see sulphur, roll).....	—	—
Bromine.....lb.	.27 — .28	.28½ — .30
Calcium acetate.....100 lbs.	2.00 — 2.05	—
Calcium carbide.....lb.	.04½ — .04¾	.05 — .05½
Calcium chloride, fused, lump.....ton	23.50 — 24.00	24.50 — 25.50
Calcium chloride, granulated.....lb.	.01½ — .02	.02½ — .02½
Calcium hypochloride (bleach'g powder) 100 lb.....100 lb.	2.25 — 2.30	2.35 — 3.00
Calcium peroxide.....lb.	—	1.40 — 1.50
Calcium phosphate, tribasic.....lb.	—	.15 — .16
Camphor.....lb.	—	.85 — .90
Carbon bisulphide.....lb.	.06½ — .06¾	.07 — .07½
Carbon tetrachloride, drums.....lb.	.10½ — .10¾	.11 — .12
Carbonyl chloride, (phosgene).....lb.	—	.60 — .75
Caustic potash (see potassium hydroxide).....	—	—
Caustic soda (see sodium hydroxide).....	—	—
Chlorine, gas, liquid-cylinders (160 lb.) lb.....lb.	.08 — .09	.09½ — .10
Chloroform.....lb.	—	.40 — .43
Cobalt oxide.....lb.	—	2.00 — 2.10
Copperas (see iron sulphate).....	—	—
Copper carbonate, green precipitate.....lb.	.21 — .22	.22½ — .23
Copper cyanide.....lb.	—	.50 — .62
Copper sulphate, crystals.....lb.	.05 — .05½	.05½ — .06
Cream of tartar (see potassium bitartrate).....	—	—
Epsom salt (see magnesium sulphate).....	—	—
Ethyl Acetate Com. 85%.....gal.	—	.80 — .90
Ethyl Acetate pure (acetic ether, 98% to 100%).....gal.	—	.95 — .
Formaldehyde, 40 per cent.....lb.	.11 — .11½	.11½ — .12½
Fusel oil, ref.....gal.	—	2.60 — 3.00
Fusel oil, crude.....gal.	—	1.50 — 1.75
Glauber's salt (see sodium sulphate).....	—	—
Glycerine, C. P. drums extra.....lb.	—	.14½ — .15
Iodine, resublimed.....lb.	—	3.50 — 3.60
Iron oxide, red.....lb.	—	.12 — .18
Iron sulphate (copperas).....ton	18.00 — 19.00	20.00 — 23.00
Lead acetate.....lb.	—	.10½ — .12½
Lead arsenate, paste.....lb.	.09 — .09½	.10 — .11
Lead nitrate.....lb.	—	.15 — .20
Litharge.....lb.	.07½ — .08	.08½ — .09
Lithium carbonate.....lb.	—	1.40 — 1.50
Magnesium carbonate, technical.....lb.	.08 — .08½	.09 — .10
Magnesium sulphate, U. S. P.....100 lb.	2.50 — 2.75	—
Magnesium sulphate, technical.....100 lb.	—	1.10 — 1.75
Methanol, 95%.....gal.	—	.66 — .68
Methanol, 97%.....gal.	—	.70 — .72
Nickel salt, double.....lb.	—	.12 — .12½
Nickel salt, single.....lb.	—	.14 — .14½
Phosgene (see carbonyl chloride).....	—	—
Phosphorus, red.....lb.	.40 — .41	.42 — .45
Phosphorus, yellow.....lb.	—	.30 — .35
Potassium bichromate.....lb.	.10½ — .11	.11½ — .11½

	Carlots	Less Carlots
Potassium bitartrate (cream of tartar)..... lb.	\$. . . \$. . .	\$0.25 1/2 - \$0.28
Potassium bromide, granular..... lb.		.14 - .20
Potassium carbonate, U. S. P..... lb.	.15 - .16	.17 - .20
Potassium carbonate, 80-85%..... lb.	.04 1/2 - .04 3/4	.05 - .06
Potassium chlorate, crystals..... lb.	.08 - .08 1/2	.08 1/2 - .12
Potassium cyanide..... lb.		.40 - .45
Potassium hydroxide (caustic potash)..... lb.	.06 1/2 - .06 3/4	.06 3/4 - .08
Potassium iodide..... lb.		2.60 - 2.75
Potassium nitrate..... lb.	.07 3/4 - .07 1/2	.08 - .09
Potassium permanganate..... lb.	.18 - .19	.20 - .22
Potassium prussiate, red..... lb.	.28 - .29	.29 1/2 - .30
Potassium prussiate, yellow..... lb.	.20 1/2 - .21	.21 1/2 - .22
Rochelle salts (see sodium potas tartrate).....	. . . . .	. . . . .
Salammoniac (see ammonium chloride).....	. . . . .	. . . . .
Sal soda (see sodium carbonate).....	. . . . .	. . . . .
Salt cake (bulk)..... ton		20.00 - 22.00
Silver cyanide..... oz.		1.35 - 1.38
Silver nitrate..... oz.		.46 - .47
Soda ash light..... 100 lb.	2.10 - 2.15	2.20 - 2.60
Soda ash, dense..... 100 lb.	2.35 - 2.40	2.45 - 2.70
Sodium acetate..... lb.	.04 - .04 1/4	.04 1/2 - .05
Sodium bicarbonate..... 100 lb.	2.00 - 2.25	2.50 - 2.75
Sodium bichromate..... lb.	.08 1/2 - .08 3/4	.08 3/4 - .08 7/8
Sodium bisulphate (nitre cake)..... ton	5.00 - 5.25	5.50 - 6.50
Sodium bisulphite powdered, U.S.P..... lb.	.04 1/2 - .05	.05 1/2 - .06
Sodium borate (borax)..... lb.	.05 1/2 - .06	.06 1/2 - .07
Sodium carbonate (soda)..... 100 lb.	1.75 - 1.90	2.00 - 2.25
Sodium chl rate..... lb.	.07 1/2 - .07 3/4	.08 - .08 1/2
Sodium cyanide..... lb.	.27 1/2 - .28	.28 1/2 - .30
Sodium fluoride..... lb.	.11 - .12	.12 1/4 - .14
Sodium hydroxide (caustic soda)..... 100 lb.	4.10 - 4.15	4.20 - 4.75
Sodium hyposulphite..... lb.		.03 1/2 - .03 3/4
Sodium nitrite..... lb.	.07 - .07 1/4	.07 1/2 - .08
Sodium peroxide, powdered..... lb.	.25 - .26	.27 - .30
Sodium phosphate, dibasic..... lb.	.04 1/2 - .04 3/4	.04 3/4 - .05 1/4
Sodium potassium tartrate (Rochelle salts) lb.		.21 - .24
Sodium prussiate, yellow..... lb.	.14 1/2 - .15	.15 1/2 - .15 3/4
Sodium silicate, solution (40 deg.)..... 100 lb.	1.00 - 1.15	1.25 - 1.40
Sodium silicate, solution (60 deg.)..... lb.	.02 1/2 - .02 3/4	.03 - .03 1/4
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	1.50 - 1.75	2.00 - 2.25
Sodium sulphide, f. sed, 60-62 per cent (conc.) lb.	.04 1/2 - .05	.05 1/2 - .05 3/4
Sodium sulphite, crystals..... lb.	.03 1/2 - .03 3/4	.04 - .04 1/4
Strontium nitrate, powdered..... lb.	.12 - .13	.13 1/2 - .20
Sulphur chl ride, red..... lb.	.05 - .05 1/2	.05 1/2 - .06 1/2
Sulphur, crude..... ton	18.00 - 20.00	
Sulphur dioxide, liquid, cylinders extra..... lb.	.08 - .08 1/2	.09 - .10
Sulphur (sublimed), flour..... 100 lb.		2.25 - 3.10
Sulphur, roll (brimstone)..... 100 lb.		2.00 - 2.75
Tin bichloride, 50 per cent..... lb.	.18 - .19	.19 1/2 - .20
Tin oxide..... lb.		.37 - .38 1/2
Zinc carbonate, precipitate..... lb.	.16 - .16 1/2	.17 - .17
Zinc chloride, gran..... lb.	.09 1/4 - .09 1/2	.10 - .11
Zinc cyanide..... lb.	.42 - .44	.45 - .47
Zinc dust..... lb.	.11 1/2 - .11	.11 1/2 - .12 1/2
Zinc oxide, XX..... lb.	.07 1/2 - .07	.08 - .09
Zinc sulphate..... 100 lb.	3.00 - 3.25	3.30 - 3.50

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude..... lb.	\$1.15 - \$1.20
Alpha-naphthol, refined..... lb.	1.25 - 1.30
Alpha-naphthylamine..... lb.	.27 - .30
Aniline oil, drums extra..... lb.	.17 1/2 - .20
Aniline salts..... lb.	.24 - .26
Anthracene, 80% in drums (100 lb.)..... lb.	.75 - 1.00
Benzaldehyde U.S.P..... lb.	1.35 - 1.45
Benzidine, base..... lb.	.90 - 1.00
Benzidine sulphate..... lb.	.75 - .85
Benzoic acid, U.S.P..... lb.	.60 - .65
Benzoate of soda, U.S.P..... lb.	.52 - .55
Benzene, pure, water-white, in drums (100 gal.) gal.	.27 - .32
Benzene, 90%, in drums (100 gal.)..... gal.	.25 - .28
Benzyl chloride, 95-97%, refined..... lb.	.25 - .27
Benzyl chloride, tech..... lb.	.20 - .23
Beta-naphthol benzoate..... lb.	3.75 - 4.00
Beta-naphthol, sublimed..... lb.	.70 - .75
Beta-naphthol, tech..... lb.	.31 - .34
Beta-naphthylamine, sublimed..... lb.	1.75 - 1.85
Cresol, U. S. P., in drums (100 lb.)..... lb.	.16 - .17
Ortho-cresol, in drums (100 lb.)..... lb.	.25 - .27
Cresylic acid, 97-99%, straw color, in drums..... gal.	.70 - .80
Cresylic acid, 35-97%, dark, in drums..... gal.	.65 - .70
Cresylic acid, 50%, first quality, drums..... gal.	.45 - .50
Dichlorobenzene..... lb.	.06 - .09
Diethylaniline..... lb.	1.10 - 1.20
Dimethylaniline..... lb.	.45 - .60
Dinitrobenzene..... lb.	.23 - .27
Dinitrochlorobenzene..... lb.	.20 - .25
Dinitronaphthalene..... lb.	.30 - .35
Dinitrophenol..... lb.	.35 - .40
Dinitrotoluene..... lb.	.25 - .30
Dip oil, 25%, car lots, in drums..... gal.	.30 - .35
Diphenylamine..... lb.	.60 - .70
H-acid..... lb.	1.05 - 1.15
Meta-phenylenediamine..... lb.	1.15 - 1.20
Monochlorobenzene..... lb.	.12 - .14
Monoethylaniline..... lb.	1.65 - 1.70
Naphthalene crushed, in bbls..... lb.	.06 1/2 - .08 1/2
Naphthalene, flake..... lb.	.06 1/2 - .08 1/2
Naphthalene, balls..... lb.	.08 - .09 1/2
Naphthionic acid, crude..... lb.	.70 - .75
Nitrobenzene..... lb.	.12 - .15
Nitro-naphthalene..... lb.	.30 - .35
Nitro-toluene..... lb.	.15 - .17
Ortho-amidophenol..... lb.	3.00 - 3.10
Ortho-dichlorobenzene..... lb.	.15 - .20
Ortho-nitro-phenol..... lb.	.75 - .80
Ortho-nitro-toluene..... lb.	.15 - .20
Ortho-toluidine..... lb.	.20 - .25
Para-amidophenol, base..... lb.	1.40 - 1.45
Para-amidophenol, HCl..... lb.	1.70 - 1.80
Para-dichlorobenzene..... lb.	.12 - .15
Paranitroaniline..... lb.	.77 - .80
Para-nitrotoluene..... lb.	.80 - .85
Para-phenylenediamine..... lb.	1.70 - 1.75
Para-toluidine..... lb.	1.25 - 1.40
Phthalic anhydride..... lb.	.40 - .50

Phenol, U. S. P., drums..... lb.	.09 1/2 - .12
Pyridine..... gal.	2.00 - 3.50
Resorcinol, technical..... lb.	1.50 - 1.60
Resorcinol, pure..... lb.	2.00 - 2.25
Salicylic acid, tech., in bbls..... lb.	.18 - .20
Salicylic acid, U. S. P..... lb.	.19 - .22
Salol..... lb.	.60 - .70
Solvent naphtha, water-white, in drums, 100 gal..... gal.	.25 - .28
Solvent naphtha, crude, heavy, in drums, 100 gal..... gal.	.14 - .16
Sulphanilic acid, crude..... lb.	.27 - .30
Tolidine..... lb.	1.30 - 1.35
Toluidine, mixed..... lb.	.43 - .45
Toluene, in tank cars..... gal.	.25 - .28
Toluene, in drums..... gal.	.28 - .31
Xylidines, drums, 100 gal..... lb.	.40 - .45
Xylene, pure, in drums..... gal.	.40 - .45
Xylene, pure, in tank cars..... gal.	.45 - .45
Xylene, commercial, in drums, 100 gal..... gal.	.33 - .35
Xylene, commercial, in tank cars..... gal.	.30 - .30

Waxes

Prices based on original packages in large quantities.

Bayberry Wax..... lb.	\$0.21 - \$0.22
Beeswax, refined, dark..... lb.	.24 - .25
Beeswax, refined, light..... lb.	.28 - .30
Beeswax, white pure..... lb.	.36 - .42
Candellilla wax..... lb.	.24 - .25
Carnauba, No. 1..... lb.	.46 - .47
Carnauba, No. 2, North Country..... lb.	.24 - .24 1/2
Carnauba, No. 3, North Country..... lb.	.14 - .15
Japan..... lb.	.22 - .22 1/2
Montan, crude..... lb.	.04 1/2 - .05
Paraffine waxes, crude match wax (white) 105-110 m.p..... lb.	.03 1/2 - .03 1/2
Paraffine waxes, crude, scale 124-126 m.p..... lb.	.02 - .02
Paraffine waxes, refined, 118-120 m.p..... lb.	.03 - .03 1/2
Paraffine waxes, refined, 125 m.p..... lb.	.03 1/2 - .03 1/2
Paraffine waxes, refined, 128-130 m.p..... lb.	.03 1/2 - .04 1/2
Paraffine waxes, refined, 133-135 m.p..... lb.	.04 1/2 - .05
Paraffine waxes, refined, 135-137 m.p..... lb.	.05 1/2 - .06
Stearic acid, single pressed..... lb.	.09 - .09
Stearic acid, double pressed..... lb.	.10 - .10
Stearic acid, triple pressed..... lb.	.11 - .11 1/2

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl..... 280 lb.	\$5.70 - 5.70
Rosin E-I..... 280 lb.	5.70 - 5.85
Rosin K-N..... 280 lb.	6.30 - 6.75
Rosin W. G.-W. W..... 280 lb.	7.10 - 7.30
Wood rosin, bbl..... 280 lb.	6.25 - . . .
Spirits of turpentine..... gal.	.81 - . . .
Wood turpentine, steam dist..... gal.	.79 - . . .
Wood turpentine, dest. dist..... gal.	.77 - . . .
Pine tar pitch, bbl..... 200 lb.	. . . - 6.50
Tar, kila burned, bbl. (500 lb.)..... bbl.	. . . - 10.00
Retort tar, bbl..... 500 lb.	. . . - 10.00
Rosin oil, first run..... gal.	.35 - . . .
Rosin oil, second run..... gal.	.37 - . . .
Rosin oil, third run..... gal.	.44 - . . .
Pine oil, steam dist., sp.gr., 0.930-0.940..... gal.	\$1.90
Pine oil, pure, dest. dist..... gal.	1.50
Pine tar oil, ref., sp.gr. 1.025-1.035..... gal.	.46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla..... gal.	.35
Pine tar oil, double ref., sp.gr. 0.965-0.990..... gal.	.75
Pine tar, ref., thin, sp.gr., 1.080-1.960..... gal.	.35
Turpentine, crude, sp. gr., 0.900-0.970..... gal.	1.25
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990..... gal.	.35
Pinewood creosote, ref..... gal.	.52

Solvents

73-76 deg., steel bbls. (85 lb.)..... gal.	\$0.37
70-72 deg., steel bbls. (85 lb.)..... gal.	.35
68-70 deg., steel bbls. (85 lb.)..... gal.	.34
V. M. and P. naphtha, steel bbls. (85 lb.)..... gal.	.23

Fertilizers

Ammonium sulphate, bulk and d. bags..... 100 lb.	\$2.70 - 3.00
Blood, dried, f.o.b., N. Y..... unit	4.00
Bone, 3 and 50, ground, raw..... ton	30.00 - 32.00
Cyanamide, f.o.b. works..... unit	4.50
Fish scrap, dom., dried, f.o.b. works..... unit	2.90 - 3.00
Nitrate soda..... 100 lb.	2.35 - 2.45
Tankage, high grade, f.o.b. Chicago..... unit	3.00 - 3.10
Phosphate rock, f.o.b. mines, Florida pebble, 68-72 p.c..... ton	4.50 - 6.50
Tennessee, 78-80 p.c..... ton	8.00 - 9.00
Potassium muriate, 80 p.e..... ton	37.00 - 40.00
Potassium sulphate..... unit	1.15 - 1.20

Crude Rubber

Para-Upriver fine..... lb.	\$0.21 - .21 1/2
Upriver coarse..... lb.	.11 1/2 - .12
Upriver caucho ball..... lb.	.11 - .12
Plantation—First latex crepe..... lb.	.15 1/2 - .15 1/2
Ribbed smoked sheets..... lb.	.15 1/2 - .15 1/2
Brown crepe, thin, clean..... lb.	.15 - . . .
Amber crepe No. 1..... lb.	.17 - . . .

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls..... lb.	\$0.10 1/2 - \$0.10 1/2
Castor oil, AA, in bbls..... lb.	.11 1/2 - .12
China wood oil, in bbls. (f.o.b. Pac. coast)..... lb.	.14 1/2 - .14 1/2
Cocoonut oil, Ceylon grade, in bbls..... lb.	.09 1/2 - .09 1/2
Cocoonut oil, Cochin grade, in bbls..... lb.	.10 1/2 - .10 1/2
Corn oil, crude, in bbls..... lb.	.10 1/2 - .10 1/2
Cottonseed oil, crude (f. o. b. mill)..... lb.	.07 1/2 - .07 1/2
Cottonseed oil, summer yellow..... lb.	.09 - .09 1/2
Cottonseed oil, winter yellow..... lb.	.09 1/2 - .10

Linseed oil, raw, car lots (domestic).....	gal.	.67	—	.68
Linseed oil, raw, tank cars (domestic).....	gal.	.62	—	.63
Linseed oil, in 5-bbl lots (domestic).....	gal.	.70	—	.71
Olive oil, Denatured.....	gal.	\$1.15	—	\$1.20
Palm, Lagos.....	lb.	.07	—	.07½
Palm, Niger.....	lb.	.06½	—	.06½
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.08	—	.08½
Peanut oil, refined, in bbls.....	lb.	.11½	—	.11¾
Rapeseed oil, refined in bbls.....	gal.	.85	—	.87
Rapeseed oil, blown, in bbls.....	gal.	.92	—	.94
Soya bean oil (Manchurian), in bbls, N. Y.....	lb.	.09	—	....
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.07½	—	....

FISH

Light pressed menhaden.....	gal.	\$0.40	—	....
Yellow bleached menhaden.....	gal.	.42	—	....
White bleached menhaden.....	gal.	.45	—	....
Blown menhaden.....	gal.	.48	—	....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$24.00	—	30.00
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	20.00	—	24.00
Barytes, crude, 88% @ 94% ba., Kings Creek.....	net ton	10.00	—	12.00
Barytes, floated, f.o.b. St. Louis.....	net ton	23.00	—	24.00
Barytes, crude, first grade, Missouri.....	net ton	7.00	—	....
Blanc fixe, dry.....	lb.	.04	—	.04½
Blanc fixe, pulp.....	net ton	45.00	—	55.00
Casain.....	lb.	.07	—	.10
Chalk, Precipitated, domestic, extra light.....	lb.	.04½	—	.05
Chalk, Precipitated, domestic, light.....	lb.	.04	—	.04½
Chalk, Precipitated, domestic, heavy.....	lb.	.03½	—	.04
Chalk, Precipitated, English, extra light.....	lb.	.04½	—	.05
Chalk, Precipitated, English, light.....	lb.	.04½	—	.05
Chalk, Precipitated, English, dense.....	lb.	.04	—	.04½
China clay (kaolin) crude, f.o.b. mines, Georgia.....	net ton	6.50	—	8.50
China clay (kaolin) washed, f.o.b. Georgia.....	net ton	9.00	—	10.00
China clay (kaolin) powdered, f.o.b. Georgia.....	net ton	13.00	—	20.00
China clay (kaolin) crude f.o.b. Virginia points.....	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points.....	net ton	13.00	—	20.00
China clay (kaolin), imported, lump.....	net ton	12.00	—	20.00
China clay (kaolin), imported, powdered.....	net ton	25.00	—	30.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	net ton	5.00	—	7.50
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27.00	—	30.00
Fullers earth, f.o.b. Mines.....	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Pa.....	net ton	15.00	—	18.00
Fullers earth, powdered, f.o.b. Fla.....	net ton	18.00	—	....
Fullers earth, imported, powdered.....	net ton	24.00	—	27.00
Graphite, Ceylon lump, first quality.....	lb.	.06	—	.07
Graphite, Ceylon chip.....	lb.	.04½	—	.05
Graphite, high grade amorphous crude.....	lb.	.00¾	—	.02½
Kieselguhr, f.o.b. mines, Cal.....	per ton	40.00	—	....
Kieselguhr, f.o.b. N. Y.....	per ton	55.00	—	60.00
Magnesite, calcined.....	per ton	60.00	—	65.00
Pumice stone, imported.....	lb.	.03	—	.40
Pumice stone, domestic, lump.....	lb.	.05	—	.05½
Pumice stone, domestic, ground.....	lb.	.06	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore.....	net ton	....	—	10.00
Quartz (acid tower) 1½ @ 2 in., f.o.b. Baltimore.....	net ton	....	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	....	—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange fine.....	lb.	.68	—	.70
Shellac, orange superfine.....	lb.	.80	—	.82
Shellac, A. C. garnet.....	lb.	.58	—	.60
Shellac, T. N.....	lb.	.68	—	.70
Soapstone.....	ton	12.00	—	15.00
Sodium chloride.....	long ton	12.50	—	13.00
Talc, paper-making grades, f.o.b. Vermont.....	ton	11.00	—	18.00
Talc, roofing grades, f.o.b. Vermont.....	ton	8.50	—	13.00
Talc, rubber grades, f.o.b. Vermont.....	ton	11.00	—	18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	7.50	—	11.00
Talc, imported.....	ton	30.00	—	40.00
Talc, California talcum powder grade.....	ton	18.00	—	25.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	per ton	\$50.00	—	....
Carborundum refractory brick, 9-in. { less than carlot	1,000	1250.00	—	....
Chrome brick, f.o.b. Eastern shipping points.....	net ton	52- 55	—	....
Chrome cement, 40-45% Cr ₂ O ₃	net ton	30- 32	—	....
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in car lots, f.o.b. Eastern shipping points.....	net ton	33- 35	—	....
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	35- 40	—	....
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	30- 35	—	....
Magnesite brick, 9-in. straight.....	net ton	65- 70	—	....
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	77	—	....
Magnesite brick, soaps and splits.....	net ton	98	—	....
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	40- 42	—	....
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	42- 45	—	....
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	35- 38	—	....

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00	—	225.00
Ferrochrome per lb. of Cr. contained, 6-8% carbon, carlots.....	lb.	.11	—	....
Ferrochrome per lb. of Cr. contained, 4-6% carbon, carlots.....	lb.	.11	—	.12
Ferromanganese, 76-80% Mn, domestic.....	gross ton	58.00	—	60.00
Ferromanganese, 76-80% Mn, English & German.....	gross ton	60.00	—	62.00
Spiegel-eisen, 18-22% Mn.....	gross ton	25.00	—	27.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.25	—	....
Ferrosilicon, 10-15%.....	gross ton	38.00	—	40.00
Ferrosilicon, 50%.....	gross ton	57.00	—	59.00
Ferrosilicon, 75%.....	gross ton	120.00	—	125.00
Ferrotungsten, 70-80%, per lb. of contained W.....	lb.	.40	—	.45
Ferrouanium, 35-50% of U, per lb. of U content.....	lb.	6.00	—	....
Ferrovannadium, 30-40% per lb. of contained V.....	lb.	4.25	—	4.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content.....	net ton	\$8.00	—	\$10.00
Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃	ton	23.00	—	25.00
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard.....	ton	23.00	—	25.00
Coke, foundry, f.o.b. ovens.....	net ton	4.25	—	4.50
Coke, furnace, f.o.b. ovens.....	net ton	3.25	—	3.50
Fluorspar, gravel, f.o.b. mines, New Mexico.....	net ton	15.00	—	....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	20.00	—	22.00
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01½	—	.01½
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	.22	—	.23
Manganese ore, chemical (MnO ₂).....	net ton	50.00	—	55.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.45	—	.50
Monazite, per unit of TbO ₂ , c.i.f., Atlantic seaport.....	unit	30.00	—	....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport.....	unit	.12	—	.12
Pyrites, Spanish, furnace size. c.i.f. Atlantic seaport.....	unit	.13	—	.13
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.11	—	.12
Rutile, 95% TiO ₂ per lb. ore.....	lb.	.15	—	....
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	2.50	—	2.75
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	2.75	—	3.00
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	1.25	—	1.75
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.25	—	2.50
Vanadium pentoxide, 99%.....	lb.	12.00	—	14.00
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1.00	—	....
Zircon, washed, iron free, f.o.b. Pablo, Florida.....	lb.	.04½	—	.13

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic.....	13.00
Aluminum, 98 to 99 per cent.....	24.50 @ 25.00
Antimony, wholesale lots, Chinese and Japanese.....	4.90 @ 5.25
Nickel, ordinary (ingot).....	41.00
Nickel, electrolytic.....	44.00
Monel metal, shot and blocks.....	35.00
Monel metal, ingots.....	38.00
Monel metal, sheet bars.....	40.00
Tin, 5-ton lots, Straits.....	27.87
Lead, New York, spot.....	4.65 @ 4.70
Lead, E. St. Louis, spot.....	4.37 @ 4.40
Zinc, spot, New York.....	5.05 @ 5.10
Zinc, spot, E. St. Louis.....	4.60

OTHER METALS

Silver (commercial).....	oz.	\$0.70
Cadmium.....	lb.	1.00-1.25
Bismuth (500 lb. lots).....	lb.	1.50 @ 1.55
Cobalt.....	lb.	3.00 @ 3.25
Magnesium (f.o.b. Philadelphia).....	lb.	1.25
Platinum.....	oz.	85.00
Iridium.....	oz.	150.00 @ 170.00
Palladium.....	oz.	60.00
Mercury.....	75 lb.	38.00-39.00

FINISHED METAL PRODUCTS

Warehouse Price
Cents per Lb.

Copper sheets, hot rolled.....	20.50
Copper bottoms.....	28.00
Copper rods.....	19.00 @ 19.75
High brass wire.....	15.75
High brass rods.....	13.25
Low brass wire.....	17.25
Low brass rods.....	17.25
Brazed brass tubing.....	25.00
Brazed bronze tubing.....	29.75
Seamless copper tubing.....	19.50
Seamless high brass tubing.....	18.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current	Cleveland	Chicago
Copper, heavy and crucible.....	9.50 @ 10.00	9.25	9.50
Copper, heavy and wire.....	9.00 @ 9.25	8.50	8.50
Copper, light and bottoms.....	7.50 @ 8.00	7.50	7.25
Lead, heavy.....	3.25 @ 3.50	3.25	3.25
Lead, tea.....	2.25 @ 2.35	2.25	2.25
Brass, heavy.....	4.25 @ 4.50	4.50	5.00
Brass, light.....	3.25 @ 3.50	3.25	3.50
No. 1 yellow brass turnings.....	4.00 @ 4.25	4.25	4.50
Zinc.....	2.00 @ 2.25	2.00	2.25

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ½ in. and larger, and plates ½ in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes.....	\$2.88	\$2.88	\$2.88
Soft steel bars.....	2.78	2.78	2.78
Soft steel bar shapes.....	2.78	2.78	2.78
Soft steel bands.....	3.42	3.48	3.48
Plates, ½ to 1 in. thick.....	2.88	2.88	2.88

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

GADSDEN—The Gadsden Clay Products Co. will build an addition to its plant, to be equipped for the manufacture of pressed bricks and other burned clay products. Work is now under way on the construction of three new kilns.

TUSCALOOSA—The proposed new company to be organized under the direction of the Industrial Committee of the local Chamber of Commerce, J. B. Brosius, secretary, for the construction and operation of a local pulp and paper mill, will be capitalized at \$2,000,000. Details of the new company and plant are being arranged.

Arkansas

EL DORADO—The Grison Refining Co. has construction under way on a new oil refinery. It is planned to establish a gasoline-producing plant in connection with the new works.

California

LOS ANGELES—The Western Pipe & Steel Co., 1670 North Broadway, has plans under way for the erection of a large plant on a 23-acre site of land acquired at Santa Fe and Slauson Aves. It will consist of a number of buildings for general steel products manufacture.

Connecticut

NEW BRITAIN—The Donnelly Brick Co. has awarded a contract to the William H. Allen Co., Inc., Hungerford Court, for the rebuilding of its plant, recently destroyed by fire. The new works will consist of a number of buildings, including drier department, tunnel kiln building, machine room and other mechanical branches.

Delaware

WILMINGTON—The Martin Leather Co., 701 East 5th St., has filed plans for the erection of a new 2-story building on East 5th St., near Spruce St., 47 x 60 ft. The company recently increased its capital from \$700,000 to \$1,500,000.

Florida

MARIANNA—The Egyptian Syrup & Production Co. recently organized has plans under way for the erection of a new sugar mill, with daily output of about 400 tons of cane sugar to be used for the manufacture of cane sirup and kindred products. The plant is estimated to cost about \$150,000 with equipment. Larkin & Pratt, Arcade Bldg., St. Louis, Mo., are architects. J. N. Nicolay heads the company.

TAMPA—The Southern Bottle Mfg. Co., recently organized with a capital of \$1,500,000, has awarded a contract to the Oatley-Jones Co., Tampa, for the erection of its proposed new plant at Gary, near Tampa. It will be 1-story, 60 x 150 ft., and will be equipped for daily capacity of about 150 gross of milk bottles, jelly glasses, etc. An adjoining building, 36 x 62 ft., will also be constructed. I. F. Jones is president.

KENDAL—The A. B. Hurst Co., recently organized, is arranging for the establishment of a local plant for the manufacture of starch products. It is proposed to develop a capacity of about 3,000 lb. per day. J. B. Hurst is secretary, and W. T. Tomlinson, vice-president and engineer.

Georgia

ATLANTA—The Simmons Plating Works, manufacturer of plated metal products, is planning for the erection of a 2-story addition to its plant for nickel plating and other operations. New machinery will be installed.

Illinois

CHICAGO—Work has been completed on the new gas plant of the People's Gas Light & Coke Co., 122 South Michigan Boulevard, said to represent an investment in excess of \$15,000,000. The plant is constructed in two sections, providing for the production both of coal and water gas. The first noted has a capacity of 14,000,000

cu.ft. per day, and the latter section 26,000,000 cu.ft. daily. The plant will be placed in operation at once.

Kentucky

LEXINGTON—The Great Southern Refining Co. has taken over an oil refinery at Pryse (Estill County), Ky., and will operate the plant in connection with its Lexington refinery. The combined output will total about 4,000 bbl. per day. W. B. Hasset is president, and Paul Blazer, vice-president.

Maryland

BALTIMORE—The Virginia-Carolina Chemical Co., 11 South 12th St., Richmond, Va., has plans under way for the erection of its proposed new fertilizer manufacturing plant at Baltimore, to be 200 x 500 ft., and estimated to cost in excess of \$3,000,000, including machinery. It is planned to commence erection early in the coming year. S. D. Grenshaw is secretary.

Massachusetts

SALEM—The Peerless Leather Co. has acquired the local plant of the Broadley Co., and will establish a new tannery. It is proposed to commence operations at an early date. Machinery will be installed at once.

Michigan

CHASSELL—The Michigan Humus & Chemical Co., has been reorganized as the National Humus & Chemical Co., with capital of \$1,000,000. The company is planning to increase its operations for the manufacture of fertilizer and powdered fuel, and a local works will be established for this purpose. C. F. Hancock is president.

Mississippi

MERIDEN—The Bang-Go Soap Mfg. Co., 2304 Front St., recently organized, is planning for the erection of a new local plant for the manufacture of soap products. R. E. Yarbrough is president, and L. L. Gunn, general manager.

Missouri

KANSAS CITY—The American Gasoline Corp. has work under way for extensions and improvements in the local refinery of the North American Refining Co., known as the Sheffield plant, recently acquired. New process stills and other equipment will be installed, and it is expected to have the works ready for service before the first of the year. The refinery will have a capacity of 4,000 bbl. of oil per day, with lubricating oil works to have an output of 300 bbl. daily.

New Jersey

TRENTON—The Acme Sanitary Pottery Co., May St., manufacturer of sanitary earthenware, has awarded a contract to Solan & Dotter, Inc., for the erection of a 2-story, brick addition, 30 x 128 ft., with new 1-story building adjoining, 18 x 60 ft.

TRENTON—The New Jersey Porcelain Co., Pennsylvania Ave. and Mulberry St., has filed plans for the erection of a new 3-story brick building at its plant.

MILLINGTON—The Asbestos Material Corp. has acquired the plant of the Bateman Co., on Central Ave., heretofore devoted to the manufacture of agricultural implements, for a new plant for the manufacture of asbestos products. The building is 2-story, concrete; possession will be taken at once and necessary equipment installed. It is said that employment will be given to about 70 persons for initial operations.

New York

EAST HAMBURG—Fire Oct. 26 destroyed the plant of the Electro-Refractory Co., Townline Road, manufacturer of steel crucibles, etc., with loss estimated at about \$200,000, of which about \$50,000 represents machinery. Headquarters of the company are at Ellicott Sq., Buffalo, N. Y.

SPARKILL—The Standard Oil Co., 26 Broadway, New York, has taken title to a tract of property totaling about 1,500 acres, in the vicinity of Sparkill and Palisade, N. Y., for a consideration stated at \$2,000,000, and is reported to be planning to use the site for a new oil works.

Ohio

WEST PARK—A. & S. Paint & Varnish Co., Elmwood Ave., has awarded a contract to the George A. Rutherford Co., 2729 Prospect Ave., for the erection of a new 3-story and basement plant, 50 x 70 ft., on Elmwood Ave., estimated to cost about \$45,000. Work will be placed under way at once. A. J. Ferbert is manager.

NEWTON FALLS—The Hubbell Tire & Rubber Co., 6515 Carnegie Ave., Cleveland, has acquired the plant of the Trumbull Tire & Rubber Co., Newton Falls, and will use the property for a branch plant. Machinery will be installed at once and production inaugurated at an early date.

EAST PALESTINE—The National Fireproofing Co., Fulton Bldg., Pittsburgh, Pa. has plans under way for the rebuilding of its plant at East Palestine, to replace the portion destroyed by fire. It will be 1-story, 100 x 100 ft., and is estimated to cost about \$60,000. Sidney F. Heckert, Bessemer Bldg., Pittsburgh, is architect.

Oregon

PORTLAND—The Oregon Brass Works, North Second St., has awarded a contract to Camp & DuPuy, East Adler St., for the erection of a new 1-story foundry addition.

Pennsylvania

PHILADELPHIA—The Pennsylvania Sugar Co., North Penn St., has added to its recent property purchases in the vicinity of its plant on North Delaware Ave., and has acquired the factory of the American Preserve Co., 946-54 North Delaware Ave., 72 x 105 ft., for a consideration said to be \$55,000. The property will be used for expansion.

Texas

WACO—The Waco Refining Co. is planning for the construction of additions to its plant for increased production. The refinery is located in the East Waco district, and was acquired recently by W. A. Rogers and associates. Mr. Rogers is president.

MEXIA—Following the acquisition of an extensive interest in the Humphreys-Mexia Co. and the Humphreys-Texas Co. by the Pure Oil Co., 74 Broadway, New York, said to involve a consideration of \$7,000,000, plans are being prepared for extensions in the properties. A new central oil-collecting and distributing plant will be constructed near Galveston, Tex., with new 130-mile pipeline, estimated to cost about \$3,500,000. A site will be selected at a Gulf Coast point at an early date for the erection of a new oil refinery to cost in excess of \$1,000,000.

Virginia

ALEXANDRIA—Fire Oct. 24 destroyed the plant of the Belle Pre Glass Co., in the northwestern section of the city, with loss estimated at about \$50,000. It is said that the plant will be rebuilt.

Washington

SPOKANE—The Consolidated Diamond Oil Refining Co. has acquired property at Dishman, near Spokane, and contemplates the construction of a new refinery on the site.

Capital Increases, Etc.

THE MARINETTE & MENOMINEE PAPER Co., Marinette, Wis., has disposed of a bond issue of \$2,000,000, to be used for financing general operations, etc.

THE DEGRASSE PAPER Co., Pyrites, N. Y., has filed notice of increase in capital from \$1,000,000 to \$4,000,000.

THE NEW ENGLAND TIRE & RUBBER Co., Holyoke, Mass., has filed notice of increase in capital from \$3,000,000 to \$53,000,000.

THE MAY FOUNDRY Co., Sixty-first and Eastwick Sts., Philadelphia, Pa., has filed notice of increase in capital from \$565,000 to \$10,500,000.

THE CENTRAL STEEL Co., Masillon, Ohio, has arranged for a bond issue to total \$5,000,000.

THE MARDEN, ORTH & HASTINGS Co., Boston, Mass., operating under a receivership since April last, has been acquired by Hunnell & Co., Inc., a new organization, composed of former employees of the company. Offices will be established at 310 Congress St., and operations conducted in the line of chemicals, tanning materials, oils, etc., as heretofore. L. C. Hunnell is president, and G. Warren Heath, treasurer.

THE TUSKELOID Co., 114 East 16th St., New York, manufacturer of composition specialties, has filed notice of increase in capital from \$50,000 to \$100,000.

New Companies

THE DIAMOND SOAP Co., Wilmington, Del., has been incorporated under Delaware laws with capital of \$200,000, to manufacture soaps and kindred products. The company is represented by Artemus Smith, Ford Bldg., Wilmington.

THE DETROIT SAND LIME BRICK Co., 507 Vinton Bldg., Detroit, Mich., has been incorporated with a capital of \$350,000, to manufacture bricks and other sand-lime products. The company has plans under way for the erection of a new local plant. The incorporators are F. William Niemann, Reinhold Polte and Albert H. Meinke.

THE WEYMOUTH CUT GLASS Co., Hammononton, N. J., has been incorporated with a capital of 100 shares of stock, no par value, to manufacture glass products. The incorporators are David Ford, John F. Rithfus and Charles H. Strunk, Hammononton.

THE PENNSYLVANIA LEAD & ZINC Co., Allentown, Pa., has been incorporated under Delaware laws with a capital of \$1,500,000, to operate zinc, lead and other similar mining properties. The incorporators are Horace B. Hemingway and George N. Schaffer, Allentown; and Philip R. Berg, Catasauqua, Pa. The company is represented by the United States Corporation Co., 65 Cedar St., New York.

THE GENERAL PACKING & RUBBER Co., INC., 28 South Charles St., Baltimore, Md., has been incorporated with a capital of \$10,000, to manufacture rubber products of various kinds. The incorporators are Zachary R. Lewis, Eben J. D. Cross and E. Ridgely Simpson.

THE HERCULENE OIL & REFINING CORP., New York, N. Y., has been incorporated with a capital of \$100,000, to manufacture refined oil products. The incorporators are J. M. Shellabarger, J. J. Donovan and E. A. Walsh. The company is represented by Shellabarger & Donovan, 30 Church St., New York.

THE NATIONAL WOODSTAINING CORP., Elizabeth, N. J., has been incorporated with a capital of \$50,000, to manufacture stains, paint specialties, etc. The incorporators are George Seeber, Carl F. Guntrum and Wilhelm Koch, 1191 East Grand St., Elizabeth.

THE EDCO OIL Co., Philadelphia, Pa., is being organized by E. M. and Edward J. Cook, and Daniel A. McKendry, to manufacture petroleum products, lubricating oils, etc. Application for a state charter will be made on Nov. 14. The company is represented by Johnson & Gilkyson, 1211 Chestnut St., Philadelphia.

THE STAINLESS PRODUCTS CORP., Watervliet, N. Y., has been incorporated with a capital of \$20,000, to manufacture metal alloys of various kinds. The incorporators are R. P. and Z. M. Devries, and J. Cran. The company is represented by C. Friend, attorney, Albany, N. Y.

HIRD & CONNOR, INC., Boston, Mass., has been incorporated with a capital of \$30,000, to manufacture chemical products. Frederic C. Van Norman is president; and M. T. Cronin, Medford, Mass., is treasurer.

THE WOODSTOWN PRESS BRICK Co., Woodstown, N. J., has been incorporated with a capital of \$150,000, to manufacture brick, tile and other ceramic products. The company is represented by the N. J. Corporation Guarantee & Trust Co., 419 Market St., Camden, N. J.

THE HANS HINRICHS CHEMICAL CORP., New York, N. Y., has been incorporated with a capital of \$75,000, to manufacture chemicals and chemical byproducts. The incorporators are R. B. Bradley, W. F. Eising and W. J. Rose, 27 William St.

THE SERVUS RUBBER Co., 38 South Dearborn St., Chicago, Ill., has been incorporated with a capital of \$500,000, to manufacture rubber products. The incorporators are Hasbrouck Haynes, Cornelius Lynde and Howard W. Lewis.

THE CORODIUM STEAM PRESSED BRICK Co., Pontiac, Mich., has been incorporated with a capital of \$100,000, to manufacture brick, tile and other burned clay products. The incorporators are Cassius J. Crawford and Roy C. Jenne, Pontiac; and Leon F. Owen, Sylvan Lake, Mich.

THE GOTHAM ASBESTOS & MINERALS Co., New York, N. Y., has been incorporated with a capital of \$25,000, to manufacture asbestos products and affiliated specialties. The incorporators are M. L. Hamburger, E. Goodman and J. J. Lazaroe, 25 West 42d St.

THE OSANTOS CHEMICAL Co., 110 South Dearborn St., Chicago, Ill., has been incorporated with a capital of 400 shares of stock, no par value, to manufacture chem-

icals and chemical byproducts. The incorporators are F. W. Metz, A. M. Domber and Guy H. Powell.

THE UNION HILL MIRROR & GLASS WORKS, INC., Union Hill, N. J., has been incorporated with a capital of \$50,000, to manufacture glass products. The incorporators are Samuel Gross, Andrew Darion and Paul Doppler, 404 Main St., Union Hill.

THE CONNECTICUT HARD RUBBER Co., New Haven, Conn., has been incorporated with a capital of \$10,000, to manufacture rubber products. The incorporators are A. A. Smith, J. A. Moffitt and William Baxter, 71 Sea St., New Haven.

THE CONSUMERS' OIL & GREASE Co., Reno, Pa., has been incorporated under Delaware laws, with a capital of \$100,000, to manufacture oils, greases and kindred products. The incorporators are Forest A. Huff, W. W. Turner and W. M. Huff, Reno. The company is represented by the Corporation Service Co., Wilmington, Del.

THE K. B. OIL CORP., Buffalo, N. Y., has been incorporated with a capital of \$300,000, to manufacture oil products. The incorporators are J. H. Tiedemann, and J. A. Clausen. The company is represented by C. D. Coyle, 168 Franklin St., Buffalo.

THE RIVER FOUNDRY Co., Detroit, Mich., has been incorporated with a capital of \$5,000, to manufacture steel and alloy castings. The incorporators are Robert Bahe-man and Joseph C. Arnold, 341 Kitchener St., Detroit.

THE STORM WATERPROOFING CORP., New York, N. Y., has been incorporated under Delaware laws with capital of \$200,000, to manufacture paints and waterproofing compounds. The incorporators are A. K. Dohrman, Eugene E. and Charles R. Allison, New York. The company is represented by the Capital Trust Co., Dover, Del.

THE RED SEAL REFINING Co., Los Angeles, Cal., has been incorporated with a capital of \$500,000, to manufacture refined petroleum products. The incorporators are H. L. Hagerman, O. A. Burchard and D. S. Fridner. The company is represented by I. W. Bull, 817 Central Bldg., Los Angeles.

THE BOND CHEMICAL PRODUCTS CORP., Wilmington, Del., has been incorporated under state laws, with capital of \$100,000, to manufacture chemicals and chemical byproducts. The company is represented by the Colonial Charter Co., Ford Bldg., Wilmington.

Industrial Notes

THE AUSTIN MACHINERY CORP. announces that the Canadian Austin Machinery Co., Ltd., Woodstock, Ont., incorporated under the laws of Canada, will henceforth act as sole manufacturer and distributor in Canada of the complete Austin line of earthmoving and concrete machine equipment. The manufacture of Austin machinery at Woodstock enables the Canadian company to supply economically its line of equipment and furnish service in maintenance.

WURSTER & SANGER, chemical engineers, announce the opening of offices at 5201 Kenwood Ave., Chicago, where they will be engaged in both consulting and construction work relating to the manufacture of soap, fatty acid distillation plants and glycerine plant equipment. Oscar H. Wurster has had long experience in plants of this sort, having been employed by M. Work Co., Lever Bros. Ltd., Morris & Co., packers, and the Louisville Soap Co. Walter E. Sanger was formerly chemical engineer with Swift & Co., packers, and the Procter & Gamble Soap Co.

L. O. KOVEN & BRO., Jersey City, celebrated its fortieth anniversary Sept. 28. A dinner was given at the company's cafeteria. The entire office force and a few outside friends were present. A number of interesting speeches on the history of the company were delivered.

L. C. BIGLOW & Co., INC., 232 West 55th St., New York City, has been appointed New York district agent for the Hartford Tap & Gauge Co., the Hanson-Whitney Machine Co., Inc., the Taylor & Fenn Co. and the Whitney Mfg. Co., all of Hartford, Conn.

BRITISH FURNACES, LTD., Millbank House, 2 Wood St., London, S. W. 1, England, with an authorized capital of £25,000 was organized during the early part of July, this year, for the purpose of manufacturing and selling Surface Combustion apparatus in the British Empire. The principal stockholders consist of the Bryan-Donkins Co., Ltd., machinist and founder, Chesterfield, England; Woodall, Duckham & Jones, Ltd., engineer and manufacturer, London, England, and the Surface Combustion Co., Inc., Bronx, New York, owner of the surface

combustion patents and manufacturer of industrial furnaces. The Surface Combustion Co., Inc., is now represented in all the principal European countries and many large industrial furnace installations have already been made. The Compagnie Générale de Construction de Fours, Paris, France, is the sole licensee and manufacturer for Surface Combustion patented apparatus in France and its colonies, Belgium, Holland, Switzerland, Italy, Spain and Portugal. John H. Bartlett, Jr., foreign representative for the Surface Combustion Co., Inc., of New York, has had charge of this work during the last few years and personally supervised the organizing of the foreign sales and manufacturing departments for the companies which took over the Surface Combustion Co. rights.

THE AMERICAN BOSCH MAGNETO CORP. has recently appointed new managers in its New York and Detroit branches. George Shortmeier, formerly New York manager for the Madison Rubber Co. and later district manager at New York for the Sinclair Oil Co., has been placed in charge of the Bosch branch at New York, replacing O. S. Stanley. Charles L. Shedd is now manager of the Bosch branch at Detroit, taking the place of Roy Davey, who has been made manager of the manufacturing sales department at Springfield, Mass. Mr. Shedd was at one time promotion manager of the truck division of the Packard Motor Car Co. at Detroit, subsequently served as official distributor at Omaha for that company and still more recently acted as sales manager of the Republic Truck Corp. at New York City.

THE BLAW-KNOX Co., Pittsburgh, Pa., announces the addition of H. O. Davidson to its staff. Mr. Davidson will have entire charge of the Prudential Sectional Building Department and will also be general manager of the C. D. Pruden plant of the Blaw-Knox Co. at Baltimore, Md. Mr. Davidson was connected for eight years with the Hydraulic Steelcraft Co., being general manager of that organization at the time he severed his connections to become a member of the Blaw-Knox staff.

JOHN F. ABERNETHY have moved to new offices and shops at 708-10 Myrtle Ave., Brooklyn, N. Y.

C. H. BOLEY & Co., INC., manufacturing industrial chemist of Philadelphia, Pa., announces the addition on Sept. 1 of T. Perry Rider, as sales manager. Mr. Rider was for many years connected with Schofield, Mason & Co., Philadelphia, Pa.

EDWARD O. BENJAMIN recently moved his offices to 530 Park Row Bldg., New York, continuing the practice of consultation, research and testing of apparatus and material relating to electrochemical welding, industrial gases, oil, rubber and allied industries.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its seventy-fourth meeting at Toronto, Canada, Dec. 27 to 31, 1921.

AMERICAN CERAMIC SOCIETY will hold its twenty-fourth annual meeting at St. Louis, Feb. 27 to March 2, 1922.

AMERICAN ENGINEERING COUNCIL will hold its next meeting in Washington, Jan. 5-6.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its annual winter meeting at Baltimore, Md., Dec. 6 to 9. Headquarters will be at the Southern Hotel and the sessions will be held in the Engineers' Club.

AMERICAN IRON AND STEEL INSTITUTE will hold its twentieth general meeting at the Hotel Commodore, New York City, on Friday, Nov. 18.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stettens Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

The following meetings are scheduled to be held in Rumford Hall, the Chemists' Club, New York: Nov. 11—American Chemical Society (in charge), Society of Chemical Industry, American Electrochemical Society, Société de Chimie Industrielle, joint meeting; Nov. 18—American Electrochemical Society, regular meeting; Dec. 2—Society of Chemical Industry, regular meeting; Dec. 9—American Chemical Society regular meeting.

CHEMICAL & METALLURGICAL ENGINEERING

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ELECTROCHEMICAL & METALLURGICAL INDUSTRY and IRON & STEEL MAGAZINE

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Assistant Editors
CHESTER H. JONES
Industrial Editor
J. S. NEGRU
Managing Editor

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Number 20

Armistice Day And a New Epoch

DULL indeed must be the mind and unsympathetic the soul that could remain unmoved by the impressive ceremonies in Washington and Arlington last Friday when America honored her nameless dead in the Great War. In the presence of a notable company representing the world's principal nations our own Unknown Warrior was honored with tributes that nations only can bestow.

The incident is rich in lessons that are not far to seek. They comprehend the obvious duties of those who are left to win the fruits of peace. We may not share the glory of this unknown soldier who fell on the field of battle, but we can and must accept the challenge of his sacrifice by doing the world's work better than it was ever done before. His death is also a challenge to the world's statesmen who are gathered in Washington to find ways of promoting peace among the nations; and in the sincerity of their participation in the memorial exercises we may find hope for the practical solution of the problem. Indeed the opening of the conference on disarmament was most auspicious, and is a fine augury for future international relations that will make unnecessary such sacrifices as our Unknown Warrior was called upon to make.

Armistice Day, 1921, was no ordinary holiday. No such auspicious conjunction of events has ever been known before. We believe it will mark the opening of an epoch of good will and friendship among nations and a period of prosperity and human happiness unparalleled in the history of the world.

Agricultural Support For the Chemical Industry

AT THE recent meeting of the Association of Official Agricultural Chemists a very significant resolution was adopted. It reads:

Whereas, the research necessary for the solution of agricultural and other industrial problems can only be carried on with the aid of a firmly established chemical industry; and

Whereas the development of chemical industry is one of the great factors tending toward the future welfare of our country, whether in times of peace or in times of war; it is therefore

Resolved, That the Congress of the United States is hereby urged to continue adequate, beneficial legislation until the various chemical industries in the United States have become firmly established.

In the first paragraph, the reference to "agricultural and other industrial problems" emphasizes a fact which agricultural interests usually do not realize—that agriculture really is an industry. Furthermore this paragraph recognizes the close relationship of agricultural problems and chemical industry.

The tendency which our national legislators have recently exhibited of grouping themselves in various

ways according to the nature of their constituency is in striking contrast to the tendency among the industries and the branches of technology. There is constantly increasing an appreciation of the mutual interests of the industries. We are coming more and more to realize that all industry demands the mining of coal, the movement of freight, the smelting of metals and the cutting of lumber on a basis of fair dealing both for the wage earners involved and for those who supply the invested capital. No one of our major industries can break down without immediately producing suffering to a greater or less degree among all others. It is a great mistake, therefore, to think of legislation intended to foster the interests of a single trade or class.

In no line of science or technology is this fact brought out more strongly than in the field of chemical industry. One man's final product is the next man's raw material. Unless the movement from natural resource to final commodity can go forward step by step with profit to each participant who really contributes to the industrial movement, we cannot expect most economical and satisfactory service to the final user. Co-operation of agricultural with manufacturing interests and manufacturing with transportation agencies can produce the best result. It will be well that every group recognize this fact and preach in support of the text which the agricultural chemists have so properly emphasized.

A Survey Of Special Libraries

THAT the special library is a valuable business asset has long been recognized by the engineering profession. Many of our industries too have come to realize that business policies are based most profitably on an accurate knowledge of facts, especially the sort of facts that are available in the technical books and current literature of the industry.

An idea of the extent to which American business is relying on its special libraries can be gained from the report of a survey recently completed by the Special Libraries Association and to which reference is made on page 909 of this issue. Of 1,300 special libraries included in this survey, 95 were collections of specialized information on industry and manufacturing, 66 were engineering libraries, 32 were chemical, 11 were mining and many of the remainder gave considerable attention to these subjects. It is interesting to note that three other classes—namely, business, banking and finance—showed a total of 142 sources of special information. Perhaps as the control of our larger industries is gradually passing into the hands of the banker and capitalist, these men are beginning to feel the need for scientific and technical knowledge. If these men are to guide our industries, it is obvious that they must be-

come to some degree familiar with their technology in order to be able to look beyond balance sheets to plant processes, yields, equipment, and research. Other financiers, who are less directly connected with industry, are called on to furnish advice on investments, and to do this intelligently they should have a readily available source of technical information.

The important rôle of the library in the program for the elimination of industrial waste has recently been brought to our attention by K. C. WALKER of the Bureau of Mines at Pittsburgh. His letter, which we are glad to print on another page of this issue, shows clearly that the special library is an important element in saving or preventing waste in our industrial world.

There are many other ways in which the special library demonstrates its value to industry. Not long ago one of our contemporaries cited an instance of a Western steel company that spent \$10,000 on a special research problem. When the librarian of the company heard of the result, he sent a book from his shelves to the president, referring him to a complete solution of the problem which had appeared several years before in a well-known technical book. Such an occurrence is unusual, to be sure, but it serves to emphasize the importance of utilizing the experience of others and beginning research with a survey of existing knowledge.

HERBERT HOOVER has aptly stated the *raison d'être* of the special library in the following words: "The function of the business library, as I understand it, is to collect and to preserve data of value to the business executives and so to organize this information that it will be available for use with a minimum of delay. There can be no question of the value of such service to the larger business firms when the work is properly organized and the librarian in charge has a clear conception of the possibilities of his position. The librarian who can make his service an integral part of his firm's organization may become a positive factor, both in the increase of profit and in the development of constructive business standards."

Deterrents for

Methanol Consumption

HEADLINES in daily newspapers continue to announce deaths or blindness resulting from the error of drinking some decoction said to be whisky. Each account lays the blame to "wood alconol" (not methanol, mark you, plain "wood alcohol"). A recent meeting of the Pennsylvania Medical Society spent a day listening to addresses on the diagnosis and treatment of methanol poisoning and to information on the number of cases which occur. In view of the very great amount of human damage being done, the physicians decided upon steps to educate the general public on the poisonous qualities of relatively small amounts of methanol, so that eventually a law could be passed absolutely forbidding its manufacture. Meantime they demanded that any package or substance containing methanol be marked "Poison" conspicuously, and a special revenue tax be assessed to bring the price up to and beyond that of denatured industrial alcohol.

Now all chemists will readily admit that doctors of medicine do not know a great deal about chemistry and the chemical industry, and what they do know is largely wrong. Otherwise they would know that methanol already costs twice as much as denatured ethyl alcohol, and they would remember that their indispensable formaldehyde all comes by way of methanol.

But that does not alter the fact that doctors have a deal more influence in public affairs than the chemists. In fact, if the medical fraternity were to unite on a movement to ban "wood alcohol," no matter how mistaken such a move would be, it would be a safe bet that the chemists could not save "methanol." Pleas based on the commercial importance of the substance would be as unavailing as was the specter of idle breweries to halt the Volstead act.

Theoretically, the first step toward the prevention of continued methanol poisoning would be to discover whether its source was commercial methanol or industrial alcohol denatured by the other and retailed for "anti-freeze" liquids and such like. But bootleggers are notoriously hard to catch, and once caught, do not divulge many of the tricks of the trade. However, since the trade itself is wholly unscrupulous and one for profit, it is to be presumed that the "kick" which is mixed into their wares is the cheapest alcohol they can get, and no qualms are felt as to whether the stuff is made unfit for human consumption (that is, denatured) by a liquid which is actually a deadly poison, and is so marked on the original container. Let the thirsty buyer beware!

In order to protect this weakling, all alcohol whose point of consumption is doubtful must contain a small amount of some substance which would not unfit the distillate for legitimate industrial uses but which, when diluted to a potable degree, would unmistakably make its presence known by a revolting color, taste or odor. TUNISON has listed a number of denaturants; would not some of the intensely bitter alkaloids do the trick? OUTERBRIDGE has already informed the chemical fraternity of a simple addition (7 mg. fluoresceine per 100 c.c.) which has effectually protected large warehouse stocks of ethyl alcohol from pilferage for many years. Dilution with water to potable proof causes a yellowish green fluorescence, reminding even the most hardened sinner of the hell-fire in store for him if he stomachs it.

Other more effective deterrents may already be known, or doubtless can be found, if those now available are so expensive as to prevent their use. Their action, even their presence, does not need to be widely advertised, and the burden should be on the shoulders of the purchaser to prove that they unfit the alcohol for legitimate use.

A stitch in time saves nine!

The Dunce

And the Devil

SOME day, when we are all settled down in ease and comfort and we feel like it and haven't any pressing obligations to bother us, we plan to write an allegory about the *Dunce* and the *Devil*. The problem is to accomplish the utter ruin of something or somebody good, like *Christian* in "Pilgrim's Progress," in which the *Devil* will be foiled in his wicked wiles because the *Dunce*, in his effort to save the hero, will beat the *Devil* to his own goal.

We have said it before and we repeat it without fear of contradiction, that every one of us is, in one respect or another, feeble-minded. Some of us can't mend a clock, others can't keep accounts, others can't saw a board straight or play poker or golf or sell goods or write poetry or sense relativity or do any one or more of thousands of things that many men do well. So, in respect to his inhibitions, each of us is a dunce. Apart from these inhibitions we may be men of signal in-

telligence. Like the genius, the dunce is a specialist in his line; but unlike the genius, he is usually unaware of this fact. You don't have to look like a dunce, or even to act like one, to be one.

The other day we heard of a man who made a remarkable success with his department store. He knew how to sell smocks and frocks and gowns and yarns and needles and pins and bonnets and laces and fur coats and silk stockings and all sorts of things to women. He knew how to advertise, when to have bargain sales, when to mark up and when to mark down; in short he was so successful a merchant that he retired in affluence when a comparatively young man. He tried the rest cure in California, but he was a little young for the long sleep and it got on his nerves; so he returned to the home town to be a bank director and a leading citizen.

Under the auspices of a leading firm of dealers in securities there took place a consolidation of a number of manufacturing concerns making paper. Local subscribers took a large block of the new stock and bonds and the bankers saw to it that some effective window-dressing was done in the personnel of the new organization. The returned Leading Citizen was made vice-president in charge of sales, and since every local stockholder and bondholder and his wife had bought things from him, all knew him to be a great merchant who was a master of sales. Everything went well until the slump in the market came along, and then the troubles began. He did not know the uses of paper or who made this or who bought that or how to hustle out and grab what was left of a market or how to get people to use his company's products as measures of economy or advantage—in short, he was lost in his job. Old Uncle Bankruptcy used to croon his doleful song into his wakeful ear by night and the affable lawyer who was a friend of the judge and likely to be appointed receiver if things should go wrong began to make friendly calls by day to "get the hang of the business." Those were gloomy times!

Now the Leading Citizen was incompetent as a paper salesman, but otherwise he was a man of rare judgment and ability. He saw that they must sell their product and that he was not succeeding as well as others who knew the business. So he resigned and they called in a competent and informed man who took his place and saved the concern. The Leading Citizen was a man of character, because he did not let his own vanity stand in the way of saving the investments of his neighbors. There are not very many men who reach this modest height. The experience aged him so that he can now enjoy the climate and the quiet and calm among the other wuzzers under the orange trees along the Pacific shores. He set an excellent example.

An Old Fake Persists

"I love it, I love it, and who shall dare
To chide me for loving that old arm-chair?"
But closer and dearer by far is the name
Of the man that can teach me to beat any game!

THIS desire to beat any game is truly a blind passion. We want to get rich quick with such intensity that we haven't even the patience to listen to the voice of reason or of experience that tells us when the cards are stacked against us.

On February 2 last we published an article on "Easy Money From Peat"; and "CHARLIE," the assistant and secretary of the corporation, wrote to us after reading

the article that we had been correct in our diagnosis of the thing as a fraud; that he had lately discovered the fact that the gasoline and methanol had been put into their respective containers before "the professor" had charged his retort with peat or begun to "make" the gasoline. CHARLIE wrote to us that he had resigned on discovering this fact, and we published his letter in our March 23 issue.

On May 24 LOUIS ENRIGHT, "the professor," was arrested for practicing fraud, and was released on \$1,000 bail. He is still at large.

On June 8 we published another letter advising us that we had saved, by our exposure, the funds of a number of prospective investors.

Later the New York *World* published in one of its editions a record of "Gasoline From Peat," setting forth ENRIGHT as a gifted inventor and, from reading the article, it appeared as though he were offering a pretty good thing. We sent a reprint of "Easy Money From Peat" to the editor of the New York *World*, but received no reply. We have failed to observe a retraction of the misleading article, but it may have appeared. Now comes the *Evening Telegram* of September 23, which tells us that LOUIS ENRIGHT, the seventy-nine-year-old president of the Enricht Gasoline Corporation, has been "demonstrating" again, this time at Seaford, L. I. It was the same old game of putting peat into the same apparatus that we depicted in our report; the peat body was "ignited and reduced to vapor," then forced through a "condenser," which transmogrified some of the gas into methanol, then through a "compressor" and past a catalyzer, etc., until presto! there was the gasoline! We told all about it, even to how the gasoline leaked out of the back end of the apparatus before the peat was put into the front end, and how the whole thing was a palpable fraud. Did it make any impression? Not beyond our own circle of readers, apparently. Here is the final paragraph of the news item in the *Evening Telegram*: "There were twenty-five or more present when the peat in the retort was ignited and the fire started to blow the gas through the apparatus. [In the earlier demonstration this was accomplished by ENRIGHT's remarkable pump.] As far as any one of the observers could tell the thing worked flawlessly, for in a few moments gasoline began flowing from the cooling coil into a barrel, and bottles were filled for the spectators."

What was the matter with the eyes of those twenty-five or more observers? Were they all so credulous that when they saw gasoline coming out of a spigot they were convinced it had just been made? In the former demonstration which we reported a witness requested the old boy to repeat the operation after his gasoline tank had been displayed and the contents removed. He showed hot indignation that anyone should lack confidence in him. But of course he refused. Now we advise our neighbor the *Evening Telegram* that it has been advertising in its news columns a rank fraud; that ENRIGHT has a bad record, and has been in this and similar games for years; that if the reporter had opened up the apparatus he would have found all the gasoline and methanol that came out safely stored there before the operation began, and that the sole beneficiary of money invested in ENRIGHT's scheme is ENRIGHT himself, and not the investor.

Will the *Evening Telegram* tell these facts to its readers for their benefit? It should. But will it?

Readers' Views and Comments

Regarding Solvent Recovery Process

To the Editor of Chemical & Metallurgical Engineering

SIR:—Our attention has been drawn to a letter signed by James C. Lawrence entitled "Recovery of Volatile Solvents by the Bregeat Process" and published on page 93 of your issue of July 20, 1921. In this he speaks of "my own firm of Blair, Campbell & McLean, Ltd., Glasgow, Scotland." We desire to inform you that Mr. Lawrence is not a member of the firm of Blair, Campbell & McLean, Ltd., has no connection with it and is not authorized to use the name of that firm for any purpose. We desire further to inform you that although the American Chemical & Sugar Machinery Co., which Mr. Lawrence refers to as "the American offshoot of Blair, Campbell & McLean, Ltd.," was authorized for a time to act as the American agent of Blair, Campbell & McLean, Ltd., it now has no connection whatever with the latter firm.

Glasgow, Scotland. BLAIR, CAMPBELL & MCLEAN, LTD.

To the Editor of Chemical & Metallurgical Engineering

SIR:—With reference to the communication from Blair, Campbell & McLean, Ltd., of Glasgow, Scotland, I would advise that the holdings of that company in the American Chemical & Sugar Machinery Co., of Philadelphia, have been acquired by the undersigned, and that the latter firm continues to manufacture its full line of equipment in its new works at Chester, Pa., now unhampered by territorial or agency agreements with Blair, Campbell & McLean, Ltd., of any nature.

Chester, Pa.

JAMES C. LAWRENCE.

Rôle of Libraries in Elimination of Waste

To the Editor of Chemical & Metallurgical Engineering

SIR:—I was greatly impressed by the array of special articles appearing in your issue of Aug. 31, 1921. It would seem as though every corner of our industrial house had been searched for ways and means of preventing waste, but no person seems to have written anything on one important phase of the waste question. I refer to the very important part the so-called special library plays in the elimination of waste.

In the first place, what does a special library do for an industrial organization? It acts as a clearing house of printed information for the field in which the organization is at work. We know what the ordinary banking clearing house has done for the banks of this country. It has opened the way for a quicker dispatch of the banks' business and thereby eliminated the *waste motion* incident to the old methods of banking.

The special library when properly supported and efficiently managed will accomplish savings throughout the entire fabric of any organization.

Andrew Carnegie has been often quoted as saying that his organization had wasted thousands of dollars by failing to find out what others had done along the same line before they experimented. Obviously it is cheaper to send experts to the library and spend a few days searching for records on a given subject than to go ahead blindly building expensive apparatus, employing many men and consuming expensive material only

in the end to find the experiment a failure, the same as others before you. One large concern is known to have spent in the neighborhood of \$50,000 on an experiment which resulted in failure. Yet records were available in the local public library showing that the experiment had been tried by someone else and failed.

Saving is preventing waste. If we can find ways and means for saving steps in an operation we are preventing the execution of wasteful operations. One chemist in a large Ohio manufacturing concern lost a train while in a large industrial city. In order that he might utilize the intervening time to best advantage he found the public library of that town and spent his time browsing about. The result of his browsing was the discovery of a process that had been tried elsewhere which saved his concern \$300 in one operation.

Still another metallurgical concern that I know of was about to start an expensive experiment, but just before launching the experiment one of the workers saw some information in print, brought to his attention through the library, that led to the subsequent abandoning of the experiment with much saving.

Instances of this nature might be multiplied. There is no need of enlarging upon the saving effected by properly supported special libraries manned by trained workers. The trouble is that most industrialists who have tried to experiment with libraries have assigned the task of organizing and operating to stenographers and similar people totally unqualified.

The special library is the one important element in our industrial world that can save or prevent waste. When run efficiently it prevents waste before it can begin by focusing all the known information on a task or project.

K. C. WALKER,

Research Reference Assistant,
Bureau of Mines Experiment Station,
Pittsburgh, Pa.

De-gasifying Silver With Iron Block

To the Editor of Chemical & Metallurgical Engineering

SIR:—On page 457 of your Sept. 7 issue occurs the following sentence: "The practice of inserting a piece of iron into the metal bath of this furnace (the Ajax-Northrup High Frequency) would materially disturb the induction."

This remark is in an article on Electric Furnaces, by J. Herlenius. The matter of placing iron in electric furnaces for the purpose of absorbing gases is touched upon in an editorial article in the same issue, page 450. In view of the prominence that you have given the matter, we think it proper to forward a statement which proves the incorrectness of the sentence quoted above. We wrote to Mr. Herlenius about it and he replied in part as follows:

"I regret the mistake made as referred to in your letter, but I took for granted that the iron would undoubtedly, on account of its lower electrical conductivity, materially disturb the induction. However, I appreciate the fact brought forth in your letter that the lines of force are absorbed by the graphite crucible."

We were certain of the truth of our contention, but wished to make, and then explain, a simple experiment which would make the facts clear to your readers.

Accordingly we placed a conducting graphite crucible in a large inductor coil, and then placed in the otherwise empty crucible a small can made of sheet iron. The crucible heated rapidly and attained a red heat within 15 or 20 minutes. The can, however, heated no faster than it would have heated simply by radiation from the walls of the crucible. It was possible to pick up the can with the fingers after the crucible was approaching red heat. Afterward the crucible was removed from the inductor coil and the can alone was placed centrally in the coil upon a stick of wood. When the high-frequency current was turned on the can became red hot almost immediately.

This experiment verifies the conclusions of theory that there are no free "lines of force" inside of the graphite crucible (provided this has good electrical conductivity and the wall is not too thin), and that therefore iron within the crucible would have no possible effect upon the induction.

E. F. NORTHRUP.

Trenton, N. J.

Vice-President and Technical Adviser
Ajax Electrothermic Corporation.

Hardened Rosin and Resin Esters

To the Editor of Chemical & Metallurgical Engineering

SIR:—In the writer's article on "Hardened Rosin and Resin Esters," in your issue of Sept. 7, the statement was made on page 474 that "Gardner ('Papers on Paint and Varnish,' p. 234) used 55 lb. of glycerine to 100 lb. of rosin. . . ."

Referring to this, Dr. Gardner has advised me that the figure 55 in his book is a misprint, and should read 15 lb. He says further: "We have never used more than 25 per cent in our experiments, and have found that 12 to 15 per cent is sufficient, although more is frequently used in practice."

A. MURRAY.

Springfield, Mass.

Variation of Hardness in Quenched Specimens

To the Editor of Chemical & Metallurgical Engineering

SIR:—On page 695 of the Oct. 12 issue of CHEMICAL & METALLURGICAL ENGINEERING an article by Carle R. Hayward seems to imply that the center of a heat-treated steel bar is necessarily harder than the edge. It is rather unfortunate that the conditions surrounding his experiments were such as to bring about this result, as the reverse effect is equally possible.

A paper by Honda, Matsushita and Idei presented at the May meeting of the Iron and Steel Institute, "On the Cause of Quenching Cracks," gives sufficient data to show that both effects are possible and outlines the conditions necessary for either result. These investigators conclude that:

(1) In a soft quenching, such as in oil from a temperature not exceeding 820 deg. C., the hardness of different specimens is greatest in the outer portion, and decreases from its periphery toward the center.

(2) In a medium quenching, such as that of a steel 0.9 per cent carbon at 780 deg. in water, or that of steel 1.47 per cent carbon at 900 deg. in oil, hardness is nearly constant everywhere.

(3) In a hard quenching, such as that of a steel containing more than 0.68 per cent carbon from 800 deg. C. or a higher temperature in water, the hardness is least in the outer portion and increases rapidly toward the center.

An examination of Hayward's data shows that all tests fall within group 3, where the hard center may be anticipated. Honda explains the phenomenon by his theory of quenching which assumes that the A₁ transformation is not a single but a compound transforma-

tion consisting of austenite $\rightleftharpoons$ martensite $\rightleftharpoons$ pearlite. In the case of hard quenching where the rate of cooling of the exterior parts through the transformation range is very rapid the last part of the transformation is completely arrested and the first change partly so. The central portions do not cool quite so rapidly and the transformation is nearly all to martensite. It is well known that austenite is softer than martensite. For a soft quenching the cooling in the outer portions is slow enough to permit the formation of martensite but not pearlite, while in the center much pearlite is formed, and for this condition the outside would be the harder.

It is also apparent that the size of specimen which also controls the rate of cooling would have an effect in determining whether the inner or outer portions of a quenched steel bar were the harder.

Physicist, Bureau of Standards.
Washington, D. C.

R. W. WOODWARD.

To the Editor of Chemical & Metallurgical Engineering

SIR:—Dr. Woodward's discussion of my article on "Hardness Variations in Heat-Treated Steel" is just what I hoped for. The data which I presented and more in my files show with scarcely an exception that round steel bars are harder at the center than at the outside. Any evidence to the contrary will be a contribution to our general knowledge of the subject. Unfortunately I have not at hand the paper by Honda, Matsushita and Idei quoted by Dr. Woodward and cannot adequately discuss their results. Their conclusions given in Dr. Woodward's communication refer apparently only to steels in the quenched condition, whereas most of my results were on steels reheated after quenching. Any theory of quenching hardness which involves the presence of austenite in the steel is of limited application, for it is doubtful if austenite is present in appreciable quantity unless a special steel is used or the cross-section rather small and the quenching is sudden. No austenite would be present in ordinary steel reheated after quenching. As noted by Dr. Woodward, the size of the specimen is very important.

CARLE R. HAYWARD.

Mass. Inst. of Technology,
Cambridge, Mass.

Non-Magnetic, Flame-, Acid- and Rust-Resisting Steel

To the Editor of Chemical & Metallurgical Engineering

SIR:—I have seen the article published in CHEMICAL & METALLURGICAL ENGINEERING for Oct. 26, 1921, page 797, on "Non-Magnetic, Flame-, Acid- and Rust-Resisting Steel," and have read the article with much interest.

I regret very much that a misstatement appears in the caption of the article: ". . . but after heat-treatment become hard and resistant to attack of all agencies." As a matter of fact, it requires no heat-treatment whatever to make the steel resistant to attack, and furthermore it is an error to say that it becomes hard after heat-treatment, as whatever hardness this steel has is natural to it. The only case in which we heat-treat the steel is in annealing for cold forming.

I should appreciate it if you would correct this statement that the steel "after heat-treatment becomes hard and resistant." To repeat, it requires no heat-treatment whatever to bring out its resistant qualities.

Crucible Steel Co. of America,
Pittsburgh, Pa.

C. M. JOHNSON,
Director Research Dept.

Eugene Schneider, Fritz Medalist

ASCHNEIDER is nearly as well known as a Big Bertha to the doughboy and American newspaper reader. Schneider, the creator of Schneiders and 75's without number, is also known personally to many fortunate American metallurgists who met him during 1919, when he was with us, the president of the French Economic Mission to the United States. Then many honors were given him, chief among which were the Gold Medal of the Mining and Metallurgical Society of America, honorary membership in the American Iron and Steel Institute, the degree of Doctor of Science by the University of Pittsburgh, of Doctor of Science by Western Reserve University in the city of Cleveland and of Doctor of Engineering by Stevens Institute of Technology.

It was only fitting, therefore, that the American Engineering Societies should send their delegation from England to France to present him their most valued token of esteem, the John Fritz Medal.

Eugène Schneider, ironmaster, owner of the Schneider Works, Member of the Chamber of Deputies from 1898 to 1910, president of the British Iron and Steel Institute, 1918-1920, was born at Le Creusot, France, in 1868. He is the grandson of a Lorrainer Schneider (1805-1875), an ironmaster of Bazeilles, who at the beginning of the last century purchased the former royal foundry of Le Creusot, which was built in 1782 under the patronage of Louis XIV.

Eugène Schneider made an early start in business. In 1887, after finishing his studies and completing his military service, he began work for his father and was soon taken into partnership. In 1898, at the death of Henri Schneider, he became the head of the business and succeeded his father in the Chamber of Deputies.

Before the war the activities of the Schneider Works extended over various branches of the iron and steel industry, including mechanical and electrical engineering and shipbuilding. Moreover, Mr. Schneider had developed the manufacture of munitions—especially artillery—to a high point of perfection, a circumstance which was of tremendous value to France in 1914 when hostilities began.

Since the first, however, his aim has been to improve the institutions which his father founded. Especially has he been active in developing a fine spirit of endeavor and better understanding of the rules of life among his employees and has striven in every way possible to improve their material conditions of living. He

has introduced the most modern safety appliances; he has organized advanced technical classes; extended the pension system inaugurated in 1877 long before national legislation touched this subject, provided medical inspection in the schools, established classes for instruction in domestic economy and made provisions for the care of orphans and of children who have lost one of their parents. The Schneider schools are regarded as models for the preparation of engineers, foremen and workers. Thanks to the encouragement which Mr. Schneider gave to the practice of thrift as well as to the loans he made, the workers in his factories have their own homes and gardens.

Production fell off in the Schneider Works with mobilization, but by the end of 1914, in spite of the shortage in labor and raw material, a tremendous effort was

made to increase the production of steel, the construction of cannon of all calibers, gun carriages, shells, and all other materials necessary for national defense. The German invasion captured 81 per cent of the blast furnaces of France and 63 per cent of its steel-making capacity. Yet within 2½ years the number of blast furnaces was trebled and the number of open hearths had increased 60 per cent. Before the war was ended rifles were being produced at 290 times the former annual rate; machine guns 70-fold, 150-mm. shells 225-fold and 75-mm. shells 15-fold, the latter reaching the enormous number of 200,000 a day.

In all this Schneider's efforts were an important factor. No less than 250,000 men were employed by him at Le Creusot and his other steel works, shipyards, iron and coal mines, optical works, machine tool plants, electrical shops, Die-



EUGENE SCHNEIDER

sel engine works, locomotive works and bridge plants. This single organization supplied three-quarters of all the French artillery, including 21-in. guns, besides one-half the American heavy artillery, all its field guns and many hundreds of cannon to Belgian, Italian, Rumanian, Russian and Serbian armies. This effort spread to the countries of the Allies and particularly to America, where, in March, 1915, Mr. Schneider sent special engineers to introduce French methods of manufacturing steel for shells and cannon. When the official French mission arrived in the United States to purchase steel, it found its task greatly lightened by his work.

After the armistice the efficient organization of the Schneider Works was as rapidly as possible converted from a war basis to a peace footing, and already, in spite of the difficulties of the present-day situation, the construction of locomotives, tractors, turbines and electrical machinery of all sizes and powers has begun.

Importance of the Olefine Gases and Their Derivatives

I—Sources and Uses of Ethylene and Propylene*

A Brief Review of Researches Which Have Formed the Foundation for an Olefine Gas Industry—
Corresponding Alcohols and Artificially Prepared Gas Mixtures as Sources of Olefines—
Properties and Applications of Ethylene and Propylene

By GEORGE O. CURME, JR.

AS THE past two decades have witnessed the rapid rise of a new branch of the organic chemical industry, based on the conversion of acetylene into organic products of commercial importance, so there has also been a somewhat slower but an even more promising movement toward the construction of another new division of the industry through the utilization of the related and widely distributed hydrocarbons, ethylene and propylene.¹ In the case of acetylene, the period beginning with the initial discovery of Kutscheroff in 1881,² leading the way to acetaldehyde and all its derivatives, and that of Berthelot in 1869,³ leading to the large variety of chlorinated products and extending to the commercial development of these basic processes, was relatively short, due in no small part to the epoch-making discovery of Willson⁴ which gave the industrial world a bountiful supply of calcium carbide and pure gaseous acetylene. In the case of ethylene and propylene the start was made much earlier, but until the great war brought into sharp emphasis the vital necessity of large quantities of ethylene, in particular, the commercial development of the olefine gases was held back, and enjoyed only a scattered attention in disjointed applications. It may be truly said that today there is no co-ordinated large-scale industrial development of this field, but from many quarters there are coming signs of activity that indicate a growing realization of its commercial importance.⁵ At the present writing a small plant is already in regular operation under the author's direction, and scattered products are offered on the market by other companies in the United States, and abroad, showing a need for ethylene and propylene products by the modern chemical industry.

EARLY STUDIES OF OLEFINE GASES

As early as 1795 the preparation of pure ethylene from the even earlier known ethyl alcohol was described

A contribution from the Mellon Institute of Industrial Research of the University of Pittsburgh. The writer wishes to acknowledge here his gratefulness to E. R. Weidlein and W. A. Hamor, of the Administration of the Institute, for their co-operative support and encouragement.

*This article, the first of a series of five, treats in a preliminary way of certain general phases of the researches conducted continuously by the writer over a period of seven years, since 1914, in the Mellon Institute of Industrial Research of the University of Pittsburgh. The processes developed now constitute the basis of the industrial operations of the Carbide & Carbon Chemicals Corporation's plant at Clendenin, W. Va.

¹The purpose of this article is to outline in a general way the technical importance of the olefine gases, as demonstrated by the recorded literature and supported by the writer's own work. It is manifestly impossible to recognize in such a brief paper all the valuable contributions made by the many investigators in this field, and accordingly only a few of the most important are cited. The bibliographic citations referred to will supply the reader with the references necessarily here omitted.

²Kutscheroff, *Ber.*, vol. 14, p. 1540 (1881); vol. 17, p. 13 (1884).

³Berthelot and Jungfleisch, *Ann. Suppl.*, vol. 7, p. 252 (1869).

⁴Willson, U. S. Patent 492,377 (1893).

⁵Garner, *Am. Gas. Eng. J.*, vol. 108, pp. 489-95; 505-08 (1918). Brooks, *CHEM. & MET. ENG.*, vol. 20, p. 629 (1920). Bacon and Hamor's "American Petroleum Industry," 1916, vol. 2, pp. 559 and 892. Ells, "Gasoline and Other Motor Fuels," 1921, pp. 286, 479, 560.

by the four Dutch chemists Deimann, Troostwyk, Bondt and Louwrenburgh,⁶ who also prepared the derivative, ethylene dichloride, in pure state at the same time, thus giving the name of olefiant gas (oil-forming) to the ethylene, which later has come to designate the whole series of homologous substances, the olefines. In 1826 Hennell,⁷ working in Faraday's laboratory, produced ethyl hydrogen sulphate from ethylene and sulphuric acid and established its relationship to ethyl alcohol. This same discovery was reannounced by Berthelot in 1855⁸ and was promptly capitalized by the Frenchman Cotellet,⁹ who in 1862 organized a company to produce ethyl alcohol from the then known ethylene content of illuminating gas by absorption in sulphuric acid and subsequent hydrolysis to yield ethyl alcohol. This enterprise was never carried into large-scale operation, and Cotellet's motives were even cast under suspicion by certain of his contemporaries. Nevertheless it is very similar indeed to the proposal which is being discussed seriously today by British chemists and which is being carried out on a large experimental scale.

At only a slightly later date Berthelot¹⁰ announced the absorption of propylene in sulphuric acid, and, by a similar process to the above, the production of isopropyl alcohol. This process, too, lacked support at the time of its discovery, but has been revived without material modification within recent years.

Again in 1900 a German, P. Fritschke,¹¹ came to the United States to take advantage of our then rather unjust excise laws, requiring tax on alcohol used in making ether, and erected a plant in Richmond, Va. This plant operated until 1907, making commercial ether from the ethylene produced in the cracking of petroleum. Since that time the Germans, making use of their cheap potato spirits, developed a process in operation for several years at Bitterfeld for producing ethane gas from ethylene by hydrogenation.¹² This was used as a refrigerant to supplant carbon dioxide on account of its better vapor pressure characteristics. Also a rather extensive production of ethylene chlorhydrin from ethylene and bleaching powder was undertaken by certain of the German and Swiss dye companies for use in an improved indigo synthesis. This later was extended under war-time conditions to the manufacture of "mustard gas" in the German offensive gas warfare, as well as to the production of nitro ethylene glycol for use as a propellant. Also within this same period many

⁶Deimann, Troostwyk, Bondt and Louwrenburgh, *Crell's Ann.*, vol. 2, pp. 196, 310 and 430 (1795).

⁷Hennell, *Phil. Trans.*, 1826, p. 240; 1828, p. 365.

⁸Berthelot, *Compt. rend.*, vol. 40, p. 102 (1855).

⁹Cotellet, *Wagners Jahresber.*, 1863, p. 593.

¹⁰Berthelot, *Ann. chim. phys.*, (3) vol. 43, p. 399 (1855).

¹¹Fritschke, *Chem. Ind.*, vol. 35, p. 637 (1912). Baskerville and Hamor, *J. Ind. Eng. Chem.*, vol. 4, p. 214 (1914).

¹²Ger. Pats. 265,171 and 265,297, issued to Elektrochemische Werke, G.M.B.H.

German and other patents have appeared for producing ethylene from acetylene by partial hydrogenation. It has been stated that ethyl alcohol has been made from this ethylene,¹³ although the more recent production of ethyl alcohol from acetylene through the intermediate formation of acetaldehyde has supplanted any efforts along this line.

RECENT DEVELOPMENTS

In this country the Commercial Research Co. carried on a rather extensive development of the production of ethylene and propylene chlorhydrins from the vapors of cracked petroleum products in the years 1912 to 1918,¹⁴ but as far as known without commercial success. During the period of the war under Government subsidy a large number of private plants were equipped with ethylene from alcohol generation units, as well as the Government arsenals, and at the time of the armistice good progress was being made toward the goal of producing 200 tons per day of mustard gas by the ethylene-sulphur monochloride process.

Since 1918 many of the plants both here and abroad, equipped for ethylene production, have continued to operate on making certain chemical specialties from ethylene generated from alcohol. Also the production of isopropyl alcohol from the propylene of cracked petroleum vapors has been announced almost simultaneously both in Germany and in the United States. At present writing this product is being made by several companies by processes varying in no broad way from Berthelot's original process. The British Government, realizing the military necessity of a large ethylene supply, has fostered the development of an ethylene industry in that country, and as a result the industrial absorption of the ethylene contained in coke-oven gases by sulphuric acid has been carried out with apparent success by the Skinningrove Iron Works,¹⁵ among other companies. To the credit of these present-day chemists who are now developing these products commercially, it must be freely granted that they have indeed contributed greatly along technical and engineering lines to make their processes succeed where earlier efforts failed. To them, second only to the early pioneers, is due full credit for the success of these adventures.

REACTIVITY OF OLEFINE GASES

During this extended period of more than 125 years the chemists of the world have not been inattentive to the interesting possibilities offered by the reactivity of the olefine gases, but on the contrary have carried on series after series of brilliant researches in this field which constitute today one of the most fascinating chapters of organic chemistry. It is beyond the scope of this paper to attempt to review this mass of accumulated knowledge which is already available in so many places and which has already been summarized excellently by others.¹⁶ That the technical development has not kept pace with the promise given by the unselfish work of the early path-makers is perhaps unfortunate, but with a competent start now well made it holds much in prospect for the coming years.

The sources of crude material from which the olefine

gases may be isolated are indeed quite widely distributed. These gases do not occur naturally, but their occurrence in artificially prepared mixtures has been generally known for many years due to the activity of many private research organizations as well as the Government bureaus which have published the analyses of gaseous mixtures from many sources. The easiest and most reliable source of the individual olefines is from the corresponding alcohol as has been referred to above, from which the gases may be obtained respectively in a pure state. This is best accomplished by passing the vapors of the alcohol over a suitable catalyst such as kaolin, with or without steam, at a temperature varying from 350 to 600 deg. C., according to conditions.¹⁷ This fact has been common laboratory knowledge for many years, and it was to the pure ethyl alcohol that the Government turned in time of emergency, when the prompt production of large quantities of pure ethylene became a matter of national necessity. Denatured ethyl alcohol is universally obtainable, and while the propyl and isopropyl alcohols have hitherto been less accessible, it appears that they will from now on be much better known. Still other ethyl and propyl compounds, such as the chlorides, acetates, etc., will also yield the corresponding olefine gas by a similar reaction to the above, but as these compounds are all commercially derived from the alcohol, their industrial importance as a source of the gases is but secondary.

OCCURRENCE IN ARTIFICIAL GASEOUS MIXTURES

A much more widely distributed source of these hydrocarbons exists in the gaseous mixtures obtained from the pyrolysis of organic matter. This includes coke-oven gas from the coking of coal, illuminating gas prepared from high-temperature decomposition of either oil or coal or both, the gases from the cracking of petroleum oils, the gases from the distillation of hardwood, oil shale, rosin, lignite, peat and many other materials of similar nature, which are now commonly treated for purposes other than the production of the olefine-containing gas mixtures. To a lesser extent there is also a certain olefine content in producer gas and blast-furnace gas. As will be readily recognized, this list includes practically all of the sources of artificial gas, and almost without exception these gases are used exclusively for the generation of power, heat or illumination. The olefine gases in these mixtures usually occur together with a variety of saturated hydrocarbons, hydrogen, nitrogen, carbon dioxide, carbon monoxide, aromatics and other higher olefines, commonly liquid when in the pure state. In some cases, as with the gases from the high temperature cracking of oils, the combined ethylene and propylene content may run as high as 35 to 45 per cent by gaseous volume under the most favorable conditions. In the more usual cases the combined olefine gas content is under 10 per cent and in most of the largest scale sources, such as coke-oven gas, a true olefine gas content of from 2 to 4 per cent is common. In the producer gas and blast-furnace gas it rarely exceeds a few tenths of a per cent. In all of the above-mentioned cases, the olefine content being an inconsiderable item at present in the operation of the processes concerned, the variations in analysis are rather wide, and no single analysis is of particular value.

In any particular case the problem of absorbing the desired olefine gases by chemical processes or that of

¹³J. Garcon, *Bull. soc. encour. ind. nat.*, vol. 127, p. 568 (1917). *Oil Paint and Drug Rep.*, vol. 91, p. 72 (1917).

¹⁴U. S. Pats. 1,253,615, 1,253,616, 1,253,617, 1,264,535, 1,295,339 and 1,315,229.

¹⁵C. F. Tidman, *J. Soc. Chem. Ind.*, vol. 40, p. 80 (1921).

¹⁶Meldola, "Chemical Synthesis of Vital Products," London, 1904. Mallisoff and Egloff, *J. Phys. Chem.*, vol. 23, p. 65 (1919). Bacon and Hamor, *lib. cit.* Hamor, *CHEM. & MET. ENG.*, vol. 23, pp. 425-34 (1920).

¹⁷Dorsey, *J. Ind. Eng. Chem.*, vol. 11, p. 288 (1919).

isolating them in the pure state is a special one for the material at hand. In the limited amount of past work on this subject the general procedure of finding a specific absorbent, such as sulphuric acid, or of using a specific reagent, such as chlorine, to form a condensable reaction product has found preference when handling such gaseous mixtures. On the other hand, a distinct advantage lies in having a pure gaseous material to deal with when carrying out chemical reactions. The former general process has the advantage of low costs, and for certain purposes at least the availability of the pure olefines from the alcohols successfully avoids the necessity of purifying the gases from the complex mixtures in which they occur. In the writer's work a novel process of producing the olefine gases is in use. Patents are now pending on the processes involved.

For use as such in the pure state when conveniently supplied to the market in compressed or liquefied form,

PROPERTIES OF ETHYLENE AND PROPYLENE

	Ethylene		Propylene	
Gas density (air = 1).....	0.976	(a)	1.498	(h)
Boiling point, 760 mm.....	-103.9 deg. C.	(b)	-47.8 deg. C.	(i)
Critical temperature.....	+9.9 deg. C.	(c)	+92.1 deg. C.	(e)
Critical pressure, in atmospheres	50.8	(d)	.....	
Density of liquid at b.p. (water at 40 deg. C. = 1).....	0.570	(e)	0.610	(e)
Density of liquid near crit. temp. (at 6.2 deg. C.); (water at 4 deg. C. = 1).....	0.306	(f)	.....	
Heat of combustion B.t.u. per cu.ft. (high).....	1,591	(g)	2,356	(g)
Heat of combustion B.t.u. per lb. (high).....	21,404	(g)	21,091	(g)
Heat of formation B.t.u., per lb..	-211	(g)	+92.6	(g)

(a) Stahrfoos, *Arch. sci. phys. nat.*, (4), vol. 28, p. 384 (1909).

(b) Burrell and Robertson, *J. Am. Chem. Soc.*, vol. 37, p. 1893 (1915).

(c) Maass and Wright, *J. Am. Chem. Soc.*, vol. 43, p. 1098 (1921).

(d) Cardoso, Arni and Bell, *Arch. sci. phys. nat.*, (4), vol. 30, p. 432 (1910).

(e) Maass and Wright, *loc. cit.* Calculated value.

(f) Cailletet and Mathias, *Compt. rend.*, vol. 102, p. 1206 (1886). Calculated value.

(g) J. Thompson, *Z. Phys. Chem.*, vol. 52, p. 346 (1905). Calculated value.

(h) Berthelot, Landolt and Bornstein, (1912), p. 150.

(i) Burrell and Robertson, Bureau of Mines Tech. Paper 142, p. 16.

as is common today with other industrial gases, it seems probable that both ethylene and propylene will find extensive application. These gases have physical properties as shown by the accompanying table.

The values given are believed to be reliable, although certain ones may be subject to slight revision.

INDUSTRIAL UTILIZATION

It may be readily seen that gases with these characteristics will find application in many ways. It is not expected that any hydrocarbon gas can rival acetylene, which possesses its unusual properties as a direct result of its highly endothermic nature. On the other hand, the olefine gases possess high fuel value, and for cutting and light welding may be expected to find favor in view of their easier transportation. It has also long been well known that illuminating gases owe their illuminating power largely to their olefine contents. The supply of these "illuminants" in pure form may now be expected to prove of value in special cases of illumination and heating, such as in country homes and the like. Furthermore in earlier scientific work seeking low temperatures ethylene has already been used as a refrigerant.¹⁵ The similarity of propylene in its boiling point to anhydrous ammonia would suggest its possible use as a refrigerant, for refrigeration at temperatures nearer normal.

More important than the direct use of the olefine gases for themselves is the pronounced chemical reac-

tivity which characterizes them. The chemical literature contains actual accounts of hundreds of reactions which may be carried out involving ethylene and propylene. It is unnecessary to state that all of these do not lead to commercially valuable products, but certain of them do show a means of building up from these materials substances which rank among the most important of the commercial chemicals. In addition to denatured alcohol, isopropyl alcohol, ethyl ether, ethylene chlorhydrin, ethylene glycol, ethylene dichloride and "mustard gas," which have already been mentioned above, there may be added diethyl sulphate, ethylene oxide, oxalic acid, formaldehyde, formic acid, acetone, propylene glycol, propylene chlorhydrin and many others, in addition to the simple combinations and derivatives of the above products themselves. It will be the purpose of following articles to describe certain of these new commercial products which perhaps are still not familiar to the chemical public, and to point out how these new materials may find their way into our rising American organic chemical industry.

Our national resources, which supply the greater part of our needs so amply from home, are also equally able to provide for an extensive ethylene and propylene industry. Consequently since modern military developments have shown that in addition to the toxic gases, acetone, alcohol, ether and such organic chemicals are also indispensable to national defense, therefore the olefine gas utilization, as soon as commercially developed, will find itself elevated to the position of one of the key industries to our modern commercial chemistry.

(Part II, on Diethyl Sulphate, will be published in a subsequent issue.)

A Survey of Library Service to Engineers

That the engineering profession has taken a leading position in the development of research and informational facilities is one of the facts disclosed by a recent survey made by the Special Libraries Association. As a result of this investigation more than 1,300 special libraries were discovered, many of which are largely concerned with engineering, technology, electricity, chemistry and industrial management.

Engineering libraries of various types are maintained by national and local engineering societies, by colleges and universities, by large manufacturing companies, by professional engineering firms, by public utility companies and by various other agencies. Some of these libraries have been in existence for many years, but many others have only recently been established. The most complete and comprehensive collection is that of the Engineering Societies Library in New York City.

Some of the engineering libraries report interesting special features. For example, the Boston Society of Engineers has a collection of books "written by engineers on subjects other than engineering." The library of a professional engineering firm reports a collection of from 100,000 to 200,000 trade catalogs covering a wide range of industries. One university library possesses 4,200 lantern slides on engineering subjects. Many of the engineering libraries have given special attention during the last few years to the collection of military, naval and aviation engineering literature.

The complete findings of the Special Libraries Association's survey have recently been published in the form of a "Special Libraries Directory," edited by Dorsey W. Hyde, Jr., president of the association, Mills Building, Washington, D. C.

¹⁵K. Onnes, *Z. komprimierte flüssige Gase Pressluft-Ind. A*, vol. 1, p. 169 (1898). *Comm. Phy. Lab. Leyden No. 51* (1899).

Impact Properties of Various Steels

Cylinders of Steel, Centrifugal Cast, Were Sectioned and Tested—A Set of Steel Bars, With Increasing Carbon Content, and Some Steel Castings Were Tested After Various Heat-Treatments—
A Comparison of Impact for Forged and Cast Steels

By F. C. LANGENBERG

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THE author of this article recently presented the results of certain investigations on the shock value of steel castings to the American Society for Testing Materials.¹ Requests for additional observations on the same subject have since been received, and the writer has therefore considered that the following further account of these and other investigations may be of general interest.

In the previous article results of tests were given showing the effect of phosphorus on cast steel made in the converter, the effect of different carbon and manganese contents on cast steel made in a small basic electric furnace, the effect of various heat-treatments on cast steel made in the acid open-hearth furnace, and results of impact tests made on forged steels of different carbon content and submitted to various heat-treatments.

Results are now given of an investigation of steel castings made by the centrifugal process, the effect of certain heat-treatments on cast steel, further details on the effect of heat-treatment on forged steels of different carbon content and a comparative summary of the impact strength of the various steels considered.

Three cylinders were received, each approximately 71½ in. long and 10.9 in. in diameter. The three castings were numbered 1, 2 and 3, respectively.

¹Noted in CHEM & MET. ENG., vol. 24, p. 1146, June 29, 1921.

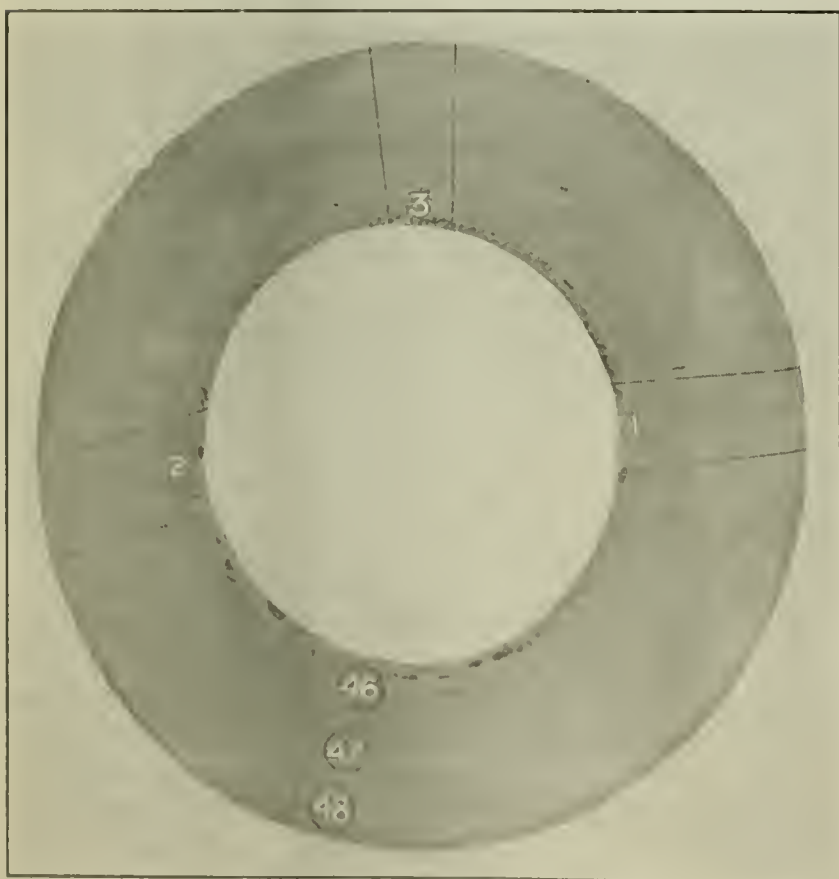


FIG. 1. MACROSTRUCTURE OF CYLINDER 3A. $\times 8$.
ETCHED WITH IODINE

Castings No. 1 and No. 3 were then annealed at 950 deg. C. for 4 hours, air-chilled, and drawn 6 hours at 600 deg. C. After the completion of the anneal, casting No. 3 was cross-cut into sections lettered from A to J, and casting No. 1 was split longitudinally.

TABLE I. CHEMICAL ANALYSES

Sample from Casting No. 3, Section A									
Sam- ple	Position in Section	% C	% Mn	% Si	% S	% P	% Ni	% Cr	% Cu
46	Near inside....	0.484	0.63	0.196	0.018	0.023	2.83	None	0.040
47	Middle.....	0.370	0.57	0.179	0.021	0.015	2.80	None	0.045
48	Near outside...	0.370	0.53	0.179	0.021	0.017	2.71	None	0.045
Sample from Casting No. 3, Section H									
52	Near inside....	0.384	0.53	0.188	0.019	0.015	2.76	None	0.045
53	Middle.....	0.354	0.55	0.179	0.019	0.015	2.70	None	0.038
54	Near outside...	0.372	0.54	0.179	0.021	0.016	2.72	None	0.043
Sample from Casting No. 1, Taken 6 in. from Reference Point									
83	Near inside....	0.454	0.43	0.484	0.014	0.018	2.29	None	0.064
84	Near outside...	0.430	0.43	0.470	0.017	0.015	2.30	None	0.060
Sample from Casting No. 1, Taken 32½ in. from Reference Point									
85	Near inside....	0.482	0.46	0.484	0.020	0.026	2.30	None	0.035
86	Near outside...	0.450	0.45	0.466	0.019	0.022	2.30	None	0.040

TABLE II. TENSILE AND CHARPY IMPACT TESTS

Treatment: Annealed 4 hours at 950 deg. C., air-chilled, drawn 6 hours
at 600 deg. C.

Physical Tests on Casting No. 3, Ring C—Transverse

— Charpy Impact Tests —

Specimen No.	Yield Point (Lb. per Sq. In.)	Tensile Strength (Lb. per Sq. In.)	Elongation (per Cent)	Contraction (per Cent)	Brinell Hard- ness	Specimen No.	Ft.-Lb.	Average Ft.- Lb.	Grand Ave.	
10	48,500	82,500	19.0	24.0	159	22	11.48	10.74	12.80	
11	49,500	83,500	21.5	30.7	171	23	10.01			
						24	11.71			
						25	17.92	14.86		
Physical Tests on Casting No. 3, Ring C—Longitudinal										
12	49,000	79,000	20.5	30.7	156	26	16.14	17.57	17.74	
13	49,000	83,000	17.5	27.4	167	27	19.01			
						28	16.60			
						29	19.24	17.92		
Physical Tests on Casting No. 3, Ring G—Transverse										
14	47,500	79,000	22.0	34.0	149	30	12.95	14.85	14.23	
15	49,000	79,000	23.5	27.4	159	31	16.76			
						32	13.58			
						33	13.65	13.61		
Physical Tests on Casting No. 3, Ring G—Longitudinal										
16	49,500	84,000	18.5	20.5	171	34	16.60	16.95	16.05	
17	49,500	77,000	*9.0	16.9	159	35	17.30			
						36	13.96			
						37	16.37	15.16		
* Rejected from average.										
Physical Tests Taken on Casting No. 1, 6 in. from Reference Point—Tangential										
59	55,000	92,500	14.5	16.9	171	69	4.65	4.80	4.61	
60	56,500	93,500	11.5	13.3	175	70	4.96			
						71	5.89			
						72	2.94	4.41		
Physical Tests Taken on Casting No. 1, 6 in. from Reference Point—Longitudinal										
61	56,000	92,500	13.5	9.5	171	73	5.82	5.31	5.31	
						74	4.81			
Physical Tests Taken on Casting No. 1, 32½ in. from Reference Point—Tangential										
63	56,000	92,000	10.0	13.3	179	75	7.21	5.85		5.39
64	55,500	94,000	12.5	13.3	175	76	4.50			
						77	4.96			
						78	4.89	4.92		
Physical Tests Taken on Casting No. 1, 32½ in. from Reference Point—Longitudinal										
65	57,000	94,500	10.5	16.9	171	..	.....	.....	.....	

The sections from castings lettered from A to J, inclusive, were then polished and etched with iodine. One-half of casting No. 1 was polished throughout its entire length and also etched with iodine. The result of the etching of a ring from casting No. 3 (Fig. 1) shows the existence of circumferential bands and also the persistence of the original ingot structure. The bands proved to be ferrite by microscopical examination.

Rings B and F from casting No. 3 were rough-machined on the interior and then forged to a wall-thickness of 1½ in. The length of the ring was not increased by this operation, the decrease in the diameter of the cylinder wall being made by an increase in the diameter of the ring. Fig. 2 shows the location of the samples taken from rings B and F in the forged condition and the physical tests obtained are given in Table III.

TABLE III. TESTS ON CASTING NO. 3, ROUGH-MACHINED AND FORGED. LOCATION OF SAMPLES IN FIG. 2

Physical Tests on Casting No. 3, Ring B—Transverse

— Charpy Impact Tests —

Specimen No.	Yield Point (Lb. per Sq. In.)	Tensile Strength (Lb. per Sq.In.)	Elongation (per Cent)	Contraction (per Cent)	Brinell Hard- ness	Specimen No.	Ft.-Lb.	Ave. Ft.-Lb.	Grand Ave.
89	55,000	94,500	22.5	40.3	192	97	19.40	20.37	19.88
90	57,500	97,000	23.5	43.3	167	98	21.34		
						99	18.15		
						100	20.64		
Physical Tests on Casting No. 3, Ring B—Longitudinal									
91	57,500	92,000	23.5	51.9	192	101	19.40	19.16	19.95
92	52,500	91,500	25.0	49.1	187	102	18.93		
						103	22.03		
						104	19.47		
Physical Tests on Casting No. 3, Ring F—Transverse									
93	53,000	91,000	20.5	46.2	187	105	21.41	21.49	22.05
94	54,500	94,000	20.5	49.1	202	106	21.57		
						107	20.71		
						108	24.52		
Physical Tests on Casting No. 3, Ring F—Longitudinal									
95	54,000	96,000	22.5	49.1	179	109	16.76	17.96	18.54
96	53,500	98,000	23.5	49.1	197	110	19.16		
						111	20.56		
						112	17.69		

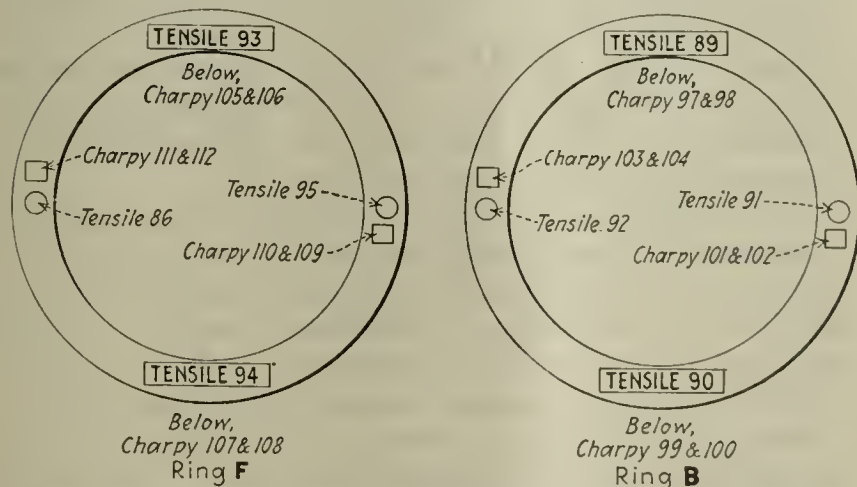


FIG. 2. LOCATION OF SPECIMENS LISTED IN TABLE III

Sections of forged ring F were then heat-treated as follows: Heated to 800 deg. C. and held for 1 hour, after which they were quenched in water. Subsequent to the quenching operation they were drawn at 675 deg. C. The sections of cast ring G were similarly heat-treated. The location of the test specimens taken from the sections so treated are shown in the drawing, Fig. 3. There is thus available for comparison tensile and Charpy tests from two rings, ring F being forged and heat-treated and ring G being treated without forging. The physical tests resulting are shown on Table IV. The forged and heat-treated ring shows better ductility than the cast and heat-treated ring, although the ductility was exceptionally good for both specimens, as was likewise the Charpy value. The Charpy values obtained upon the heat-treated casting are superior to those generally obtained upon gun forgings. This statement

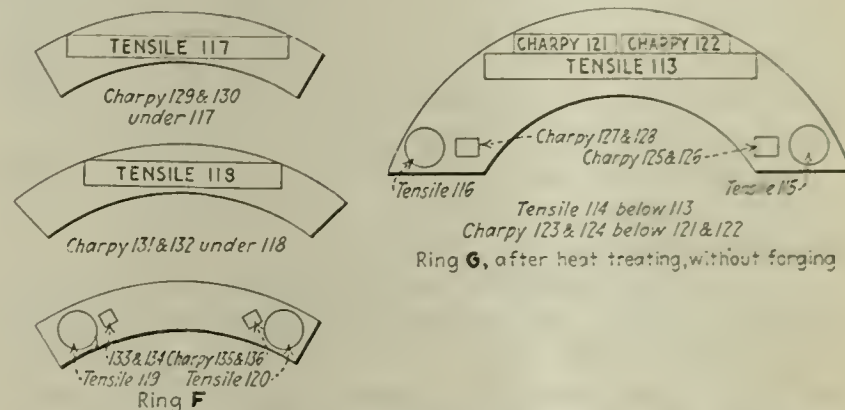


TABLE VI. CHEMICAL COMPOSITION AND CHARPY VALUES OF HEAT-TREATED BAR STOCK

Chemical Composition						Heat-Treatments							
C	Mn	S	P	Si	Cr	Original	V ₁	V ₂	V ₃	V ₄	V ₅	V ₆	V ₇
0.14	0.45	0.035	0.018	0.131	....	45.39	28.01	38.10	47.18	47.95	49.50	48.34	52.61
0.18	0.56	0.043	0.024	0.132	....	41.51	30.72	35.69	46.24	45.00	44.62	46.87	50.51
0.32	0.51	0.027	0.009	0.128	....	22.96	15.20	10.94	18.85	19.24	19.86	22.34	26.30
0.46	0.40	0.050	0.020	0.144	....	10.70	7.99	.....	14.04	13.96	13.89	15.67	16.60
0.49	0.60	0.028	0.013	0.127	....	12.72	10.32	.....	16.06	14.51	14.35	17.53	19.24
0.57	0.65	0.028	0.012	0.167	....	8.38	7.91	.....	12.57	10.86	11.17	12.02	14.04
0.71	0.67	0.035	0.027	0.147	....	4.42	2.48	.....	.....	4.73	7.60	10.32	15.67
0.83	0.55	0.028	0.018	0.152	....	1.31	1.39	.....	.....	3.42	3.33	4.34	6.36
1.01	0.39	0.029	0.016	0.160	....	2.09	1.47	.....	.....	3.25	3.18	4.19	4.42
1.22	0.34	0.031	0.025	0.181	....	1.39	1.31	.....	.....	2.48	2.09	2.63	2.63
1.39	0.20	0.029	0.015	0.191	....	0.93	0.85	.....	.....	1.86	1.31	1.47	1.62
1.46	0.20	0.035	0.011	0.133	0.35	0.77	1.24	.....	.....	1.94	2.01	2.01	1.94

The heat-treatments were as follows: Original, as received; V₁, annealed just above A_{c3}; V₂, hardened in water from just above A_{c3}; V₃, hardened in oil from just above A_{c3}; V₄, quenched in oil from just above A_{c3} and drawn at 375 deg.

C.; V₅, quenched in oil from just above A_{c3} and drawn at 460 deg. C.; V₆, quenched in oil from just above A_{c3} and drawn at 560 deg. C.; V₇, quenched in oil from just above A_{c3} and drawn at 650 deg. C.

The quenching temperatures were:

Carbon	Quenching Temperature Deg. C.	Carbon	Quenching Temperature Deg. C.	Carbon	Quenching Temperature Deg. C.	Carbon	Quenching Temperature Deg. C.
0.14	866	0.46	819	0.71	800	1.22	790
0.18	858	0.49	816	0.83	795	1.39	790
0.32	836	0.57	809	1.01	790	1.46	790

All pieces were held at quenching temperature 20 minutes, and at the drawing heat 30 minutes.

should be made with the reservation that the elastic limit and tensile strength are not so high as gun forgings from which Charpy bars have been taken.

Material used for test consisted of slabs 1½ in. thick which were cut from a 10-in. round ingot, cast in the foundry of Watertown Arsenal.

The chemical analysis was C 0.30, Mn 0.62, Si 0.181, P 0.038, S 0.038. Three heat-treatments were applied—

Treatment A: Heated to 900 deg. C., soaked 2 hours at this temperature and water-quenched, followed by drawing 2 hours at 650 deg. C. and furnace-cooled.

Treatment B: Heated to 900 deg. C., soaked 2 hours at this temperature and furnace-cooled.

Treatment C: Heated to 950 deg. C., soaked 2 hours at this temperature and cooled in air, followed by drawing 2 hours at 500 deg. C. and furnace-cooled.

The impact results as given by the Charpy machine were as follows: Treatment A, mean of seven tests, 14.35 ft. lb.; treatment B, mean of eight tests, 11.33 ft. lb.; treatment C, mean of eight tests, 11.87 ft. lb.

An inspection of the mean results shows that water-quenching has raised the impact strength from 11.33 to 14.35 ft.-lb., while air-chilling and drawing at 500 deg. C. raised the impact strength but slightly.

The chart Fig. 4 shows graphically the results of Charpy tests on twelve forged steels mentioned in the previous article. A repetition is given of the chemical compositions and heat-treatments in Table VI.

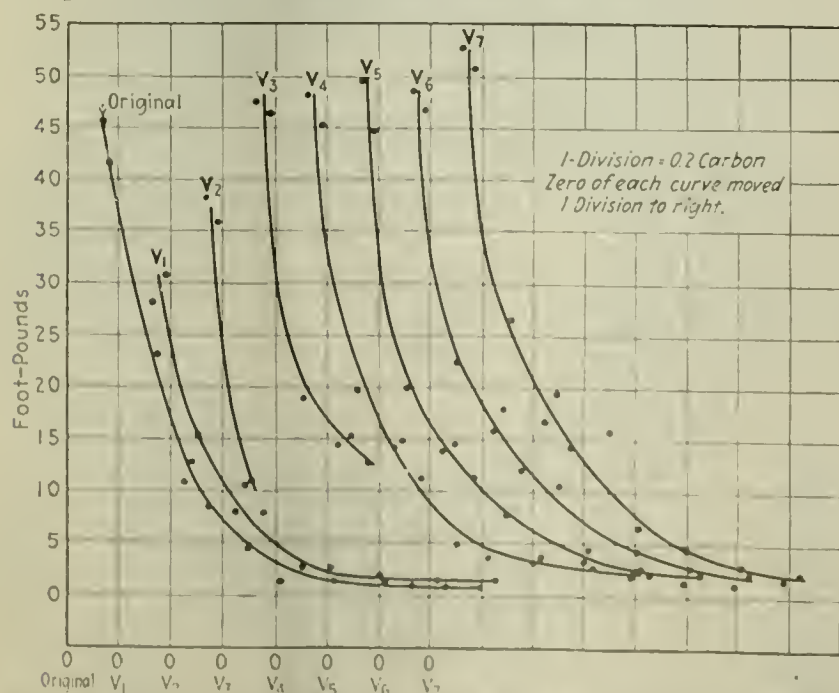


FIG. 4. IMPACT RESULTS OF FORGED STEELS OF INCREASING CARBON CONTENT UNDER VARIOUS HEAT-TREATMENTS

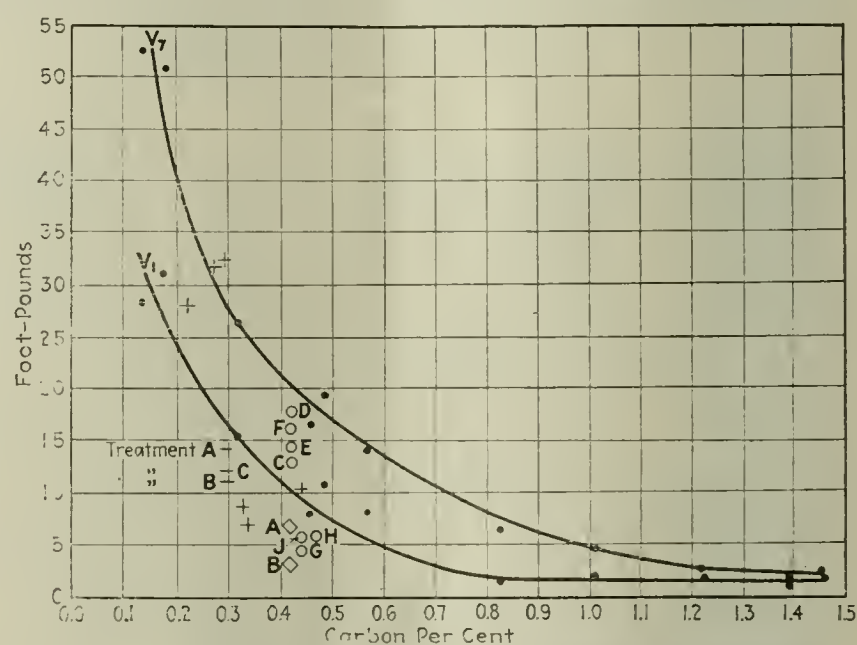


FIG. 5. COMPARATIVE IMPACT VALUES OF CAST AND FORGED STEELS

In the chart (Fig. 5) are graphically summarized and compared the impact results of the various cast and forged steels referred to in this and the previous article.

The diamond mark represents steel castings of "Experiment No. 1" of the previous article, before the American Society for Testing Materials.¹

The castings each contained 0.42 carbon and 0.86 manganese. They were annealed at 950 deg. C. for 2 hours and air-chilled, then drawn 4 hours at 500 deg. C. Steel A represents a phosphorus content of 0.043 and steel B represents a phosphorus content of 0.104.

The plus sign represents castings having different carbon and manganese content. The castings had been air-chilled at a temperature of 900 deg. C. The carbon content is shown on the chart and the corresponding manganese content is as follows:

C	Mn	C	Mn
0.44	0.93	0.222	1.29
0.27	1.08	0.33	1.54
0.298	1.3	0.346	1.76

The circle represents steel castings produced by the centrifugal process. Details of treatment, etc., are given above.

The minus sign represents cast steels heat-treated in three different manners, as described above.

Acknowledgment is made to Captain W. B. Bently, now professor of chemistry, Ohio University, who conducted the tests on the investigation of steel castings made by the centrifugal process, and to Nicholas Richardson, research engineer, Watertown Arsenal, who has assisted in compiling data on forged steels.

University Researchers Should Patent Discoveries in Their Own Names

BY WILLIAM J. HALE
The Dow Chemical Co.

IN A recent article by William Hoskins and Russell Wiles on the "Promotion of Scientific Research," which appeared in *CHEMICAL & METALLURGICAL ENGINEERING* (vol. 24, p. 689, April 20, 1921), we meet with a novel proposition—namely, that universities should patent the inventions of their research men and lease the same to the industries, the proceeds to be applied directly in the continued furthering of research.

The suggestion is indeed worthy of study from the standpoint of both industry and university. The paper is replete with rich suggestions and advice, but the plan in itself affords no ray of hope for financial aid to university research. My critical attitude in this connection will better be condoned if I attack first the weak points and then bestow praise upon the numerous commendable statements made by these authors on the subject of research.

PARTICULAR RATHER THAN GENERAL PATENTS OF INDUSTRIAL VALUE

1. Foremost of all arguments against the proposition, it must be asserted that patents of general processes are rarely of much pecuniary value. I cannot recall a single instance where a patent on some basic principle yielded a revenue worthy of consideration. True, a number have been sold outright at handsome prices, such as the Nernst lamp, for instance, but the purchasers here, as elsewhere, are the financial losers.

The early basic patents would seem to serve primarily the purpose of an inspiration for subsequent inventors. The basic patent of the sewing machine—an eye in the point of the needle, unheard of in all preceding centuries—yielded nothing. The Selden patent on internal combustion engines with clutch release is at the basis of the great automobile industry, but it survived only a few years till broken.

It is, therefore, the application of some particular phase of these basic discoveries alone that claims the attention of industrialists. It is the particular rather than the general that commands industrial value. No sooner is a new principle promulgated than each conceivable adaptation of it is visualized in every industrial research laboratory in the country. So much better equipped than the average university laboratory for purposes of detailed practical applications, there is little wonder that the industrial scientist can evolve new points of value and points equally as patentable as the general principle itself. In other words, a university laboratory could not be expected to give more than the merest generalization in its claims for patents, and by the time the patent was granted there would be so many more patents pending on details, and especially upon new ideas growing out of the original patent, that the university itself might be forced to pay an appreciable amount in royalties to subsequent inventors in order to present anything attractive for lease to industry.

2. Industries nowadays patent everything. We have had costly experiences when acting to the contrary. We patent to protect ourselves and not to claim any wonderfully conceived new ideas. When thus protected in our operations, we proceed with comparative impunity, as we know we cannot be interfered with. The

patents of others little interest us any more than to direct the attention of our research men to still better adaptations of our own particular manufacturing processes.

DIFFICULTIES ENCOUNTERED WITH MORE THAN ONE LICENSEE

3. If there appears some altogether new patent of which we wish to make use, naturally it is to our advantage to buy it outright or lease it on some very small royalty. If another concern desires to lease this same patent, I doubt if we should continue with our lease unless our costs of production were materially lower than our competitor's. It is not worth while to take on extra competition unless you have a material advantage at several points. So soon, therefore, as a university owning rights to a patent began to lease the same to several companies (she never could get much pecuniary assistance from leasing to one company alone) so soon would the value of the patent depreciate and sooner or later the free use of the patent would be forced upon her—a fact made apparent as soon as the university failed to prosecute a single concern using the patent without license. The regular licensees, paying their fees for their own protection, have a right to assume that their leased rights will be guarded by law.

4. A good chemical staff at a large university today with constant and persevering attention to research, where the ultimate goal is financial aid to the university, will scarcely be able to evolve much of a basic nature in the course of a college year. If, however, its concerted action is directed to some particular small problem there is reason to hope for positive results—but think of the "leaks"! You might just as well announce the work at the start. University men are the last to anticipate the valued factors in their researches. In other words, a corps of men at an industrial plant are so much more advantageously situated with scientific, material and legal equipment that a new idea, no matter how crude its conception, can be safely secured for their industry long before the university men realize what they are at work upon. When, however, the university man works alone or with a close collaborator and the question of time is left out of consideration, we find many discoveries to his credit, and patents have usually followed free from outside interference.

THE QUESTION OF PATENT COUNSELORS

5. I know of no type of university man willing to grant that patent counselors could be helpful to university scientists. The scientific men fully realize that these counselors are anything but scientists. They may have had some scientific training, but they are not capable of diagnosing scientific problems save where exactly similar questions have been a matter of study between them and the Patent Office. The only possible help from the patent attorneys would be in the form of a comprehensive report from them on all patents bearing on the general processes involved. With such reports at hand, the investigator cannot do better than consult privately with industrial leaders, men of high standing in their profession and in their community. These men and these men alone are the only men who can help the inventor. Though this is, indeed, solid truth, some way or other I just can't picture to myself the solicitation of advice from industrial leaders on the part of our university professors.

6. There is nothing dishonorable in a university scientist seeking a patent. On the contrary, he gains enormously thereby in international prestige. Of course he usually is condemned at home by the university drones unable to comprehend the value of ideas other than their own; but such childish criticisms are negligible. No true scientist doubts for a moment the rights of a man to patent his own inventions. The great majority of our well-known chemists of England, France and Germany are holders of patents in their respective countries. In this country the so-called baneful influence of the industries has been held over young scientists as a sword of Damocles, so to speak, but I assure you the sword is now sheathed. The real inventor or discoverer should have a right to his own ideas and he alone should reap what little benefits may accrue therefrom.

NEED FOR GREAT INCREASE IN SCIENTIFIC RESEARCH

This paper of Messrs. Hoskins and Wiles presents a number of points in which one must concur with the highest commendation. "An immense increase in scientific research is perhaps the most important future step for the welfare of this country." This is a truth of such limitless scope that we can scarcely realize its import. These authors avow that researches must begin as pure science and take the direction of applied science in order to raise the standards of the physical well-being of our people. At this point Messrs. Hoskins and Wiles introduce the crux of the whole matter: "Industry is taking care of the application of science." The university therefore must stimulate the researches in pure science, else "the stream will dry up."

The establishment of a 10-year period for research in pure science for a man after receiving his doctorate is all well enough and admirable for the future of both university and industry, no matter where the young man casts his lot, but the salary paid is usually so small during the early years of this constructive period that barely a living wage is afforded the scientist. Physically he may become more or less a wreck.

The financing of these men and their investigations brings out the proposal which the authors have suggested. They argue that the industries will gladly pay for patents thus obtainable after assignment to the universities. This is all true enough, but, as stated in my foregoing criticism, there will be so little of patentable nature that the university and the investigator will reap greater renown if he goes on his quiet way with never a thought of patent or legal advice until he himself runs across something which he recognizes is new and which he is anxious to secure in his own name. A man in this age unable to recognize at least the partial value of his discoveries is really to be pitied and actually to be classed as a moron; I doubt if universities should countenance his presence too long among the more intellectual. The custom of university scientists in presenting purely scientific papers is highly to be commended. I would that we industrial men could get the time to contribute likewise in this capacity. Just where Messrs. Hoskins and Wiles find authority for the statement, "It seems to be agreed that to permit members of the scientific faculties at our universities to patent their discoveries for their own personal benefit is an entirely wrong procedure," is unknown to me. It strikes me as of ancient mariner lore—antique in thought maybe, worthy of admiration

and praise for the goodly influence in the past, but in this dynamic age certainly out of harmony. In practically every university today there are professors of chemistry who hold patents and there will be more and more as university men awake to their possibilities.

The one point which Messrs. Hoskins and Wiles would bring against this right to patent in the name of the scientist is that this action may tend to restrict the direction of research into lucrative fields, especially in the realms of applied science. This indeed is the strongest criticism of the procedure and one in which I have interested myself to a large extent. In order to avoid this pitfall I have advocated an actual payment for research in pure science. (*J. Ind. Eng. Chem.*, vol. 12, p. 690, 1920.) Somewhat later, when industrial conditions are improved, I hope this question can be brought up again. To deprive the university scientist of the right to patent in his own name and reap whatever profits accrue would indeed destroy about the last vestige of incentive left to him. High salary and high recognition with promotion come only slowly, owing to the dead timber still standing; the university therefore cannot safely consider a step so likely to drive its research men into research and industrial institutes.

SPECIAL RESEARCH FELLOWSHIPS

The founding of special research fellowships, particularly where the donor is a scientist himself and directs (though indirectly) the research work of the Fellow, is an admirable example of what we may hope for under favored conditions, and with this practical suggestion I believe Messrs. Hoskins and Wiles have admirably described a means of co-operation of university and industry.

Metallurgical Examination of Broken Crankshaft

A broken crankshaft from a 10-ton ammonia refrigeration machine was submitted to the Bureau of Standards for examination by one of the other Government departments. The material proved to be inferior in that it was decidedly porous and showed evidence of not having received sufficient reduction in forging. The break which occurred was in the nature of a fatigue failure and had its origin in the angle between one of the throws and the bearing. A defect at this point had been filled in previously with arc-fused metal. Such a procedure would not necessarily lead to failure had the defect been located elsewhere, but at the point in question the stresses are much higher than at other points on the shaft, and the break once started would be propagated rapidly owing to the unsound character of the steel.

Present Status of German Leather Industry

A cablegram from the representative of the Department of Commerce, Berlin, reports that German tanneries are producing calfskins, patent leather and kid leather up to 65 or 75 per cent of their pre-war output. The tanners are receiving adequate supplies of raw hides and skins to keep the industry occupied. France is supplying 70 per cent of the calfskins and 90 per cent of the kid leather. Denmark and Sweden are other sources of supply; England sends additional patent leather, Russia virtually nothing. Labor conditions in the leather industry are satisfactory, with almost no unemployment. Present wages per hour of 6.25 to 8 marks compare with 1913 rate of 45 to 65 pfennigs per hour.

Contrast Etching for Metallographic Specimens

BY HENRY S. RAWDON* AND MARJORIE G. LORENTZ*

THE terms "contrast" etching and "plain" etching are used to designate the character of the results obtained with different reagents upon any type of alloy and particularly those consisting of one constituent such as the "pure" metals, the α brasses and bronzes, β brass, etc. Microscopic examination of sections of such materials after plain etching usually reveals only the grain boundaries, as a network of black lines together with such extraneous features as inclosures. The grains themselves show no "individuality" other than that of shape and size. However, in the same material after contrast etching, each grain has an individuality of its own which is the result in large measure of its relative brightness as compared with the neighboring grains. The plain etch-pattern bears much the same relation to the contrasted one as a simple outline sketch of a group of objects does to the completed drawing of the same. For general purposes, the contrast etch-pattern is usually preferred, although in some cases, particularly for examinations at high magnification, the plain etching is the more desirable one to use.

Contrast may be developed in at least two very different ways. If the polished surface of the specimen

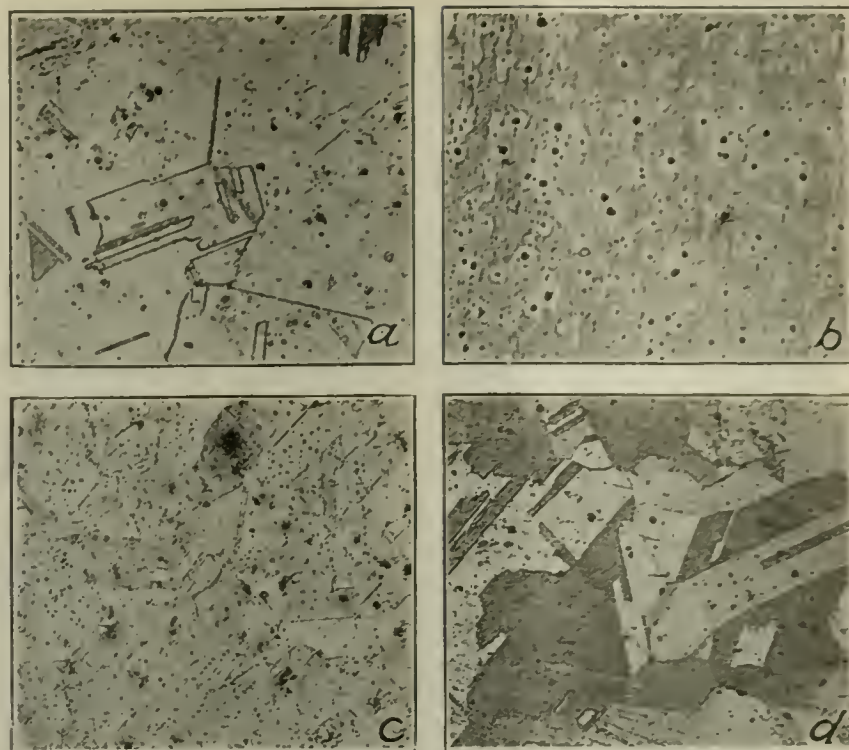


FIG. 2. MICROSTRUCTURE OF BRASS ETCHED BY MEANS OF HYDROGEN SULPHIDE. $\times 85$

a. α brass (Cu 67, Zn 32, Pb 1 per cent) etched with 10 per cent solution of silver nitrate. Note the absence of contrast.

b. Same specimen as a, which after polishing was suspended in an atmosphere of hydrogen sulphide for 1 minute, and acquired a surface film of sulphide. Black spots mark inclusions of lead.

c. The specimen after being etched as in a was placed in hydrogen sulphide as in b. The contrast of the etch pattern produced was much less pronounced than in d.

d. The specimen after being filmed by means of hydrogen sulphide as in b was etched with silver nitrate solution as in a. A brilliant contrast results.

The nature of the roughening produced by very deeply etching a specimen of brass (copper 69, zinc 31 per cent approximately) is shown in Fig. 1. The contour of the roughened surface was revealed by using sections perpendicular to this surface, precautions being first taken to protect it by means of a coating of electrolytically deposited copper. The micrographs plainly show the regularity in the roughening of a crystal produced by etching and also that it conforms to the crystalline orientation of the grain as revealed by the etching pits. This means of producing contrast is well understood and has been frequently described. The second method, however, is not so well known.

It is often desirable in the study of the microstructure of metals to produce contrast without much roughening of the surface. This may be accomplished by the use of reagents which cause the formation of a very thin film on the surface, the thickness of which varies from grain to grain. This effect has been described in considerable detail for copper¹ and is usually attributed to an oxidation film. The part that such films play in contrast etching may be revealed rather strikingly, as shown in Figs. 2 and 3, by a double etching process in which the filming operation is separate from that of etching.

Hydrogen sulphide gas may be used as a convenient means for producing a thin film on the specimen and an aqueous solution of silver nitrate as the reagent for etching which, of itself, produces little if any contrast (Fig. 2a). When the slightly warmed polished brass specimen (copper 67, zinc 32, Pb 1 per cent, approximately) was suspended in a bottle by hydrogen sulphide to which a drop of concentrated hydrochloric acid had been added to accelerate the action, a film having the appearance shown in Fig. 2b was produced. (It may be noted here that hydrogen sulphide of itself,

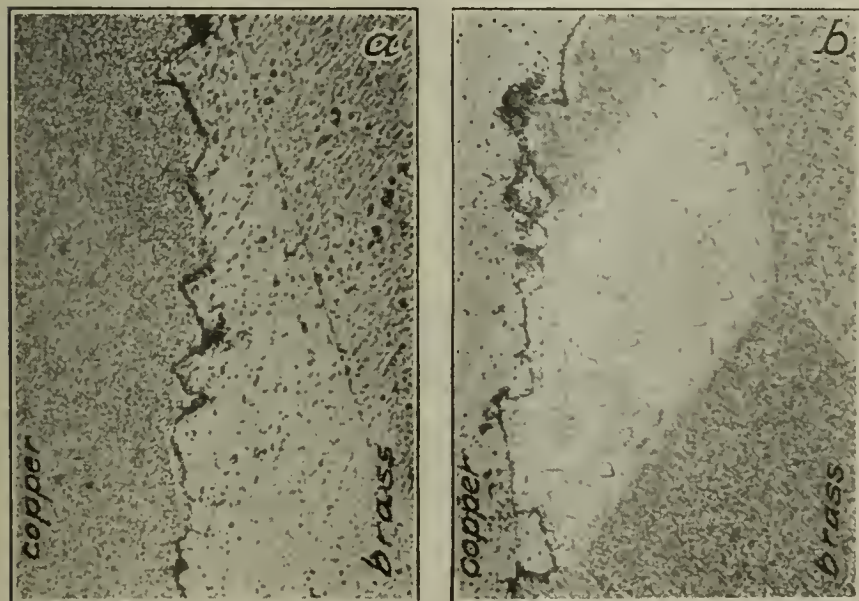


FIG. 1. ROUGHENING OF THE SURFACE AS A RESULT OF PROLONGED ETCHING. $\times 500$

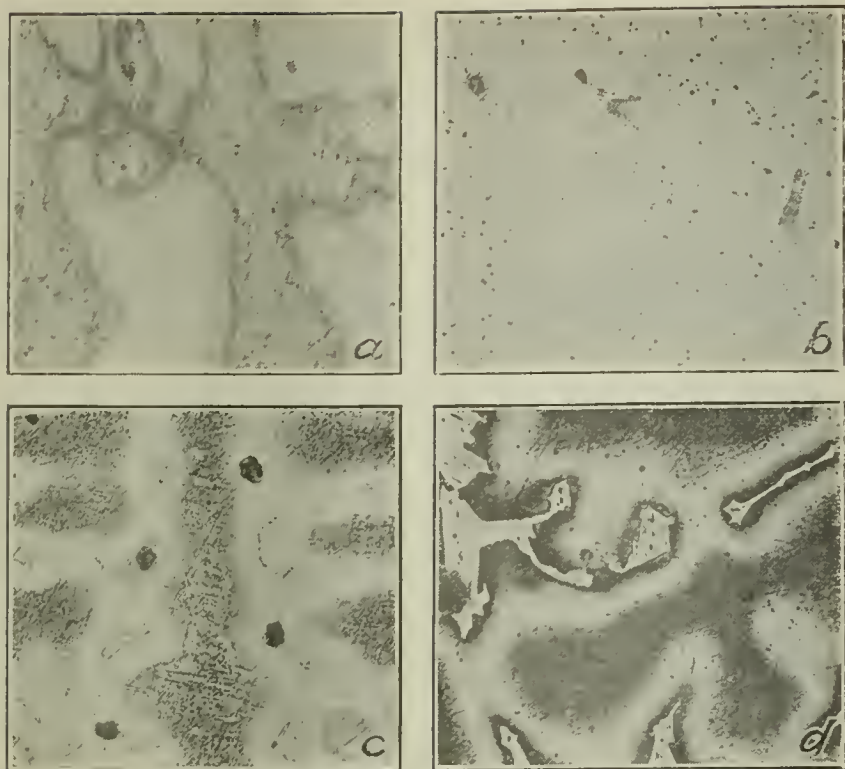
A polished section of an α brass (Cu 69, Zn 31 per cent) was etched 12 hours in 50 per cent copper ammonium chloride and a section perpendicular to the etched face was then examined after etching with copper ammonium chloride. Note the similarity in orientation of the notches in the etched surface of a, which represents a portion entirely within a single crystal. Note in b how the orientation of the notches of the etched surface is the same as that of the etching pits within the crystal.

is etched sufficiently, the surface metal is dissolved and a differential roughening of the various grains will result as the crystalline facets are revealed within the boundaries of the different grains. Since the orientation of all the facets within any particular grain is the same, it follows that practically all the light incident upon such an etched surface of a crystal will be reflected in a definite manner. The direction of the reflected beam varies for different grains depending upon the difference in the orientation of the crystalline facets from grain to grain. Thus a crystal-grain will appear light or dark according to the position of the eye of the observer with respect to the beam reflected from this crystal.

By permission of the Director, Bureau of Standards.

*Physicist (metallography) and assistant physicist, respectively. Bureau of Standards.

¹Henry S. Rawdon and Marjorie G. Lorentz, "Metallographic Etching Reagents. I—For Copper," Bureau of Standards Sci. Paper 399 (1920).

FIG. 3. MICROSTRUCTURE OF CAST BRONZE. $\times 85$

a. Cast zinc bronze (Cu 88, Sn 10, Zn 2 per cent) etched with 10 per cent solution of silver nitrate. Adhering silver covers the eutectoid constituent.

b. Specimen a which, after polishing, was placed in an atmosphere of hydrogen sulphide for 1 minute.

c. Specimen a, filmed by hydrogen sulphide as in b, then etched with silver nitrate as in a.

d. Specimen a, etched with silver nitrate and then exposed in hydrogen sulphide as in b.

A brilliant contrast is produced. The adhering silver covering the eutectoid (see a) protects this constituent from the action of the sulphide and thus increases the contrast.

particularly if dry, has an almost negligible effect upon a metal; a trace of acid fumes, however, quickly causes a heavy sulphide film to form.) No evidence of crystalline structure was revealed by the hydrogen sulphide attack. On the other hand, when a specimen etched by means of silver nitrate solution was introduced into the hydrogen sulphide atmosphere, the sulphide film formed on certain crystals with greater readiness than on others, so that a slightly contrasted etch-pattern resulted (Fig. 2c). However, the best results by far were obtained by first producing a uniform sulphide film on the polished surface of the specimen and then etching the filmed sample in the silver nitrate solution (Fig. 2d). Such a procedure gave excellent results with α brasses and $\alpha\beta$ brasses. With cast bronze (copper 88, tin 10, zinc 2 per cent), excellent results were obtained by producing the sulphide film on the etched surface rather than by etching the previously filmed specimen (Fig. 3). It will be noted in Fig. 3a that after etching with silver nitrate, the eutectoid constituent of the bronze remained coated with a deposit, presumably precipitated silver. This deposit protected this constituent from the action of the hydrogen sulphide gas to some extent when the etched specimen was introduced into the gas and so added to the contrast of the resulting etch-pattern.

The fact that the results given above are of rather

FIG. 4. MICROSTRUCTURE OF ANNEALED BRASS. $\times 85$

The polished specimens were heated for 10 minutes on a hot plate in the air, so as to produce a uniform oxide film. The oxidized specimens were then etched with 10 per cent silver nitrate solution.

general application and do not depend upon any peculiar properties of the sulphide film was demonstrated by using oxide films instead of sulphide. Specimens of brass were gently heated on a hot plate in the air until they were uniformly coated with oxide and were then etched with silver nitrate solution. The very striking contrast pattern produced as a result of this procedure is shown by Fig. 4. A somewhat similar effect sometimes results when a specimen is polished too long on a wheel which has been allowed to become nearly dry. Ferrite, for example, may under such circumstances develop a black-and-white contrast pattern upon etching instead of showing its usual appearance.

For demonstration purposes, one is restricted somewhat in the choice of reagents used, since it is necessary that the solution used be one that produces a "plain" etch-pattern. For practical use, of course, this limitation does not hold.

Development of the Gas Industry

A survey completed by the American Gas Association reveals in striking degree the magnitude to which the gas service of the nation has grown. Some interesting statistics are:

Gas furnishes the cooking heat, and in many cases illumination, in the homes of over 49,000,000 citizens.

Communities served with gas number 4,600 and meters 8,580,000, the gas mains totaling 68,300 miles.

To make the gas consumed by households and industry last year required 8,500,000 tons of bituminous coal, 2,000,000 tons of anthracite coal, 1,500,000 tons of coke, and 960,000,000 gal. of oil.

Hotels, clubs, restaurants and institutions using gas for cooking number 71,490, while those using it in part number 13,776.

The tremendous use of gas for industrial purposes is seen in the fact that 25 per cent of the nation's consumption is now by manufacturing concerns, it being used in over 1,500 different processes. The steady growth is recorded in the following table, compiled from Brown's Directory of Gas Companies:

GAS SALES BY YEARS, 1901 to 1920

	Cu.Ft.		Cu.Ft.
1901.....	101,625,366,000	1911.....	159,100,674,000
1902.....	92,714,667,000	1912.....	178,228,754,000
1903.....	105,676,479,000	1913.....	188,285,840,000
1904.....	113,930,140,000	1914.....	198,838,834,000
1905.....	112,444,237,000	1915.....	204,309,522,000
1906.....	122,849,725,000	1916.....	231,381,313,000
1907.....	132,011,582,000	1917.....	264,493,003,000
1908.....	138,570,073,000	1918.....	271,593,141,000
1909.....	143,117,693,000	1919.....	306,632,786,000
1910.....	149,430,549,000	1920.....	319,887,813,000

Domestic Production and Imports of Hides and Skins, 1920

The domestic production of hides and skins in the United States during 1920 exceeded the imports of foreign ones by 150,000,000 lb. The estimated output for the year was 849,530,000 lb., the imports aggregated 700,113,000 lb.—both on a "green" basis. These totals, as tabulated in *Commerce Reports*, included:

Kinds of Hides and Skins	Domestic Production,* Lb.	Imports† Lb.
Cattle hides.....	673,676,000	334,475,000
Calfskins.....	115,954,000	52,035,000
Sheep and lamb skins.....	29,719,000	112,523,000
Horse, colt, ass.....	30,000,000	21,890,000
Buffalo hides.....	.....	20,727,000
Goatskins.....	181,000	150,074,000
Kangaroo and wallaby skins.....	.....	1,389,000
All other hides and skins (exclusive of furs).....	.....	7,000,000
Total.....	849,530,000	700,113,000

* Estimated.

† Converted to a green basis, 1 lb. of dry equal to 2 lb. of green.

Recent Developments in the Sulphuric-Acid Industry—II*

Review of Such Modern Tendencies in the Chamber Process as the All-Masonry Construction of Towers, the Introduction of Interchamber Towers and So-Called Cooling Chambers, and Recent Changes in Design of Acid Chambers and Accessories

BY ANDREW M. FAIRLIE
Consulting Chemical Engineer

IT IS the intention of the author to confine himself in the present paper to a review of the more recent advances which have been made in the manufacture of sulphuric acid, particularly as these developments affect the design, construction and operation of Glover and Gay-Lussac towers and of chambers and their accessories.

Acid-proof masonry without lead curtains, as applied to Glover-tower construction, is a development of recent years. The first all-masonry acid-proof towers built in this country were erected at Nitrolee, S. C., in 1911, of stone and an acid-proof cement imported from Germany, and were used as nitric-acid towers. Later, in 1914, all-masonry towers were built for a phosphoric-acid plant at Mt. Holly, N. C., and these towers, so far as known, were the first all-masonry towers to be built of American-made chemical brick and cement. The bricks for the Mt. Holly plant were furnished by the B. Mifflin Hood Brick Co., of Atlanta, Ga., and the cement by the Chemical Construction Co., of Charlotte, N. C. The first all-masonry acid-proof towers for use in a sulphuric-acid plant were built at Macon, Ga., in 1914. Since then many acid-proof all-masonry towers—Glovers, Gay-Lussacs and concentrators—have been built in all parts of the country.

The steel supports of a Glover tower designed by the Chemical Construction Co. and also the manner of packing the tower are shown in Fig. 4. Manufactured forms of packing ordinarily are not used in the Glover tower, on account of the danger of cracking and collapsing under the intense heat. The Glover tower is usually packed with checkerwork chemical brick, with graded sizes of lump quartz, or with a combination of the two, the quartz on top.

Different views of the Glover and Gay-Lussac towers built for the new 250-ton plant of the Union Acid Works, Baltimore, Md., are shown in the accompanying illustrations. Fig. 5 shows the masonry Glover and Gay-Lussac towers under construction; Fig. 6 the masonry Glover towers (in left foreground) and masonry Gay-Lussacs (in left background) completed, with lead draft pipe from the last chamber entering the bottom of the first Gay-Lussac; Fig. 7 acid distributors on top of Glover tower and upper part of first Gay-Lussac tower, with acid distributors on top. In this photograph the method of staying the brickwork with angle-irons, tee-irons and tie-rods is clearly shown.

A form of tower construction recently designed for hot gases and acids is controlled by Perry & Webster, Inc., of New York City, and has been described and illustrated by Wells and Fogg in Bureau of Mines Bulletin No. 184.⁹

At one or two chamber plants recently constructed so-called "cooling towers" or "cooling chambers" have been introduced. The plants where such "cooling towers" have been installed have chambers of unusually large cubic capacity in proportion to total lead surface of tops and curtains. It is to compensate for the deficiency of heat-radiating surface of such large chambers that the small "cooling chambers," which have an unusually small volume of cubic space in proportion to area of lead surface, are installed. Properly speaking, the chambers themselves are just as truly cooling chambers as are the smaller structures to which the name "cooling chambers" has been applied. As the "cooling chambers" are made of the same materials as the chambers proper, their object is not to effect any necessary preliminary cooling of the gases prior to admission into the large chambers, as obviously gases hot enough to damage the large lead chambers would also damage the small ones. At the plant of the Tennessee Copper Co., where there were originally installed sixty-four cooling chambers 10 ft. 8 in. x 10 ft. 8 in. x 70 ft. high, and eight cooling chambers of the same width and height but twice the length, it was usual to find that the temperature of the gas in the second large chamber was higher than that of the gas in any of the "cooling chambers."

These cooling chambers were, nevertheless, very effective for the real purpose for which they were installed—namely, to supplement the large chambers for the radiation of the heat of the reactions and thus effect a lower temperature of the gas mixture entering the Gay-Lussac tower, resulting in improved niter recovery.

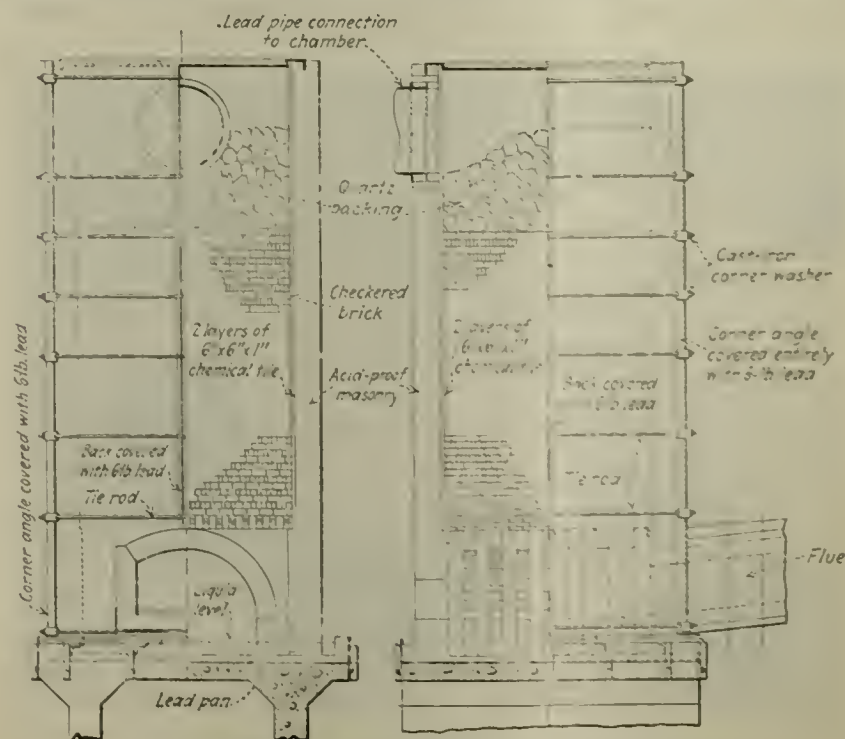
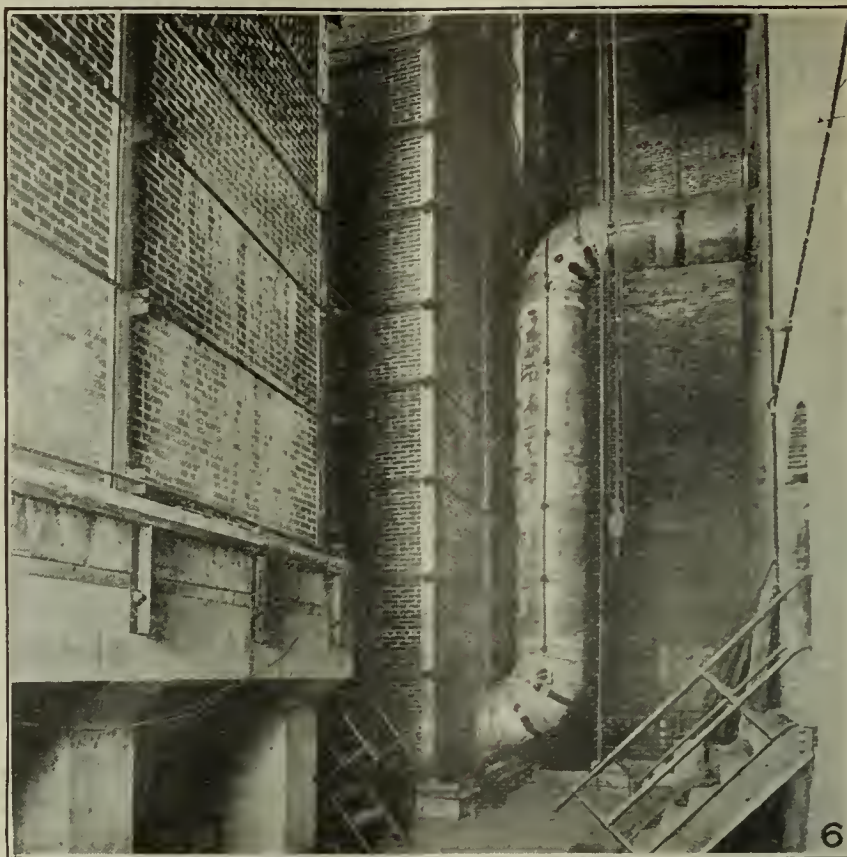
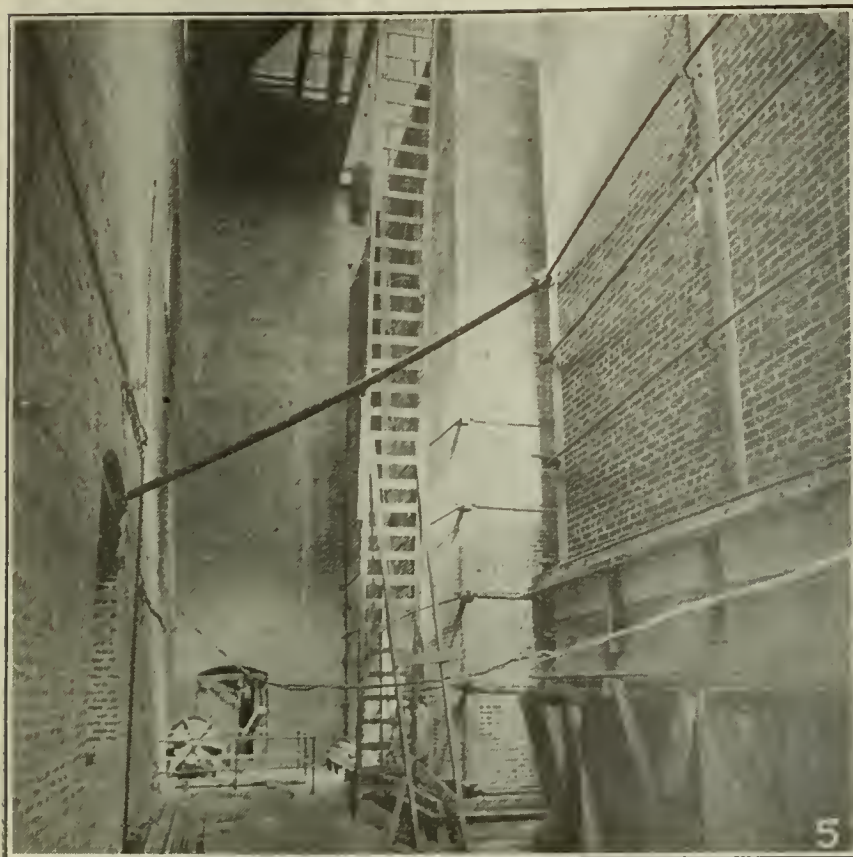


FIG. 4. STEEL SUPPORTS AND PACKING FOR ALL-MASONRY GLOVER TOWERS

*For Part I see CHEM. & MET. ENG., vol. 25, No. 19, p. 861.

⁹"The Manufacture of Sulphuric Acid in the United States," by A. E. Wells and D. E. Fogg, U. S. Bureau of Mines, 1920, p. 143.



FIGS. 5 AND 6. ALL-MASONRY GAY-LUSSAC AND GLOVER TOWERS AT UNION ACID WORKS, BALTIMORE. UNDER CONSTRUCTION (FIG. 5) AND COMPLETED (FIG. 6)

No radical changes in the design of sulphuric-acid chambers have been developed in the United States within recent years. During the war the total chamber plant capacity of the entire country was vastly increased, and some of the plants whose construction was undertaken by the Government were of unusual size. Among these may be mentioned the Pratt Process plant at Little Rock, Ark., practically 100 per cent completed at the time the armistice was signed, and the 800-ton plant at Brunswick, Ga., which was only 40 per cent completed on armistice day, soon after which construction was stopped.

Construction on the two-unit plant of the Union Acid Works, at Baltimore, Md., designed and built by the Chemical Construction Co., was started in April, 1920. One unit of a capacity of 150 tons 50 deg. Bé. acid was completed in January and the second unit was completed in August of this year. Each of the two units consists of three Glens Falls sulphur Burners, one Glover tower, two Gay-Lussac towers built as one structure with a downtake for the gases between, six cham-

bers, and five interchamber towers. The Glover tower is 17 ft. square outside by 31 ft. high and has walls 18 in. thick throughout. The Gay-Lussac tower structure, with downtake included, measures outside 17 ft. x 30 ft. 8 in. x 48 ft. high, and the towers inside are 12 ft. 5½ in. x 14 ft. in horizontal cross-section. The brick walls of the Gay-Lussac towers are 18 in. thick from the foundation up to a height of 21 ft., and from that point to the top are 14½ in. thick. In each unit three of the chambers are 60 ft. x 30 ft. x 40 ft. high, two are 70 ft. x 30 ft. x 52 ft. high, and the last one is 40 ft. x 30 ft. x 52 ft. high. A view of the chambers during construction is shown in Fig. 8, wherein the chambers of the completed unit are on the right, with scaffolding for lead burners still hanging in the steel framework, and the pan of one of the chambers of the unfinished unit is in the foreground. All acid pumping at this plant, with the exception of acid delivered to the storage tanks, is done by means of airlifts. Chamber hydration will be by means of water atomizers with 1½-in. lead supply lines.

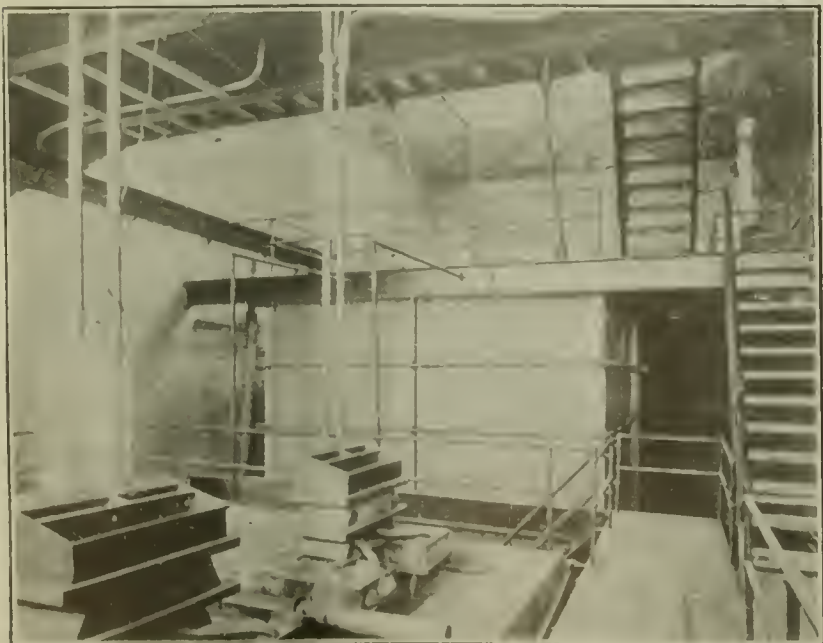


FIG. 7. TOPS OF GAY-LUSSAC AND GLOVER TOWERS OF ALL-MASONRY CONSTRUCTION, SHOWING ACID DISTRIBUTORS

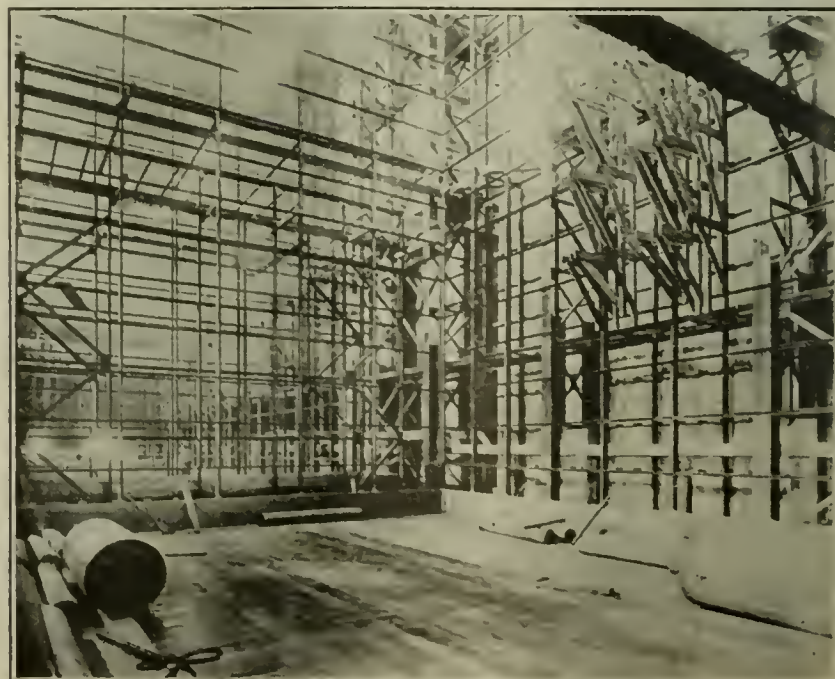
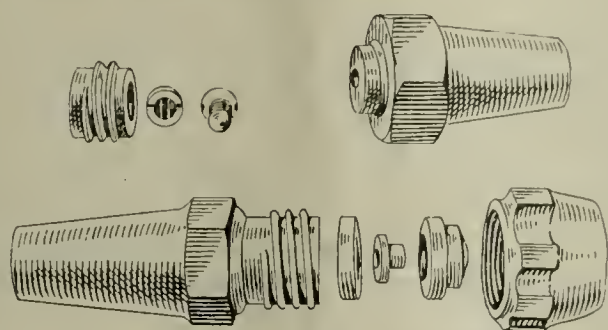


FIG. 8. LEAD CHAMBERS OF UNION ACID WORKS DURING CONSTRUCTION

Shortly before the outbreak of the war a new and unusual type of sulphuric-acid chamber was brought out in England. This was a radical departure from the long-established rectangular chamber in that it was shaped in the form of a truncated cone, and was designed for the application of flowing water on the outside of the lead curtains or walls. This new chamber is known as the Mills-Packard acid chamber, a description of which appeared in a recent issue of *CHEMICAL & METALLURGICAL ENGINEERING*.¹⁰ By means of the Mills-Packard chamber the chamber space required per pound of sulphur burned has been reduced to from 3.5



FIGS. 9 AND 10. STONEWARE WATER-ATOMIZING NOZZLE FOR SULPHURIC-ACID CHAMBERS. FLANGED TYPE SHOWN ABOVE AND THREADED TYPE BELOW

to 4.5 cu.ft. The first chamber of this type was built in 1914, and its success is attested by the fact that since then 110 Mills-Packard acid chambers have been built.

Water has almost entirely superseded steam in the United States as a means of hydration in the chambers. In some plants in the Northern States steam is still

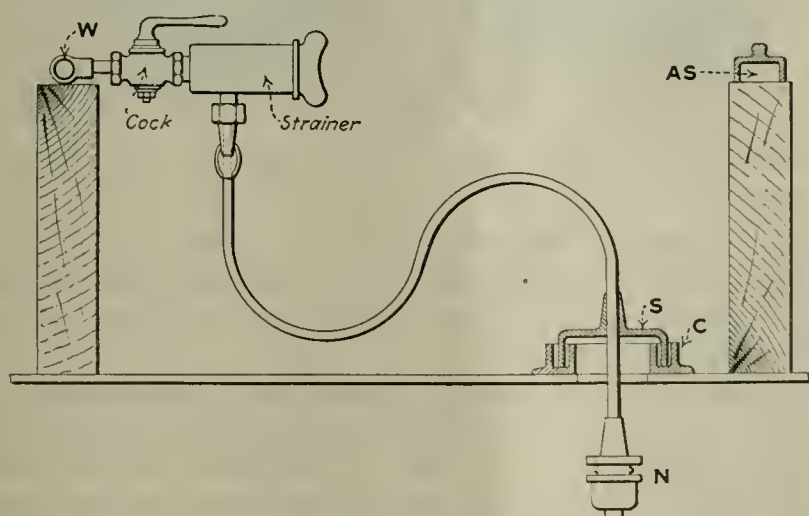


FIG. 11. INSTALLATION OF ATOMIZING NOZZLE IN TOP OF CHAMBER

C—Lead cup. S—Lead seal. N—Nozzle. W—Water supply to cock and strainer. AS—Spare seal.

used during the coldest months, owing to possible danger of freezing the water pipes unless the latter were drained. At other plants water is used throughout the year, except on the last chamber or last two chambers. As far north as Baltimore it has been found practicable to use water on all the chambers throughout the year.

The atomizers used for spraying the water inside the chambers are of various types, and include the Witclay nozzles of the Schutte & Koerting Co., the "Spra-rite" atomizing nozzles of the Binks Spray Equipment Co. and the stoneware atomizers of the Monarch Manufacturing Co. Fig. 9 shows the latest design of the Monarch stoneware atomizing nozzles, threaded type,

(U. S. Pat. 1,099,028). The disk has two or more small exposed surface grooves, molded tangential to the circumference of a concave circular space at the bottom. These grooves are equal distances apart. The water, forced through these grooves against the concave circular space, acquires a rotary motion, and is emitted from the nozzle as a fine mist. The flanged type is shown in Fig. 10. This nozzle has the advantage that, if it becomes clogged, it can usually be cleaned by inserting a pin through the small orifice (without shutting off the water supply), thereby lifting the disk and allowing the water to flush out the obstruction. If necessary, the grooves of the disk can readily be cleaned with a brush. Fig. 11 shows an installation of a water atomizer within a chamber, with lute (C) and lute cap (S) on the chamber top, and showing also the strainer and cock. The Monarch Manufacturing Co. has recently developed a new type of water strainer, to be used with their atomizer, as shown in Fig. 12, in which the strainer is not soldered, as in the old type, to the basket. The Duriron Co. has very recently developed a new type of atomizing nozzle, to be made of

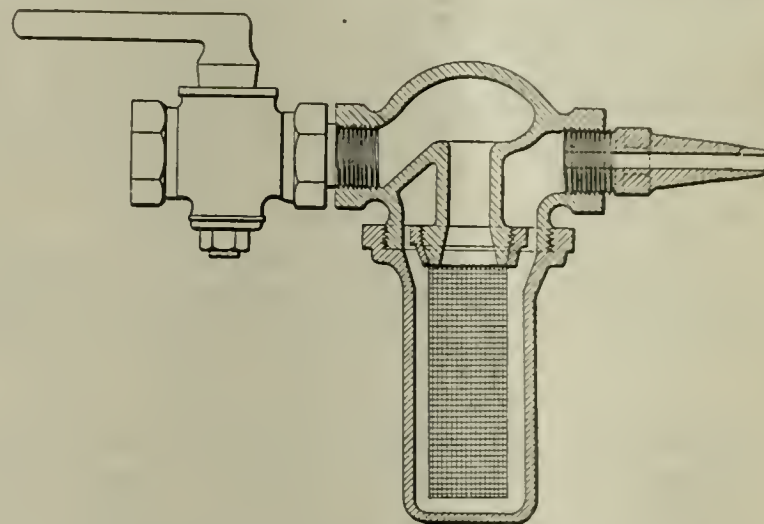


FIG. 12. A NEW TYPE OF WATER STRAINER FOR USE WITH WATER ATOMIZERS IN ACID CHAMBERS

Duriron, for acid chambers, on which four patent claims have been allowed. It is not yet on the market.

The interchamber towers for the plant of the Union Acid Works at Baltimore are 7 ft. wide x 29 ft. long x 24 ft. high. There are five of these towers at each unit, and they serve as coolers and mixers of the gas on its way from one chamber to the next. These towers are built with steel frames supporting lead curtains,

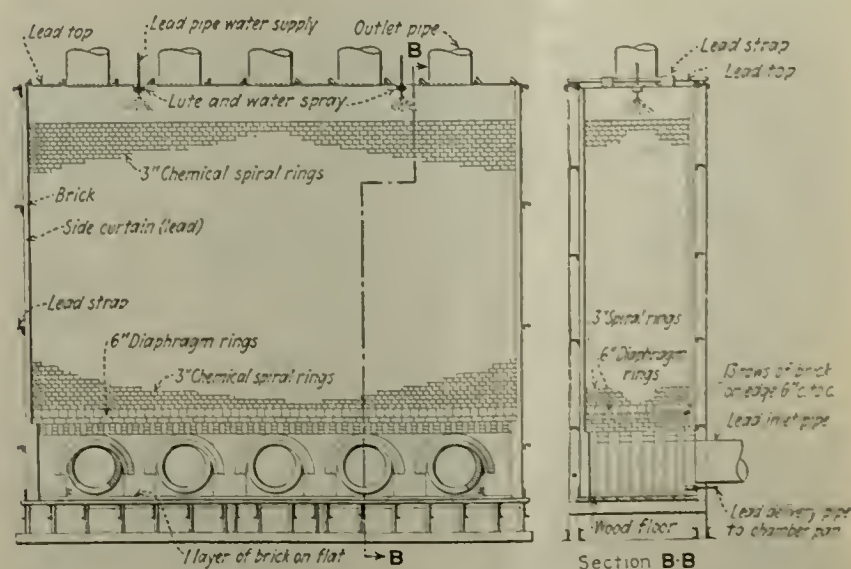


FIG. 13. ELEVATION AND CROSS-SECTION ON INTER-CHAMBER TOWER DESIGNED BY CHEMICAL CONSTRUCTION CO.

¹⁰"Water-Cooled Acid Chambers Adopted in England," *CHEM. & MET. ENG.*, vol. 24, No. 18 p. 786, May 4, 1921.



FIG. 14. SPIRAL RING TOWER
PACKING BLOCK

which are lined with a 4-in. brick wall. The towers are packed with staggered rows of 3-in. spiral rings furnished by the Hood Brick Co., of Atlanta. The elevation and cross-section is shown in the drawing (Fig. 13). Atomizing nozzles for water are inserted through the lead top. Data relative to the results obtained in such towers can be found in the Bureau of Mines Bulletin previously cited by Wells and Fogg.¹¹

At some plants a packed "filter tower" has been introduced between the last chamber and the first Gay-Lussac tower, to aid in drying the gases by passing them over the condensing surfaces of the packing in this tower, before entering the Gay-Lussac.

All-masonry Gay-Lussac towers do not differ materially from all-masonry Glover towers, except in size, in thickness of walls and in packing materials. The first all-masonry Gay-Lussac towers were built with walls 8 to 10 in. thick; but it was found that acid would seep through these walls in places, and the thickness of Gay-Lussac tower walls has been increased to a minimum of 14 in., and in the newest towers the lower part of the tower walls is 18 in. thick. Two or more Gay-Lussac towers, with the downtake for gas between, are commonly built together as a single masonry structure. Such a structure is shown in the photographs of the masonry towers of the Union Acid Works (Figs.

¹¹Op. cit., p. 108.



FIG. 15. TOP VIEW OF TIER OF SPIRAL RINGS
STACKED IN TOWER

5 and 6). Gay-Lussac towers, as usually designed, are taller, and narrower in horizontal section, than the Glover tower of the same plant. At some plants a single tall Gay-Lussac tower is employed, but usually two towers somewhat less in height are preferred, and lately there has been a growing tendency to add a third tower, and the effect of this in reducing niter losses has been found to justify the expense.

During recent years the use of coke for packing Gay-Lussac towers has been gradually becoming less popular. Checkered brick or tile have been used to some extent, and since the advent of the "spiral ring," a manufactured packing block of peculiar design, this has been used by the million for packing chemical towers. The spiral ring, illustrated in Fig. 14, was patented by A. M. Webb,¹² Feb. 4, 1919. The ring was first put on the market in the early part of 1918 by the B. Mifflin Hood Co., of Atlanta, Ga. A brief description of this ring was given in the American Fertilizer Handbook for 1918¹³; and the results of some comparative tests made on different types of packing materials, of which the spiral ring was one, were quoted in a paper by Zeisberg.¹⁴ The appearance of a layer or tier of spiral rings, as stacked in a tower, is illustrated in Fig. 15. The spiral ring is not recommended by the manufactur-

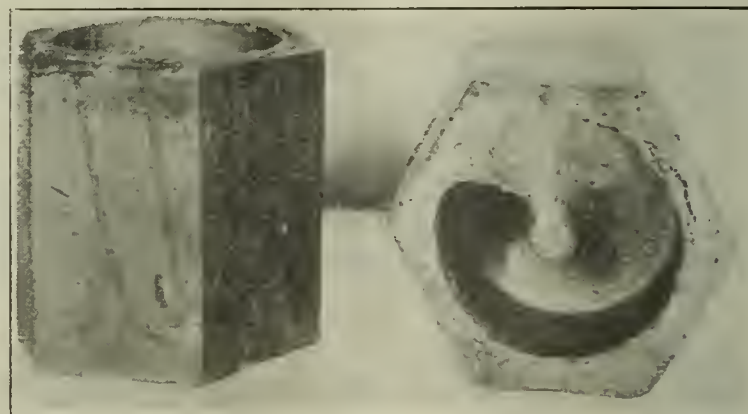


FIG. 16. A NEW TOWER PACKING BLOCK, HEXAGONAL
EXTERIOR WITH HELICAL FLANGE INSIDE

ers as a packing material for Glover towers. For Gay-Lussac and interchamber towers, or for packing the acid-making units of tower systems, it is claimed to have superior merit.

A new form of tower-packing block is hexagonal in shape, and the spiral flange in the interior either extends entirely to the center of the block, or its inner edge joins a central post which fills what would otherwise be a hole, extending through the block from top to bottom. This block is shown in Fig. 16.

The hexagonal block, which has been given the trade name "Hexahelix," was developed by the author, and is protected by U. S. Patent 1,365,671. The hexagonal exterior shape has the peculiarity that six blocks can be exactly fitted around any one block, without leaving voids or spaces between blocks. The internal spiral flange is so designed that gases and liquids are compelled to pursue a spiral or tortuous course, and cannot take a vertical or short-cut course, in passing through a block. The combination of the external with the internal features of these blocks, when stacked regularly in a tower (not staggered) compels a tortuous winding flow for both gases and liquids.

(Part III will appear in a subsequent issue)

Atlanta, Ga.

¹²U. S. Pat. 1,293,370.

¹³Op. cit. p. 82.

¹⁴F. C. Zeisberg, "The Resistance of Absorption Tower Packing to Gas Flow," *Trans., Am. Inst. Chem. Eng.*, vol. 12, part 2, p. 231.

National Tube Co.'s New Plant for Hammer-Welded Pipe

Welded Pipe Up to 8 Ft. Diameter, Having Various Kinds of End Joints, Made in Highly Specialized, Massive Machinery—Details of Welding Machines and Welding Practice—Finishing Department Handles an Important Branch of the Work

BY ERNEST EDGAR THUM

PREVIOUS articles^{1 2} have discussed the general subject of welding in its branches inherited from ancient times and its recent adaptations, showing that until late years there had been no method devised for making large vessels without lap joints which would safely withstand heavy shocks and pressures. A plant built for heavy welded work by the Blaw-Knox Co. was also described, and its operation discussed in some detail. It is now the intention to present similar data on a large and well-equipped plant for making welded pipe from 24 in. up to 96 in. diameter installed by the National Tube Co. at its Christy Park Works, at McKeesport, Pa.

NEED FOR LARGE PIPE

It is doubtless well known that the smallest sizes of wrought-iron and steel pipe (less than 3 in. internal diameter) are made by butting the edges of the hot bent plate and forcing them together by drawing them through a forming die. Piping from 2½ in. up is made by lap welding; the edges of the skelp are slightly beveled, the bent plate is reheated and rolled over a mandrel. Brief mention of the methods and properties of such welds was made in the first article of this series, page 558.

While lists of dimensions, published in handbooks, show lap-welded pipe up to 36 in. diameter, such sizes are rarely obtainable, if at all. In fact any lap-welded pipe over 20 in. diameter is very difficult to make and handle. The flat skelp itself is over 5 ft. wide, the scarfing, bending, welding and straightening rolls—in fact, all the mechanical equipment—become quite bulky, the capacity of the furnaces is limited to a very few pieces, and the handling is either very laborious, or, if done by machines, fraught with possibilities of damage.

Nevertheless there are certain definite advantages of wrought over cast iron, and riveted pipes. Cast iron is of course out of the question for high-pressure work, and there are many places in low-pressure lines where it is essential that the frictional loss be held to the minimum, or, stated in another way, that the carrying capacity of a given diameter should be a maximum. The velocity of flow in riveted pipe is approximately 18 per cent less, and in cast iron, 10 per cent less, than in steel pipe having smooth walls, free from scale and projections at the joints. Making allowance for such factors, the engineers of the National Tube Co. have calculated that in a penstock, bearing 270 lb. pressure and passing 200 cu.ft. water per second, a hammer-welded pipe of ⅝-in. plate, 48 in. diameter will be the equivalent of a 52-in. pipe of ⅜-in. plate, triple-riveted longitudinal and double-riveted circular seams. Weight

of the welded pipe per ft. is 340 lb., against about 540 lb. for the riveted.

Water mains might advantageously be laid of these pipes in many locations, particularly high-pressure fire lines. Siphons on ditches and aqueducts, as well as conduits on principal water supplies, also suggest themselves. Gas lines of welded pipe would avoid many chances of loss by leakage, while much piping for hot or cold air about metallurgical plants would doubtless remain more efficient if it had fewer riveted joints. These are the principal uses which produce a demand for a considerable tonnage of large pipe and which determined the National Tube Co. to supplement its existing plants with facilities for making hammer-welded pipe 24 in. diameter and larger.

HAMMER-WELDING DEPARTMENT AT CHRISTY PARK

Sufficient room was available at the Christy Park Works (where seamless tubing and bottles are made by cupping and deep-drawing) and a new department was added to that plant.

The mill building is L-shaped, one leg consisting of two adjacent bays, of 90 ft. and 50 ft. span respectively, where the pipe is manufactured from flat plates. In the other bay, 75 ft. wide, at right angles to the foregoing, the finishing and testing is done. All this area is under cover of the most substantial kind of mill building, light and airy, and commanded by overhead cranes. Flat plates entering the plant aboard cars are handled exclusively by magnets. Serving the bending rolls, welding machines and annealing furnaces is a special charging crane.

All piping and wiring, except the 24-in. main for water gas, is placed in an underground, concreted tunnel 4 ft. x 6 ft. in dimension. This gives unusually clear overhead in the mill buildings. The service lines are not only safe from ordinary damage but are located



FIG. 1. BENDING ROLLS AND PLATE TABLE; PULPIT IN THE BACKGROUND

¹"Welding; Particularly Hammer Welding," CHEM. & MET. ENG., vol. 25, p. 553, Sept. 21, 1921.

²"Hammer-Welding Plant of the Blaw-Knox Co., CHEM. & MET. ENG., vol. 25, p. 747, Oct. 19, 1921.

so as to be readily accessible for inspection, alterations or repair. The ducts carry steam-heating lines, high- and low-pressure air and water, and the electric mains. Water gas, the fuel for the welding machines, is carried in a 24-in. main near the eaves, on the outside of the building. Producer gas for heating and annealing furnaces is conveyed from the gas house to the hammer-welding department by underground brick flues. These services are furnished by the power plants already installed for the other departments at Christy Park, except the water gas, which is generated in a separate unit, especially for the welding machines.

HEATING AND BENDING FLAT PLATE

On entering the plant the first group of apparatus consists of charging machine, heating furnace, scarfing rolls, transfer table and bending rolls. The bending rolls themselves (Fig. 1) are exceedingly powerful, and can bend a cold 1-in. plate 21 ft. long into any cylinder down to 30 in. diameter. Consequently all but the very heaviest plates are placed directly upon the transfer table, and are led into the rolls.

A thicker plate would be placed upon the charging

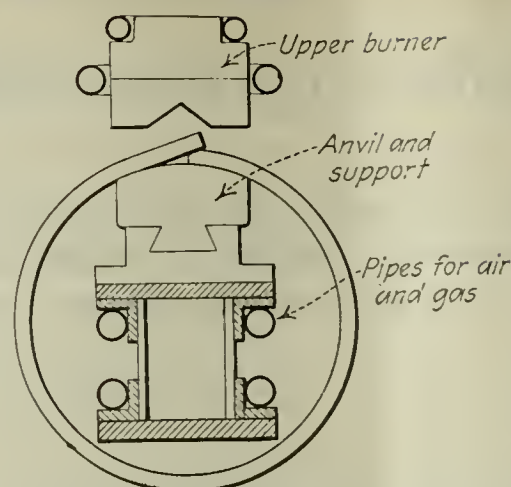


FIG. 4. CROSS-SECTION OF HORN, SHOWING RELATIVE LOCATION OF BEAM, ANVIL, GAS AND AIR PIPES, UPPER BURNER AND WORK

it is pushed out of the front of the furnace by the charging machine, through the scarfing rolls, stopping on the plate table, on which it travels into the bending rolls. A temperature of 1,900 deg. F. is necessary, as the bending, which requires 5 minutes or more, must be completed before the temperature drops into the brittle range.

Once in the bending rolls, it is gripped by the bottom rolls and worked back and forth, passing through the stages shown in Fig. 2 and ending as shown in the left-hand sketch. Such work may be observed in many boiler shops; about the only difference is in degree;

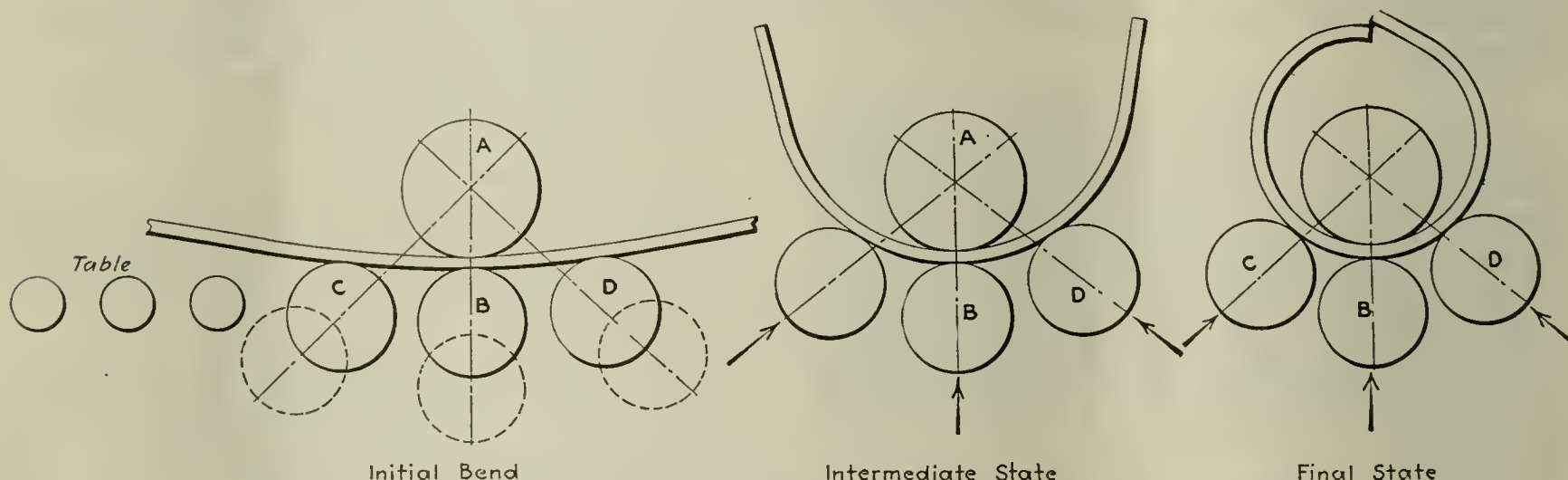


FIG. 2. THREE STAGES IN FORMING A CYLINDER FROM A FLAT PLATE

machine, which then moves to a correct position behind the heating furnaces. A set of chain-driven fingers slide the plate forward through the wide, low door of the heating furnace. The latter is quite similar to skelp-heating furnaces in use in other mills. It has a sand-covered flat hearth 17 x 23 ft. in area, with a low arching roof, and bordered on each side by a line of vertical ports. Regenerative checker chambers are built below the floor line on each side, so that producer gas can be used with considerable economy.

When the plate is judged to be ready for bending,

roll *B* forces the plate tight up to *A*, which is driven by a 175-hp. motor, so that the upper roll will not slip against the plate and fail to drive it over the side rolls *C* and *D*. Reaching the final stage, rolls *B*, *C* and *D* drop back to their lowest position, the end housing swings outward from a hinge near the floor line and frees roll *A*, which lifts up clear; the electric charging crane then removes the bent plate from the bending machine and deposits it on the carriage of the welding machine. All operations on this set of apparatus are controlled by one man from a pulpit.

WELDING MACHINES

Fig. 3 shows two welding machines, one designed for work up to 60 in. diameter, and the other for pipe from 48 in. to 96 in. diameter. Since the welding to be done on these units is confined to longitudinal seams on long cylinders, the carriage may be considerably simplified compared with one used for various seams on irregular shapes. It is mounted on a track so that it and its burden can move forward and backward over the anvil-bearing horn. The work rests on two sets of rollers, one forward pair and one rear pair. The beams bearing these rollers are capable of vertical movement, each pair independently, while the rollers are capable of transverse motion as well. If a weld is made on a tapered pipe, one of the roller sets is lowered a corresponding amount so the seam itself shall be horizontal



FIG. 3. WELDING MACHINES, WITH WORK IN PROGRESS

and on top. Controls are on the operating platform at the left side.

The anvil is keyed to the front end of a "horn," a heavily reinforced beam, about 12 in. deep and reaching forward about 22 ft. clear of its support (Fig. 4). The beam itself is considerably longer; it rests upon a heavy rocker bearing and extends backward, supporting a heavy counterweight. Thus the horn itself is relatively rigid and immovable; a hydraulic piston supports the counterweight at rest and raises and lowers the anvil slightly to clear small obstructions inside the unfinished pipe.

Since Fig. 4 shows that the anvil and horn just about fill the interior of the small pipes, the burners are mounted directly in front. Thus a certain area may be

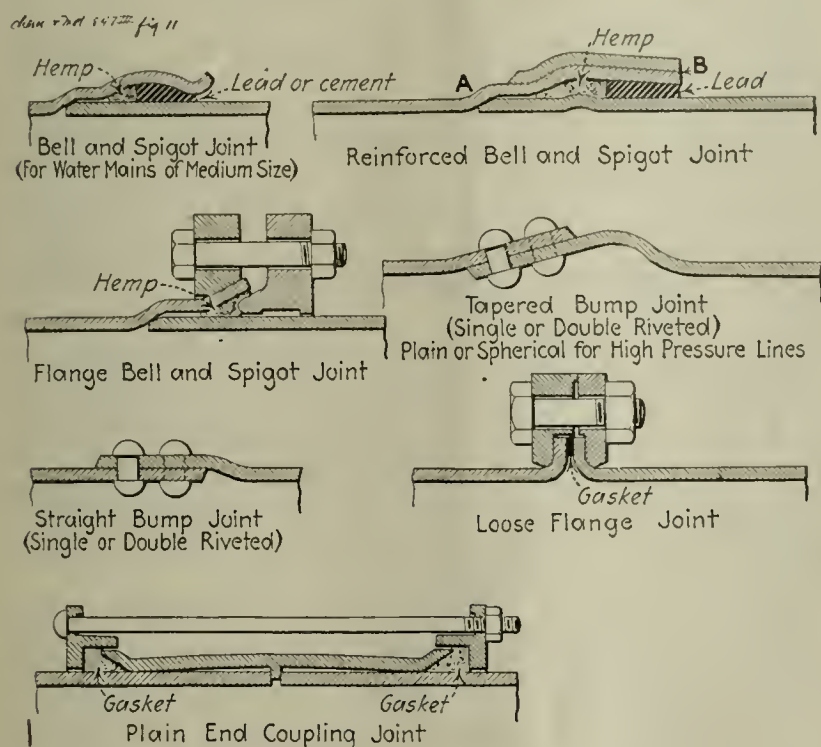


FIG. 5. VARIOUS STYLES OF JOINTS

heated, and the carriage moved in, bringing the hot portion directly over the anvil and under the air hammer, swung from a beam directly above. Gas and air pipes hug the side of the horn closely, and project past the anvil, being stiff enough to form the overhanging support for the lower burner. The upper burner is shown in Fig. 4; it can be raised and lowered at will in order to prevent fouling the work and to judge of the temperature of the metal being heated.

Water gas is the fuel. As noted in a previous article,³ this gives a high temperature (1,900 deg. C.) and requires but $2\frac{1}{4}$ volumes of air for its perfect combustion. Thus it is relatively easy to get a quick and uniform mixture of air and gas without danger of forming heavy scale on the metal from the impingement of a poorly mixed stream of air and gas, portions of which would contain an excess of oxygen. All the gas lines are liberally supplied with traps or receivers, having explosion doors closed only with a rubber gasket. Each of the pipes leading to the burners is regulated by an ordinary one-way cock. These are adjusted by trial so that each pipe delivers the proper volume to its burner. Just beyond these cocks are gate valves, all operated simultaneously from the pulpit. A match thrown into the gas stream lights the burner for the first time; the incandescent brick is sufficient to ignite it thereafter.

Two men operate the machine; the welder, who controls the heat, the movement of the carriage, and the hammer. His assistant stands on the platform alongside the pipe, and with a clawbar, known as a "picker," rolls the pipe on its cradle as directed by the welder.

After adjusting the cradle rollers to the correct height, the carriage is moved forward over the horn, and any necessary blows struck alongside the seam to bend the flat edges⁴ so that one side is sure to lap slightly under the other. Then, when a portion of the seam at its mid-length is laid down to the satisfaction of the foreman, he heats an area of metal there to the correct temperature, lifting the upper burner from time to time to judge the heat. Turning off the gas, the carriage moves forward so the hot spot is between anvil and hammer, and the welding is rapidly done. A few light blows stick the metal together and eject considerable liquid cinder. Air from the cylinder is exhausted against the seam directly below the hammer, blowing away loosened scale before it is driven into the hot metal. As the metal cools somewhat, the force of the blow is increased, and the lap is reduced to the thickness of the plate, continuing the work down to dull red, through recalcence. A few strokes on either side give correct bend to the portions of the pipe which could not be pinched in the bending rolls, a few more drive the unwelded seam just alongside into its proper position, and an adjoining portion is ready for heat.

The burners are 20 in. long, and heat an area about 2 ft. long by 16 in. wide, requiring, in $\frac{3}{8}$ -in. plate, between 40 seconds and 1 minute to bring to temperature. Shifting the carriage ahead is quickly done, and in 3 or 4 seconds the weld is being hammered. Perhaps 100 blows suffice to weld and shape 12 to 14 in. of seam, so that a complete cycle requires approximately 3 minutes. Thus a 20-ft. pipe can be welded from end to end in about an hour.

SPECIFICATIONS FOR STEEL

Hammer welding is such a new departure that no definite requirements for the steel can yet be laid down. The American Society for Testing Materials⁵ has adopted the following tentative specifications for open-hearth steel plates for hammer welding; the physical and chemical properties of the steel used at Christy Park conform to these requirements:

Carbon.....	0.18 max. (no 25 per cent excess allowed)
Mn.....	0.30 to 0.60
P.....	0.04 max.
S.....	0.05 max.
Preferably free of Si, Ni, Cr. Maximum 0.05 for any one.	
Tensile strength: $\frac{3}{8}$ -in. plate or thinner.....	48,000 lb. per sq. in. or more
Thicker plate	45,000 lb. per sq. in. or more
Yield point, by drop of beam.....	0.5 tensile strength
Elongation in 8 in. (per cent).....	1,500,000 $\div$ tensile strength
(Less 1 per cent for each $\frac{1}{8}$ in. above $\frac{3}{8}$ in., with a minimum of 20 per cent).	
(Or less 2.5 per cent for each $\frac{1}{8}$ in. below $\frac{3}{8}$ in.).	
Cold bend.....	180 deg. flat upon itself without crack

Annealing is done in a regenerative furnace fired by producer gas. It is 10 ft. high by 12 ft. wide and 23 ft. long inside, with a row of vertical ports at each side. Its massive doors swing from the side, like garage doors, and are operated by hydraulic racks engaging pinions keyed to the hinge bolt.

The aim is to maintain this furnace at 1,650 deg. F. at all times. Bearing in mind the immense amount of reserve heat stored in the brickwork, it is apparent that it requires but a short time for a piece of ordinary thickness to acquire the annealing temperature, after which it is left to "soak" for 30 minutes. Thus each pipe is annealed singly immediately after welding is completed.

After this heat-treatment the doors are opened, the

³Plates up to 1 in. are welded without scarfing, by merely lapping over a distance approximately equal to one thickness and hammering down flat. Thicker plates are scarfing on their edges, bent to shape and welded.

⁴Proceedings, vol. 19, Part 1, p. 150. Specification A-78-21.

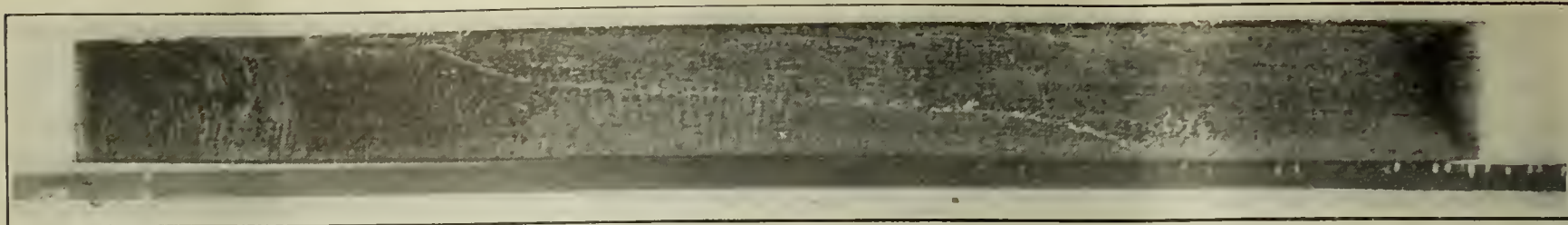


FIG. 6. MICROSTRUCTURE OF WELD IN UNSCARFED 3-IN. PLATE, PICKLED IN MIXED NITRIC AND SULPHURIC ACIDS

hot pipe is carried by crane immediately to the bending rolls. It requires but a few seconds to slip it around the top roll, adjust the end housing and lower rolls, when the whole pipe is rolled over and over to make sure the curvature is equal in all parts.

TESTS ON WELDS

The pipe is now ready for the finishing operations. First it is mounted in a large lathe, having a bed 42 ft. long to accommodate sections made of two lengths welded together with a circumferential seam. Two separate carriages may be set the proper distance apart so that tools cut off each end simultaneously. These crop ends have been used to determine the relative efficiency of the weld. In a recent test of this kind, two transverse test-pieces were cut from the extreme outer edge and two adjacent to these or a few inches farther in, one pair representing the body of the plate and one pair containing the weld. These pieces were straightened cold and milled on four sides to give a smooth surface for a distance of 9 in. and then pulled in a testing machine. On the average, the first ring cut showed the outside weld to have 95 per cent of the strength of the weld a few inches farther in.

Averaging 120 tests taken from pipe which passed inspection and whose fractures actually occurred at the weld gives the following results:

	Metal	Weld
Yield point.....	31,390 lb. per sq.in.	29,260 lb. per sq.in.
Ultimate strength.....	53,690 lb. per sq.in.	49,480 lb. per sq.in.
Efficiency of joint (based on tensile strength).....		92 per cent

One of the most interesting pieces of equipment is the flanging machine, used to expand, contract or flange—in fact, shape the end of the pipes into the many styles of joints which are specified for large conduits.

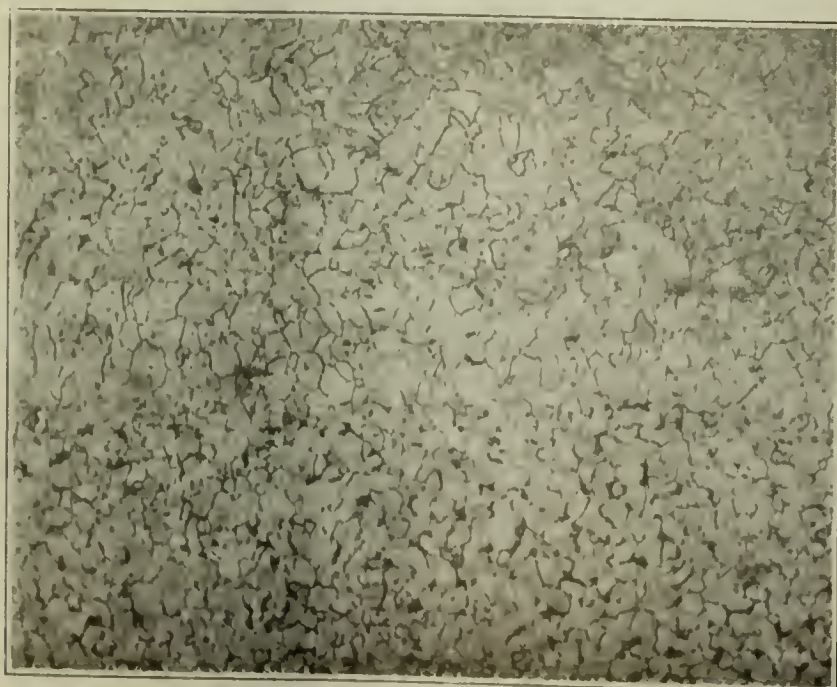


FIG. 7. MICROSTRUCTURE OF A GOOD WELD IN 30-IN. HAMMER-WELDED PIPE, MADE OF $\frac{1}{8}$ -IN. PLATE

One end of the machine is a lathe headstock movable along the bed to adjust itself to different lengths of pipe and also to permit the necessary travel during its operation. A pipe is attached to the faceplate of this headstock, while the weight is carried by a steady-rest or set of idling rollers placed somewhat beyond the center of gravity.

After the pipe is fixed in this manner, the headstock travels to the left, placing the open end of the pipe directly between water-gas burners, adjustable to clear the outside diameter of the pipe. Rotation of the pipe heats the end uniformly for the necessary distance, when the gas is turned off and further forward movement of the headstock brings the hot end up to the forming tool. This consists of a very substantial housing inclosing the necessary motive power, gearing and adjusting screws for an upper and lower forming roll and a pair of idlers to the sides. These rollers have been machined so their surfaces have the contour desired, and they pinch against the hot pipe, which meanwhile is being rotated by the headstock, forming the end to the correct shape.

Testing is done in a huge hydraulic testing machine with 45-ft. reach and 2,500 lb. per sq.in. capacity. Since it is customary to subject all pipe to a 50 per cent overload, and penstocks have been built up to 1,400 lb. per sq.in. working pressure, this machine is expected to fulfill requirements of even the heaviest pipe. In routine testing, the metal at 50 per cent overload is seldom stressed over 15,000 lb. per sq.in., well within the elastic limit of the material.

Any necessary rivet holes are then made by drilling or punching, and the pipe is subject to a rigid final inspection for shape and general condition. (It is necessary to make large wrought pipe closely conforming to a true circle along its length, in order to present the maximum resistance to collapse against external pressure—caused either by water or earth on the outside or by vacuum on the inside.) After painting with the specified protective coating the pipe is ready for shipment.

MICROSCOPY OF THE WELD

It is usually possible to determine the place where the joint has been made by a visual examination of a polished section after pickling with mixed nitric and sulphuric acid (Fig. 6), or after etching with a copper reagent. Deep etching digs a number of pits along the line of the weld where the acid attack is intensified. Microscopic examination usually reveals a small amount of oxide or slag inclusions along the line of the weld, although there will be stretches such as shown in Fig. 7, where none exist. Utter elimination of slag is perhaps impossible, but in a weld having 92 per cent strength they must be held to the extreme minimum. Sound welds properly annealed are characterized by the features shown in Fig. 7; a slight decarbonization in a very thin sheet, and a suggestion of columnar habit in the ferrite crystals occupying this region.

Determination of Volatile Matter in Coal

BY H. P. WILKINSON, JR.

THE value of the proximate analysis of bituminous coal to the engineer, coal dealer, power plant superintendent or coke plant superintendent is unquestioned. But there is always room for doubt as to how much can be predicted from this analysis concerning the behavior of the coal under consideration. This is especially true in the case of the coke-oven superintendent who expects the analysis to guide him in figuring the expected yield of his ovens. The ash and sulphur can be accurately determined by well-defined methods, and those tell him much about the quality of the coke. For the quantity, however, he must look to the volatile matter determination. At best this is an arbitrary figure, for regardless of the care exercised in taking, preparing and delivering the sample to the chemist it is practically impossible for two men working in different laboratories to obtain the same result. Assuming that the well-defined standard method is used, the results may be affected by the condition of the crucible, the style of cover used and the way it fits, the kind of burner and its condition, the kind of gas and the regulation of the flame, the possibility of mechanical losses due to the moisture passing off, and, greatest of all, the influence of the personal equation, which must be relatively great in any process having so many chances for error.

Considering it possible to overcome all these difficulties, the chemist's determination of volatile matter is still inadequate in predicting coke yield. It does not allow as much redeposition of carbon as occurs in the oven, due to the smallness of the sample and the size and shape of the space it occupies. Nor does it permit of any regulation of time or temperature, and these factors are both used in byproduct coke ovens, and have an influence on the amount of redeposited carbon, and thus on the amount of coke yielded.

The present outlook in the natural gas fields indicates a serious shortage, or even the complete exhaustion of the supply in a short time. This can be offset greatly by producing more coke-oven gas and there is a possibility that legislation may be enacted to restrict the burning of uncoked coal to those coals which are entirely unsuited for coking. This prospect for increasing activity in the manufacture of byproduct coke emphasizes the inadequacy of the present laboratory method for volatile matter, and creates a desire for a more reliable one—a method which will give data from which it is possible to predict the quantity and quality of coke yield. With a knowledge of this desire in mind, the writer conducted a series of experiments to evolve a method which will give a closer comparison between the volatile determination of the laboratory and the coking loss of the ovens.

METHOD USING LARGE SAMPLE AND ELECTRIC FURNACE

The method finally settled on as being most satisfactory involves the use of an electric furnace with variable temperature, and a 100-g. sample. The furnace is of the resistance type and consists of a vertical cylinder 2 in. in diameter and 4 in. long inside. (A slight taper facilitates the removal of the coke.) This sits on a silica base and the junction of the base and cylinder are ground to make a joint which is practically air tight. The top fits just as closely and a clamp is provided to insure against leaks. Through the top are

two holes, one into which a thermocouple is fitted and to the other is attached a tube for conducting the gases out of the laboratory.

In running a test the furnace is heated to the temperature of the ovens. The cover is then removed and the weighed 100-g. sample poured in quickly and the cover replaced and clamped. The coking is then allowed to proceed to completion, the time required being determined by the quality of the gas coming off through the outlet tube and varying with the temperature. The current is regulated during the coking to maintain uniform heating. When the coking is complete, the furnace is lifted from its base and the coke removed and quenched. It is then dried at 104 to 110 deg. C. and weighed, the weight in grams being the expected coke yield of the coal and the loss in weight the volatile matter.

DATA CHECK OPERATING RESULTS

In his experiments the writer used a number of coals, and the work was repeated often enough on the various samples to prove that he was duplicating his own results. The samples were ground to pass through a 40-mesh sieve. The data listed below were obtained from the "general mixture" from the coal-handling plant of the Toledo Furnace Co. This gives more satisfactory results for publication, since the coke produced in the laboratory can be compared with the coke produced in ovens charged with the same coal. The analyses of this by the standard method and by the writer's methods are:

	Standard Method Per Cent	Writer's Method Per Cent
Volatile matter.....	32.94	28.12
Fixed carbon.....	59.54	64.36
Ash.....	7.52	7.52
Fixed carbon and ash.....	67.06	71.88

The average yield in dry coke of the ovens per ton of dry coal was 72.10 per cent. Thus it is readily seen that 28.12 per cent is practically the true coking loss and therefore the valuable volatile figure. To show how nearly the method reproduces oven conditions the analyses of the two cokes are given:

	Oven Coke Per Cent	Laboratory Coke Per Cent
Volatile matter.....	1.76	1.90
Fixed carbon.....	88.52	88.25
Ash.....	9.72	9.85

The fact that this method gives a volatile figure that compares so favorably with the coking loss of the ovens is no doubt due to the size of the sample and the regulation of the temperature. The size of the sample permits the hot gases to redeposit approximately the same amount of carbon that the oven does. This, coupled with the regulation of the temperature, accounts for the quality of the coke.

The writer believes that this method will be a welcome innovation to routine control laboratories, because it gives uniformly reliable data from which actual coking yield can be predicted.

Toledo, Ohio.

Bibliographies of Japan and China Available

Reading and reference bibliographies of Japan and China have been compiled by the Far Eastern Division of the Bureau of Foreign and Domestic Commerce, including books and periodicals pertaining to the history, constitution and politics, economic and commercial conditions, and life and customs of these two countries.

Legal Notes

BY WELLINGTON GUSTIN

Tank Agitation Patent Held Invalid as Not Being Invention

In a suit brought by Niel D. Nielson and another against Libby, McNeill & Libby for infringement of patents, the Federal District Court for the Northern District of Illinois held invalid the Nielson patents 1,268,601, claims 6, 7, 12-15, and 1,268,602, considering the state of the prior art, and rendered a decree for defendants.

These patents were granted to Nielson June 4, 1918, for improvements in "agitating means," being a means for agitating the contents of a tank, and specifically a vertical, cylindrical tank, by means of an agitator, preferably in the form of a wheel, resembling an ordinary screw propeller such as is used in driving boats, arranged upon the inner end of a shaft extending through the side of the vessel near its bottom.

The first patent shows a tank having the central portion of its bottom convex; the second patent shows a tank or vat with a concave bottom. Both patents in suit show tanks provided with jackets into which a heating or cooling medium may be introduced to vary the temperature, but this feature was not mentioned in any of the claims in issue.

COURT QUOTES EXTENSIVELY FROM DECISION DECLARING MARCHAND PATENT INVALID

In holding the claims as numbered above of the first patent and all the claims of the second patent invalid as not being invention from the knowledge of the prior art, the court referred to the U. S. Supreme Court decision in the case of Marchand vs. Emken, 132 U. S., 195, wherein the Marchand patent was held invalid in the following language:

"The pretence that the complainant had discovered some occult and wonder-working power in the motion of a screw revolving in the bottom of a tub is not sustained by the proof. Whether the contents of the tub be oxygenated water, or soap, or lye, or tartaric acid, the action will be the same. That rotary, eddying motions in liquid will result from the revolving screw, that the liquid will rise highest at the periphery of the tub and thus have the tendency at the top to fall toward the center were well-understood operations of centrifugal force. As every device, apparatus, formula, law of nature, motion and ingredient adopted by the complainant was old, the patent must be held invalid, unless it can be said that giving to oxygenated water a well-known rotary motion springs 'from that intuitive faculty of the mind put forth in the search for new results or new methods, creating what had not before existed, or bringing to light what lay hidden from vision.' . . . No such faculty has been tasked in giving form to this patent. There is here no sufficient foundation upon which to rest a claim which, if construed as broadly as the complainant insists it should be, practically makes all pay tribute who stir the mixture in question by machinery, and by hand also, provided substantially the same movement can be produced by hand stirring, and this seems to be a disputed

question upon the proof. The complainant's claim to be enrolled upon the list of inventors is based upon propositions too theoretical and visionary for acceptance."

Laboratory Tests Cannot Outweigh the Test of Practical Use

A recent case in the Federal District Court for the Northern District of Illinois involved the Newberry patent, No. 851,347, for waterproofing portland cement by mixing therewith an insoluble salt of a fatty acid and no glycerine or other like water-attractive substance, and for the process for making the same. This same patent was involved in former litigation in McCormick Waterproofing Portland Cement Co. et al. vs. Medusa Concrete Waterproofing Co., 138 C. C. A., 14, where the Court of Appeals of the U. S. for the Seventh Circuit sustained a decree of the trial court holding the patent to be valid and infringed. In that case the court found that for forty years those skilled in the art had been aiming to overcome the attraction which concrete had for water. There it was said the capillarity of cement construction had been well known, and until Newberry came into the field nobody had offered anything like a practical solution of the difficulty.

PROOF THAT DEVICE DOES WORK KILLS EXPERT TESTIMONY THAT IT WILL NOT WORK

In this new attack upon the validity of this patent Dr. Gudeman was a new expert and it was attempted to show that laboratory tests determined that the Newberry process had no practical value. The court herein says that laboratory tests cannot turn the balance in the scale against practical use. The testimony of experts that a device will not work is of no value, if it does work. In the light of the practical use of this patent process the court assumed that Newberry discovered something worth while.

This action was brought by the Medusa Concrete Waterproofing Co. against the Ceresit Waterproofing Co. and others for infringement. The patent says to use an insoluble salt of a fatty acid and no glycerine or other like water-attractive substance, and it is mixed in small percentage with the cement. The defendant claimed that, because his product is in a paste, it does not come within the claims of the patent. Newberry recommends the drying of the product, although in the process of manufacture it is first in a wet or pasty shape of the defendant's product. But the patent says: "The resultant stearate of lime is to be dried, so that it is in the form of a dry powder."

MANNER OF MIXING THE ONLY DIFFERENCE IN THE PRODUCTS IN QUESTION

Newberry testified that his product was made and sold both in the paste and the powdered form, but the demand in the powdered form was greater because it was more convenient to mix with the cement and other materials when in the form of powder. Mr. Miner, an expert witness, testified that the only difference in the two products of the competing companies was the manner of mixing the compound with the cement on the job; the Medusa powder being mixed with the dry material and the water added to the mixture, whereas the Ceresit is mixed with the water and in that form added to the dry material.

The court said the infringement was clear, and a decree was granted the plaintiff.



Enamel-Lined Apparatus

Plant of the Elyria Enameled Products Co. at Elyria, Ohio, Engages in the Manufacture of Enameled Equipment for Service in Many Varieties of Plant Processing—Steel and Cast-Iron Containers—Burning Equipment—Composition and Properties of Enamels—Control and Management of Operations

By CHESTER H. JONES

WELL KNOWN to the industries producing a wide variety of substances for all markets where chemicals enter into the processes, ranging from the canning of fruits and vegetables, through acids and metallic compounds to dyestuffs and pharmaceuticals, the Elyria Enameled Products Co. at Elyria, Ohio, operates a plant of interest alike to chemical, ceramic and metallurgical engineers. The methods of manufacturing chemical plant equipment should be known, that the user may realize the limitations of mechanical design of ware and chemical resistance of enamel coatings. The modern methods of ceramic control in mixing ingredients and firing to the metal hold the attention of all ceramists. Metallurgists are interested in the best kind of metal for the purpose and in methods for making it better. Connecting the control of these operations in a scientific laboratory, the several branches are welded together to function through an ideal staff of technologists.

The photograph above, which was taken looking north, shows the entrance of the plant, with the laboratory building in the foreground and the office building on the left. Fig. 1 gives an idea of the building layout. Raw material in the form of steel plates grading in

thickness from $\frac{3}{8}$ in. to $\frac{1}{4}$ in. is unloaded from cars at the north end of the tank shop. The rough castings for enameled cast-iron vessels are shipped in from the Sterling Foundry Co., a subsidiary corporation at Wellington, Ohio, and are stored in the large stock room shown near the cast-iron machine shop. Storage is

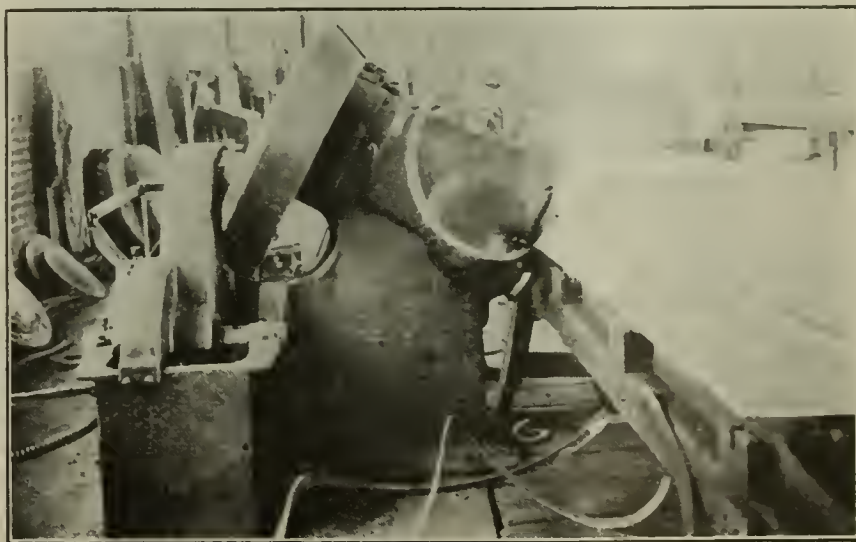


FIG. 2. SHEARING OPERATION

provided for 100,000 gal. of oil to be used as fuel for the furnaces. Oxyacetylene supply is furnished from Linde oxygen drawn from cylinders and acetylene made in the gas house in special carbide outfits, both separately piped to the welding stations about the plant.

Steam is supplied from two Erie City hand-fired boilers. The engine room has a 100-kw. Westinghouse direct-current 220-volt generator direct-driven by an Erie City engine. One Ingersoll-Rand two-stage steam-driven compressor furnishes air at 90 lb. pressure for air hammers and enamel spraying outfits, while another produces 40 lb. air for the sand-blast plant. Feedwater for the boilers is heated in an open type Swartout feed-water heater.

The auxiliary mechanical department apart from the process operations is completed by an electrical shop

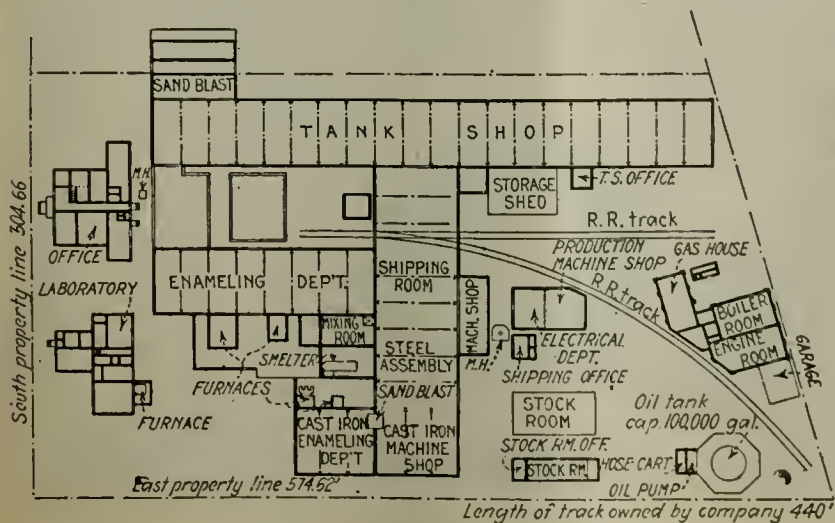


FIG. 1. BUILDING LAYOUT



FIG. 3. WELDING STEEL TANKS

and production or repair machine shop. This latter shop is equipped with lathes and drill presses for light machine and electrical repairs.

The steel plate enters the north end of the long tank shop (Fig. 1), where it is handled throughout the work by two overhead traveling cranes, one Toledo and one Morgan. The operations in this room consist of laying out, cutting and trimming, rolling and welding. Fig. 2 is a view of the shearing operation, where a bevel shear is trimming the plate to size. From this machine the plate continues to the Cleveland rolls, in the background of the same view, where the side of the circular container is formed to required radius. Bottoms for large tanks are kept in stock.

The welding of steel sections to form the rough completed tank is carried on at twenty-four stations, each of which is furnished with a No. 8 low-pressure torch. Operators use gloves and special goggles. Fig. 3 shows the work of making a joint at the junction of a convex bottom on a cylindrical tank. At the Columbus meeting of the American Ceramic Society Emerson P. Poste, director of research, presented a paper which shows the quality of steel obtained at these welds when the metal undergoes heat-treatment incidental to the firing of the enamel onto the ware, enhancing the quality and strength.

The surplus metal on the inside of the tank is ground off after welding by portable electric grinders made by the Heisey Wolff Co., of Cincinnati, and Van Dorn Electric Co., of Cleveland. The completely constructed tanks enter the sand-blast compartments.

The equipment for cleaning the surface to be enameled by sand blast consists of four Paxon units and according to the superintendent represents the "last word" in sand-blast machinery design. Coarse sand falls from steel storage hoppers into the sand-blast machines, where, mixing with the 90-lb. air supply, it is forced through armored hose to the operator's nozzle. Fig. 4 shows the operator applying the stream of sand to the inside of a tank. Protection is afforded him by a respirator and helmet which is fed with compressed air.

The sand from this operation falls through the steel grid floor and is elevated to a rotary screen separator. The head of one of the sand elevators with drive appears on the balcony in Fig. 4. The coarser particles fall back to storage for the next operation, while the fine dust is carried to four dust separators resembling baghouses. Circulation through this system is obtained by four Sturtevant exhausters driven by 20-hp. motors. The fines from the baghouses are rejected. All motors and switch boxes are totally inclosed to protect from dust. The steel containers are next transferred by industrial cars to the enameling department.

The mixing, smelting and grinding of the materials which go to make up the enamels for both the steel and cast-iron pieces is carried on in the mixing room and smelter, shown adjacent to the enameling department in Fig. 1. Typical formulas are given in the accompanying tables reprinted from the *Journal of the American Ceramic Society*, vol. 2, No. 12, December, 1919. The term "ground coat" in these tables refers to the first coat applied to the cleaned metal, while "cover coat" is applied over the ground coat to give finished appearance to the ware.

After mixing by hand or rotary mixer the raw batch is introduced into the oil-fired smelting furnace appearing in Fig. 5. This is essentially a reverberatory furnace and the operator is seen rabbling the mix. A rotating U. S. furnace is also employed for the same work. When the fusion is uniform, the molten glass is tapped and run into a vessel of cold water to produce the shattered frit. In the case of one type of cast-iron ground coat the smelting process is varied by placing the thoroughly mixed batch on a cast-iron tray, heating to a red heat and stirring at intervals. The resultant product from this sintering operation resembles pumice stone.

Wet grinding of the frit is in general used for sheet



FIG. 4. SAND BLASTING

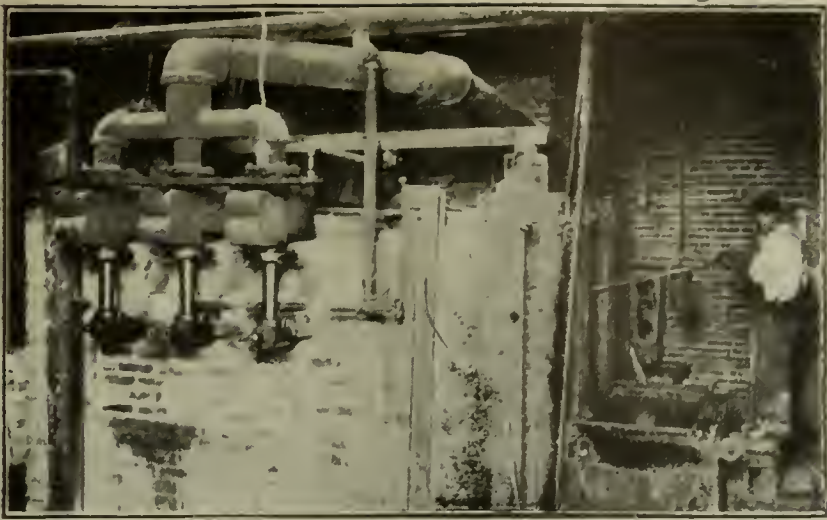


FIG. 5. SMELTING FURNACE

steel enamels and cast-iron ground coats and dry grinding for cast-iron cover coats. The grinding room equipment includes one 1,000-lb. Abbe and one 1,000-lb. Patterson pebble mills, three 200-lb. Abbe, one 100-lb.

BATCH FORMULAS				
Raw Materials	No. 1 Steel Ground Coat ^a	No. 2 Steel Cover, White ^b	No. 3 Cast-Iron Ground Coat	No. 4 Cast-Iron Cover, White ^c
Soda.....	74	...	...	71
Borax.....	356	154	288	133
Saltpeter.....	...	65	16	...
Chilean saltpeter.....	...	...	...	24
Lead oxide.....	...	...	...	144
Zinc oxide.....	...	...	...	44
Tin oxide.....	...	...	...	73
Calspar.....	...	65	...	24
Barium carbonate.....	...	...	...	11
Magnesium carbonate.....	...	10	...	...
Feldspar.....	363	386	...	372
Fluorspar.....	53	13	...	107
Cryolite.....	...	117	...	...
Quartz.....	144	190	700	...
Manganese dioxide.....	6½	...	...	...
Cobalt oxide.....	2½	...	...	...
Mill additions.....	6% clay 2.5% borax	12% tin oxide 7% clay ½% Mg oxide	9% sand 12% clay	None

^a *Trans. Am. Ceram. Soc.*, Vol. 14, p. 759 (1912).
^b *Ibid.*, Vol. 14, p. 498 (1912).
^c *Ibid.*, Vol. 15, p. 622 (1913).

MOLECULAR FORMULAS				
	No. 1 Steel Ground Coat	No. 2 Steel Cover, White	No. 3 Cast-Iron Ground Coat	No. 4 Cast-Iron Cover, White
Na ₂ O.....	0.64	0.50	...	0.30
K ₂ O.....	0.08	0.18	...	0.09
CaO.....	0.24	0.28	...	0.35
BaO.....	...	...	...	0.61
MgO.....	...	0.04	...	...
PbO.....	...	...	...	0.13
ZnO.....	...	...	...	0.12
MnO.....	0.03	...	...	...
CoO.....	0.01	...	...	...
Al ₂ O ₃	0.20	0.30	...	0.15
SiO ₂	2.26	2.51	...	0.86
B ₂ O ₃	0.63	0.26	...	0.15
F ₂	0.23	0.60	...	0.30
SnO ₂	...	...	...	0.10

Patterson and one 50-lb. Abbe pebble mills. Four of these mills are seen in Fig. 6.

Dry grinding simply consists of pulverizing the frit to a dust for direct application to the ware.

In wet grinding the mill additions consist of various materials introduced with the frit and water to hold the frit in suspension and form a creamy liquid suitable for spraying on the metal. According to R. R. Danielson, U. S. Bureau of Standards, in milling the ground coats it is general practice to add high-grade ball clay and water to the frit at the beginning of the operation and to add the borax in hot solution about one-half hour preceding the end of the operation. Magnesium carbonate and ball clay with small amounts (about 0.25 per cent) of an electrolyte such as magnesium sulphate or cobalt and nickel sulphates may be used for mill additions to cover coats. Typical mill additions are also shown in the tables.



FIG. 7. APPLYING ENAMEL TO STEEL

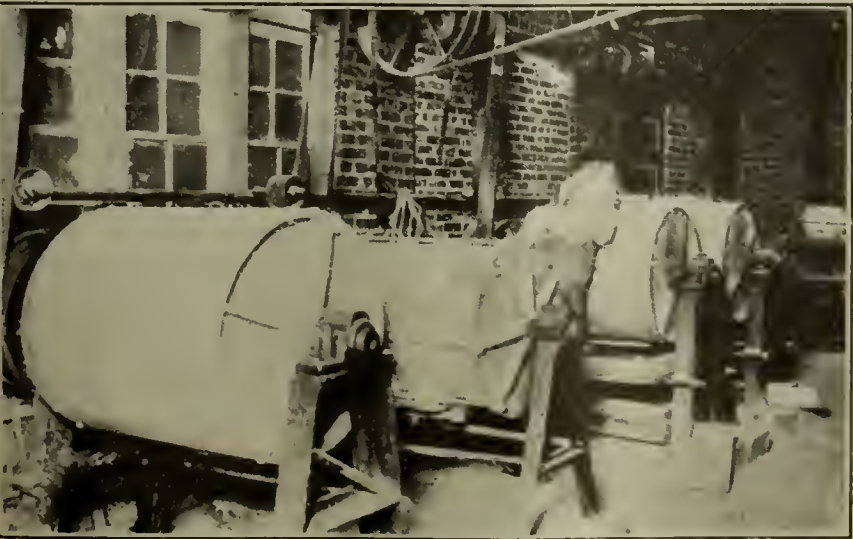


FIG. 6. GRINDING MILLS

While accurate data on the properties of enamels from the standpoint of chemical operations can be obtained only by submitting the particular process or essential conditions under which the enameled ware is to be used to the research laboratory, nevertheless the company makes three general grades some of the uses of which are outlined in the following paragraphs.

Enamel No. 11, which is applied to cast-iron ware, has been found to resist the action of inorganic acids such as hydrochloric, nitric, phosphoric, sulphuric, hydrobromic, hydriodic, aqua regia at any strengths and any mixtures of these. It is acted upon by hydrofluoric acid of any strength. It resists reactions of stannic chloride in hydrochloric acid, zinc chloride up to 300 deg. C., gaseous hydrochloric acid, aluminum chloride, bromine, chlorine, iodine (moist or dry), tungstic oxide precipitation by hydrochloric and nitric, sulphur dioxide, thorium nitrate in nitric acid, and manganese dioxide with hydrochloric acid. It may be

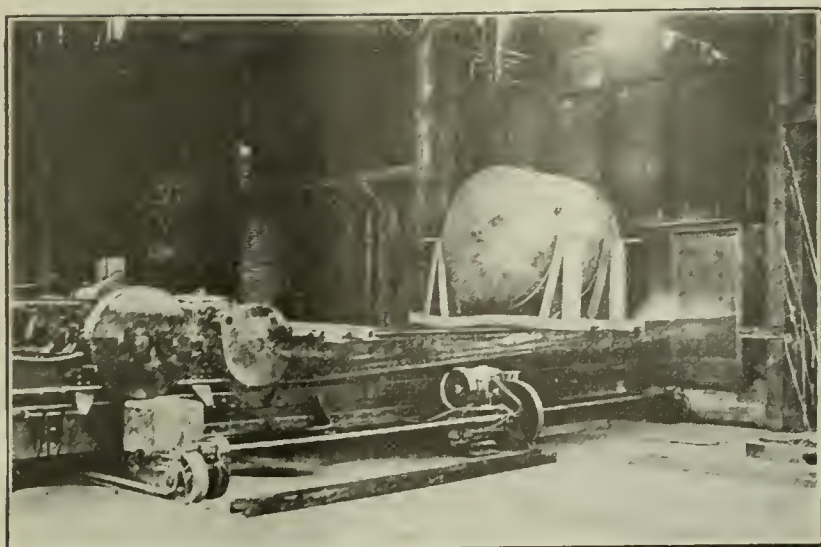


FIG. 8. STEEL ENAMEL FURNACES

used for all organic acids, acid chlorides and organic compounds, being particularly resistant to acetic vapors.

It is successful in vessels for heating magnesium hydroxide under pressure, for evaporating lime salts of sulphocarbates or boiling sodium carbonate, for ammonia and sodium or potassium salts of inorganic compounds, but is decomposed by caustic alkalis and is acted upon slightly by hot milk of lime. Sodium cyanide and similar salts are too alkaline and react with it. It is more resistant to alkalis than most enamels.

Enamel No. 20, which is applied to steel, has been used successfully for all strengths of organic acids (hot or cold), ammonium sulphate, acetic anhydride, acetic acid of all strengths, (but not the vapors), brine, moist chlorine, hydrochloric acid in alcohol, hydriodic acid, lactic acid of all strengths (hot or cold), hot phenol, tin chloride plus 1 per cent hydrochloric acid, zinc chloride solution, hot sulphur chloride, inorganic acids below 0.5 per cent strength cold, sulphuric acid above 50 per cent strength and mixed acids high in sulphuric acid, hot or cold. If the reagent is one which attacks iron severely, the enamel coat must be perfect, limiting the size to 600 gal. If there is no severe action on iron, any size up to 3,000 gal. can be had. The limiting size must be decided for each condition by itself. It is also used for hot carbonate, cold sodium hydroxide 10 per cent and hot ammonia.

Enamel No. 21, which is also applied to steel, is used for all conditions of milk, such as milk heating, holding, mixing, etc.; for oils, fats, alcoholic solutions of shellac, ammonia, aniline hydrochloride, acetic acid, storage cold; ammonium nitrate, bleach liquor, dry chlorine, dry hydrochloric acid gas, cold beverage sirups involving citric acid, grape juice, hydrogen peroxide,



FIG. 9. ASSEMBLING ENAMELED STEEL APPARATUS

tincture of iodine, making invert sugar, hot oil of peppermint, cold phenol, salicylic acid and hot acetic anhydride, dry sulphur dioxide, tannic acid, hot bromine, distilled water, and hot fuming sulphuric. The last has been handled more successfully by No. 21 than by other enamels. For perfect coats the sizes are limited to 1,000 gal. Otherwise any size up to 7,000 gal. can be obtained. Here, as with No. 20, the limiting size can be determined only after making a study of the case in hand.

Cast-iron units may be used with 75-lb. steam pressure in the jacket and up to 100 lb. inside the still. It has a coefficient of heat transmission about one-fourth that of copper. With steam, temperature up to 160 deg. C. in the jacket can be obtained. Up to 225 deg. C. an oil jacket can be used. Superheated steam at 315 deg. C. has been used on the small units. The enameled units have also been heated by a direct, well-spread flame up to temperatures of 300 deg. C., but such service is rather severe, limiting the life of the enamel.

Steel units are usually heated by means of a steam jacket, the 500-gal. sizes permitting 30-lb. pressure, the



FIG. 10. ENAMELED STEEL APPARATUS READY FOR INSPECTION AND TEST

large ones, such as 3,000 gal., being limited to 10-lb. pressure. The pressure within the tank may be one and a half times as great as that in the jacket. The coefficient of heat transmission is about one-third that of copper, using straw as a heating medium. Using oil in the jacket (which has been done up to 250 deg. C.), the coefficient drops to one-fifth that of copper.

The wet enamel from the mill room is stored in containers, whence it is drawn to the compressed air-spraying machines made by the De Vilbis, Toledo, Ohio, and the Paasche Co., Chicago, and located in the enameling room. Fig. 7 shows one of these outfits in operation on a steel tank, the spraying apparatus appearing on the left of the view. This is the usual method for coating the steel containers. They receive from three to five coats. Smaller pieces may be coated by dipping in a large tub of solution, or in cases where only one side is coated, the wet slip can be "slushed" over the surface held at such an angle as permits the excess to be drained off. Buffalo Forge Co. portable blowers are used for drying the successive coats of enamel as they are applied.

The steel enamel furnace room adjacent to the spraying department is equipped with one 6-ft., one 10-ft. and one 14-ft. furnaces, all constructed from firebrick

and of the open type with flame introduced from below. The largest furnace has hydraulic lifts for operating the doors, which part on a horizontal center line, saving time on the opening and closing movements. The burning temperature varies between 1,800 and 2,200 deg. F.

Fig. 8 is a view along the front of the three steel enamel furnaces, with the largest in the foreground. The charging machine, shown loaded with a piece ready to enter the large furnace, is manufactured by the Morgan Engineering Co., Alliance, Ohio. Each one of these machines is equipped with three electric motors, permitting movement of the piece in any one of three directions. The electrical controllers are operated in a pulpit to the rear of each machine.

One Morgan 5-ton overhead electric crane operates the length of the enameling department and along the front of the furnaces for moving the pieces about the enameling floor and placing them on the charging machines.

Oil is used for fuel in the steel-enameling furnaces and is burned by the General Combustion Co. oil-gas system. The blower equipment in this system consists of one 50/60-hp. electric-driven unit delivering 4,200



FIG. 11. ENAMELED STEEL APPARATUS UNDER TEST

cu.ft. of free air per minute and one 20-hp. electric unit with a 2,500-cu.ft. capacity, both pressures approximating 3 lb. Motors and blowers are manufactured by the General Electric Co. Brown Instrument Co. pyrometers record the burning chamber temperatures.

The first action on placing the coated ware in the furnace consists of dehydration of the clay and other mill additions which in drying have still retained moisture. The individual particles of the coat then melt and run together, giving an even distribution of glass over the whole surface. After the ground coat has been processed, the operation is repeated with the cover coats until the required surface is produced. All burning operations are carried on in an oxidizing atmosphere.

The steel assembly building, housing the assembling operations and shipping room, with the cast-iron machine shop at the east end, is 170 ft. long and has a Toledo electric crane with 36 ft. clearance operating its entire length. As the enamelled pieces are conveyed from the enamel department to the assembly department, those requiring steel jackets are built up by oxyacetylene welders near the point of entrance. Other parts, such as motors, agitators, brackets and pipe fittings, are attached until the required unit is finished and is then finally painted. Fig. 9 shows a series of operations of this nature. Fig. 10 is a view of com-

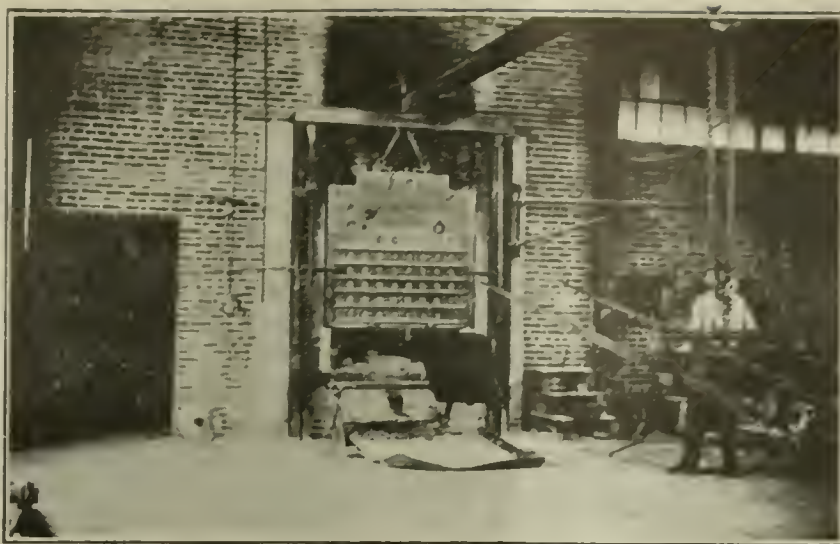


FIG. 12. CAST-IRON ENAMELING FURNACE

pleted units ready for inspection and test and Fig. 11 some of the units under test. The piece on the left of Fig. 11 is undergoing pressure test on the jacket.

The assembly machine shop adjoins the main building on the north and is furnished with lathes, drill presses and all other machine tools needed in the building up of the small parts for complete units. As noted, the cast-iron preparation room occupies the east end of the assembly building. Here all the rough castings are made ready for the enameling operations and later returned for additional machining required for assembly.

This department employs large boring mills, lathes and shapers for complete production. A small Paxon sand-blast equipment, similar to the units at the tank shop, operates in connection with this room and for use in cleaning surfaces to be enameled.

The cast-iron department enameling equipment, adjoining the machine shop, consists of one 4-ft. coal-fired muffle furnace and one 7-ft. Dutch oven furnace built by L. W. Manion, Canton, Ohio, using refractories from the Massillon Stone & Firebrick Co., Massillon, Ohio. Fig. 12 shows the front of the former with charging machine ready for operation.

The dry process of enameling is used largely for the cover coat on cast iron where the pulverized frit is dusted onto the piece and melted to an even surface. This gives the best enamel for resisting acids, being particularly high in silica. The absence of mill additions in the form of clay and electrolytes assures the intimate contact of particles of the dry frit to produce a true glass coating.

The dry powder is seen in a pan on the floor (Fig.

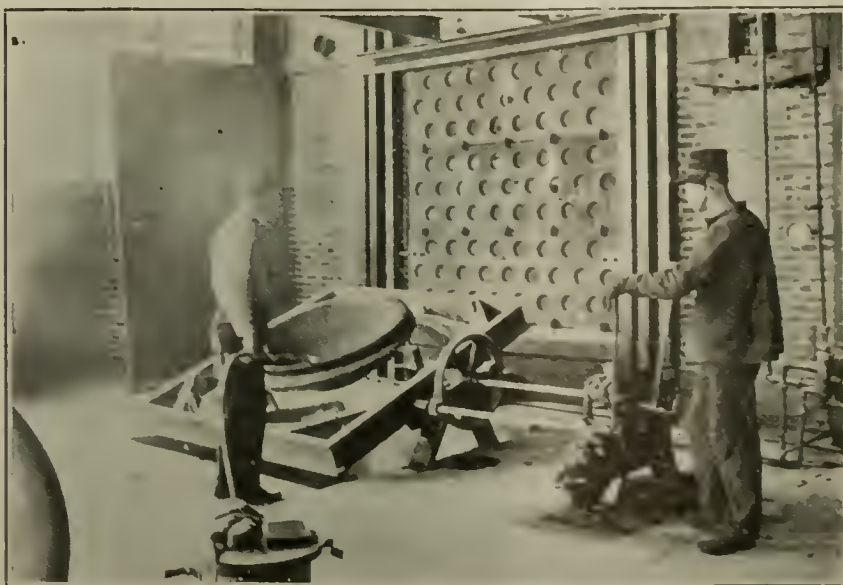


FIG. 13. FRONT OF CAST-IRON ENAMELING FURNACE WITH DREDGING APPARATUS IN OPERATION

12) ready for dusting onto the piece balanced above. Fig. 13 is the front of the 7-ft. furnace with the dredging apparatus in operation. The wet ground coat is first sprayed onto the cleaned surface in the usual manner, and after thorough drying the piece is placed in the muffle furnace and brought to a uniform temperature approaching a bright red.

Upon removal, the ware is not permitted to cool as in the case of steel enameling, but is immediately dusted with the dry frit powder. This is usually accomplished by placing powder in a sieve shaken by a compressed air or electrically operated vibrator held above the piece. The apparatus is called a "dredge" and is shown operating on the left in Fig. 13.

When a proper amount of frit has been applied to the revolving piece, it is run back into the furnace on



FIG. 14. ASSEMBLING ENAMELED CAST-IRON APPARATUS

forks and permitted to come to sufficient temperature to fuse the coat. The piece is again withdrawn and the operation is repeated, continuing with these cycles until the required thickness of glass is built up. The final firing is somewhat harder than the previous ones, resulting in a smooth surface and high gloss.

With the enameling operation completed, the thoroughly cooled ware is returned to the machine shop and assembly room, where it undergoes operations similar to the steel assembly. The complete apparatus may range from unjacketed open-top dishes to jacketed vacuum pans with agitator and other accessories. Fig. 14 shows some of the cast-iron units in process on the assembly floor.

It will be noted by reference to Fig. 1 that the shipping tracks are very well and simply located, entering the center of the plant in such a way as to discharge raw material and receive loaded cars from the shipping



FIG. 15. ENAMELED APPARATUS LOADED FOR SHIPMENT



FIG. 16. INTERIOR OF SUPERINTENDENT'S OFFICE

section in the assembly building. Fig. 15 shows a car at this location ready for shipment. Some of the smaller orders and express shipments are handled to railroad shipping platforms by Packard trucks.

The business control of the factory is handled from the factory manager's and superintendent's office, interior view of which appears in Fig. 16, and the department of mechanical design, employing two mechanical engineers and several draftsmen, as seen in Fig. 17, functions with the necessary aid of the research and control laboratories.

The laboratory building contains chemical engineering, metallurgical engineering and ceramic engineering departments, with analytical laboratory, chemical engineering laboratory, stock room and first aid room. The chemical engineering laboratory is equipped with cast-



FIG. 17. DRAFTING ROOM

iron and steel vacuum pans and condensers. The work here is chiefly concerned with the development of apparatus for adaptation to new lines of industry and investigation in connection with chemical inquiries.

The ceramic engineering department has to do with factory control and research on enamel. The apparatus for this work includes refractometer, petrographic microscope, Freas oven and Hoskins electric furnace. The furnace room has an experimental pot smelter, Abbe pebble mills, an experimental commercial furnace and other equipment for carrying out research on an industrial scale. The metallurgical engineering section deals largely with the quality of steel and cast iron used and the effect of various enameling processes upon them. A completely furnished microphotographic room operates in connection.

The laboratory work will be described in a subsequent issue of CHEMICAL & METALLURGICAL ENGINEERING.

Recent Chemical & Metallurgical Patents

British Patents

For complete specifications of any British patent apply to the Superintendent, British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Mono-azo Dyes.—Mono-azo dyes are obtained by coupling 4-nitraniline-2-sulphonamide (in which one or both hydrogen atoms of the sulphonamide group are replaced by alkyl, aryl or aralkyl) with a 2-naphthylamine sulphonic acid or a 2-amino-8-naphthol sulphonic acid, or a derivative thereof, in acid solution. As diazo components are mentioned 4-nitraniline-2-sulpho-ethylanilide, 4-nitraniline-2-sulphanilide, 4-nitraniline-2-sulphodiphenylamide, 4-nitraniline-2-sulphomethylanilide, 4-nitraniline-2-sulphomethylamide, 4-nitraniline-2-sulphomethyl-o-toluidide, 4-nitraniline-2-sulphopiperidide; as second components, 2-amino-8-naphthol-6-sulphonic acid, 2-methylamino-8-naphthol-6-sulphonic acid, 2-methylamino-8-naphthol-6-sulphonic acid, 2-naphthylamine-8-sulphonic acid, 2-naphthylamine-6:8-disulphonic acid, o-anisyl-2-naphthylamine-8-sulphonic acid. The products may be reduced with alkaline reducing agents. According to one example, diazotized 4-nitraniline-2-sulpho-ethylanilide is coupled with 2-amino-8-naphthol-6-sulphonic acid in glacial acetic acid solution yielding a navy-blue wool dye; in a second example the solution obtained by effecting the same combination in weak mineral acid solution is reduced by sodium sulphide giving a bluish wool dye. (Br. Pat. 164,218. Farbenfabriken vorm. F. Bayer & Co., Leverkusen, Germany. July 27, 1921.)

Dyes; Intermediate Products.—Indigoid vat dyes are obtained by condensing a halogenated isatin (in which the α -ketonic oxygen is replaced by a substituent such as halogen, sulphur, the anilido-group, etc.) with 1-oxy-6-naphthol ether or a halogen substitution product thereof, or with 1:6 dioxynaphthalene followed by alkylation or aralkylation; the products may be further halogenated. The dyestuffs obtained from 5:7 dichlorisatin α -chloride and 1-oxy-6-naphthol ether dyes cotton grayish blue to black shades, or, after chlorinating, black shades, from a hydrosulphite vat; that from dibrom- β -naphthisatin chloride and 1-oxy-6-naphthol ether dyes fast olive green shades; that from 1-chloro- or bromo-2:3-naphthisatin chloride and 1-oxy-6-naphthol ether dyes greenish gray; that from 5:7 dibromisatin- α -chloride and chloro-1-oxy-6-naphthol ether dyes grayish blue; 1-oxy-6-naphthol ethers are obtained by acetylating 1-amino-6-naphthol, alkylating the -OH group, removing the acetyl group and replacing the amino group by the hydroxy group in the usual manner. Chlor-1-oxy-6-naphthol ethers are obtained by chlorinating 1-oxy-6-naphthol ethers with SO_2Cl_2 in glacial acetic solution. Brom-1-oxy-6-naphthol ethers may be prepared by brominating the carbonate of 1-oxy-6-naphthol ether and then splitting off the carbonate group. (Br. Pat. 164,594. Farbenfabriken vorm. F. Bayer & Co., Leverkusen, Germany. Aug. 4, 1921.)

Alloys Containing Alkaline Earth Metals.—Alloys containing one or more alkaline earth metals are made by the reaction of an alloy containing an alkali metal or metals and one or more halogen salts of the alkaline earth metal or metals, mixed or not with other salts, the materials being maintained in a highly fluid state during the reaction. The salts used may include double or multiple salts, mixtures of different alkaline earth salts, salts of other metals which are capable of replacing the alkali metal in the alkali metal alloy such as aluminum, cadmium, copper, zinc, lead and bismuth, or salts of metals inert to the alkali metal in the alloy, such as sodium. If the metal which is to be alloyed with the alkaline earth metal does not alloy with an alkali metal, mechanical mixtures of the metals and alkali metal may be used. The salts may be present in large excess of the theoretical amount—for example 2 to 5 times—and may be heated considerably above their

melting point. In some cases the alkali-metal alloy or the molten salt or both may be maintained in motion during the reaction—for example by a counter-current method—or by causing the materials to impinge on each other, and the molten salt may be renewed during the process of substitution. The production of the following alloys is referred to: lead and calcium; lead and barium; lead, calcium and barium; lead, calcium and magnesium; lead, barium and magnesium; aluminum and magnesium; aluminum and beryllium; copper, calcium and boron; lead, manganese and barium; copper, aluminum and calcium. (Br. Pat. 164,608. G. J. Kroll, Luxemburg. Aug. 4, 1921.)

Phthalic Acid and Anhydride.—Phthalic acid or its anhydride are prepared by treating naphthalene vapor with air or other oxygen-containing gas in the presence of a small amount of vanadyl chloride at 300 to 650 deg. C. The mixture of naphthalene vapor, air and vanadyl chloride vapor is passed through a vessel or tube, empty or containing pumice, firebrick, kieselguhr, etc., and the products condensed in cooling chambers. In place of naphthalene other volatile hydrocarbons or their derivatives yielding phthalic acid on oxidation, such as α - or β -methyl-naphthalene, tetrahydronaphthalene, α -naphthol, or o-xylene, may be used. (Br. Pat. 164,785. British Dyestuffs Corporation, Ltd., London. A. G. Green, Hale, Cheshire, and J. W. Porter, Belfast. Aug. 10, 1921.)

Sodium Formate.—Sodium formate is produced by introducing carbon monoxide into water containing sodium sulphate and lime, the sodium sulphate being maintained at a concentration not greater than 7 per cent calculated as Na_2SO_4 . This concentration may be regulated by the presence of basic sodium calcium sulphate, $\text{Na}_2\text{Ca}_2(\text{SO}_4)_4(\text{OH})_2$, obtained by heating calcium or sodium hydroxide in water with sodium sulphate and calcium sulphate, or with substances containing or forming these compounds—e.g., calcium sodium sulphate or sodium chloride and calcium sulphate. Another method of maintaining the sodium sulphate concentration consists in adding sodium sulphate or calcium sodium sulphate or basic sodium calcium sulphate to replace the sulphate as it is consumed, excess of lime being either present in the reaction vessel or gradually added thereto. (Br. Pat. 165,163. M. Enverli, Oestrich, Rheingau, Germany. Aug. 17, 1921.)

Phenol-Aldehyde Resins.—Resins are obtained by condensing the *ar*-tetrahydronaphthol or mixture of *ar*-tetrahydronaphthols, obtained by alkali fusion from technical tetrahydronaphthalene sulphonic acid, with an aldehyde with or without the aid of a condensing agent; the resins may be rendered fast to light by treatment with acidylating, alkylating or aralkylating agents. According to examples, *ar*-tetrahydronaphthol and 30 per cent formaldehyde are boiled together, or heated in an autoclave to 110-115 deg. C.; or heated to 60-70 deg. C. in the presence of a little hydrochloric acid, ammonium chloride or potassium hydroxide, and the resulting viscous products washed and dried; these products are further treated with acetic anhydride, or with ethyl bromide and caustic potash. In other examples acetaldehyde is employed and the resins obtained heated with benzoic anhydride. For formaldehyde and acetaldehyde may be substituted their polymers or substances which form an aldehyde. The products are clear brittle masses, soluble in alcohol, benzene, dichlorobenzene, linseed oil and turpentine. (Br. Pat. 165,322. Akt. Ges. für Anilin-Fabrikation, Berlin. Aug. 17, 1921.)

Separating Nitrogen Oxides in a Mixture of Gases.—Nitrogen oxides are absorbed from dry gaseous mixtures by substances other than alumina which are capable of forming addition products at temperatures between 0 and -80 deg. C. and of liberating the nitrogen oxides again at a higher temperature, generally about 100 deg. C. The substances mentioned as suitable are ferric chloride, calcium, magnesium, copper, zinc and iron oxides, and certain aluminous products, such as dehydrated bauxite. The essential condition to be observed in order that these substances may absorb the nitrogen oxides is that the substances are obtained or dehydrated at low temperature. The heating to liberate the nitrogen oxides may be effected in a partial vacuum. (Br. Pat. 166,095; not yet accepted. Société Anonyme L'Azote Français. Paris. Aug. 31, 1921.)

Current Events

in the Chemical and Metallurgical Industries

More Plants Resuming Operations

Paper.—The Bryant Paper Co., specializing in the production of book papers, has resumed operations at a capacity basis, following a curtailment for about 12 months past. The plant will run on a 24-hour schedule, giving employment to about 1,200 operatives.

The American Strawboard Co., Noblesville, Ind., has resumed production with a full working force, and all departments are operating. The plant has been idle for some time past.

The Eastern Manufacturing Co., Bangor, Me., is now operating at full capacity in its pulp department, following production on about a 50 per cent basis for some months. The paper mills of the company are also running full.

Oil.—The Sinclair Oil Co., Muskogee, Okla., has resumed operations at its local refinery, following a shut-down for the past two months.

Copper.—The International Smelting Co. is arranging to blow in one reverberatory furnace at its Miami, Ariz., smelting plant on Nov. 20, following a suspension of operations for the past six months.

Sugar.—The Owosso Sugar Co., Owosso, Mich., has opened its plant at Lansing, Mich., giving employment to about 300 men.

The Mount Pleasant Sugar Co., Lansing, Mich., has commenced production at its mills with a working force of over 250 men.

Iron.—The Reading Iron Co. placed its Keystone blast furnace in operation on Nov. 1, following a suspension from Nov. 15, 1920.

The Carnegie Steel Co., Pittsburgh, Pa., has lighted another furnace at its New Castle, Pa., plant, increasing operations to about 75 per cent of normal. About 200 additional men will be employed at once.

The Bethlehem Steel Co., Bethlehem, Pa., has recently resumed operation of its Furnace D, making two units now in blast at the plant. The furnace has been banked since last April. Blast Furnace G at the mill is being relined.

The Donner Steel Co., Buffalo, N. Y., has blown in a second stack at its plant. The Rogers, Brown Co. has also placed a second furnace in blast at its mill.

In the Buffalo, N. Y., district, one blast furnace is now in operation at each of the plants of the Buffalo-Union Furnace Co., Wickwire-Spencer Steel Co. and the Lackawanna Steel Co.

Steel.—The Canonsburg Steel & Iron Co., Canonsburg, Va., has arranged for immediate resumption of operations at its local plant, following a shut-down since last spring. The company specializes in the manufacture of sheet steel, with plant giving employment to about 400 men.

The Atlantic Foundry Co., Akron, Ohio, is operating at full capacity in its steel department. The gray iron castings department is running at about one-half normal.

Enamelware.—The National Sanitary Manufacturing Co., Salem, Ohio, has increased production to about 60 per cent of normal, and plans to run full at an early date.

Alcohol.—The United States Industrial Alcohol Co., 27 William St., New York, is planning for the immediate reopening of another distillery at its New Orleans, La., plant, following a period of idleness. The company resumed at one of its New Orleans distilleries about the middle of October. The Baltimore, Md., plant of the company is running full.

Czechoslovakia Restricts Exports

The exportation from Czechoslovakia of sulphur, phosphorus, mercury and various chemicals, drugs and fertilizers, has been forbidden until further notice.

Chemists Clubs Exchange Greetings

During the recent visit of the British Society of Chemical Industry to the United States greetings were exchanged between the Chemical Industry Club, London, and the Chemists' Club, New York. The following message was conveyed to the Chemists' Club by Captain C. J. Goodwin on behalf of the Chemical Industry Club:

Aug. 10, 1921.

To the Chemists' Club, New York:

The chairman and the committee of the Chemical Industry Club, London, desire on behalf of the members, on the occasion of the visit to the United States of representatives of the Society of Chemical Industry, to send their very cordial greetings to their colleagues of the Chemists' Club of New York.

Both institutions are united in a desire to cultivate and provide for the social side of chemical industry and chemical science, and by opening their doors to visiting members of either club have already done something and may yet do more to promote the acquaintance and consolidate the friendship of the chemists of both nations.

At the present moment the greetings we send through Captain Goodwin have more than a purely personal and domestic interest. They are an indication of the sincere desire on this side for increasing friendship and good understanding between Great Britain and the United States, as a guarantee not only of the progress of the two great English-speaking nations but of the peace and well-being of the world.

This visit takes place at a time when all the influences that make for international friendship need to be cultivated, and among the most stable bonds of unity is the common service of mankind through scientific research and the application of its results to industry. On this basis the scientists, and especially the chemists, of your nation and ours, may find common ground in their sympathies, aims and work. Both can gain nothing but good for a better acquaintance and closer association with each other, and in sending these words we desire you to accept them, not only as a courtesy, but as representing our sincere desire for ever increasing friendship and co-operation between Great Britain and the United States.

(Signed) H. Edwin Coley,
Hon. Sec.

The following cordial response was made to the Hon. Sec. of the Chemical Industry Club, by Thomas R. Duggan, trustee of the Chemists' Club:

Sept. 15, 1921.

Dear Mr. Coley: Your letter of the 10th of August was duly conveyed to the Chemists' Club through the kind offices of C. J. Goodwin. . . . It is needless for me to say that letters of this sort passing between the various countries where English is spoken can only do good, more especially when those countries are knitted together in one common cause; that is, the uplifting and the spreading of science throughout the English speaking races. . . . It is my pleasure to pass to you the friendly feeling which the whole of the Chemists' Club feels toward the Chemical Industry Club.

On behalf of the trustees and officials of the Chemists' Club I have to thank you for your kind greetings and also to thank Mr. Goodwin, who so kindly conveyed by word of mouth the feelings that have existed between the two Clubs and which he hoped and we also hope will exist for many years to come.

(Signed) Thomas R. Duggan,
Trustee.

Bauxite Deposits in Australia

The Australian bauxite deposits are being thoroughly investigated with a view to the establishment of an aluminum industry in that commonwealth.

Program, Baltimore Meeting, American Institute of Chemical Engineers

The fourteenth annual meeting of the American Institute of Chemical Engineers will be held in Baltimore, Dec. 6 to 9, with headquarters at the Emerson Hotel. In addition to the technical program and plant visits noted below, excellent arrangements have been made for the entertainment of the ladies.

TUESDAY, DEC. 6.

Meeting at Emerson Hotel.

9 a.m.—Registration.

9:15 a.m.—Business session. Canvass of ballots for officers.

Reports of officers and council. Reports of committees.

10:30 a.m.—Reading of papers.

Symposium on Chemical Engineering and National Defense.

Address, President David Wesson.

"Chemical Engineering and National Defense," M. C. Whitaker.

"Explosives and Fertilizers," Alfred H. White.

12:10 p.m.—Luncheon at Emerson Hotel.

1:15 p.m.—Excursion to Curtis Bay Industries: The American Refractories Co.; the Davison Chemical Co. and Silica Gel Corporation; the U. S. Industrial Alcohol Co.

8:15 p.m.—"Get Together" at Maryland Country Club.

WEDNESDAY, DEC. 7.

9:15 a.m.—Leave for Edgewood Arsenal. Note: This visit is open to U.S.A. citizens only.

12:30 p.m.—Luncheon at Edgewood. A complete inspection and tour of the arsenal will be made during the morning and afternoon. Brigadier General Amos A. Fries will give a short address in connection with the inspection of the arsenal on the subject of chemical warfare.

8:15 p.m.—Theater party. Invitation extended to the ladies and the institute by the local committee and the local chemical industry.

THURSDAY, DEC. 8.

9:15 a.m.—Meeting at Emerson Hotel. Reading of papers.

Symposium on Chemical Engineering and National Defense, continued.

"The Future Warfare," Raymond F. Bacon.

"Chemistry and the Next War," Maximilian Toch.

"Fundamental Research in Conservation and Defense," Harrison E. Howe.

"The Chlorine Industry as an Essential Factor in Our National Defense," Benjamin T. Brooks.

12 p.m.—Visit to Annapolis.

1:30 p.m.—Luncheon at Carvel Hall, Annapolis.

8 p.m.—Meeting at the Johns Hopkins University at Homewood.

"The Oxidation of Carbon Monoxide to Dioxide at Room Temperatures by a Catalyst," Prof. J. C. W. Frazer.

"Ultra Violet Light," Prof. R. W. Wood.

FRIDAY, DEC. 9.

Meeting at Emerson Hotel.

9:15 a.m.—Business session.

10:15 a.m.—Reading of papers.

"Some Aspects of the Lime Industry," Major Edward Holmes.

Paper by Prof. Cavalier of France.

"Glass as a Material for Chemical Use," A. E. Marshall.

12 p.m.—Luncheon at Emerson Hotel.

1:15 p.m.—Visit to Baltimore industries: Practically all of the Baltimore plants engaged in chemical and allied lines of manufacture have offered to throw their plants open to the institute. Lists will be available at the registration desk, and arrangements made to suit the individual preferences of members.

7 p.m.—Subscription dinner at Emerson Hotel. \$3 per cover.

SATURDAY, DEC. 10.

Optional visits at Baltimore and Washington.

Industrial Cost Association Holds Second Conference in Pittsburgh

With headquarters at the William Penn Hotel in Pittsburgh, Pa., the Industrial Cost Association held its second National Industrial Cost Conference on Nov. 2, 3 and 4. The meeting was well attended and the members departed with the comfortable feeling of having accomplished a creditable amount of useful work.

After registration and the other formalities had been gone through on Wednesday morning, the president, Horace S. Beck, controller S. K. F. Industries, Inc., New York, called the first session to order and made a short address. He commented on the work done by the association during its first year of existence and commended the officers and members on what had been accomplished. He also stated that it was planned for the coming year to have presented at each local section meeting a paper prepared under the direction of the executive committee of the association, in order to assist in the work of the sections.

The afternoon session was opened by an address of welcome from Mayor Babcock, of Pittsburgh. The conference then listened to a paper read by S. B. Taylor, general manager, S. K. F. Industries, Inc., New York, on "What the Sales Manager Should Have From the Accounting Department." Mr. Taylor enumerated various details and figures that must be supplied by the accounting department. He laid particular stress on the need for cordial co-operation between the members of the accounting department and the members of the sales department. The plea for co-operation was strongly indorsed in the discussion which followed his paper.

E. C. Grimley, Victor Talking Machine Co., Camden, N. J., then discussed the matter of taking inventories, contrasting the time required and the benefits accomplished from the old-fashioned annual or semi-annual inventory which necessitated shutting down the plant, and the more modern perpetual inventory as practiced in most progressive plants.

In the evening papers were read by F. S. Willett, controller, Dodge Manufacturing Co., Mishawaka, Ind., on "Responsibility of the Controller or Accountant in Times of Business Depression," and by T. W. Dinlocker and A. W. Wainwright, both of S. K. F., on "Idleness and Its Relation to Industry in Retrospect."

The Thursday morning session was opened by an interesting paper by Addison Boren, Yale & Towne Manufacturing Co., Stamford, Conn., on "Terminology." After luncheon at the Heinz plant the delegates listened to addresses by J. B. Ayres, sanitation and safety engineer, and Major William Hogg, assistant to the vice-president, National Tube Co., Pittsburgh. These gentlemen described some of the safety and sanitation work of the United States Steel Corporation and outlined the actual savings in dollars and cents possible to attain.

At the meeting of Friday morning, J. M. Howell, General Electric Co., Schenectady, N. Y., read a paper on "How Can a Cost System, Although Efficient, Demoralize an Organization?" In his paper he criticised the ready-made cost system as applied by certain consulting accountants and told of the harm it could do when local conditions were not taken into consideration.

U. S. Potters' Convention

At a special meeting of the executive committee of the United States Potters' Association at East Liverpool, Ohio, Oct. 20, it was voted to hold the annual convention of the organization at Washington, D. C., during the first week in December, with a three-day session.

German Ammonia Output to Be Marketed by Fertilizer Syndicate

Ninety-six per cent of the German output of ammonia will be marketed by the Fertilizer Syndicate, reports a cable from Berlin, but it is not expected that the syndicate will be able to place it on the market before June, owing to the present scarcity of raw material caused by the disaster at Oppau.

Atmospheric Pollution Committee, A.I.C.E.

A committee has been appointed by the American Institute of Chemical Engineers to study conditions in chemical engineering processes which result in the production of gases which pollute the atmosphere. It is the purpose of the committee to study the non-injurious effluent SO_2 gas concentrations rather than the result of processes producing said gas. The work of the committee will be carried on through investigations, publications and discussions of the results obtained. The committee will welcome any information or facts bearing on the question of atmospheric pollution in any of these phases relative to the chemical manufacturing industry either through members of the institute or others.

The membership of the committee is as follows: James R. Withrow, chairman, professor of industrial chemistry, Ohio State University, Columbus, Ohio; Charles Baskerville, professor of chemistry, College of the City of New York, New York, N. Y.; Arthur B. Conner, chemical engineer, Detroit Chemical Works, Detroit, Mich.; Andrew M. Fairlie, consulting chemical engineer, Atlanta, Ga.; Henry Howard, Grasselli Chemical Co., Cleveland, Ohio; Cyril B. Clark, chemical engineer, General Chemical Co., 25 Broad St., New York, N. Y.; Albert E. Marshall, works manager, Davison Chemical Co., Curtis Bay, Md.; Arthur M. Comey, E. I. du Pont de Nemours & Co., Wilmington, Del.

American Association of Textile Chemists and Colorists

Formal organization of the American Association of Textile Chemists and Colorists was completed at a meeting held in the Engineers' Club, Boston, Nov. 3.

Prof. Louis A. Olney, of the Lowell Textile School, was elected president. Other officers are: William D. Livermore, chief chemist of the American Woolen Co., Lawrence, Mass., and William H. Cady, chief chemist of the United States Finishing Co. of Providence, R. I., vice-presidents; Walter E. Hadley, chief chemist of the Clark Thread Co., Newark, N. J., secretary; Winthrop C. Durfee, consulting and manufacturing chemist, of Boston, treasurer, and the following executive council, who will govern the new association: George A. Moran, chief chemist of the Pacific Mills, Lawrence, Mass.; Walter M. Scott, chief chemist of Cheney Bros., South Manchester, Conn.; A. E. Hirst, chief chemist and assistant superintendent, American Printing Co., Fall River; Elmer C. Bertolet, professor of textile chemistry, Philadelphia Textile School; James L. Amsden, chemist of the Rockland Finishing Co., Haverstraw, N. Y., and W. K. Robbins, of the Amoskeag Manufacturing Co., Manchester, N. H.

The objects of the organization are:

To promote the technical interest of its members in the properties and application of dyes and the processes of scouring, bleaching and finishing.

To develop a closer relationship between theory and practice in the application of dyes and other chemicals used in the textile industry.

To serve the textile and color industries by developing standard methods of testing dyes and analyzing textile materials in general and of standardizing systems for these tests and recording their results.

To encourage research work along textile chemical lines.

To encourage and supervise the establishment of a complete textile chemical library.

Two classes of membership have been provided for—active and junior. Active members must be at least twenty-six years of age and actively engaged as textile chemists or in some branch of the application of dyes. Students and apprentices may become junior members.

Weeks and Ford to Confer

The Secretary of War and Henry Ford will "get down to figures," as the Secretary of War puts it, on Muscle Shoals at a conference slated for Nov. 18 in Washington. Since the Army engineers and Mr. Ford's engineers have reached an understanding as to the engineering phases of Mr. Ford's offer, all that remains to do is the bargaining.

Emergency Tariff Act Extended

The Senate on Nov. 8 voted to extend the emergency tariff act, which provides among other things for the control of certain dye and chemical imports, until the permanent tariff bill will have become a law. The consideration of the extension, to which there was no real objection, nevertheless gave an opportunity for further discussion on the floor of the Senate of the dye embargo. Senator Smoot of Utah, in urging that the act be extended, declared that no one is more opposed to a permanent dye embargo than himself, but he contended that as long as there is not enough protection under the Underwood act, which he declared all would admit is not sufficient, he urged that the present method of handling dye imports be continued until the permanent tariff becomes a law.

"For months past," said Senator Smoot, "I have been studying the question of German manufacture of dyes. I have collected current prices in Germany, Switzerland, England and in other countries. I also have collected the prices of American products. I am quite certain that we can protect the industry without imposing an embargo."

The bill as it passed the House was extended until Feb. 1. This was amended by the Senate so as to continue the emergency tariff in force "until otherwise provided by law." The discussion of the amendment revealed that the passage of the tariff bill may be delayed much longer than had been expected. One Senator predicted that it would not be enacted until summer.

Senator Pomerene of Ohio declared that "the dye-makers have got control of chemists, at least persuasively so, and chemists have come to the conclusion that they are not able to do anything in this country without an embargo." He expressed curiosity as to the source of the chemists' inspiration. He said the word "embargo" was hated in America more than any other one word in the language. Since Senator Pomerene's position is typical of that of a considerable number of Senators, his remarks are of interest as they outline the reasoning of those who are opposed to the granting of that measure of protection. Among other things he said:

"It is little short of a crime to place the woolen, the cotton, the silk and the paint industries of this country in a position where they must buy all of their supplies at home. Many domestic dyes are the equivalent of those produced elsewhere, but many are not good. The dye-makers in their unadulterated selfishness would place all of those great industries entirely at the mercy of themselves. I do not think it makes much difference to those industries whether they are dominated by a German dye trust or an American dye trust.

"I do not think the dye-makers are in danger of destruction by competition from abroad. During the past year only \$5,000,000 worth of dyes was brought into this country, while nearly \$30,000,000 worth was shipped out. American dyes were shipped abroad and were sold in other countries in competition with German dyes."

Senator Pomerene read from correspondence with H. W. Harris of Alliance, Ohio, who served more than 25 years in the consular service. In that correspondence he pointed out that American textiles are being crowded out of foreign markets because of the inferiority of the dyes used.

Chemistry Building Dedicated at Dartmouth

The Steele Chemistry Building at Dartmouth College, Hanover, N. H., the latest addition to the institutional buildings, was dedicated on Oct. 29 in the presence of Governor A. O. Brown of New Hampshire, former Governor Samuel E. Pingree of Vermont, Dean Henry P. Talbot of the Massachusetts Institute of Technology and Dr. William H. Nichols. The structure was erected through a bequest of \$250,000 from the late Sanford H. Steele, an alumnus of Dartmouth.

Early Vote on Patent Office Salary Bill

Early consideration of the bill providing for increases in salaries and certain reorganization in the Patent Office is assured. A majority of the Committee on Rules is understood to have agreed to vote for a special rule which will bring that bill before the House for a final vote soon.

Personal

CHARLES E. HEILMAN, chief metallurgist of the General Motors Laboratory, spoke on Nov. 10 on "Correlation Between the Testing of Automotive Parts, With Their Heat-Treatment and Service," at the Detroit Chapter of the American Society for Steel Treating.

HARRISON E. HOWE has been elected editor of the *Journal of Industrial and Engineering Chemistry* and director of the American Chemical Society News Service, to succeed Dr. Charles H. Herty. Dr. Howe has had a wide and varied experience in chemical industry. After completion of post-graduate work at the University of Michigan, Dr. Howe began his commercial career by accepting a position in the beet-sugar industry. Later he became chief chemist of the refinery. In 1904 Dr. Howe joined the staff of the Bausch & Lomb Optical Co. At first he was attached to that concern's Chicago office and traveled widely in that region in an effort to interest schools and others to use more scientific apparatus. Later he became branch manager of the Chicago office. After a time he was transferred to Rochester, N. Y., to edit the publications and books of instruction of the company. From that post he was promoted to the position of chief chemist. In 1916 Dr. Howe was employed by Arthur D. Little, Inc., as a chemical engineer and as manager of its commercial department. Later he was transferred to Montreal as assistant to the president. While in Canada he was engaged in the important survey of the dominion's natural resources made for the Canadian Pacific Railway. During the war Dr. Howe went to Washington as a consulting chemist in the Nitrate Division of the Ordnance Department of the Army. After the Armistice he returned to the Little company for a short period and on June 1, 1919, joined the staff of the National Research Council as the chief of its Division of Research Extension. He has been a member of the Council of the American Chemical Society since 1912 and is now a councilor-at-large. He is a member of the committee on national policy and was formerly chairman of the Division of Industrial and Engineering Chemistry of the society. He was instrumental in forming the society's Rochester section. He is the representative of the American Institute of Chemical Engineers on the board of American Engineering Council.

Dr. ERNEST FOX NICHOLS, inaugurated last spring as president of the Massachusetts Institute of Technology, was prevented by illness from assuming his duties at the opening of the academic year. He is expected to return about Jan. 1. His ill health was brought about by overwork previous to his election to the presidency. Meanwhile the institute will be governed by an administrative committee.

Dr. WILLIAM H. NICHOLS addressed the Rochester Chamber of Commerce at its midweek luncheon, Nov. 2.

Prof. LOUIS A. OLNEY, of the Lowell Textile School, has been elected president of the newly organized American Association of Textile Chemists and Colorists.

LATHROP E. ROBERTS, of Northampton, Mass., has been added to the Bureau of Mines staff at Berkeley, Cal., to take care of the additional work in physical chemistry. Mr. Roberts will be in immediate charge of the physical chemistry work at Berkeley, Cal. He is a graduate of the University of Chicago and has done extensive work on the theory of orientation of molecules. He was instructor in chemistry for two years at the University of Pittsburgh and for the past eighteen months has been in charge of the research laboratory of the American Writing Paper Co., Holyoke, Mass.

ERNEST T. TRIGG, Philadelphia, Pa., an official of John Lucas & Co., manufacturers of paints and varnish, has been appointed chairman of the recently established industrial relations committee of the Chamber of Commerce of the United States, Washington, D. C.

Dr. LANSING S. WELLS, until recently research chemist with The Barrett Co., Frankford, Philadelphia, Pa., has

accepted an appointment as assistant professor of organic and physical chemistry, Montana State College, Bozeman.

SANFORD L. WILLIS, of the Corning Glass Works, sailed for Glasgow, Scotland, on Nov. 12. During the next four months Mr. Willis intends to visit the principal industrial centers of Europe, where his work will be concerned chiefly with an investigation of the foreign patents and manufacturing rights for Pyrex glassware.

JOHN F. WOOD, East Liverpool, Ohio, heretofore secretary-treasurer of the National Brotherhood of Operative Potters, has been elected president to succeed Edward Menge, who resigned recently on account of ill health.

Obituary

GEORGE L. GOULD, a prominent paint manufacturer of Boston and a former president of the National Paint, Oil and Varnish Association, died at his home in Malden, Mass., on Oct. 30. He was born in Woburn, Mass., on Feb. 6, 1852. Mr. Gould started in the paint business in 1867 and for more than thirty years was president of the Gould & Cutler Corporation of Boston. He was also a director of Benjamin Moore & Co., Brooklyn, and president of C. J. Prince Co. of Boston. Mr. Gould was the author, in 1914, of a historical sketch of the paint, oil and related industries of Boston, and in many other ways had contributed to the development of these industries.

GEORGE H. STEVENSON, of Maplewood, N. J., who for the past eighteen years had been connected with the General Chemical Co. of New York, died on Oct. 31 at the age of fifty-four years.

DIMITRI KONSTANTINOVITCH TSCHERNOFF was born in Petrograd, Russia, on Nov. 1, 1839, and died on Jan. 2, 1921.

He obtained his early education in the Russian Gymnasium (corresponding to the American high school), after which he entered the Technologic Institute. On graduation from this institute in 1858 he was engaged as a professor of geometry and algebra and later as a librarian and superintendent of the museum in the same institute. At the same time he attended lectures in the mathematical physics section at the University of Petrograd. In 1866 Tschernoff left the institute and entered the employ of the Obouchoff steel plant (founded three years previously), where steel guns were manufactured. It was in this period of his life that the most important and pioneer work was done by him on the heat-treatment of steel, its crystallization and metallography.

In 1880 he left the Obouchoff plant and went to the south of European Russia, where he discovered and developed some rock salt mines. This enterprise brought him a rather large fortune. Tschernoff returned to Petrograd in 1884 and held several prominent positions in government departments. Five years later he became professor of metallurgy in the Michael Artillery Academy, in which capacity he remained up to the time of the Russian revolution. During that autumn he was spending his vacation as usual in city of Yalta (Crimea). The events of the Russian revolution progressed very rapidly, so that Prof. Tschernoff, with his wife and daughter, was compelled to stay in Yalta without being provided for the winter season. Suffering from hunger and the lack of sufficient clothing, and deprived of his books and laboratory, Tschernoff nevertheless continued his work as well as he could, and gave a number of lectures on steel before classes in the local Polytechnic Institute. At the same time he worked on some mathematical problems, but his physique broke down through long-continued undernourishment and on Jan. 2, 1921, he passed away.

His works in metallurgy are very well known to the students of that science and a good abstract of his most important papers was published in *Revue de Métallurgie* in 1915 (pp. 829-882) in commemoration of his seventy-fifth birthday. It may be pointed out here that he was a man of remarkable versatility. Perhaps next to metallurgy his interest lay in such widely diversified branches of knowl-



DIMITRI KONSTANTINOVITCH TSCHERNOFF

edge as astronomy, aviation and botany. Photography also claimed a large part of his interest and attention, and his favorite photographs were those he took of the frost on the windows of his conservatory. Some of the photographs in this wonderful collection were used during his lectures on the crystallization of steel. Among other things in which he evinced great interest was the construction of the violin and the violoncello, of which he was very fond. He advanced a theory that the fibers of the wooden boards comprising the violin box should be arranged in a certain manner in order to obtain the best tonal value. Violins which he constructed in accordance with this theory were found to be of excellent tone and enjoyed considerable popularity among Russian musicians.

In his house, surrounded by a beautiful park and located in the remote residential part of Petrograd, Tschernoff led a very simple and modest life, being entirely devoted to his family and his works. In spite of very poor eyesight, which he overstrained while making his observations on the bessemer process, he was a very hard reader. On the large table in his office one could notice a great number of the latest editions and magazines on various subjects and written in different languages. He was absorbed from very early in the morning and up to late in the evening in his endless study, taking a respite for a short time by working in his garden or in his small machine shop. He permitted himself a good rest during only two days in each month. Every other Sunday of the month his house was opened to a company of his own friends, and his family acquaintances. In the evenings of these Sundays Tschernoff usually placed chess, to which, like his old friend Mendeléeff, he was ardently devoted.

As in the case of a number of Russian scientists, the horrors of the revolution compelled him to live the last three years of his life under very miserable conditions, which broke his body but not his spirit, for according to a letter from his younger son he continued his study and work up to the last moments of his life. So far as is known at the present time, his widow, Mme. A. N. Tschernoff, and one of their daughters live in Petrograd (Sergievskaja St. No. 1, Apt. 1) under miserable conditions.

A. I. KRYNITZKY.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, Nov. 14, 1921.

The chemical market during the past week was not very brisk, owing to the holiday spirit, and trading was confined to small quantities. Exporters report a steady demand for the more important commodities and the market seems to be in good shape on these products. Consumers have been purchasing caustic soda in carload lots at lower figures, but lesser quantities are still commanding top-notch prices. Cream of tartar has firmed up considerably and recent quotations have been well sustained. Yellow prussiate of soda has eased up after a period of extreme activity and goods are now available in several additional quarters. Caustic potash opened rather dull, but finished very strong, with buyers paying particular attention to the available supplies of spot material. Yellow prussiate of potash was firmer, with supplies limited and the call decidedly better. There was also an increased export demand from the Far East for formaldehyde. In general, the market had every appearance of stability. Prices all around show signs of remaining steady and resale surplus stocks are diminishing in noticeable volume.

CHEMICALS

Recent importations of powdered *chlorate of potash* have had a discouraging effect on trading and the market remained dormant, with prices a trifle easier. Sales were quoted down to 6c. per lb. at the close of the week. The general tone of the market was rather weak. The crystal variety, however, remained firm at 8c. per lb. Small-lot trading was about the only thing that featured the market on *bichromate of potash*, with prices hovering around 11@11½c. per lb. for spot material. Consumers have shown some interest in this item, but business still retains its conservative form of trading. Firmness in *yellow prussiate of potash* was characteristic of the market and prices closed somewhat higher at 21c. per lb. Limited stocks among leading holders have caused this strength in the local market. Trading in *bichromate of soda* was fairly active and prices remained unchanged at 8½@8¼c. per lb. The tendency of the *caustic soda* market was toward lower levels, and sales at the close were reported down to \$4 per 100 lb. for carload quantities. Lesser lots sold at \$4.10@ \$4.20. Leading producers of prime *acetate of soda* are finding a steady outlet among consumers at 4@4¼c. per lb. Dealers in the resale market are offering odd lots at 4c. per lb., with a probability of shading on round-lot actual business. There was a relaxation noted in the market on *yellow prussiate of soda* and prices eased off slightly to 14½c. per lb. The demand was rather quiet and imported shipments were noted in several new directions. Business in *oxalic acid* was reported more active since the recent sharp slump and orders were placed in better volume at 12½c. per lb. The market ranged up to 14c. per lb. according to quantity and seller. Prime *Glauber's salt* is offered by producers at \$1.50 per 100 lb. packed in single bags for carload quantities and up to 2c. per 100 lb. for smaller lots. The inquiry on this product seems to be fairly active, with consumers in several instances looking for contract figures. Manufacturers of *zinc carbonate* report sales to the consuming trade at 16c. per lb. Second-hand merchants quote the market about 2c. per lb. lower on firm business. The demand for the chemical has not been so very bright and most of the passing transactions have been for small quantities. The market on *soda ash* is reported steady, although business during the past week has not come up to expectations. Domestic ash remains practically unchanged at \$2.10 per 100 lb. for large quantities and up to \$2.50 for proportionately smaller lots. Foreign material is available at \$1.95@\$2 per 100 lb. A noteworthy improvement is reported in *formaldehyde* on the spot market and prices remained quite firm. The domestic demand has become more active and export business has shown a decided

improvement, especially to Japan. Prices remained at 11@11½c. per lb. for quantity orders. Producers of *silicate of soda* quote carlots of the 60 deg. at \$2.30 per 100 lb., with less than carload quantities at 3c. per lb. The 40 deg. test is offered at 95c. per 100 lb. for large-quantity orders. Business seems to be running along in fair fashion with the inquiry coming from various consuming channels. Trading in *nitrite of soda* was rather limited and the market closed at 7@7½c. per lb. Buyers did not seem very anxious to buy at the quoted figures and purchased only small quantities for immediate necessities.

COAL-TAR PRODUCTS

The coal-tar products market displayed practically the same tendency as the heavy chemical market. Holiday periods had somewhat of a bad effect on trading and stability of prices, but in general the entire list showed signs of firmness. Inquiries were more numerous and leading producers were optimistic about the outlook for the near future. The leading feature of the market was the increased demand for phenol, and factors are predicting higher prices for this product in the very near future. Naphthalene flakes have also attracted considerable attention in the market and holders are keeping their spot stocks well in hand for the expected rise in price. Imported arrivals have not been as plentiful as a few months ago, owing to the recent additional tax of 15 per cent ad valorem. Dimethylaniline attributed considerable activity and showed increased strength both in inquiries and prices. The *benzene* market still remains in the same unsettled condition, with spot supplies practically exhausted even among second-hand dealers. Coke-oven operations have improved somewhat, but no effect will in any way be noticeable on the spot market for at least another month. *Naphthalene flakes* are firm, with the demand better from various quarters and quotations running around 7c. per lb. in second-hand channels and up to 8½c. per lb. from producers. Leading factors expect a rise soon. *Phenol* has shown some considerable improvement and large holders of prime material are quoting revised prices. Sellers holding large export orders were somewhat surprised to learn that all the better grade product is being withheld from the spot market at the present levels. Sales of prime white goods were made at 9½c. per lb. Sales of *dimethylaniline* were made at 60c. per lb., with other factors quoting up to 65c. per lb. The demand has shown that consumers have used the major portion of their old stocks and are eager to feel out the present market. Inquiries for *benzaldehyde* are being received in fairly good volume and sales for U.S.P. material were recorded at \$1.35 per lb. Resellers of *aniline oil* are maintaining prices around 18c. per lb., which is about the figure asked by producers. Buyers have not shown any real snap to trading and spot stocks have not been diminishing rapidly enough to keep prices steady.

WAXES

Importers of *beeswax* report a steady demand for the low grades and prices ruled quite steady. The crude African closed at 14@15c. per lb., with the Brazilian at 21@23c. per lb. Pure white refined was held at 34@38c. per lb. according to quantity and seller. Traders in *candelilla wax* reported a better demand, and prices were quoted higher at 25@25½c. per lb. Available stocks were somewhat limited. Spot offerings of *Japan wax* were reported at 22@24c. per lb. The general tone of this market was hardly steady, probably because of weak shipment prices. *Japan wax* for shipment closed at 16@16½c. per lb. c.i.f. New York. There were numerous offerings of *carnauba wax* in the market, but shipment prices showed very little change, leaving the general tone of the market practically unchanged. The demand was for small lots. No. 1 closed at 45c. per lb., with No. 2 North Country at 23c. per lb. The No. 3 North Country was held at 14½@15c. per lb. for prompt delivery. Prices on crude oil advanced sharply during the week, but this did not seem to have any noticeable effect on buyers of *paraffine wax*. Sellers have tried to advance prices in proportion to the advance in crude oil, but the movement did not show any signs of aggressiveness. Some large holders, on the other hand, have withdrawn from the market.

The St. Louis Market

ST. LOUIS, Mo., Nov. 11, 1921.

Activities in the chemical and drug markets continue to show increased signs of improvement and conditions as a whole have a very bright appearance. Dealings in the month of October increased considerably over those of preceding months and the first ten days of the present month show an appreciable increase over the same period of last month. It was expected that the calling off of the railroad strike would have a bad effect on the market for the more important commodities; however, this was not the case, as the demand continued, in fact, with a marginal increase.

Heavy importations of foreign chemicals have been noted for some time but with no ill effect on the domestic market, which leads us to suppose that the bulk of the importations is going direct to the consuming trade and not being distributed among second hands.

The general market shows no weakness and the tendency of manufacturers is to advance rather than follow the other direction, for many of the prices that are ruling are not consistent with manufacturing costs and have been forced only by the keen competition. Many of the more important items have taken an upward trend already, as for instance, *salicylates*, which took a sudden rise this week.

Buyers are more optimistic, as is evidenced by the increase in the volume of orders, further indicating that business is on the road to improvement.

ALKALIS

The market on *caustic soda* is very firm and continues at \$4 per 100 lb. for 73 to 75 per cent solid, f.o.b. point of production. No change in *soda ash*, *bicarbonate soda* or *sal soda*.

CHEMICALS, DRUGS AND PHARMACEUTICALS

Ammonia water, 26 deg., moves in routine way. An extraordinarily heavy demand for *sulphate ammonia*, pure granular, has been experienced the past several weeks and continues today. *Bismuth salts*, especially the *subnitrate*, is moving very strong in spite of the fact that this is the off season. *Bromides* are commanding a fair position. The heavy demand recently reported on *carbon bisulphide* has slowed up to some extent. *Cream of tartar* is experiencing a fair demand. *Creosotes* and *guaiacols* are now commanding a very good demand and this should continue for the reason that this is the season for these two commodities and large stocks should be carried. *Ethers* are moving freely. The photographic trade is making quite a demand for hydroquinone and recently manufacturers have reduced their schedule. *Hypo* is moving through regular channels at regular rates. Among the iodides, *iodine resublimed* and *potash* are the heavy sellers, at the present time, but the remainder of the *iodide salts* are also holding their own. Consumers are making a heavy demand on manufacturers for *salicylates*, especially the *acetyl salicylic acid*, of which there is an apparent shortage. The *salicylates* have also advanced the early part of this week. *Soda benzoate* continues to be in demand. Inquiries and demand for *thymol iodide* are very good. The demand for *zinc stearate* continues, although not much is expected of this commodity at this time, as the season is over. *Zinc sulphate*, pure granular, is moving in a lively way.

ACIDS

Manufacturers of heavy mineral acids report a continued increase in activities and look for further improvement in the near future. *Acid benzoic* is moving in a fair way. Fair quantities of *citric acid* are being sold, undoubtedly due to wholesalers' stocks being exhausted. *Gallie acid* and *pyrogallie acid* are in good demand; the manufacturers are in good position to fill large orders. *Acid tartaric* is moving in a routine way.

VEGETABLE OILS AND NAVAL STORES

Turpentine has stiffened very strongly during the last week, reaching price of 85c. in single barrels and 81c. in 5-bbl. lots ex-warehouse. *Castor oil* remains firm with prevailing price of 12½c. per lb. *Linseed oil* has advanced slightly over last week and is now moving at 70c. basis raw oil ex-warehouse.

The Iron and Steel Market

PITTSBURGH, Nov. 11, 1921.

Production of steel ingots in October was at the rate of about 44 per cent of capacity, the highest rate shown since February and more than double the rate of last July. There was a sharp increase July to August, a small increase August to September and a large increase September to October.

The Steel Corporation's unfilled obligations decreased by 273,841 tons during September, against an increase of 28,744 tons in September and decreases averaging about 500,000 tons a month in the 13 months preceding. The Steel Corporation's unfilled tonnage, long regarded as a useful index to business conditions, would be quite misleading if interpreted in the usual way, when increases have been regarded as favorable and decreases as unfavorable. The corporation entered this year with a large volume of contract business with customers. There was little occasion to enter additional tonnage, as customers were covered. Requirements of customers were indicated by their specifying against contracts. Shipments represented activity and decreased the unfilled tonnage. In March the corporation shipped its products at about 51 per cent of capacity and the unfilled tonnage decreased 649,102 tons. In July the corporation shipped at about 25 per cent and the unfilled tonnage decreased by only 287,544 tons. Which was the better month?

In each month, March to August inclusive, the new bookings of contract or other tonnage were very small, the decrease in unfilled obligations being but a trifle less than the shipments. In September two price advances occurred, in wire products and sheets respectively, bringing in considerable quantities of business at the old prices. The shipments were at about 34 per cent of capacity and the increase in unfilled obligations about 2 per cent, indicating that bookings were at about 36 per cent of capacity, easily the largest bookings for months. In October the shipments were at about 44 per cent of capacity, while the decrease in unfilled tonnage was about 20 per cent of capacity, indicating bookings at about 24 per cent.

STEEL PRICES

Finished steel prices in general exhibit a slight sagging tendency from week to week. In most if not all products there can be no clear cut declines for the simple reason that there are no clear cut prices. Sales occur at various prices according to the tonnage of order and the character of specifications, as well as the particular needs of a mill for rolling schedules at one time and another. There is, of course, quite free competition. Sales of bars, shapes and plates generally fall within the range of 1.50@1.60c. In sheets there are "regular" prices of 3c. on black and 4c. on galvanized, and these prices are shaded somewhat more than a week ago. In tubular goods there are published lists, the shading of which is more widespread than a week ago, though perhaps no deeper. Tin plate presents a stable market. For a long time several independents were shading the Steel Corporation price of \$5.25, the corporation departing from its common policy of 6 months or so past in the matter of recognizing price competition, but on Nov. 3 the corporation decided to reduce its price to \$4.75. At this price the market seems stabilized.

PROSPECTS

Recovery from the extremely low production rate of last July was unavoidable, because at that time consumption was being taken care of partly by stocks, and in time the stocks would be liquidated. The 44 per cent operating rate of last month involves a different condition, the production probably balancing the country's needs with general business of its present volume and character. So little steel is being taken by the railroads and so little is passing into large construction jobs that the remainder represents really a fairly large tonnage for the common everyday activities. The production of steel, measured in ingots, is just equal to production in 1906 and 1907, years of great activity and years in which much steel passed to railroads and into large construction undertakings. The general public, so to speak, is taking much more steel than in 1906 and 1907, although population has increased by only about 22 per cent.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots		Less Carlots	
Acetic anhydride.....lb.	—	—	\$0 40	\$0 45
Acetone.....lb.	\$0 12½	\$0 12½	13	13½
Acid, acetic, 28 per cent.....100 lbs.	2 75	3 00	3 25	3 50
Acetic, 56 per cent.....100 lbs.	6 00	6 25	6 50	7 00
Acetic, glacial, 99½ per cent, carboys, 100 lbs.	10 75	11 00	11 25	11 50
Boric, crystals.....lb.	12½	13	13½	14
Boric, powder.....lb.	13	13½	14	14½
Citric.....lb.	—	—	45	47
Hydrochloric.....100 lb.	1 25	1 50	1 60	1 75
Hydrofluoric, 52 per cent.....lb.	12	12½	12½	13
Lactic, 44 per cent tech.....lb.	09½	10	10½	12
Lactic, 22 per cent tech.....lb.	04½	05½	06	07
Molybdic, C.P.....lb.	3 25	3 50	3 60	4 00
Muriatic, 20 deg. (see hydrochloric).....lb.	—	—	—	—
Nitric, 40 deg.....lb.	06½	06½	06½	07
Nitric, 42 deg.....lb.	06½	07	07½	07½
Oxalic, crystals.....lb.	12½	13	13½	14½
Phosphoric, 50 per cent solution.....lb.	13	13½	14	18
Picric.....lb.	20	25	27	35
Pyrogallol, resublimed.....lb.	—	—	1 90	2 00
Sulphuric, 60 deg., tank cars.....ton	—	—	11 00	12 00
Sulphuric, 60 deg., drums.....ton	—	—	13 00	15 00
Sulphuric, 66 deg., tank cars.....ton	17 00	18 00	—	—
Sulphuric, 66 deg., drums.....ton	21 00	22 00	22 50	23 00
Sulphuric, 66 deg., carboys.....ton	—	—	—	—
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	21 00	22 00	—	—
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	23 00	23 50	24 00	24 50
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	31 00	32 00	33 00	34 00
Tannic, U. S. P.....lb.	—	—	75	85
Tannic (tech.).....lb.	45	48	50	55
Tartaric, imported crystals.....lb.	—	—	26	27
Tartaric acid, imported, powdered.....lb.	—	—	27½	28½
Tartaric acid, domestic.....lb.	—	—	—	35
Tungstic, per lb. of W.O.....lb.	—	—	1 10	1 20
Alcohol, Ethyl.....gal.	—	—	4 70	5 00
Alcohol, Methyl (see methanol).....gal.	—	—	—	—
Alcohol, denatured, 188 proof.....gal.	—	—	37	38
Alcohol, denatured, 190 proof.....gal.	—	—	35	36
Alum, ammonia, lump.....lb.	03½	03½	04	04½
Alum, potash, lump.....lb.	03½	04	04½	04½
Alum, chrome lump.....lb.	08½	09	09½	10
Aluminum sulphate, commercial.....lb.	01	02	02½	02½
Aluminum sulphate, iron free.....lb.	02½	02½	03	03½
Aqua ammonia, 26 deg., drums (750 lb.).....lb.	07½	07½	08	08½
Ammonia, anhydrous, cyl. (100-150 lb.).....lb.	31	32	33	35
Ammonium carbonate, powder.....lb.	07	07½	08	09
Ammonium chloride, granular (white sal ammoniac).....lb.	07	07½	07½	07½
Ammonium chloride, granular (gray sal ammoniac).....lb.	07	07½	07½	07½
Ammonium nitrate.....lb.	07½	07½	07½	08½
Amylacetate tech.....gal.	—	—	2 40	2 70
Arsenic oxide, (white arsenic) powdered lb.....lb.	06	06½	06½	07
Arsenic, sulphide, powdered (red arsenic) lb.....lb.	11	11½	12	13
Barium chloride.....ton	58 00	60 00	62 00	70 00
Barium dioxide (peroxide).....lb.	20	21	22	23
Barium nitrate.....lb.	07½	08	08½	09
Barium sulphate (precip.) (blanc fixe) lb.....lb.	04	04½	04½	05
Bleaching powder (see calc. hypochlorite).....lb.	—	—	—	—
Blue vitriol (see copper sulphate).....lb.	—	—	—	—
Borax (see sodium borate).....lb.	—	—	—	—
Brimstone (see sulphur, roll).....lb.	—	—	—	—
Bromine.....lb.	27	28	28½	30
Calcium acetate.....100 lbs.	1 85	2 00	—	—
Calcium carbide.....lb.	04½	04½	05	05½
Calcium chloride, fused, lump.....ton	23 50	24 00	24 50	25 50
Calcium chloride, granulated.....lb.	01½	02	02½	02½
Calcium hypochloride (bleach) powder 100 lb.....lb.	2 25	2 30	2 35	3 00
Calcium peroxide.....lb.	—	—	1 40	1 50
Calcium phosphate, tribasic.....lb.	—	—	15	16
Camphor.....lb.	—	—	85	90
Carbon bisulphide.....lb.	06½	06½	07	07½
Carbon tetrachloride, drums.....lb.	10½	10½	11	12
Carbonyl chloride, (phosgene).....lb.	—	—	60	75
Caustic potash (see potassium hydroxide).....lb.	—	—	—	—
Caustic soda (see sodium hydroxide).....lb.	—	—	—	—
Chlorine, gas, liquid-cylinders (100 lb.) lb.....lb.	08	09	09½	10
Chloroform.....lb.	—	—	40	43
Cobalt oxide.....lb.	—	—	2 00	2 10
Copperas (see iron sulphate).....lb.	—	—	—	—
Copper carbonate, green precipitate.....lb.	20	20½	21	22
Copper cyanide.....lb.	—	—	50	62
Copper sulphate, crystals.....lb.	05	05½	05½	06
Cream of tartar (see potassium bitartrate).....lb.	—	—	—	—
Epsom salt (see magnesium sulphate).....lb.	—	—	—	—
Ethyl Acetate Com. 85%.....gal.	—	—	80	90
Ethyl Acetate pure (acetic ether, 98% to 100%).....gal.	—	—	95	—
Formaldehyde, 40 per cent.....lb.	11	11½	11½	12½
Fusel oil, ref.....gal.	—	—	2 50	3 00
Fusel oil, crude.....gal.	—	—	1 50	1 75
Glauber's salt (see sodium sulphate).....lb.	—	—	—	—
Glycerine, C. P. drums extra.....lb.	—	—	14½	15
Iodine, resublimed.....lb.	—	—	3 50	3 60
Iron oxide, red.....lb.	—	—	12	18
Iron sulphate (copperas).....ton	18 00	19 00	20 00	23 00
Lead acetate.....lb.	—	—	10½	12½
Lead arsenate, powd.....lb.	15	15½	15½	16½
Lead nitrate.....lb.	—	—	15	20
Litharge.....lb.	07½	08	08½	09
Lithium carbonate.....lb.	—	—	1 40	1 50
Magnesium carbonate, technical.....lb.	08	08½	09	10
Magnesium sulphate, U. S. P.....100 lb.	2 50	2 75	—	—
Magnesium sulphate, technical.....100 lb.	—	—	1 10	1 75
Methanol, 95%.....gal.	—	—	66	68
Methanol, 97%.....gal.	—	—	70	72
Nickel Salt, double.....lb.	—	—	12	12½
Nickel salt, single.....lb.	—	—	14	14½
Phosgene (see carbonyl chloride).....lb.	—	—	—	—
Phosphorus, red.....lb.	40	41	42	45
Phosphorus, yellow.....lb.	—	—	30	35
Potassium bichromate.....lb.	11	11½	11½	12

	Carlots	Less Carlots
Potassium bitartrate (cream of tartar).... lb.	\$.15 — .16	\$0.27 — \$0.29
Potassium bromide, granular..... lb.	.15 — .16	.16 — .20
Potassium carbonate, U. S. P..... lb.	.04 — .04	.05 — .06
Potassium carbonate, 80-85%..... lb.	.08 — .08	.08 — .12
Potassium chlorate, crystals..... lb.	.05 — .06	.40 — .45
Potassium cyanide..... lb.	.05 — .06	.06 — .08
Potassium hydroxide (caustic potash).... lb.	.07 — .07	.08 — .09
Potassium iodide..... lb.	.18 — .19	.20 — .22
Potassium nitrate..... lb.	.28 — .29	.29 — .30
Potassium permanganate..... lb.	.21 — .21	.21 — .22
Potassium prussiate, red..... lb.		
Potassium prussiate, yellow..... lb.		
Rochelle salts (see sodium potas tartrate)		
Salammoniac (see ammonium chloride)....		
Salt soda (see sodium carbonate).....		
Salt cake (bulk)..... ton		20.00 — 22.00
Silver cyanide..... oz.		1.35 — 1.38
Silver nitrate..... oz.		.46 — .47
Soda ash, light..... 100 lb.	2.10 — 2.15	2.20 — 2.60
Soda ash, dense..... 100 lb.	2.35 — 2.40	2.45 — 2.70
Sodium acetate..... lb.	.04 — .04	.04 — .05
Sodium bicarbonate..... 100 lb.	2.00 — 2.25	2.50 — 2.75
Sodium bichromate..... lb.	.08 — .08	.08 — .08
Sodium bisulphate (nitre cake)..... ton	5.00 — 5.25	5.50 — 6.50
Sodium bisulphate powdered, U.S.P..... lb.	.04 — .05	.05 — .06
Sodium borate (borax)..... lb.	.05 — .06	.06 — .07
Sodium carbonate (sal soda)..... 100 lb.	1.90 — 2.00	2.10 — 2.30
Sodium chloride..... lb.	.07 — .07	.08 — .08
Sodium cyanide..... lb.	.28 — .28	.29 — .30
Sodium fluoride..... lb.	.11 — .12	.12 — .14
Sodium hydroxide (caustic soda)..... 100 lb.	4.00 — 4.10	4.15 — 4.50
Sodium hyposulphite..... lb.	.07 — .07	.07 — .08
Sodium nitrite..... lb.	.25 — .26	.27 — .30
Sodium peroxide, powdered..... lb.	.04 — .04	.04 — .05
Sodium phosphate, dibasic..... lb.	.14 — .14	.15 — .15
Sodium potassium tartrate (Rochelle salts) lb.	.95 — 1.00	1.10 — 1.25
Sodium prussiate, yellow..... lb.	2.30 — 2.40	2.45 — 3.00
Sodium silicate, solution (40 deg.)..... 100 lb.	1.50 — 1.75	2.00 — 2.25
Sodium silicate, solution (60 deg.)..... 100 lb.	.04 — .05	.05 — .05
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	.03 — .03	.04 — .04
Sodium sulphide, fused, 60-62 per cent (conc.) lb.	.12 — .13	.13 — .20
Sodium sulphite, crystals..... lb.	.05 — .05	.05 — .06
Strontium nitrate, powdered..... lb.	18.00 — 20.00	.09 — .10
Sulphur chloride, red..... ton	.08 — .08	.25 — 3.10
Sulphur, crude..... lb.		2.00 — 2.75
Sulphur dioxide, liquid, cylinders extra..... lb.	.08 — .09	.09 — .10
Sulphur (sublimed), flour..... 100 lb.	.16 — .16	.17 — .17
Sulphur, roll (brimstone)..... 100 lb.	.09 — .09	.09 — .10
Tin bichloride..... lb.	.42 — .44	.45 — .47
Tin oxide..... lb.	.11 — .11	.11 — .12
Zinc carbonate, precipitate..... lb.	.07 — .07	.08 — .09
Zinc chloride, gran..... lb.	3.00 — 3.25	3.30 — 3.50
Zinc cyanide..... lb.		
Zinc dust..... lb.		
Zinc oxide, XX..... lb.		
Zinc sulphate..... 100 lb.		

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude..... lb.	\$1.15 — \$1.20
Alpha-naphthol, refined..... lb.	1.25 — 1.30
Alpha-naphthylamine..... lb.	.27 — .30
Aniline oil, drums extra..... lb.	.18 — .20
Aniline salts..... lb.	.24 — .26
Anthracene, 80% in drums (100 lb.)..... lb.	.75 — 1.00
Benzaldehyde U.S.P..... lb.	1.35 — 1.45
Benzidine, base..... lb.	.90 — 1.00
Benzidine sulphate..... lb.	.75 — .85
Benzoic acid, U.S.P..... lb.	.60 — .65
Benzoate of soda, U.S.P..... lb.	.52 — .55
Benzene, pure, water-white, in drums (100 gal.)..... gal.	.27 — .32
Benzene, 90%, in drums (100 gal.)..... gal.	.25 — .28
Benzyl chloride, 95-97%, refined..... lb.	.25 — .27
Benzyl chloride, tech..... lb.	.20 — .23
Beta-naphthol benzoate..... lb.	3.75 — 4.00
Beta-naphthol, sublimed..... lb.	.70 — .75
Beta-naphthol, tech..... lb.	.31 — .34
Beta-naphthylamine, sublimed..... lb.	1.75 — 1.85
Cresol, U. S. P., in drums (100 lb.)..... lb.	.16 — .17
Ortho-cresol, in drums (100 lb.)..... lb.	.25 — .27
Cresylic acid, 97-99%, straw color, in drums..... gal.	.70 — .80
Cresylic acid, 95-97%, dark, in drums..... gal.	.65 — .70
Cresylic acid, 50%, first quality, drums..... gal.	.45 — .50
Dichlorobenzene..... lb.	.06 — .09
Diethylaniline..... lb.	1.10 — 1.20
Dimethylaniline..... lb.	.45 — .60
Dinitrobenzene..... lb.	.23 — .27
Dinitrochlorobenzene..... lb.	.20 — .25
Dinitronaphthalene..... lb.	.30 — .35
Dinitrophenol..... lb.	.35 — .40
Dinitrotoluene..... lb.	.25 — .30
Dip oil, 25%, car lots, in drums..... gal.	.30 — .35
Diphenylamine..... lb.	.60 — .70
H-acid..... lb.	1.05 — 1.15
Meta-phenylenediamine..... lb.	1.15 — 1.20
Monochlorobenzene..... lb.	.12 — .14
Monothylaniline..... lb.	1.65 — 1.70
Naphthalene crushed, in bbls..... lb.	.07 — .08
Naphthalene, flake..... lb.	.07 — .08
Naphthalene, balls..... lb.	.08 — .09
Naphthionic acid, crude..... lb.	.70 — .75
Nitrobenzene..... lb.	.12 — .15
Nitro-naphthalene..... lb.	.30 — .35
Nitro-toluene..... lb.	.15 — .17
Ortho-amidophenol..... lb.	3.00 — 3.10
Ortho-dichlor-benzene..... lb.	.15 — .20
Ortho-nitro-phenol..... lb.	.75 — .80
Ortho-nitro-toluene..... lb.	.15 — .20
Ortho-toluidine..... lb.	.20 — .25
Para-amidophenol, base..... lb.	1.40 — 1.45
Para-amidophenol, HCl..... lb.	1.70 — 1.80
Para-dichlorobenzene..... lb.	.12 — .15
Paranitroaniline..... lb.	.77 — .80
Para-nitrotoluene..... lb.	.80 — .85
Para-phenylenediamine..... lb.	1.70 — 1.75
Para-toluidine..... lb.	1.25 — 1.40
Phthalic anhydride..... lb.	.40 — .50

Phenol, U. S. P., drums..... lb.	.09 — .12
Pyridine..... gal.	2.00 — 3.50
Resorcinol, technical..... lb.	1.50 — 1.60
Resorcinol, pure..... lb.	2.00 — 2.25
Salicylic acid, tech., in bbls..... lb.	.18 — .20
Salicylic acid, U. S. P..... lb.	.19 — .22
Salol..... lb.	.70 — .72
Solvent naphtha, water-white, in drums, 100 gal..... gal.	.25 — .28
Solvent naphtha, crude, heavy, in drums, 100 gal..... gal.	.14 — .16
Sulphanilic acid, crude..... lb.	.27 — .30
Tolidine..... lb.	1.30 — 1.35
Toluidine, mixed..... lb.	.43 — .45
Toluene, in tank cars..... gal.	.25 — .28
Toluene, in drums..... gal.	.28 — .31
Xylidines, drums, 100 gal..... lb.	.40 — .45
Xylene, pure, in drums..... gal.	.40 — .45
Xylene, pure, in tank cars..... gal.	.45 — .45
Xylene, commercial, in drums, 100 gal..... gal.	.33 — .35
Xylene, commercial, in tank cars..... gal.	.30 — .35

Waxes

Prices based on original packages in large quantities.

Bayberry Wax..... lb.	\$0.21 — \$0.22
Beeswax, refined, dark..... lb.	.24 — .25
Beeswax, refined, light..... lb.	.28 — .30
Beeswax, white pure..... lb.	.34 — .38
Candellila wax..... lb.	.25 — .25
Carnauba, No. 1..... lb.	.45 — .46
Carnauba, No. 2, North Country..... lb.	.23 — .23
Carnauba, No. 3, North Country..... lb.	.14 — .15
Japan..... lb.	.22 — .22
Montan, crude..... lb.	.04 — .04
Paraffine waxes, crude match wax (white) 105-110 m.p..... lb.	.04 — .04
Paraffine waxes, crude, scale 124-126 m.p..... lb.	.04 — .04
Paraffine waxes, refined, 118-120 m.p..... lb.	.04 — .04
Paraffine waxes, refined, 125 m.p..... lb.	.04 — .04
Paraffine waxes, refined, 128-130 m.p..... lb.	.04 — .05
Paraffine waxes, refined, 133-135 m.p..... lb.	.05 — .05
Paraffine waxes, refined, 135-137 m.p..... lb.	.05 — .06
Stearic acid, single pressed..... lb.	.09 — .09
Stearic acid, double pressed..... lb.	.10 — .10
Stearic acid, triple pressed..... lb.	.11 — .11

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on earload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl..... 280 lb.	\$5.80 — 5.80
Rosin E-I..... 280 lb.	5.85 — 5.90
Rosin K-N..... 280 lb.	6.40 — 6.85
Rosin W. G. W. W..... 280 lb.	7.10 — 7.30
Wood rosin, bbl..... 280 lb.	6.25 — .
Spirits of turpentine..... gal.	.80 — .
Wood turpentine, steam dist..... gal.	.78 — .
Wood turpentine, dest. dist..... gal.	.76 — .
Pine tar pitch, bbl..... 200 lb.	. — 6.50
Tar, kiln burned, bbl. (500 lb.)..... bbl.	. — 10.00
Retort tar, bbl..... 500 lb.	. — 10.00
Rosin oil, first run..... gal.	.35 — .
Rosin oil, second run..... gal.	.37 — .
Rosin oil, third run..... gal.	.44 — .
Pine oil, steam dist., sp.gr. 0.930-0.940..... gal.	\$1.90 — .
Pine oil, pure, dest. dist..... gal.	1.50 — .
Pine tar oil, ref., sp.gr. 1.025-1.035..... gal.	.46 — .
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla..... gal.	.35 — .
Pine tar oil, double ref., sp.gr. 0.965-0.990..... gal.	.75 — .
Pine tar, ref., thin, sp.gr. 1.080-1.960..... gal.	.35 — .
Turpentine, crude, sp. gr., 0.900-0.970..... gal.	1.25 — .
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990..... gal.	.35 — .
Pinewood creosote, ref..... gal.	.52 — .

Solvents

73-76 deg., steel bbls. (85 lb.)..... gal.	\$0.37 — .
70-72 deg., steel bbls. (85 lb.)..... gal.	.35 — .
68-70 deg., steel bbls. (85 lb.)..... gal.	.34 — .
V. M. and P. naphtha, steel bbls. (85 lb.)..... gal.	.23 — .

Fertilizers

Ammonium sulphate, bulk and d. bags..... 100 lb.	\$2.50 — 3.00
Blood, dried, f.o.b., N. Y..... unit	4.00 — .
Bone, 3 and 50, ground, raw..... ton	30.00 — 32.00
Cyanamide, f.o.b. works..... unit	4.50 — .
Fish scrap, dom., dried, f.o.b. works..... unit	2.90 — 3.00
Nitrate soda..... 100 lb.	2.35 — 2.45
Tankage, high grade, f.o.b. Chicago..... unit	3.00 — 3.10
Phosphate rock, f.o.b. mines, Florida pebble, 68-72 p.c..... ton	4.50 — 6.50
Tennessee, 78-80 p.c..... ton	8.50 — 9.00
Potassium muriate, 80 p.c..... ton	37.00 — 40.00
Potassium sulphate..... unit	1.00 — 1.10

Crude Rubber

Para-Upriver fine..... lb.	\$0.21 — .21
Upriver coarse..... lb.	.11 — .12
Upriver cauchoo ball..... lb.	.11 — .12
Plantation—First latex crepe..... lb.	.15 — .15
Ribbed smoked sheets..... lb.	.15 — .15
Brown crepe, thin, clean..... lb.	.15 — .
Amber crepe No. 1..... lb.	.17 — .

Oils

VEGETABLE

The following prices are f.o.b. New York for earload lots.

Castor oil, No. 3, in bbls..... lb.	\$0.10 — \$0.10
Castor oil, A.A. in bbls..... lb.	.11 — .12
China wood oil, in bbls. (f.o.b. Pac. coast)..... lb.	.13 — .13
Cocanut oil, Ceylon grade, in bbls..... lb.	.09 — .09
Cocanut oil, Cochui grade, in bbls..... lb.	.10 — .10
Corn oil, crude, in bbls..... lb.	.10 — .10
Cottonseed oil, crude (f. o. b. mill)..... lb.	.06 — .07
Cottonseed oil, summer yellow..... lb.	.08 — .09
Cottonseed oil, winter yellow..... lb.	.09 — .09

Linseed oil, raw, ear lots (domestic)	gal.	67	—	68
Linseed oil, raw, tank cars (domestic)	gal.	62	—	63
Linseed oil, in 5-bbl lots (domestic)	gal.	70	—	71
Olive oil, Denatured	gal.	\$1.15	—	\$1.20
Palm, Lagos	lb.	.07½	—	.07¾
Palm, Niger	lb.	.06½	—	.06¾
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.08½	—	.08¾
Peanut oil, refined, in bbls.	lb.	.11½	—	.11¾
Rapeseed oil, refined in bbls.	gal.	.84	—	.86
Rapeseed oil, blown, in bbls.	gal.	.92	—	.94
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.09	—	....
Soya bean oil, tank cars, f.o.b., Pacific coast.	lb.	.07½	—	....

FISH

Light pressed menhaden	gal.	\$0.40	—	....
Yellow bleached menhaden	gal.	.42	—	....
White bleached menhaden	gal.	.45	—	....
Blown menhaden	gal.	.48	—	....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	\$24.00	—	30.00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	20.00	—	24.00
Barytes, crude, 88% @ 94% ba., Kings Creek	net ton	10.00	—	12.00
Barytes, floated, f.o.b. St. Louis	net ton	23.00	—	24.00
Barytes, crude, first grade, Missouri	net ton	7.00	—	....
Blanc fixe, dry	lb.	.04	—	.04½
Blanc fixe, pulp	net ton	45.00	—	55.00
Casein	lb.	.07	—	.10
Chalk, Precipitated, domestic, extra light	lb.	.04½	—	.05
Chalk, Precipitated, domestic, light	lb.	.04	—	.04½
Chalk, Precipitated, domestic, heavy	lb.	.03½	—	.04
Chalk, Precipitated, English, extra light	lb.	.04½	—	.05
Chalk, Precipitated, English, light	lb.	.04½	—	.05
Chalk, Precipitated, English, dense	lb.	.04	—	.04½
China clay (kaolin) crude, f.o.b. mines, Georgia	net ton	6.50	—	8.50
China clay (kaolin) washed, f.o.b. Georgia	net ton	9.00	—	10.00
China clay (kaolin) powdered, f.o.b. Georgia	net ton	13.00	—	20.00
China clay (kaolin) crude f.o.b. Virginia points	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points	net ton	13.00	—	20.00
China clay (kaolin), imported, lump	net ton	12.00	—	20.00
China clay (kaolin), imported, powdered	net ton	25.00	—	30.00
Feldspar, crude, f.o.b. Maryland and North Carolina points	net ton	5.00	—	7.50
Feldspar, crude, f.o.b. Maine	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore	net ton	27.00	—	30.00
Fullers earth, f.o.b. Mines	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Pa.	net ton	15.00	—	18.00
Fullers earth, powdered, f.o.b. Fla.	net ton	18.00	—	....
Fullers earth, imported, powdered	net ton	24.00	—	27.00
Graphite, Ceylon lump, first quality	lb.	.06	—	.07
Graphite, Ceylon chip	lb.	.04½	—	.05
Graphite, high grade amorphous crude	lb.	.00¾	—	.02½
Kieselguhr, f.o.b. mines, Cal.	per ton	40.00	—	....
Kieselguhr, f.o.b. N.Y.	per ton	55.00	—	60.00
Magnesite, calcined	per ton	60.00	—	65.00
Pumice stone, imported	lb.	.03	—	.40
Pumice stone, domestic, lump	lb.	.05	—	.05½
Pumice stone, domestic, ground	lb.	.06	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore	net ton	....	—	10.00
Quartz (acid tower) 1½ @ 2 in., f.o.b. Baltimore	net ton	....	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore	net ton	....	—	17.00
Quartz, lump, f.o.b. North Carolina	net ton	5.00	—	7.50
Shellac, orange fine	lb.	.68	—	.70
Shellac, orange superfine	lb.	.78	—	.80
Shellac, A. C. garnet	lb.	.58	—	.60
Shellac, T. N.	lb.	.68	—	.70
Soapstone	ton	12.00	—	15.00
Sodium chlorate	long ton	12.50	—	13.00
Talc, paper-making grades, f.o.b. Vermont	ton	11.00	—	18.00
Talc, roofing grades, f.o.b. Vermont	ton	8.50	—	13.00
Talc, rubber grades, f.o.b. Vermont	ton	11.00	—	18.00
Talc, powdered, Southern, f.o.b. cars	ton	7.50	—	11.00
Talc, imported	ton	30.00	—	40.00
Talc, California talcum powder grade	ton	18.00	—	25.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh	per ton	\$50.00	—	....
Carborundum refractory brick, 9-in.	1,000	1250.00	—	....
Chrome brick, f.o.b. Eastern shipping points	net ton	52-55	—	....
Chrome cement, 40-45% Cr ₂ O ₃	net ton	30-32	—	....
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in ear lots, f.o.b. Eastern shipping points	net ton	33-35	—	....
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	35-40	—	....
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	30-35	—	....
Magnesite brick, 9-in. straight	net ton	65-70	—	....
Magnesite brick, 9-in. arches, wedges and keys	net ton	77	—	....
Magnesite brick, soaps and splits	net ton	98	—	....
Silica brick, 9-in. sizes, f.o.b. Chicago district	1,000	40-42	—	....
Silica brick, 9-in. sizes, f.o.b. Birmingham district	1,000	42-45	—	....
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.	1,000	35-38	—	....

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	\$200.00	—	225.00
Ferrochrome per lb. of Cr. contained, 6-8% carbon, earlots	lb.	.11	—	....
Ferrochrome, per lb. of Cr. contained, 4-6% carbon, earlots	lb.	.11	—	.12
Ferromanganese, 76-80% Mn, domestic	gross ton	58.00	—	60.00
Ferromanganese, 76-80% Mn, English & German	gross ton	60.00	—	62.00
Spiegel, 18-22% Mn	gross ton	25.00	—	27.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo	lb.	2.25	—	....
Ferrosilicon, 10-15%	gross ton	38.00	—	40.00
Ferrosilicon, 50%	gross ton	57.00	—	59.00
Ferrosilicon, 75%	gross ton	120.00	—	125.00
Ferrotungsten, 70-80%, per lb. of contained W	lb.	.40	—	.45
Ferroumium, 35-50% of U, per lb. of U content	lb.	.60	—	....
Ferrovandium, 30-40% per lb. of contained V	lb.	.4.25	—	.4.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content	net ton	\$8.00	—	\$10.00
Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃	ton	22.00	—	23.00
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard	ton	22.00	—	23.00
Coke, foundry, f.o.b. ovens	net ton	4.25	—	4.50
Coke, furnace, f.o.b. ovens	net ton	3.25	—	3.50
Fluorspar, gravel, f.o.b. mines, New Mexico	net ton	15.00	—	....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	20.00	—	22.00
Ilmenite, 52% TiO ₂ , per lb. ore	lb.	.01½	—	.01¾
Manganese ore, 50% Mn, c.i.f. Atlantic seaport	unit	.22	—	.23
Manganese ore, chemical (MnO ₂)	net ton	50.00	—	55.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.	lb.	.45	—	.50
Monazite, per unit of ThO ₂ , c.i.f., Atlantic seaport	unit	30.00	—	....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.12	—	.12
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport	unit	.13	—	.13
Pyrites, domestic, fines, f.o.b. mines, Ga.	unit	.11	—	.12
Rutile, 95% TiO ₂ per lb. ore	lb.	.15	—	....
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal)	unit	2.50	—	2.75
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.	unit	2.75	—	3.00
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	1.25	—	1.75
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.25	—	2.50
Vanadium pentoxide, 99%	lb.	12.00	—	14.00
Vanadium ore, per lb. of V ₂ O ₅ contained	lb.	1.00	—	....
Zircon, washed, iron free, f.o.b. Pablo, Florida	lb.	.04½	—	.13

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	13.125
Aluminum, 98 to 99 per cent	24.50@25.00
Antimony, wholesale lots, Chinese and Japanese	4.80@5.25
Nickel, ordinary (ingot)	41.00
Nickel, electrolytic	44.00
Monel metal, shot and blocks	35.00
Monel metal, ingots	38.00
Monel metal, sheet bars	40.00
Tin, 5-ton lots, Straits	28.375
Lead, New York, spot	4.67@4.70
Lead, E. St. Louis, spot	4.32@4.40
Zinc, spot, New York	5.15@5.20
Zinc, spot, E. St. Louis	4.70@4.75

OTHER METALS

Silver (commercial)	oz.	\$0.70
Cadmium	lb.	1.00-1.25
Bismuth (500 lb. lots)	lb.	1.50@1.55
Cobalt	lb.	3.00@3.25
Magnesium (f.o.b. Philadelphia)	lb.	1.25
Platinum	oz.	85.00
Iridium	oz.	150.00@170.00
Palladium	oz.	55.00-60.00
Mercury	75 lb.	40.00-41.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	20.50
Copper bottoms	28.00
Copper rods	19.00@19.75
High brass wire	15.75
High brass rods	13.25
Low brass wire	17.25
Low brass rods	17.25
Brazed brass tubing	25.00
Brazed bronze tubing	29.75
Seamless copper tubing	19.50
Seamless high brass tubing	18.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current	Cleveland	Chicago
Copper, heavy and crucible	9.75@10.25	9.25	9.50
Copper, heavy and wire	9.25@9.50	8.50	8.50
Copper, light and bottoms	7.50@8.00	7.50	7.25
Lead, heavy	3.50@3.75	3.25	3.25
Lead, tea	2.25@2.35	2.25	2.25
Brass, heavy	4.25@4.50	4.50	5.00
Brass, light	3.25@3.50	3.25	3.50
No. 1 yellow brass turnings	4.00@4.25	4.25	4.50
Zinc	2.00@2.25	2.00	2.25

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ½ in. and larger, and plates ½ in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes	\$2.88	\$2.88	\$2.88
Soft steel bars	2.78	2.78	2.78
Soft steel bar shapes	2.78	2.78	2.78
Soft steel bands	3.42	3.48	3.48
Plates, ½ to 1 in. thick	2.68	2.88	2.88

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

TUSCALOOSA—F. G. Blair, Tuscaloosa, will head the new company now being organized under the auspices of the local Chamber of Commerce, J. B. Brosius, secretary, to construct and operate a new plant for the manufacture of bond and kraft paper. The company will be capitalized at \$2,000,000, and the new mills are estimated to cost close to \$1,000,000. It is proposed to develop a daily production of about 50 tons.

California

MERCED—The California Pottery Co. has begun operations at its new local plant, placing 4 kilns, recently completed, in service. The initial unit will comprise a total of 16 kilns, and these will be completed and placed in operation as quickly as possible. Employment will be given to about 30 operatives, and this number will be gradually increased as the plant expands.

LOS ANGELES—The International Shales Process Co. has awarded a contract to the Golden State Construction Co., 415-17 Delta Bldg., for the erection of a series of distillation plants for oil-refining operations in California, Utah, Nevada and Colorado. Each plant unit is estimated to cost close to \$90,000, and it is said that a total of 100 plants will be constructed. The first refinery will be located in Kern County.

Connecticut

NEW HAVEN—The New York, New Haven & Hartford R.R. Co. has awarded a contract to the American Creosoting Co., 17 Battery Pl., New York, for the erection of a new local creosoting treatment plant for railroad ties, with annual capacity of about 1,500,000 cross-ties. It is expected to have the plant ready for operation during the coming spring.

Delaware

SOUTH WILMINGTON—The Wilmington Sugar Refining Co. is pushing construction on its new local refinery, and expects to have the entire project completed within 24 months; certain units will be ready prior to this time and placed in operation. The plant will occupy a 12-acre site in the vicinity of B St., and will consist of a total of 10 buildings, estimated to cost, with machinery, in excess of \$7,000,000. A wharf about 800 ft. long will be built along the Christiana River. The Armstrong & Latta Co., Land Title Bldg., Philadelphia, Pa., has the erection contract.

Illinois

CICERO—The Oriental Glass Manufacturing Co. has purchased 10 acres at West 33d St. and 52nd Ave., Cicero, for the erection of a glass factory to cost \$175,000 and will manufacture colored sheet glass. The plant will be complete for operation within the next three months.

CHICAGO—Paul G. Carhardt, architect, is preparing plans for a 2-story concrete and mill construction dyeing plant, 500 x 150 ft., to be built at Grand Ave. near 54th Ave.

Maryland

POCOMOKE CITY—The Pocomoke City Roller Mills has preliminary plans under way for the erection of a new flour mill on local site. It will be 3-story and basement, 40 x 55 ft., and is estimated to cost about \$35,000. Bids for construction are expected to be called near the close of the year. W. S. Jewell heads the company.

BALTIMORE—Fire, Oct. 29, destroyed one of the plants of the Baltimore Brick Co., Maryland Trust Bldg., at Highland Ave. and Monument St., with loss estimated at close to \$100,000. The loss included 5 kiln buildings, machine shops, power house and other structures. It is said that the plant will be rebuilt. Warren Griffiss is general manager.

BALTIMORE—The Cooknut Corp., Lexington and Paea Sts., has construction

under way on its new 4-story plant, 80 x 100 ft., on Canton St., to be equipped for the manufacture of lard substitutes, estimated to cost about \$100,000 with machinery. W. R. Spruill is president.

CRISFIELD—The Standard Oil Co., Pratt St., Baltimore, is considering the construction of a large oil-distributing plant at Crisfield, and a number of available sites are being inspected. It is purposed to make this the main distributing works in the central Atlantic coast district, and extensive tankage and equipment will be provided.

Massachusetts

PITTSFIELD—The Pittsfield Lime & Stone Co. has plans under way for enlargements in its plant at Richmond Summit. Four new kilns will be constructed and present kilns altered and improved. New operating equipment will be installed.

ROXBURY—Fire, Oct. 31 destroyed a building at 10 Hampden St., occupied by the Chadwick-Boston Lead Co., for general service, with loss estimated at about \$30,000.

BOSTON—The Tileston & Hollingsworth Co., 892 River St., Hyde Park, manufacturer of paper products, has construction under way on a new plant addition on River St., to be equipped as a paper washery. It is estimated to cost about \$23,000. The Aberthaw Construction Co., 27 School St., Boston, has the erection contract.

WORCESTER—The American Steel & Wire Co. is building a 3-story addition to its South Works, 120 x 145 ft., estimated to cost about \$150,000. It is expected to have the structure ready for service at an early date.

Minnesota

MINNEAPOLIS—The Minnesota Mfg. Co., 722 North Third St., manufacturer of sweeping compounds and other chemical specialties, is taking new bids for the erection of a 3-story plant on Eighth Ave., near Third St., estimated to cost about \$35,000. It will be 46 x 130 ft. E. J. Miller is secretary.

Missouri

SPRINGFIELD—The Bromite White Lime Co., Woodruff Bldg., is considering the erection of a new 2-story and basement plant, with cost estimated at about \$50,000. It is expected to have plans drawn at an early date. D. F. Klepinger is secretary.

COLUMBIA—The Edwards Brick Co., St. Louis, recently reorganized with a capital of \$50,000, is planning for the establishment of a new plant at Columbia for the manufacture of brick and other burned clay products. S. E. Cullom is ceramic engineer for the company.

Nebraska

OMAHA—The Omaha Semi-Steel Foundry Co., 1409 Jackson St., has taken bids for the erection of a new 1- and 2-story foundry at Eleventh and Grace Sts., 60 x 100 ft., and will commence construction at an early date. W. F. Gernandt, 701 O. L. & B. Association Bldg., is architect.

New Jersey

NEWARK—Fire, Oct. 29, destroyed a portion of the plant of the Thrift Rubber Co., Woosyc St., Irvington, with loss estimated at about \$10,000.

WHARTON—The Replogle Steel Corp. is completing extensions and improvements at its local plant, under way for some time past, and will hold the works in readiness to operate as soon as market conditions warrant. The steel plant consists of two blast furnaces and a sintering plant, with auxiliary departments, said to be valued in excess of \$5,000,000.

EDGEWATER—The Archer Daniels Linseed Co., 20 Ninth Ave., Minneapolis, Minn., has awarded a contract to the Tilt-Hargan Co., 90 West Broadway, New York, for the erection of its new plant at Edgewater. It will consist of a main 3-story oil works, 150 x 250 ft.; three 1-story warehouse buildings; four grain tanks, each about 100 ft. high; and electric power plant for operation. Work will be commenced at once. Samuel Mairs is secretary.

North Carolina

MONROE—The Hender on Rolling Mills Co. has awarded a contract to J. S. Sterns, Monroe, for the erection of a new flour mill on local site, estimated to cost about \$40,000. J. E. Henderson is president.

CHARLOTTE—The North Charlotte Creosoting Co., recently organized with a capital of \$100,000, is planning for the erection of a new creosoting plant for timber treatment, with initial capacity of about 50,000 ft. of material per day. A retort, 68 ft. long, will be constructed in connection with the other works departments.

Ohio

ASHTABULA—The Silurim Mfg. Co., 421 Sloan Bldg., Eugene W. Steinbrenner, president, has plans under way for the erection of a new plant at Ashtabula, for the manufacture of rubber insulating materials. It will be 4-story, brick, and is estimated to cost in excess of \$750,000, including machinery. Alfred W. Harris, Schofield Bldg., Cleveland, is architect.

YOUNGSTOWN—The Vahey Oil Co. has plans under way for the erection of a new 1-story building on West Rayen St. Stanley & Scheibel, Wick Bldg., are architects. W. H. Vahey is president.

AKRON—A. C. Horrocks, formerly connected with the local plant of the Goodyear Tire & Rubber Co., has organized a new company with capital of \$50,000, for the manufacture of rubber specialties. The new organization has leased the plant of the Denmead Rubber Co., and will commence operations at an early date.

Pennsylvania

PHILADELPHIA—Horace T. Potts & Co., 316 North Third St., manufacturer of iron and steel products, has broken ground for the erection of a new 1-story foundry at Erie Ave. and D Sts., to be used in connection with an extensive new plant at this location. The William Steele & Sons Co., 1600 Arch St., is contractor.

SCRANTON—The Diamond Oil & Paint Co., 211-19 South Seventh Ave., has taken bids and will soon award contract for the erection of a new 2-story building, 60 x 100 ft., on Seventh Ave., estimated to cost about \$60,000. Edward J. Lynott is president.

PHILADELPHIA—The Wittman Moriarty Co., Fourth and Vine Sts., manufacturer of leather products, has taken bids for the erection of an addition to its tanning plant at Ontario and C Sts. Work will be commenced at an early date.

South Carolina

SPARTANBURG—Caldwell & Co., manufacturers of cottonseed products, are planning for the erection of a new plant, about 25 x 65 ft. Ralph M. Caldwell is secretary and manager.

Tennessee

KNOXVILLE—The Knoxville Fertilizer Co. has awarded a contract to the Foundation Co., 120 Liberty St., New York, for the erection of its proposed new plant in Vestal section, to be 154 x 350 ft., and estimated to cost about \$200,000. The plant will be equipped for an annual output of about 50,000 tons of acid phosphate. Manley & Young 814 West Hill Ave., are engineers. James W. Dean is secretary-treasurer.

Texas

MEXIA—The Texas-Mexia Co. will soon commence the installation of a 50-bbl. still at its properties, and plans for the installing of other equipment at its refinery for increased output.

DALLAS—The Superior Chemical Products Co., recently organized, has acquired the plant of the Southern States Chemical Co., and will use the works for the manufacture of general chemicals for fire-extinguishing and other service.

WACO—The Southwestern Portland Cement Co., El Paso, has preliminary plans under way for its proposed new mill in the vicinity of Waco, estimated to cost in excess of \$2,000,000. O. J. Binford is secretary.

Virginia

LYNCHBURG—The Kerr & Wilson Co. has completed plans and will soon commence the erection of a new plant at South Roanoke, Va., for the manufacture of wood extract products. It will be 1-story, 80 x 130 ft.; estimated cost about \$30,000.

West Virginia

MORGANTOWN—The University of West Virginia has preliminary plans under way for the erection of a new chemical laboratory, estimated to cost about \$400,000. Bids will be asked early in 1922. Lee Coulter is dean.

Industrial Notes

BEN L. WHITNEY, formerly with the Byers Company, has opened an office at 528 Detroit Savings Bank Bldg., Detroit, Mich., as representative of Orton & Steinbrenner Co., manufacturer of material handling machinery, coal crushers, drag-line excavators, locomotives, etc.

THE YORK HEATING & VENTILATING CORP., Philadelphia, Pa., announces that Thornton Lewis, who for the last fifteen years has been associated with the Buffalo Forge Co. and actively identified with the heating, ventilating and air-conditioning profession, has joined the organization as vice-president and general manager. He is a member of the executive committee in charge of the research laboratory established by the American Society of Heating and Ventilating Engineers at the Bureau of Mines, Pittsburgh. During the war period Mr. Lewis was consulting engineer for the du Pont companies of Wilmington, Del., having charge of the design and supervision of all heating, ventilating and drying installations. This company recently moved from York, Pa., to Bridgeport, Pa., where it has a plant of 50,000 sq. ft. of floor space with a 400-ft. frontage on the Reading railroad.

THE QUIGLEY FURNACE SPECIALTIES CO., INC., New York, announces that its pulverized fuel department has been acquired by the Hardinge Co., New York. The Hardinge Co. states there will be no change in the method of conducting the business at its offices, as the organization of the engineering department has been taken over practically intact. This transfer will in no way affect the refractory specialties business, which includes the manufacture and sales of Hytempite, Insulbrix and Insuline products.

CHICAGO PNEUMATIC TOOL CO. advises the public that it has brought suit in the United States District Court in the Western District of Michigan against the Keller Pneumatic Tool Co. for injunction and accounting of profits and damages due to alleged infringements of certain United States patents by their manufacture and sale of the so-called "Keller-Master Super-Hammer." The patents involved are Nos. 879,106, 897,958, 1,029,082 and 1,126,096. Suit has also been brought against the H. Channon Co. in the United States District Court at Chicago for alleged infringement by the sale and offering for sale of the above-mentioned Keller hammers and for unfair competition by acts calculated to produce confusion in the trade. These suits should not be confused with the one heretofore brought against the Keller Pneumatic Tool Co. in the United States District Court at Philadelphia for alleged infringement of patents 730,887, 822,147, 866,573 and 917,242, which suit is being vigorously prosecuted. Suit is also pending in the United States District Court at Chicago against the Keller Pneumatic Tool Co. for alleged infringement by the use of the trade name "Keller" and certain other trademarks of the Chicago Pneumatic Tool Co.

Capital Increases, Etc.

THE METROPOLITAN OIL CORP., Indianapolis, Ind., a Delaware corporation, has filed notice of increase in capital from \$5,000,000 to \$10,000,000.

THE LOUIS J. ROBINSON TANNING CO., a New Jersey corporation, has filed notice of organization to operate in New York, with capital of \$100,000. The company is represented by L. J. Robertson, 450 West End Ave.

THE MANITO CHEMICAL FERTILIZER CO., 1205 Lehmann Bldg., Peoria, Ill., has filed notice of change of name to the Manito Chemical Co., at the same time increasing its capital from 2,000 shares of stock, no par value, to \$150,000.

THE OJOY CHEMICAL CO., INC., Syracuse, N. Y., has filed a voluntary petition in bankruptcy, with liabilities stated at \$20,317 and assets, \$6,975.

THE MICHIOAN PAINT CO., Detroit, Mich., has filed notice of dissolution under state laws.

THE ACORN BRASS MFG. CO., 426 South Clinton St., Chicago, Ill., has filed notice of reduction in capital from \$30,000 to \$15,000.

THE TAYLOR-WARTON IRON & STEEL CO., 30 Church St., New York, N. Y., manufacturer of alloy steel and iron castings, etc., with plant at High Bridge, N. J., has arranged for a bond issue to total \$3,250,000.

Daniel J. O'Connell has been appointed receiver for the HAMILTON PAPER BOX CO., 69 Greene St., New York, N. Y.

New Companies

THE PHILADELPHIA ASBESTOS CO., Philadelphia, Pa., has been incorporated with a capital of \$12,000, to manufacture asbestos products. J. W. Hoffman, Jr., 5226 North Fairhill St., is treasurer.

THE MIOLA CHEMICAL CORP., Montclair, N. J., has been incorporated with a capital of \$25,000, to manufacture chemical products. The incorporators are Paul H. Sullivan, Charles S. Shirley and James E. Lally, 88 Grove St., Montclair.

THE AMERICAN-MEXICAN REFINING CO., 11 South La Salle St., Chicago, Ill., has been incorporated with a capital of \$100,000, to manufacture refined oil products. The incorporators are N. O. Johnson, D. A. Tasiopoulos, and Henry L. Blim.

THE CLAY CRAFT POTTERIES, INC., Los Angeles, Cal., has been incorporated with a capital of \$300,000, to manufacture pottery specialties. The incorporators are E. R. Carpenter, Los Angeles; W. P. Yoo and M. H. Carpenter, Glendale, Cal.

THE NEPON DRUG & CHEMICAL CO., Rockaway Park, L. I., has been incorporated with a capital of \$50,000, to manufacture chemicals, chemical byproducts, drug specialties, etc. The incorporators are T. J. Smith, G. F. Wolfe and J. Clark. The company is represented by Joseph Shalleck, 152 West 42d St., New York.

THE REED & FIBRE CORP., Gardner, Mass., has been incorporated with a capital of \$50,000, to manufacture fiber products and affiliated specialties. Maurice J. Taub is vice-president; and Nathan Gewandter, 62 A St., Gardner, treasurer.

THE EAGLE CEMENT CORP., Jersey City, N. J., has been incorporated with a capital of \$150,000, to manufacture cement products. The company is represented by the United States Corporation Co., 15 Exchange Pl., Jersey City.

THE UNION BLUE CORP., New York, N. Y., has been incorporated with a capital of \$50,000, to manufacture blueing, chemical specialties, etc. The incorporators are S. and L. Pressner, and B. Frankel. The company is represented by G. C. Young, 165 Broadway, New York.

THE ROMANITE PRODUCTS CORP., Buffalo, N. Y., has been incorporated with a capital of \$500,000, to manufacture tile specialties, composition products, etc. The incorporators are E. A. Willson, A. L. Kink and R. M. Houser, 702 Mutual Life Bldg., Buffalo.

THE CHICAGO CHINA DECORATING WORKS, INC., 1529 West 21st St., Chicago, Ill., has been incorporated with a capital of \$20,000, to manufacture chinaware and other pottery products. The incorporators are Jacob Williamson, Edwin M. Conway and R. E. Leopold.

THE SOUTHERN PINE PRODUCTS CO., Biloxi, Miss., has been incorporated under Delaware laws with capital of \$2,000,000, to manufacture turpentine, rosin and kindred products. The incorporators are D. J. and E. C. Gay, Biloxi; and J. O. Gillespie, Gulfport, Miss. The company is represented by the United States Corporation Co., 65 Cedar St., New York.

THE LANSDALE PORCELAIN ENAMEL WORKS, INC., Lansdale, Pa., has been incorporated with a capital of \$30,000, to manufacture porcelain products and other ceramic specialties. Abraham H. Landis, Lansdale, is treasurer.

THE PROGRESS PROCESS CO., Louisville, Ky., has been incorporated under Delaware laws with capital of \$660,000, to manufacture chemicals, chemical byproducts, etc. The incorporators are T. K. J. Blakely and James P. Helm, Louisville. The company is represented by the Corporation Trust Co. of America, duPont Bldg., Wilmington, Del.

THE SALINA CHEMICAL CO., Syracuse, N. Y., has been incorporated with a capital of \$10,000, to manufacture chemicals and chemical byproducts. The incorporators are C. J. Dence, C. E. Brownell and M. B. Eldredge. The company is represented by C. R. Milford, Skaneateles, N. Y.

THE JEWEL MFG. CO., Lansing, Mich., has been incorporated with a capital of \$30,000, to manufacture soaps, chemical products, etc. The incorporators are Louis Simon and Herman C. Nielsen, Lansing, Mich.

THE FEDERAL PAINT & VARNISH CO., Boston, Mass., has been incorporated with a capital of \$25,000, to manufacture paints, varnish, etc. Benjamin J. Bond is president; and E. C. Meyer, 24 Seaver St., Roxbury, Mass., treasurer.

KIRBACH, INC., New York, N. Y., has been incorporated with a capital of \$50,000, to manufacture chemicals and chemical byproducts. The incorporators are H. Kir-

bach, E. G. Hothorn and F. R. Fox. The company is represented by C. S. Aronstam, 100 Broadway, New York.

INDUSTRIAL LABORATORIES, INC., 1 Montgomery St., Jersey City, N. J., has been incorporated with a capital of \$100,000, to manufacture chemicals and chemical byproducts. The incorporators are Frank E. Williamson, Carl W. von Helmsolt and William G. Clarke.

THE EDIBLE OILS REFINING CORP., 140 South Dearborn St., Chicago, Ill., has been incorporated with a capital of \$20,000, to manufacture refined oil products. The incorporators are Taylor E. Brown, Clifford J. Thompson and David E. Peterson.

THE PEERLESS TANNING CO., Salem, Mass., has been incorporated with a capital of \$10,000, to manufacture leather products. Theodore T. Granes is president; and Wallace F. Haley, 35 Pleasant St., Salem, treasurer.

THE PURITAN PETROLEUM CO., New York, N. Y., has been incorporated under Delaware laws with capital of \$5,000,000, to manufacture oil products. The company is represented by the United States Corporation Co., 65 Cedar St., New York.

THE NILE QUEEN CORP., 3425 Indiana Ave., Chicago, Ill., has been incorporated with a capital of \$200,000, to manufacture chemicals and chemical byproducts. The incorporators are J. Delos Bell, George H. Walker and Claude A. Barnett.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its seventy-fourth meeting at Toronto, Canada, Dec. 27 to 31, 1921.

AMERICAN CERAMIC SOCIETY will hold its twenty-fourth annual meeting at St. Louis, Feb. 27 to March 2, 1922.

AMERICAN ENGINEERING COUNCIL will hold its next meeting in Washington, Jan. 5-6.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its annual winter meeting at Baltimore, Md., Dec. 6 to 9. Headquarters will be at the Emerson Hotel.

AMERICAN IRON AND STEEL INSTITUTE will hold its twentieth general meeting at the Hotel Commodore, New York City, on Friday, Nov. 18.

AMERICAN PETROLEUM INSTITUTE will hold its second annual meeting at the Congress Hotel, Chicago, Dec. 6, 7 and 8.

COLLEGE OF THE CITY OF NEW YORK, department of chemistry, will give public lectures under the auspices of the City College Chemical Society in the Doremus Lecture Theater, at 4:30 p.m., as follows: Nov. 17, "The Significance of the Coal Tar Dye Industry," by Dr. Ellwood Hendrick, consulting Editor, CHEM. & MET.; Nov. 30, "Afterthoughts of the War," by Leland L. Summers, of the War Industries Board; Dec. 6, "America in Chemistry," by Dr. Edgar F. Smith, provost emeritus, University of Pennsylvania, and president, American Chemical Society.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stettens Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

The following meetings are scheduled to be held in Rumford Hall, the Chemists' Club, New York: Nov. 18—American Electrochemical Society, regular meeting; Dec. 2—Society of Chemical Industry, regular meeting; Dec. 9—American Chemical Society, regular meeting. Jan. 6—American Chemical Society, regular meeting; Jan. 13—Society of Chemical Industry, Perkin Medal; Feb. 10—American Electrochemical Society (in charge), Society of Chemical Industry, Société de Chimie Industrielle, American Chemical Society, joint meeting; March 10—American Chemical Society, Nichols Medal; March 24—Society of Chemical Industry, regular meeting; April 21—Society of Chemical Industry (in charge), American Electrochemical Society, Société de Chimie Industrielle, American Chemical Society, joint meeting; May 5—American Chemical Society, regular meeting; May 12—Société de Chimie Industrielle (in charge), American Chemical Society, Society of Chemical Industry, American Electrochemical Society, joint meeting; May 19—Society of Chemical Industry, regular meeting; June 9—American Chemical Society, regular meeting.

CHEMICAL & METALLURGICAL ENGINEERING

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A consolidation of
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ALAN G. WIKOFF
R. S. McBRIDE
CHARLES N. HULBURT
Assistant Editors
CHESTER H. JONES
Industrial Editor
J. S. NEGRU
Managing Editor

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Number 21

Pointing the Way To Industrial Peace

FRIENDLY criticism is always welcome, especially when it comes from one who has succeeded in solving some of the same sort of problems that have been puzzling us. And this is one of the accomplishments of B. SEEBOHM ROWNTREE, a highly successful manufacturer of York, England, who has spent two months in the United States studying methods and conditions in our industries. His public addresses have been of particular interest to American business men because they offer a keen analysis of our industrial relations by one who is recognized as an authority on the social aspects of industry.

Mr. ROWNTREE tells us that although the American manufacturer leads the world in the application of science to the material problems of his business, his relations with his employees are still guided by the crudest of rule-of-thumb methods. He is willing to spend his money for costly excursions into abstract science, but he is often inclined to regard the recommendations of his industrial manager as too idealistic to be of practical application. The American executive attempts to increase the efficiency of his plant by improving industrial processes and by eliminating wastes in production, but he does not give commensurate consideration to the problems of labor and its growing spirit of unrest. The British manufacturer, although perhaps not quite as alert nor as aggressive, has far outstripped his American brother in the progress toward industrial peace. He has put into actual operation many of the schemes which appear Utopian to most of us.

Our visitor's principal criticism of the employer, as a class, is that he is unimaginative. He sees business through his own eyes, to which labor is but a commodity which disturbs his plans and threatens his profits. As long as this attitude remains unchanged, industrial unrest will continue to be regarded as a necessary adjunct of industry. Mr. ROWNTREE maintains that such a misconception can and must be corrected, but that this will not be accomplished by conflict nor by any scheme which attempts to recast or revolutionize the entire industrial system. He gives us five minimum conditions which, in his opinion, constitute the price which must be paid for industrial peace: (1) Wages must be sufficient to permit the worker to live in reasonable comfort. (2) Working hours must be such as will give the worker adequate opportunities for recreation and self-expression. (3) There must be an increased economic security for the worker, notably with regard to the menace of unemployment. (4) The employee must share with the employer in determining working conditions. (5) The worker must receive a direct interest, if possible, in the profits of the industry in which he is engaged.

Many American manufacturers will no doubt offer practical objections to this platform, but the fact remains that in Great Britain most of these principles are being applied with conspicuous success. Unemployment measures, wage equalization funds, pensions, workers' councils and profit-sharing schemes have made greater headway in British industries than in our own. If it is true that our industries have had a lopsided development, that we have emphasized the material and neglected the human aspects of business, then American executives can profit by Mr. ROWNTREE'S friendly criticism and constructive suggestions.

Classification Of Research

IN THE department headed "Readers' Views and Comments" is published a letter from Dr. HYDE, commenting upon our editorials entitled "When Is a Research a Mere Inquiry?" (Oct. 5) and "How May Research Be Fostered?" (Oct. 12). Dr. HYDE calls attention to a classification of research activities published in the first of these editorials, and ascribed to him, but which is in error. The editors must plead guilty of the fault, and gladly give space to the diagram used by Dr. HYDE, a duplicate of which was unfortunately not in hand. Inspection of the two will show that both of us are in agreement that "Research" should not apply to all kinds of work mentioned—in fact Dr. HYDE classifies some of it as plain "Engineering" rather than "Engineering Research."

Obviously we made no effort to appraise research activities in a critical manner and from many angles. An opportunity was taken, however, to protest in as vigorous a manner as possible—and to this end we used certain literary license in overdrawing an opposite picture merely to emphasize the point—against an indiscriminate use of the word "Research." Fortunately, perhaps, for the English language, the dictum of even so powerful an organ as CHEMICAL & METALLURGICAL ENGINEERING is unable to change the accepted usage of words! And since dictionaries follow usage rather than lead in developing language, definitions of research can easily be found that would include those investigations that Dr. HYDE wishes to exclude. And doubtless a little search in our own columns would convict us of the same fault against which we are declaiming.

Nevertheless, we beg of you, be a little more careful in the use of words—precision in this is as desirable as in any other activity or observation. There are real differences between research, investigation, inquiry, scrutiny, experimentation, testing. With the wonderful resources of the English language available, it is a shame to debase it into jargon. Not all experimenters are researchers; not all surveyors are engineers.

Apropos of Getting a Job

HE WAS a graduate chemical engineer from a good institution, and looking for work. He asked the old man if he couldn't recommend him somewhere. The old man asked him in return to name any of his qualifications that he could indicate as warranting his employment. The younger one thought the name of his *alma mater* a sufficient guaranty of his merit. Then the old chemist proceeded:

"The open door of opportunity is narrow and there are many trying to crowd through it. You stand now on the outside of the crowd, all trying to get in. On the other side of it a few good men are wanted, but are you any better than the rest of the crowd?"

"No, I don't profess to be a genius. All I claim is to be a good graduate chemical engineer without experience."

"I'm afraid you are not even a good graduate. Here is American industry sorely in need of applied chemistry, and hardly anyone to apply it until somebody shows the world just how it is done. That's the trouble with you fellows outside the door: you're unwilling to think. You want to get in, and then have somebody nurse you along until you are taught enough things that others know, to have earning capacity. It is a proper attitude for an apprentice, but it is not the proper attitude for a professional man.

"Let's take a look about us. There is the sulphuric acid works, the rubber works, the coke plant, and the tar refinery. You say they don't want any more chemists, and you observe the crowd trying to get in. If you were to succeed, I doubt if you would be of much use to any of them. You will have to be born again, if you want to be a good chemical engineer, and what I am trying to do now is to start you in the process of being born again.

"Do you see the big bakery over there? See the candy factory? See the two big laundries? See the new hotel with its immense restaurant?"

"But they don't want any chemists!"

"Yes, they do. They don't wish for them, but chemistry is just what they lack. Of course the men at the head of the concerns don't know it, but that is where your chance comes in. If they knew they needed chemists, they would call for specially trained men, and you wouldn't have any show at all. When your friend STEVE first went to a pulp mill he knew the superintendent didn't want any chemists. He hadn't any use for theorists, he said. It was the same old story that the administrator of every one of these establishments would tell you if you asked for a post as chemist with them. STEVE took a job as a yard rustler, and despite the backache from unaccustomed work, he climbed around in his leisure and made tests and discovered not only shocking losses, but worked out plans whereby they might be completely avoided. He didn't talk until he was sure that what he had to say meant dividends. Then this yard rustler who was also a graduate chemical engineer opened up and the authorities had to listen. Did they listen because he was a graduate of Massachusetts Institute of Technology? Not on your life! And look at him today! He is one of the leading chemical engineers of the country, while some of his classmates are doubtless still making routine tests!

"If you start in as a dishwasher or a porter or a de-

livery clerk in any of those establishments I named and keep constantly using your head, never forgetting the chemical aspect of every problem that comes up, reading up the literature and corresponding with men who know more than you do, your chances are a hundred per cent better than those of any of the fellows who are trying to get through the open doors. If you are discouraged today with all the opportunities awaiting the man who looks for them, it is because you can't think for yourself, or because you won't. If you can't think for yourself, you'd better quit chemistry. If you merely lack the habit of thinking for yourself, it is time to acquire it. That is being born again!"

Signposts of Metallurgical Progress

IT IS perhaps trite to remark that Americans are prone to become provincial, and that a study of conditions abroad would do much to improve their perspective. Even so, we repeat that much the same forces are moving in industry both here and abroad—we may not be able to see them ourselves and at home, but we can discern them in the foreign situation, or can be told them by European visitors.

The French have long been noted for a peculiar excellence and artistry in their manufactured products, yet Professor CAVALIER, French exchange professor in the United States, in a statement on "Problems and Progress of Iron and Steel Metallurgy in France," written for the American Society of Mechanical Engineers, says:

The war, in bringing together for the national defense the industrialists and the men of science in the process of intensive production of metal, has powerfully contributed in France to the employment and to the diffusion of new and precise methods of work and of control. In the development of the use of scientific methods, the progress realized by systematic study in the laboratory usually penetrates slowly into industrial practice. Producers in the average industry have a tendency to consider the laboratory as a luxury which does not pay. Without doubt these good industrial habits which were acquired under the force of circumstances will continue. And thus the war will have contributed to the progress of our metallurgical industry, even though it be in a measure which only compensates to a slight extent for the great losses resulting from the destruction of our factories.

Here is a general statement of the advantage of science to industry—but sometimes "science" is little more than close observation and the application of common sense. A particular instance of this infusion of common sense into industry was noted some time ago in these columns—an instance drawn from some remarks of EUGÈNE SCHNEIDER, when he showed it to be possible to reduce large ingots to gun tubes in 11½ days and seven heatings, whereas 43 days and nine heatings were the usual allowance. Why build greater shops if the old ones can do this?

Lastly, an eminent European metallurgist recently in this country expressed to a party of friends his personal opinion that American metallurgical industry, especially in the East, was greatly overbuilt. "This being granted," he continued, "it is evident that there will be the keenest competition for the available business. Much of it will go to the lowest bidder, who ordinarily will have perfected his methods so that he can produce at an extraordinarily low price, but I am confident that a larger and larger proportion of the business will go to the people who can put quality into their product, as well as into their management and production methods."

The Railroad "Problem"

THE railroads are poor. There is no doubt about that, for the railroads themselves admit it. By this time it ought to be clear that the railroad "problem" is like the poor, in that we have it with us always. Who can remember a time when there was not a railroad "problem"? Back in the 1880's the problem was "rebating," etc., and how to stop it. In 1887 came the original interstate commerce act. Ever since it has been just one thing after another.

An outstanding feature of this practically continuous performance is that the issue has been so different at one time and another. For instance, there were certain periods before the war when nearly every business man, and nearly every business review, was saying that business would not be really good until the railroads were permitted to advance their rates. Of late the chorus has been shouting that business will not be good until rates are reduced.

Perhaps the explanation is that it is psychological. Railroads are a good thing and—what is more to the point—an easy thing to talk about. The railroads are almost ubiquitous. Everybody patronizes the railroads directly or indirectly. Then the stockholders and bondholders of the railroads are very numerous. Next, a couple million or so persons are employed by the railroads. Last, but by no means least, particularly when one judges by the amount of noise made, are those that sell or would like to sell to the railroads.

The railroad problem, or question, or subject of debate, has fallen in various categories. Sometimes it is said to be a political matter. At other times it is "an economic question," while at other times it is said to be just plain business. Other things may be important, but men do not feel themselves so directly interested nor do they have the same unbounded confidence in their ability to discuss them and to cite to the man buttonholed convincing facts if only the buttonhole will stand the strain.

Business is not as good as men would like to have it, and there is nothing more convenient on which to blame the condition than freight rates. There is a fine slogan: "Everything else has been liquidated—why not freight rates?" Then details are entered into. The railroads have not been earning the expected return on valuation, which is only 6 per cent, but if rates were reduced there would be more business and so the railroads would make more money after all.

The first freight blockade or congestion in the history of American railroading occurred in the winter of 1902-1903. In recent years such blockades have been frequent, and on each occasion it has been urged that we must have improved transportation facilities and the public can afford to pay for the improvement. The popular conception seems to be that light railroad earnings, an average of 2.6 per cent on valuation in the eight months January to August inclusive instead of the desired 6 per cent, are the evidence of traffic being light. The physical volume of traffic, however, is reported, the public paying little if any attention. In the first eight months of this year the ton-mileage was only 24 per cent under that in the same period of 1920, and 1920 was the record year for freight movement. Last August the ton-mileage was only 29 per cent under that of

August, 1920, the record month in all history for freight movement. The way is not as easy as is assumed for the railroads to obtain a large increase in business and handle the business satisfactorily.

Chicago Citizens Support Landis Award

PUBLIC sentiment on the labor union situation in Chicago has crystallized to a definite action which should be far reaching in its effect on all industry. One hundred and fifty business men and representative citizens have organized under direction of the Chamber of Commerce into a body known as the Citizens Committee to Enforce the Landis Award. It is to be a permanent organization with the purpose of bringing about 100 per cent adoption and enforcement of the terms and conditions laid down by Judge LANDIS in the building arbitration decision.

A statement issued at the first meeting on Nov. 10 shows that two months has elapsed since Judge LANDIS gave his award in the building controversy. Prior to that time Chicago for years paid tribute to dishonesty, graft and various forms of extortion, and conditions have grown more intolerable each year. Investors have hesitated to supply funds for building because of extravagant cost. Business expansion has halted because of excessive overhead. Industries have feared to take advantage of Chicago's natural facilities and market position because of the city's reputation based on conditions in the building trades.

In spite of the agreement of contractors and building trade unions to participate in the arbitration, some of the contractors and some of the unions have proceeded to work without regard for the award. Continuation of the present trend will place Chicago in an even worse condition than existed before. The real program of expansion and the relief so sorely needed will not occur.

The committee will make no fight on the trade unions as such. Those unions which in letter and spirit have accepted the Landis award and are working under it will have the support of the citizens. Those behaving otherwise will automatically lose the support of the public. Those contractors who have entered into agreements with unions outside of the award deserve neither the consideration nor the support of the public.

Thinking folks desirous of fair dealing for all branches of society carry the balance of power in the United States. When it becomes otherwise we are lost. They are slow to move, but once under way become irresistible. This is only one of many instances where a chamber of commerce with right ideals serves as an activator to facilitate public reaction. We believe this committee will succeed in its undertaking.

Pitiable End of A Russian Scientist

WE ARE informed by Colonel A. I. KRYNITZKY, an expatriated Russian at present on the staff of the Bureau of Standards, that the venerable Prof. TSCHERNOFF, international authority on metallurgy, has succumbed to privation. A letter from his younger son contains the information that the widow, Mme. A. N. TSCHERNOFF, and one of their daughters live at Petrograd, Sergievskaja St., No. 1, Apartment 1, under most miserable conditions.

Readers' Views and Comments

Classification of Research Activities

To the Editor of Chemical & Metallurgical Engineering

SIR:—I am very appreciative of your letter of Nov. 3 containing copies of the two editorials which appeared in *CHEMICAL & METALLURGICAL ENGINEERING* Oct. 5 and 12, 1921, and which were prompted largely by the paper which I presented before the American Society for Steel Treating in Indianapolis.

No doubt the idea in the mind of the writer of the first editorial is the very laudable one of placing research on a high standard and excluding all that which is unworthy of the name. I am heartily in accord with him on this point and am inclosing a reprint of a paper entitled "The Methods of Research" which I presented before the Illuminating Engineering Society about nine years ago and which had for its object the discouraging of those many abortive efforts which are put forth in the name of research. Unfortunately, however, the editorial writer of your journal has, in my judgment, discriminated on the basis of the material of research rather than on that of the ideals and methods of research.

We may quarrel with regard to the extension of the meaning of the word research to include investigations in other than in pure science, but by the dominating power of common usage the term has taken on a wide significance. In view of the fact that this wide significance has been crystallized in the very name of the National Research Council it is unfortunate that a criticism of its use, such as that which was connoted in the editorial, should be made. In accordance with the accepted significance of the term, the investigation of the phenomena which underlie successful electric welding must be termed research equally with the investigation of the ultimate structure of the atom. I find that this apparent unwillingness to admit the extended use of the term is as evident in the second editorial as in the first.

I should like to add a further word of comment with respect to the second editorial. The writer apparently disregards the classification which I have suggested, by which pure scientific research is divided into "frontier research" and "intensive co-operative research." We are in agreement that frontier research should be carried on in universities and privately endowed laboratories. I am strongly of the opinion, however, that that which I have termed "intensive co-operative research"

is a legitimate and even a necessary function of industrial corporations.

Finally I should like to call attention to the fact that the classification given in the editorial is not correctly taken from my chart. There is one mistake of a fundamental character and one of relative unimportance. The former is the classification of Engineering under the general head of research. According to my chart Scientific Research and Engineering are to be distinguished, although under Engineering there is one link to research. The relatively unimportant error is that number 5, "Engineering Practice," has no part whatever with research and is, therefore, performed by corporation and private engineers and not "in corporation and private laboratories" as stated.

I am sending you the chart which served as the basis for my discussion.

I thank you for this opportunity of replying to the two editorials.

EDWARD P. HYDE.

Nela Research Laboratory,
Nela Park, Cleveland, Ohio.

Air Required in Baking Cores Made With Linseed Oil

To the Editor of Chemical & Metallurgical Engineering

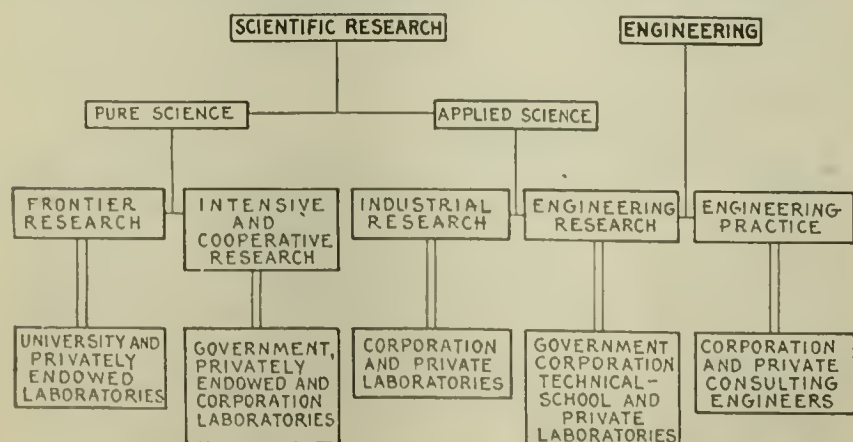
SIR:—In reading an article published in your issue of Oct. 26, 1921, on "Air Required in Baking Cores Made With Linseed Oil," by A. A. Grubb and U. S. Jamison, I note in the early part of the article a discussion of the amount of oxygen absorbed by linseed oil in drying, as well as the amount of hydrogen and carbon given off in the form of water and carbon dioxide.

The results of two investigations by Cloez and A. Genthe were quoted. Both of these authors had determined the increase in weight of the linseed oil, while Cloez had also determined the chemical composition of the linseed oil and the dry oil. Messrs. Grubb and Jamison draw conclusions from these results as to the total amount of oxygen which had been absorbed and the amount of carbon dioxide and water which had been given off.

Your authors apparently had overlooked the publication by myself and A. E. Ratner on this subject. The published report was entitled "The Decomposition of Linseed Oil During Drying" and was published in the report of the Eighth International Congress of Applied Chemistry, vol. 12, page 165.

An examination of this article will show that Mr. Ratner and myself in carrying out this investigation not only weighed the linseed oil before and after drying but also absorbed the carbon dioxide and water which were given off. We found that the oil, after 74 days, had increased 18.05 per cent in weight, while 14.55 per cent of water and 5.21 per cent of carbon dioxide had been given off. These figures show that 37.8 per cent of oxygen had been absorbed. These percentages were calculated on the weight of the linseed oil.

On comparison with the figures quoted by Grubb and Jamison, it will be noted that they find a much larger percentage of carbon having been given off and a much smaller percentage of hydrogen than are shown by our



CLASSIFICATION OF RESEARCH ACTIVITIES

figures. The calculation of the results published by Ratner and myself indicate that 1.42 per cent of the carbon was given off as carbon dioxide and 1.62 per cent of the hydrogen, calculated on the weight of the linseed oil. This is equivalent to 1.87 per cent of the carbon present in the oil and 14.73 per cent of the hydrogen. It may readily be that in the results given by Cloez the carbon percentage of the original oil was somewhat high, while the carbon percentage of the dried oil, as obtained by the analysis, may be low, the opposite being true of the hydrogen analysis. Unless the ultimate analysis was carried out with the greatest of care, there may be considerable error in the carbon and hydrogen determinations. On the other hand, the absorption of carbon dioxide and water as given off in the drying of linseed oil can be carried out with great accuracy. It also seems more reasonable that the hydrogen should be given off in larger quantity than the carbon in the drying of a substance like linseed oil.

Polytechnic Institute,
Brooklyn, N. Y.

J. C. OLSEN,
Professor Chemical Engineering.

Facts and Fancies About the Oppau Explosion

To the Editor of Chemical & Metallurgical Engineering

SIR:—In recent issues of your journal, and in particular on pages 814-815 and 818-822 of the Nov. 2 issue, many different explanations of the recent disaster at Oppau have been discussed, and it has been concluded that no theory yet advanced can be regarded as more than speculative. The cause of the sudden decomposition of the 4,500 tons of ammonium sulphonitrate $(\text{NH}_4)_2\text{SO}_4 \cdot \text{NH}_4\text{NO}_3$ remains a mystery.

So far only *chemical* explanations have been adduced. It is very possible, however, as will be evident from what follows, that the primary cause of the explosion may have been of a purely *physical* nature.

Ammonium nitrate is a salt which exists in no fewer than six different crystalline modifications.¹ Five of these are stable at atmospheric pressure, each throughout a definite temperature interval only. The various transition points have been very carefully investigated², and it has been found that changes in crystal form, as the substance cools, occur at 125.2, 84.2, 32.1 and —18 deg. C. Each transformation is attended by considerable evolution of heat and by a considerable change in volume, in some cases positive (expansion) and in others negative (contraction).

The study of these transition points became a matter of practical importance during the Great War, when ammonium nitrate, mixed with TNT to give amatol, was used very extensively as a high explosive. Any change of state involving an increase in volume which might occur in a filled and sealed shell would, it is clear, constitute a grave source of danger, owing to the inevitable rupture of the shell. The time-honored experiment of bursting a bomb by filling it with water, screwing the fuse tight and leaving it out of doors on a cold winter night may be mentioned as a familiar, exactly analogous phenomenon.

Now the change of state which is most significant in the case of stores of ammonium nitrate is that which occurs at 32.1 deg. C. (89.8 deg. F.), since this temperature will very frequently be exceeded in summer. The transformation brought about by raising the temperature above 32.1 deg. C. resembles that induced by cooling water below 0 deg. in two respects—it is very

subject to delay and it is accompanied by a large increase in volume. The presence of other substances accentuates the tendency toward delayed transformation; it is quite possible to raise ammonium nitrate mixture to a temperature well above 32.1 deg. C. without immediate change of state occurring, just as it is possible to supercool water solutions without immediate appearance of ice. In such an event, however, the system will be like a cocked gun. Any disturbance of the metastable conditions will start a rapid change of state.

Is it not plausible that this is what took place at Oppau on the morning of Sept. 21? We are told that the temperature in the storehouse during the previous night was over 100 deg. F. Suppose transformation to have been delayed, and to begin suddenly at some point in the caked mass of ammonium sulphonitrate at such a temperature. It would spread rapidly through the entire 4,500 tons. The consequence would be a great increase in the volume of the material. At many places in the interior of the hard, rocky mass, tremendous pressures would be set up, which could be relieved only by explosive disintegration. This preliminary *physical* explosion might very conceivably be severe enough to induce a secondary *chemical* explosion throughout the entire mass, playing the part of the primer in the detonation of a high-explosive shell.

All this is, of course, like the other theories which have been put forward, merely speculative, but it constitutes a possibility which ought not to be left out of consideration. One of the first points for investigation should be the exact effect of ammonium sulphate (with which ammonium nitrate forms at 30 deg. two double salts, both unstable in water solution³) upon the transitions of ammonium nitrate. It is quite likely that the double salts formed also exist in more than one allotropic modification. As you have aptly stated in your editorial of Nov. 2, "an intensive study of the nature of ammonium nitrate and its mixtures may not explain all of the mysteries of the Oppau explosion, but it will do much to prevent the recurrence of similar disasters."

Chemistry Department,
Columbia University,
New York City.

JAMES KENDALL.

Explosion of Agitator Charged With Naphtha

To the Editor of Chemical & Metallurgical Engineering

SIR:—At a neighboring refinery an agitator charged with 50 deg. Bé. naphtha exploded recently without any apparent cause. The explosion occurred almost immediately after the agitator had been charged with approximately 900 bbl. of the naphtha. This oil had a temperature of about 70 deg. F. and was pumped up from the bottom through the chemicals, which consisted of litharge and caustic soda. The agitator has a capacity of about 2,100 bbl. and is not lead-lined. Electric light wiring was carried in conduit and it seems unlikely that a spark from this source may have been the cause. It is said a street car about 100 yd. distant passed by at the time of explosion, and, by a spark, may have ignited the light vapors which were carried in that direction. No strong wind prevailed at this time.

Will you please inquire if some of your readers or contributors can give a cause for this fire?

W. H. PAPE,

Tulsa, Okla.

Mechanical Supt., Cosden & Co.

EDITOR'S NOTE: We invite discussion of this subject and shall be glad to publish pertinent comments.

¹Bridgman, *Proceedings*, American Academy of Arts and Sciences, 1916, vol. 51, p. 605.

²Early and Lowry, *J. Chem. Soc.*, 1919, vol. 115, p. 1387.

³Roozeboom, *Heterogene Gleichgewichte*, 1911, vol. 3, Part 1, p. 138.

American Iron and Steel Institute

Varied Program of Technical Papers at the Twentieth General Meeting Included Furnace Design, Firebrick, a Direct Process for Steel Manufacture, Welding, Relation of Iron and Steel Industry to the Chemical Industry, and Steel Lumber

LAST Friday, Nov. 18, the American Iron and Steel Institute met for its twentieth general meeting in New York City, and was proud to entertain Marshal Foch. Over a year ago, when President Gary was in Paris, Marshal Foch expressed the desire to meet a representative gathering of men in the American steel industry. And so the steelmakers put on their holiday togs and forgot their business worries long enough to do honor to the leader of the allied armies.

The result was the largest banquet New York has ever seen—and who will say that men in the steel industry do not enjoy big things?—largest in point of numbers, and second to none in a genuinely enthusiastic and whole-hearted welcome to an admired friend. President Gary, William D. Guthrie and Charles M. Schwab ably expressed the sentiments of the assembled members and the industry they represent toward their honored guests. Mr. Schwab's talk was especially interesting, since it was the first public comment since the Disarmament Conference by the genial head of the greatest munition plant of the world, and he echoed the thoughts voiced by Mr. Gary in the morning.

"I would like to take advantage of this occasion to say something which has long been upon my heart, and which at this significant moment it is clearly my duty to say," said Mr. Schwab. "It was stated at some of the sessions of the recent League of Nations at Geneva, it has often been carelessly suggested in the press, that the flame of war is in great measure kept alive by those interested in the private building of naval ships and the manufacture of munitions of war.

"I can, of course, speak only for myself, but I believe I know and express the sentiments of others placed in positions similar to mine when I say this:

"If the armed protection of our country is necessary, the establishment of which I am the head will devote itself with all its energy to providing means for the protection of this country's homes and families. But I say to you from the bottom of my heart that if the statesmen now assembled in Washington, under the far-sighted leadership of our President and Secretary Hughes, should find it possible to bring about disarmament and permanent peace, gladly would I see the war-making machinery of the Bethlehem Steel Corporation sunk to the bottom of the ocean."

Morning Session

Judge Gary, as is the custom, opened the morning session with an address—not before the members had tendered him a hearty welcome, almost an ovation. After calling attention to statistics showing a steady improvement in American business during the autumn months, he warned his audience that it was yet impossible to predict when the world, or even this country, would return to normalcy. This he felt was due to high cost of living, the high cost of production and transportation and the high cost of earning and owning money, costs which were inflated for a variety of reasons, but which must be adjusted more nearly to their mutual

relations before the war. Judge Gary was inclined to blame the high cost of living largely to grasping middlemen handling food, clothing and shelter. Production and transportation costs were controlled by inflated labor rates and low performance in highly unionized trades. Lastly, taxes were so high that there was little incentive for the owner of money or property to put it to use and further extend his holdings. When these conditions would be corrected, he could not prophesy.

Enthusiastic applause marked his assertion that the industry confidently expected a sharp limitation of naval armament. Considerations as to tonnage lost to the steel industry were unworthy of notice. As a matter of fact, what could be better for business—either in steel or paper, wheat or textiles—than a world at peace?

TECHNICAL PAPERS

S. W. Miller, president of the American Welding Society, opened the technical session with an extensive paper on Fusion Welding. He discussed in detail the effects of oxygen and oxide in welds and in the plates to be welded—a matter which we hope to present in extenso later. The following properties of recommended metal should be interesting:

TABLE I. PROPERTIES OF WELDING MATERIALS

	Steel to Be Welded	Gas Welding Usual Welding Rod	Preferred Welding Rod ¹	Electric Welding Hard Drawn Rod ²
C.....	0.15 (max.)	0.06 to 0.10	0.20	0.15 to 0.18
Mn.....	0.30 to 0.60	0.15	0.40 to 0.60	0.40 to 0.60
S (max.).....	0.05	0.03	0.04	0.04
P (max.).....	0.04	0.03	0.04	0.04
Ni.....	.....	.....	3.25 to 3.75	.....
Tensile strength	50,000	52,000 (max.) ²	58,000 ²	60,000 ² (max.)
Yield point	30,000	.....	.....	.....
Elongation in 8 in., per cent, 30	.....	.....	.....	.....
¹ Corresponds to S.A.E., specification 2320.				
² Strength of weld.				
³ Chemical analysis not so important as hardness, uniformity and high general quality.				

In order that tests may be of value, they should be executed on fairly large specimens and show the following data:

Chemical analysis of the wire. Chemical analysis of the base metal. Tensile strength and other characteristics of the base metal. Microstructure of the base metal. Microstructure of the welding wire or electrode. Tensile characteristics of the welded pieces. Bending characteristics of the welded pieces, hot and cold. Size of electrode or welding wire. Amount of wire used. Amperes during welding. Open circuit voltage. Welding voltage. Make of torch and size of tip. Gage pressure of oxygen and acetylene.

A cold bend test is extremely informative. Take a single V flush weld about 2 in. long, and bend it so the top of the V is stretched, measure the angle at fracture, and note what portion of the bend occurred in the weld and what portion in the plate.

WELDING OF CAST IRON

The welding of cast iron is easier than that of any other metal, and the results obtained are better, except possibly in case of cast aluminum, where the results are just as good. In welding cast iron any material

that is to be added should be of such a character that the application of heat will not burn out the carbon and silicon to such an extent as to make the weld difficult to machine. This means that it should contain a considerable proportion of silicon, this being the first constituent to disappear under the heat. Ordinary machine iron is entirely unsuitable for the purpose, and it is usual for a good cast-iron welding rod to contain at least 3 per cent of silicon. When this metal is melted into the weld, it produces a fine-grained structure lower in graphitic carbon than the material being welded, because it is applied in small quantities and cools rapidly. In gas welding of cast iron it is permissible to use a tip that is large in proportion to the size of the casting, blocking up the edges to keep the melted metal from running away. But in steel welding by gas, too large a tip will make the metal boil and foam, and is certain to injure the weld. A properly welded piece of cast iron will always break outside the weld. The principal difficulty in cast-iron welding is in taking care of the shrinkage or contraction, which of course cannot be avoided, although it can usually be allowed for by expanding other parts of the piece, or by setting the pieces farther apart than they were when broken. The proper methods to follow to avoid strain in the welded piece, due to expansion and contraction, require close attention and much experience on the part of the welder; and even with the greatest care cracks occur at times. It is quite possible that there will be heavy strain in the welded piece, which, however, will not be great enough to cause trouble until it is put in service, when the additional strain due to this may cause it to break. Chilled iron is readily welded, although, on account of its brittleness, the difficulties from expansion and contraction strains are increased when compared with gray iron. Malleable castings dare not be melted, and therefore are not capable of being welded, unless they can be annealed, which is usually impossible. It is therefore customary to join broken parts of malleable iron by using a manganese brass or a similar alloy, which will unite with the malleable iron at a temperature below its melting point. The joint so made is strong and ductile and answers every purpose. Of course, if the malleable iron be melted, it will revert to chilled iron and lose its strength and ductility. Even the use of manganese brass will to some extent change these properties, but not sufficiently to cause trouble in practice.

DIRECT PROCESS FOR STEEL MANUFACTURE

An interesting paper discussing a "Direct Process for Steel Manufacture" was presented by O. E. Bourcoud. After a brief review of the many previous and unsuccessful attempts, he says that solution of the problem depends upon, first, a method of producing large volumes of hot reducing gas of great purity from low-grade fuels (a matter discussed by him at length in *CHEMICAL & METALLURGICAL ENGINEERING*, April 6, 1921, under the title "Gasification of Powdered Coal"), and second, correct application of a stream of this gas to the ore to be reduced. The essential conditions surrounding the latter may be defined by a study of blast-furnace operations, which Mr. Bourcoud presents in a very interesting manner, showing that his resulting mathematical formulas for the reduction of hematite apply equally well to the 80-ton furnace described many years ago by Sir Lowthian Bell, and to the modern 500-ton Lackawanna furnace studied by H. H. Campbell. His formula shows that the time required to reduce a

spherical lump of ore to a given depth varies directly as the square of that depth, inversely as the percentage of reducing compounds in the gas and inversely as the square root of its velocity head. Using gas containing 45 per cent of active elements at an average temperature of 850 deg. C. and at a velocity of 9.1 m. per second, 480 seconds would be required to reduce an ore particle 1 mm. in diameter. If the particle be smelted in a rotary furnace and lie on top the charge 42 seconds in every hour, the ore would need to remain in the furnace 11.7 hours, and a 10-ton per hour furnace would need to be nearly 1,000 ft. long.

In order to reduce this evidently impracticable size, the author proposes to introduce spiral baffles in a 10-ft. rotary furnace, with a pitch of 2 m. forcing the gas to spin through in a whirlwind fashion, thus increasing the pressure head and increasing the amount of active gas from 7 per cent to 55 per cent of the total in the furnace. In such a furnace passing 62 cu.m. of gas per second at 850 deg. C., the mean velocity of gas in contact with the ore would be 33.9 m. per second, the angle of impact about 63 deg., and the normal pressure about 4 kg. per square meter. A grain of ore 3.4 mm. in diameter would be reduced in 140 seconds, and a 10-ton per hour furnace would be 75 m., or 250 ft., long.

The paper concludes with plans and estimates of a complete plant, consisting of proper gas producers, pre-heating (and nodulizing) furnaces, reduction furnaces, machines for compressing the hot sponge out of contact with air and charging directly into electric furnaces, where the metallic iron is melted and separated from any unreduced oxides, the latter forming a slag. Extensive tables showing the thermal balance and estimated (pre-war) costs of the operation are also appended.

J. M. Camp, director of the bureau of technical instruction, Carnegie Steel Co., then read a paper on the "Relations of the Iron and Steel Industries and the Chemical Industries," a paper which we shall print in a subsequent issue.

Afternoon Session

W. A. Hull, of the Bureau of Standards, recounted the work which has been done at that institution, at the Mellon Institute, and by leading refractory manufacturers, on the properties of firebricks. During the last 20 years various tests have been devised and reduced to a workable basis. However, there is still a great need of information on the actual conditions of service, information which the consumer should have in order to purchase his firebrick intelligently. It follows that specifications are largely influenced by the brick manufacturers, who describe in them something they can make cheaply and in quantity, whereas the specification should often call for something ideal for the purchaser, but at first little more than a mark for the producer to aim at.

"The question of price is one of the big stumbling blocks in the way of improvement. Not until the information gained by the production man and the metallurgist penetrates to the purchasing agent's sanctum in sufficient quantities to produce an effect can the refractories question be said to be on a fair way to a satisfactory solution."

Therefore, notwithstanding serious complaints by prominent metallurgists, Mr. Hull is of the opinion that the average product is unquestionably better than it

was 20 years ago. The eyes of the users have been opened to the fact that even the best brands do not run as uniform as they had been assumed to do, and defects that had formerly been counted of small consequence have been found to be vital factors in shortening the life of important installations. Some large metallurgical establishments are now making some of their own refractories, because their own efforts give vastly better results in special service than anything they are able to buy. American brick for byproduct coke ovens, and the recent successful application of silica refractories to limekilns and beehive ovens, are two achievements which indicate that firebrick makers can deliver an excellent product in large quantity when they have acquired the necessary information on what duty the brick must withstand.

OPEN-HEARTH PORTS

"Improvements in Port Construction in Open-Hearth Steel Furnaces" was discussed in a paper by John W. Kagarise, of the Edgar Thomson Works. Owing to the fact that flame temperatures are perilously near the softening point of furnace refractories, the shape and contour of the passages through the "block" were either built to oppose minimum resistance to the rush of hot gases, or the flame rapidly rendered them so. Only since the advent of successful water-cooling devices has it been possible to build ports on rational lines with reasonable assurance of permanence.

Experiments were made at the South Chicago Works in 1903, using a series of 1-in. pipes, one behind another reaching from front to back of furnace and bent so as to cool the two sides and top of the gas port mouth. By this means a life of 300 to 400 heats is now obtained. Clear water is not available in the Pittsburgh district, so the Duquesne plant developed the so-called Parks port. In this, the gas port arch is laid of 9-in. brick; then eleven 4-in. water pipes are laid side by side, and the arch finished by a 4½-in. brick cover. The water pipes reach from outside the block to within a foot of the mouth; a 1-in. pipe inside each discharges cooling water near the welded end. In case one of the pipes becomes plugged or is lost, it can easily be withdrawn and a new one inserted; 300 to 400 heats are obtained.

Welded steel plate water jackets have been successfully exploited by L. L. Knox, recent designs of the cross-port cooler extending from front to back of the furnace near the front of the port, and thus is very accessible when it is necessary to clean out sediment. The Lackawanna Steel Co. uses a so-called Blair port, which is a trough-like water jacket, which when inverted and properly set forms the complete side walls and arch of the gas port. Some early forms have been in use 6 years.

While operators now readily agree that some form of water cooling is indispensable, only recently have they turned their attention to a principle stated in 1912 by C. A. McCollum of the Homestead works: that well-mixed air and fuel should enter the furnace at high velocity through constricted openings, and waste gas leave at low speed through wide flues. In order to effect this, the Steel Co. of Canada has adopted the McKune system, and the Brier Hill Steel Co. the Egler furnace. Both these designs close the air uptakes on the incoming side with water-cooled valves. Air is blown through the checker chambers into a well and from there through the central port. Gas also enters the central port

through appropriate openings, and the mixture burns at the mouth much like a blow torch. At South Chicago, constriction at the incoming end is more simply effected by lowering water-cooled dampers through the roof, directly in front of the air ports, partially closing them and forcing the air to enter at the center of the furnace, cutting across the gas current. Such a furnace has made 106 heats each of 85.5 tons in a month, working on regular orders of steel ranging from 0.08 to 0.45 carbon. Charge was 53 per cent hot metal, 41 per cent scrap and 6 per cent ore. Coal consumed per ton was 348 lb. of 13,200 B.t.u. Kentucky coal.

"Venturi Line" furnaces have also been developed at South Chicago, so called from the fact that the arch above the ports dips sharply toward the bath, and the side walls also bulge inward, thus giving internal lines roughly like a Venturi meter. These restricted openings, a gas port mouth set back about 3 ft. from the neck, and induced draft from a waste heat boiler installation have given thorough mixing of air and fuel and good flame control. Combined with side dampers, this type of furnace gave the remarkable tonnage noted.

Various modifications of these systems are necessary when the fuel is changed from producer gas to natural gas, to pulverized coal, to byproduct oven gas, or to tar. Byproduct gas has given some trouble owing to its non-luminous flame; tar has been introduced to cure this defect, but it has been found at Duquesne that if a small quantity of air be burned in the gas as it enters the furnace, the luminosity of the flame can be controlled at will.

Conditions in Swedish Iron Industry

Reports submitted at a recent meeting of the Swedish Iron Works Association show that during the second quarter of this year but twenty of the 134 blast furnaces have been running, and only a few of the steel plants have been kept going on very short time, reports Consul General Murphy of Stockholm in *Commerce Reports*.

SIX MONTHS' IMPORTS AND EXPORTS OF IRON AND STEEL

January-June	Exports Tons	Imports Tons	January-June	Exports Tons	Imports Tons
1914.....	189,500	137,200	1918.....	200,300	51,400
1915.....	238,600	103,500	1919.....	129,600	33,700
1916.....	276,000	163,300	1920.....	134,400	110,300
1917.....	244,500	43,500	1921.....	61,300	71,300

In the first seven months of 1920 the export of iron ore amounted to 1,900,000 tons, while the export for the corresponding period of the present year amounted to 2,560,000 tons—an increase of 660,000 tons.

At the end of July, 1920, out of the 131 blast furnaces in Sweden, but 66 were running and of the 203 Lancashire hearths but 84 were operating. At the time mentioned there were likewise but 12 of the 18 bessemer, 41 of the 77 Martin furnaces, 4 of the 20 electrical steel furnaces partially in operation. At the end of July of this year the situation was still worse—i.e., 20 blast furnaces, 49 Lancashire hearths, 6 bessemer, 17 Martin and 5 electrical steel furnaces were running.

The production of pig iron in the first seven months of this year amounted to 225,600 tons, against 249,500 tons in the corresponding period of last year; blooms, 13,800 tons, against 31,300 tons; bessemer ingots 15,400 tons, against 26,600 tons; and Martin ingots, 96,500 tons, against 200,600 tons in January-July of 1920. rolled and forged iron and steel were manufactured to the extent of 63,600 tons, against 173,400 tons.

Sulphate-Free Sulphites for Standard Sulphur Dioxide Solutions

BY S. LANTZ SHENEFIELD, FRANK C. VILBRANDT AND JAMES R. WITHROW

THIS paper points out: (1) The doubtful validity of all previous work based on the use of sodium sulphite as a standard in sulphur dioxide investigations; (2) the inability to prepare sodium sulphite free from sulphate according to manipulation details in the literature; (3) the difficulties encountered in preparing pure moist sodium and calcium sulphites and their subsequent oxidation during drying.

The question of SO_2 fumes from chemical as well as smelter plants is of constant interest. Simplification of the methods for SO_2 determination naturally demands attention. Important and acceptable as the iodine method for the determination of SO_2 may be, there has always been a demand for an alternative method, and, if possible, one based on a more stable standard titrating solution. The use of potassium permanganate has been investigated repeatedly for this reason. This laboratory became interested in this latter method to reduce the cumbersomeness of the field test when the iodine method is used.

UNRELIABILITY OF SODIUM SULPHATE AS STANDARD

In any important investigation it is fundamentally desirable, if possible, to use as a standard the actual material to be investigated, if the latter can be got into condition of known concentration. In the analytical study on pollution of the atmosphere by fumes from smelters many chemists have encountered great difficulty in the evaluation of methods of determining the SO_2 content because they have accepted statements in the literature with respect to the reliability of sodium sulphite as a standard in the study of SO_2 pollution. The danger from accepting such statements is not always realized, thereby leading to erroneous conclusions regarding certain analytical methods of evaluating SO_2 , sulphurous acid or sulphites.

This work endeavors to prove the unreliability of accepting sodium sulphite as such a standard. It is shown how far the preparation of sulphate-free sulphite can be accomplished when the product is recrystallized or dried, and also the possibility of obtaining such a product in the freshly prepared moist condition.

The use of sulphites for standardizing permanganate solutions would eliminate a host of troubles which occur in the analysis of a mixture of gases containing a water-soluble component such as sulphur dioxide. Quite naturally, therefore, sulphites have been used by previous workers for standardization in the comparison of the permanganate and iodine methods [Lunge and Smith, *J. Soc. Chem. Ind.*, vol. 2, p. 460 (1883); Lunge and Segaller, *ibid.*, vol. 19, p. 222 (1900); Pinnow, *Z. anal. Chem.*, vol. 43, p. 91 (1904); and Millbauer, *Z. anal. Chem.*, vol. 48, p. 17 (1909)], and also directly as a standard in iodimetry [Giles and Shearer, *J. Soc. Chem. Ind.*, vol. 3, p. 197 (1884); Volhard, *Ann.*, vol. 242, p. 101 (1887); Richardson and Aykroyd, *J. Soc. Chem. Ind.*, vol. 15, p. 172 (1896); and Ferguson, *J. Amer. Chem. Soc.*, vol. 39, p. 364 (1917)] and for testing the applicability of the permanganate method [Honig and Zatzek, *Monatsh.*, vol. 4, p. 738 (1895); Dymond and Hughes, *J. Chem. Soc.*, vol. 71, p. 314 (1897); and Sweeney, Outcault and Withrow, *J. Ind. Eng.*

Chem., vol. 9, p. 949 (1917)]¹ for sulphur dioxide, sulphurous acid and sulphite determinations.

In continuing an investigation started in this laboratory on sulphur dioxide fume from sulphuric acid plants, irregularities of unknown origin were found in a previously published paper on the subject from this laboratory (Sweeney, Outcault and Withrow, *loc. cit.*). An effort had been made therein to use sodium sulphite as a standard of known concentration of SO_2 . Preliminary gravimetric analyses of this substance disclosed variable sulphite composition and the constant presence of sulphates by qualitative tests with barium chloride in acid solution. It was then found in a review of the literature that in all cases therein where sulphate-free sulphites were claimed to have been prepared mention is omitted of any qualitative test used to demonstrate this. It seems to have been *assumed* that recrystallization eliminated the sulphates. This raises grave doubts as to the validity of all previous work on the use of sulphites as standards, except in those cases where rigorous quantitative examination was frequently made upon the sulphite. We have therefore undertaken the preparation of sulphate-free sulphites to determine the actual occurrence of sulphate contamination with various preparation precautions.

OXIDATION OF SODIUM SULPHITE

The oxidation, upon standing, of Na_2SO_3 in the hydrated and anhydrous forms and in solution has been a matter of debate in the literature. It is claimed by some that it is stable under one or another of these conditions while others claim to have proved its instability [Davies, *J. Soc. Chem. Ind.*, vol. 1, p. 88 (1882); Giles and Shearer, *loc. cit.*; Reese, *Chem. News*, vol. 50, p. 219 (1884); Bothamley, *Am. J. Pharm.*, vol. 62, p. 520 (1890); Bigelow, *Z. phys. Chem.*, vol. 26, p. 493 (1898); Griffin, *J. Soc. Chem. Ind.*, vol. 19, p. 321 (1900); Young, *J. Amer. Chem. Soc.*, vol. 24, p. 314 (1902); Pinnow, *loc. cit.*; Lumiere and Seyewitz, *Z. angew. Chem.*, p. 784 (1904); Kastle and Elvolve, *J. Inf. Dis.*, vol. 6, p. 619 (1909); Hartley and Barret, *J. Chem. Soc.*, vol. 95, Tr., p. 1178 (1909); Elvolve, *Am. J. Pharm.*, vol. 82, p. 211 (1910); Foerster, *Arbb. Kais. Gesundh. Amt.*, vol. 49, p. 468 (1914); *Centralb.*, 1915, i, p. 447, and Haller, *J. Soc. Chem. Ind.*, vol. 38, p. 54 (1919)].

The irregularities of the reaction of KMnO_4 solutions on sulphites when the percentage recovery of SO_2 is found by the KMnO_4 method has been studied by Honig and Zatzek (*loc. cit.*, p. 746); Raschig [*Z. angew. Chem.* (1904) p. 580]; Pinnow [*loc. cit.*]; Day and Baker [*Analyst*, vol. 37, p. 439 (1912)], and Craig [*J. Soc. Chem. Ind.*, vol. 38, p. 96 (1919)].

The need for stabilization of sulphite solutions is also keenly recognized in the medical profession. The conclusions obtained in this field by various workers is that organic bodies in general are inhibitors of oxidation of sulphite solutions. [Foerscher, *J. Prakt. Chem.*, vol. 37, p. 27 (1846); Bigelow, *loc. cit.*; Young, *loc. cit.*; Titoff, *Z. phys. Chem.*, vol. 45, p. 641 (1904); Ruff and Jeroch, *Ber.*, vol. 48, p. 499 (1905); Baker and Day, *J. Soc. Chem. Ind.*, vol. 31, p. 1048

¹Correction—The former article on SO_2 by Sweeney, Outcault and Withrow (*loc. cit.*) from this laboratory credits the Selby Smelter Commission (U. S. Bureau of Mines Bull. 98 and Dymond and Hughes, *loc. cit.*) with using sodium sulphite as a basis for standardization and study. A subsequent correction [*J. Ind. Eng. Chem.*, vol. 9, p. 1148 (1917)] requests omission of this statement. Nevertheless, Dymond and Hughes actually depended on Na_2SO_3 as such a basis, though the Selby Smelter Commission did not do so.

(1912); Pinnow, *loc. cit.*; Sauillard, *Compt. rend.*, vol. 160, p. 318 (1915); Matthews and Weeks, *J. Am. Chem. Soc.*, vol. 39, p. 635 (1917); and Haller, *loc. cit.*] A general review of the literature on the substitution of other sulphites for the sodium salt reveals the fact that other sulphites are equally or more difficult to prepare pure. [Seuber and Elton, *Z. anorg. Chem.*, vol. 4, p. 44 (1893); Demmer, *Das Chemische Technologie*, vol. 1, p. 116 (1895); Griffin, *loc. cit.*; Weston and Jeffries, *Chem. News*, vol. 97, p. 85 (1908); Alexander, *Z. anal. Chem.*, vol. 48, p. 31 (1909); Henderson and Weiser, *J. Am. Chem. Soc.*, vol. 35, p. 239 (1913), and Abegg, *Handbuch der Anorganische Chemie* (1908).]

Whenever we attempted to use commercial sodium sulphite, unsatisfactory results were obtained in spite of all precautionary measures, and purification methods, such as the use of air-free water, repeated crystallization and centrifuging. The synthetic preparation of sodium sulphite was therefore undertaken. After unsatisfactory efforts with SO_2 and NaOH , carrying on all the operations in the absence of air, Na_2CO_3 was used. The apparatus consisted of a train for washing SO_2 from a cylinder through FeSO_4 solution for absorbing any oxidizing gases, BaCl_2 in HCl solution for precipitating any sulphates, water for absorption of spray from the previous wash bottles, saturated Na_2CO_3 solution for sulphite preparation and a Na_2CO_3 trap solution to prevent back suction of air into apparatus or the escape of SO_2 into the air.

The water and sodium carbonate solutions used were both sulphate and air free. After absorption of SO_2 in the Na_2CO_3 solution to form NaHSO_3 , an equivalent amount of Na_2CO_3 in solution was added and the evolved CO_2 was swept out with pure N_2 from a gasometer after passing through alkaline pyrogallate. The solution was then cooled to 0 deg. C. The fine crystal meal separating was filtered without removal from the apparatus by technique similar to that used by Hartley and Barret (*loc. cit.*)

For drying the hepta-hydrate a modification of the customary two-piece desiccator was used. The drying agent was 96 per cent H_2SO_4 and sodium pyrogallate solution was the oxygen absorbent.

RESULTS

The damp $\text{Na}_2\text{SO}_3 \cdot 7\text{H}_2\text{O}$ upon being put in the desiccator gave not the slightest test for sulphates with BaCl_2 . The same was true of the mother liquor taken from the salt. In spite of the precautionary measures taken to prevent oxidation or leakage of air into the apparatus, some oxidation did subsequently take place; after one week of standing the product analyzed 7.52 per cent $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$ and 88.7 per cent $\text{Na}_2\text{SO}_3 \cdot 7\text{H}_2\text{O}$ with about 3.78 per cent excess moisture. The quantity of surface exposed on crystals of sodium sulphite is naturally enormously great compared with a solution of the salt, so that one naturally expects a more ready oxidation on moist crystals than one would in a concentrated solution which Lumiere and Seyewitz (*loc. cit.*) claim is stable.

An investigation was started to see if any other sulphite could be prepared in a more stable form. Calcium sulphite can be used as readily as sodium sulphite as a gravimetric standard for SO_2 . Since calcium sulphite is about forty-six times as insoluble as calcium sulphate at 18 deg. C., it was believed that any sulphate present in calcium sulphite could be readily washed out. This

was attempted and proved to be the case, for no sulphates were present on the wet or moist product. This fact also indicates that since sulphates were originally present and could be washed out, the sulphate contamination was not due to adsorption. Precautionary measures used in drying proved of no avail, for in all cases the dry sulphite was contaminated with sulphates produced by oxidation during the drying. It was felt, therefore, that calcium sulphite preparation offered no advantages over sodium sulphite.

ORIGIN OF THE SULPHATE CONTAMINATION

The sulphate found by the qualitative test with BaCl_2 resulted undoubtedly from oxidation of the sulphite. Such oxidation could occur in one of two ways. It might have resulted from leakage of air into the apparatus or from auto-oxidation of the sulphites themselves. In this work the apparatus, method and precautions used to exclude air leakage during preparation and drying were all that possibly could be expected.

It seems clear therefore that the preparation of sulphate-free sulphites for standard sulphur dioxide solutions is so difficult (if not impossible) that all work heretofore based upon such use of sulphites is of questionable validity.

While unsuspected air leakage could always be a possibility, nevertheless the precautions taken forced the conclusion that some form of auto-oxidation was really responsible for the sulphate contamination. Some of the sodium sulphite could conceivably oxidize other portions, being itself reduced to various possible derivatives, for Jungfleisch and Brunel [*Compt. rend.*, vol. 156, p. 1719 (1913)] have shown that $3\text{SO}_2 + 2\text{H}_2\text{O} \rightarrow \text{S} + 2\text{H}_2\text{SO}_4$. As our object was an effort to confirm, if possible, the literature claims that a sulphate-free sulphite was readily preparable, we did not stop at this time to investigate the interesting and complicated fields which, it is well known, auto-oxidation presents among the sulphur acids.

A sample of dry $\text{Na}_2\text{SO}_3 \cdot 7\text{H}_2\text{O}$, chemically pure, was tested for stability and showed an increasing amount of oxidation on standing. From an initial analysis of 89.61 per cent $\text{Na}_2\text{SO}_3 \cdot 7\text{H}_2\text{O}$ by gravimetric analysis, it dropped to an average of 68.5 per cent two months later. Therefore the use of sodium sulphite heptahydrate as a weighable gravimetric standard in itself appears to be wholly unsatisfactory in refined work because of the necessity of its frequent analysis. To investigate the influence of manipulation details on the variation errors, a study was made of the influence of time of standing in solution before completion of the analysis. It was found that when air-free water was used for dissolving the sodium sulphite the purity of $\text{Na}_2\text{SO}_3 \cdot 7\text{H}_2\text{O}$ as determined by the iodine method dropped from 88.5 per cent when solution stood 5 minutes before completion of analysis to 87.2 per cent after a 15-minute period and to 84.6 per cent when the solution was allowed to stand 40 minutes. In each of the above cases HCl was added to the iodine solution so that any oxidation that took place occurred within the Na_2SO_3 solution and the difference was not due to loss of SO_2 on standing as an acidified sulphite solution. This demonstrates that dilute Na_2SO_3 solutions are unstable in the presence of air, the extent of oxidation being a function of the time the solutions were in contact with the air.

The conclusions reached are:

1. All statements in the literature concerning the

preparation of sulphate-free sodium sulphite should be seriously questioned.

2. The validity of all investigations in the literature based upon the use of the prepared sodium sulphite as a sulphur dioxide standard is doubtful.

3. The inability to prepare sulphate-free sulphite for use as an SO_2 standard solution according to directions given in the literature has been shown.

4. Due to the rapid oxidation of sodium sulphite solutions in the presence of air, if for no other reason, this use of the substance for standardization of oxidation solutions is objectionable.

5. No method tried by us gave a dry $\text{Na}_2\text{SO}_3 \cdot 7\text{H}_2\text{O}$ free of SO_4 when tested by BaCl_2 and HCl , notwithstanding claims in the literature that "pure sulphites" or " SO_4 -free sulphite" could be prepared.

6. A sulphate-free sodium sulphite heptahydrate and also calcium sulphite can be prepared moist.

7. Drying of sodium sulphite and calcium sulphite contaminated the product by oxidation.

8. This sulphate contamination is not due to adsorption of sulphates on sulphite.

9. Moist sulphites, all sodium sulphite solutions, and particularly dilute solutions, oxidize rapidly in air.

10. A recrystallization process, if carried on in the presence of air, will not give a sulphate-free product on account of this rapid oxidation.

11. Dry $\text{Na}_2\text{SO}_3 \cdot 7\text{H}_2\text{O}$ is not stable toward oxidation in the air.

12. The production of sulphate-free calcium sulphite presents the same difficulties as does sodium sulphite.

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Concentrated HCl as Metallographic Etching Reagent for Nickel

BY HENRY S. RAWDON* AND MARJORIE G. LORENTZ*

NICKEL and the nickel-rich alloys are usually classed among the best of the non-corrodible materials in common industrial use. Since they are so inactive chemically, they are etched for microstructural examinations with very considerable difficulty as a rule. Very active reagents, such as nitric acid or an acid to which a strong oxidizing agent has been added, are required. When etched with such solutions, pitting of the surface is apt to be excessive, and this is often the most conspicuous feature of the microstructure revealed. Another point, which is usually a disadvantage, is the plain etch-pattern produced lacking in contrast. Only the grain boundaries are revealed and none of the grains has any "individuality."

It is the purpose of this note briefly to refer to the use of concentrated hydrochloric acid as a metallographic etching reagent for nickel as having some very desirable features which most of the other reagents lack. The use of concentrated hydrochloric acid for this purpose was developed during the general study of etching reagents now in progress at the Bureau of Standards.¹

In the accompanying micrographs the character of

RESULTS OBTAINED WITH CONCENTRATED HYDROCHLORIC ACID AS ETCHING REAGENT

Material Etched	Etching Period	Results
Elec. nickel	1 hour	No action
Cast nickel	1 hour	Excellent contrast
Drawn nickel	1 hour	Excellent contrast
Rolled nickel	1 hour	Excellent contrast
Cast Monel	1 hour	Excellent contrast
Hot-rolled Monel	1 hour	Excellent contrast
Cold-drawn Monel	1 hour	Excellent contrast
Nickel sheet	1 hour	Excellent contrast
Elec. nickel melted and cooled in vacuo	2 hours	Poor; no contrast
Cast cupronickel (45 per cent Ni)	1 hour	Excellent contrast
Cast cupronickel (28 per cent Ni)	15 min.	Fair; no contrast
Rolled cupronickel (20 per cent Ni)	20 min.	Fair contrast
Manganese nickel (3 per cent Ni)	1 hour	Excellent contrast
Annealed nickel-brass (26 per cent Ni)	30 min.	Fair contrast
Annealed nickel-brass (17 per cent Ni)	30 min.	Fair contrast
Cold-rolled nickel-brass (17 per cent Ni)	15 min.	Poor contrast
Nickel-brass (5 per cent Ni)	15 min.	Poor contrast

the results which may be obtained by its use is illustrated; for comparison, there is shown also the structure as revealed by one of the common reagents. One of the best of these has been described by Merica² and consists of 50 per cent concentrated nitric acid, glacial acetic acid, 25 per cent, and water, 25 per cent; the proportions may be varied somewhat, however. The marked contrast and absence of pitting in the structures as revealed by etching with hydrochloric acid are very evident. One feature which appears to be the principal disadvantage in this use of hydrochloric acid is the long etching period required. As shown in the accompanying table, it was often necessary to keep the specimen immersed in the acid for 1 hour or more.

The results summarized in the table show that the general effect of concentrated hydrochloric acid is a contrast etch pattern. The best results by far were obtained with nickel and with alloy of high-nickel content. With alloys in which copper forms a considerable percentage of the composition, the results obtained were decidedly inferior to those with the high-nickel specimens. Micrographs showing the appearance of the microstructure as revealed by concentrated hydro-

²P. D. Merica, "Nickel," Bureau of Standards Circular 100.

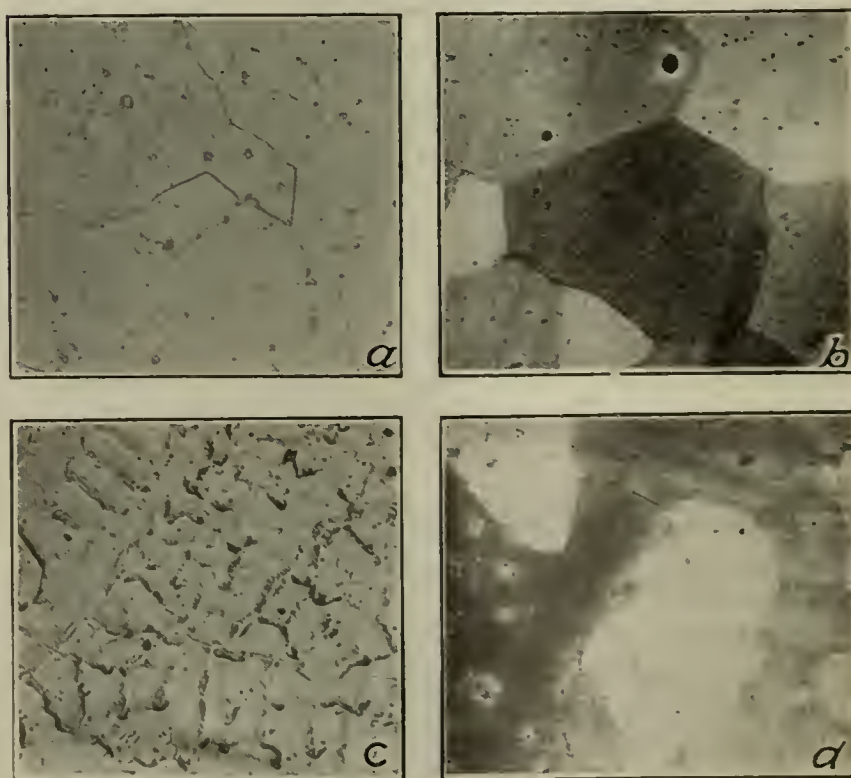


FIG. 1. MICROSTRUCTURE OF CAST NICKEL AND CAST MONEL METAL. $\times 85$

- Cast nickel etched with acetic acid solution of nitric acid, 45 seconds.
- Same material as a, etched with concentrated hydrochloric acid 1 hour.
- Cast Monel metal, etched as in a, 15 seconds.
- Same material as c, etched as in b.

*Physicist and Assistant Physicist, respectively, Bureau of Standards.

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¹Henry S. Rawdon and Marjorie G. Lorentz, "Metallographic Etching Reagents. I—For Copper," Bureau of Standards Sci. Paper 399; also forthcoming Sci. Paper, second of the series, "Metallographic Reagents. II—For Copper Alloys, Nickel and the Alpha Alloys of Nickel."

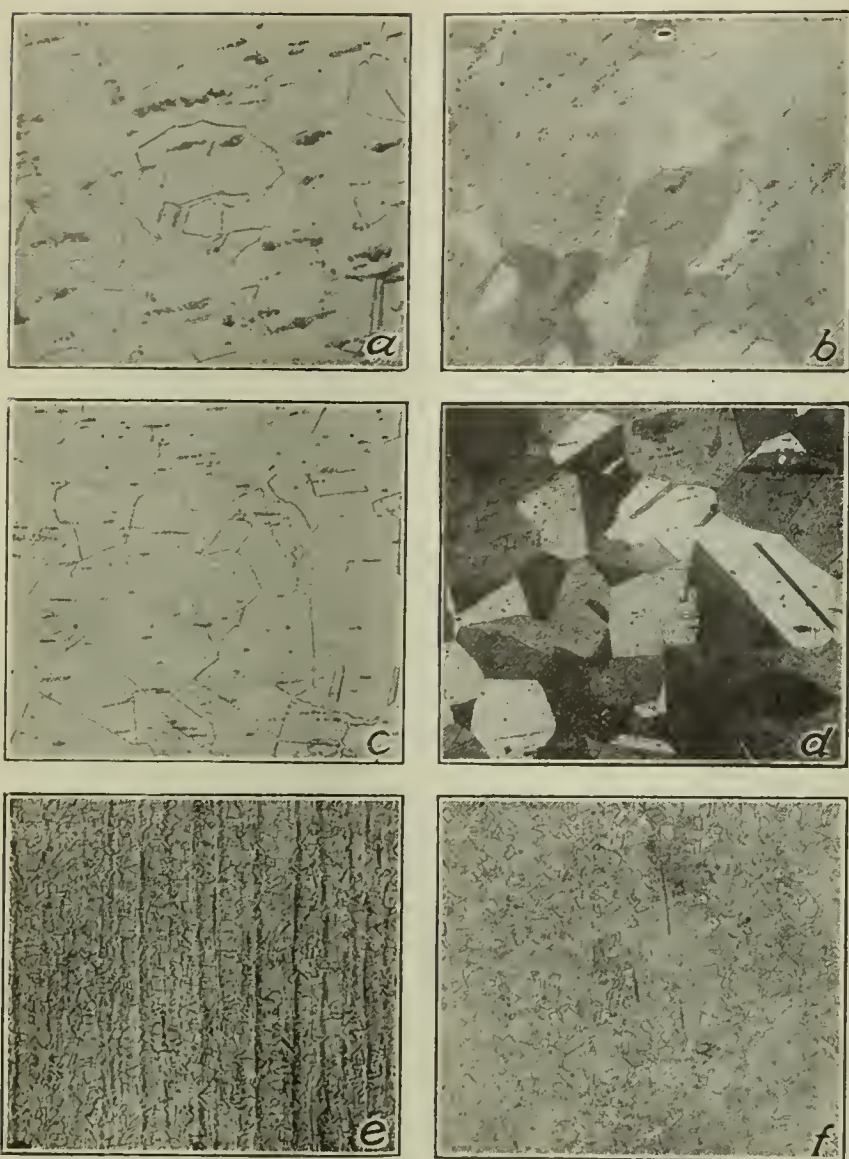


FIG. 2. MICROSTRUCTURE OF WROUGHT NICKEL AND MONEL METAL. $\times 85$

- a. Sheet nickel, etched with acetic acid solution of nitric acid for 2 minutes.
- b. Same material as a, etched with concentrated hydrochloric acid for 1 hour.
- c. "Manganese-nickel," etched as in a, 30 seconds.
- d. Same material as c, etched as in b.
- e. Hot-rolled Monel metal, etched as in a for 15 seconds.
- f. Same material as in e, etched as in b.

chloric acid and by the acetic acid solution of nitric acid are given for the following materials:

Cast nickel (Ni, 99.3 per cent; Cu, 0.13; Fe, 0.25; C, 0.10; Si, 0.05).

Manganese-nickel (Ni, 97 per cent; Mn, 3).

Cold-rolled nickel sheet (Ni, 99.1 per cent; Cu, 0.35; Fe, 0.40; Mn, 0.05; C, 0.03; Si, 0.08).

Cast Monel metal (Ni, 66.3 per cent; Cu, 28.5; Fe, 2.49; Mn, 1.85; C, 0.12; Si, 0.73).

Hot-rolled Monel metal (Ni, 66.6 per cent; Cu, 29.3; Fe, 1.90; Mn, 1.76; C, 0.13; Si, 0.18).

Results obtained with ferric chloride as an etching reagent are somewhat similar for some of the materials to those described for hydrochloric acid. However, pitting of the surface was usually found to be rather pronounced and the nice gradations of light and shade were lacking. With oxidizing reagents such as H_2SO_4 and H_2O_2 , the appearance of the etched specimen was in all cases inferior to that produced by the nitric acid solution illustrated in the micrographs, and the pitting of the material was, in most cases, very pronounced.

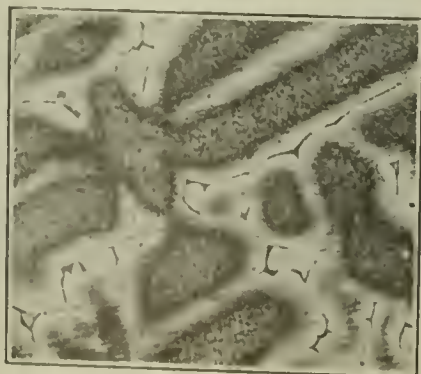


FIG. 3. MICROSTRUCTURE OF CAST ALUMINUM-BRONZE (8 PER CENT AL). $\times 85$
Etching reagent, concentrated hydrochloric acid, 15 minutes.

The action of the reagent upon the common copper alloys was also examined. With bronze and aluminum-bronze results were obtained which were equal to those given by the usual reagents. Fig. 3 shows the results obtained with a cast aluminum-bronze (8 per cent Al), an alloy which is etched satisfactorily with considerable difficulty. For most of the common copper alloys, however, superior results can be obtained much more easily with the reagents usually employed.

New Chemistry Building at Iowa City

Prof. Edward Bartow, head of the department of chemistry at the State University of Iowa, in a recent address outlined the plans for the new chemistry building which is being erected at Iowa City. An initial appropriation of \$400,000 has been made for commencing the construction of the 6-story building which, when completed, is to occupy an entire city block. It is to include a central structure facing the east with three wings extending to the north and south. The main lecture room or auditorium will be located in the central structure on the east side of the building. On the lower level there will be two entrances to the room, which will enable it to be filled or cleared without delay—a desirable feature in changing classes. Back of the main lecture room there will be a preparation room which will also serve the smaller lecture rooms.

The library, furnishing shelf room for 40,000 books and table room for 200 students, is to be placed above the main lecture room and will be easily accessible both from the street and from all parts of the building.

The storerooms will be located in the geographical center of the block, one on each floor. The storeroom on the lower floor will be devoted to reception of supplies, that on the second floor to general storage, on the third, fourth, fifth and sixth floors to delivery rooms for the laboratories. On the sixth floor connection will be made through a corridor to the laboratories located on the east front.

With rooms for general utility, such as the storerooms, lecture rooms and library, in this central portion of the building, access to them from laboratories in the wings will be easy. This plan for the building was chosen rather than that of a hollow square because it makes it possible to reach any part of the building through corridors rather than through laboratories; the distances between the laboratories and general utility rooms are reduced to a minimum, and part of the building can be constructed now and wings to complete the building can be added later without interfering with the part already constructed.

Ground was broken on the southeast corner of the city block on August 9, 1921. Approximately one-half of the central structure and two of the wings are to be built immediately. In accordance with the general plan, wings may be added to the part under construction in any one or all of three places.

Each wing will contain four floors, 57 ft. wide and 81 ft. long, with light on three sides. This space can be used as a whole or divided into smaller rooms. Small laboratories, offices and special rooms can be cut off from either end of these wings and others will be placed along the corridors and on the second, third and fourth floors of the storeroom unit. Special rooms of this type are needed for instructors and for advanced students. Seminar room in which special reference books can be placed have been provided in the central portion.

Importance of the Olefine Gases and Their Derivatives

II—Diethyl Sulphate*

**Diethyl Sulphate of High Purity Can Be Prepared From Pure Ethylene and Sulphuric Acid—
Advantages as an Ethylating Agent: Low Volatility, Which Obviates Use of Autoclaves;
High Reaction Intensity; It Is Non-Toxic, Non-Flammable and Non-Corrosive**

By G. O. CURME, JR., AND H. R. CURME

IN A consideration of the many possible derivatives of ethylene, aside from those best known as a result of numerous recent publications, diethyl sulphate ("ethyl sulphate") is deserving of especial attention. It recommends itself particularly on account of the improvement it offers in many old and long-established processes, and also on account of the new fields of chemical operation which it promises to develop. As is generally known, the homologous dimethyl sulphate has already been widely used for purposes of introducing the methyl group, and apparently for no reason other than its more general commercial availability has progressed relatively much further in its field than has the diethyl sulphate in the field of ethylation. That this has been done commercially in spite of an average price high in proportion to the value of the methyl groups contained is indeed a tribute to the smoothness of reaction which characterizes the alkylation by means of the alkyl sulphates. Now that the diethyl sulphate is available in even more abundant quantities, it may confidently be expected that its use will also expand.

The preparation and isolation of diethyl sulphate, $(C_2H_5)_2SO_4$, itself is not a new accomplishment, as this material was described by Wetherill¹ in 1848 as a product of the interaction of sulphur trioxide on absolute ether. It is, when pure, a colorless liquid, with a pleasant though faint ethereal odor. It boils without decomposition at 96 deg. C. at 15 mm. pressure, and at 120.5 deg. C. at 45 mm. At temperatures above 140 deg. C. it begins to decompose slowly, and at 208 deg. C. it boils with considerable decomposition—the true boiling point probably lies several degrees higher. It has the density $D_{20}^{20} = 1.1837$.² On cooling it forms crystals which melt at -24.5 deg. C. This liquid is entirely neutral in reaction. It is not miscible with cold water; with warm water it is slowly hydrolyzed, and on boiling it yields eventually two molecules of ethyl alcohol and one of sulphuric acid. Diethyl sulphate is not flammable.

Since its discovery numerous investigators have studied it and have worked with it in a variety of ways. From the first it has been recognized as an ethylation agent of marked value, although in all hands it has not met with the same success. For instance, Lassar-Cohn³ states that in his experience it has not given satisfactory results, and yet Weyl⁴ a few years later

says, "Diethyl sulphate has attained great significance for ethylation." This difference in results may well be due to any of several causes, as the earlier experimenters may have had impure samples at their disposal. Their experience with the dimethyl sulphate may have led them to follow methods worked out for its use too closely, or indeed with a limited supply available the tests may have been carried out improperly. In any event positive evidence has since shown the value of this reagent and to the writers' knowledge in certain industrial processes it is being used today with commercial yields approaching the theoretical.

COMMERCIAL PRODUCTION

Only within the last twenty years have there been attempts to utilize diethyl sulphate commercially, and these attempts have been put under the difficulty of having a rather expensive source of material. In 1902 E. Merck⁵ obtained a patent on the production of diethyl sulphate by the vacuum distillation of the product obtained by mixing ethyl alcohol and sulphur trioxide. Later patents⁶ have proposed the production by means of the dry distillation in vacuo of sodium ethyl sulphate, and further by the interaction of chlorosulphonic acid and absolute ether.⁷ In all of these processes the initial product is highly impure and requires extensive after-treatment to obtain a commercially satisfactory product. Also the yields are rather poor, being in general less than 50 per cent of that demanded by theory. In the work carried on under the writers' direction, it was observed that the expense of using anhydrous materials, or vacuum distillations, could be avoided by using, instead of alcohol, the product of its dehydration—namely, ethylene. It was found that with pure ethylene and commercial sulphuric acid (66 deg. Bé.) a continuous cycle could be established producing high purity diethyl sulphate directly.⁸ The material from this source is now commercially available, and is finding a variety of technical applications.

ONLY ORDINARY PRECAUTIONS REQUIRED IN HANDLING

In the case of the homologous dimethyl sulphate a toxic effect from handling the material and inhaling its vapors has been noted and described by Weber.⁹ In this same report it is stated that the acute inflammation characteristic of dimethyl sulphate is not noted at all with the diethyl sulphate, and only the general action on the central nervous system is observed. From

*A contribution from the Mellon Institute of Industrial Research, of the University of Pittsburgh.

¹This article, the second of a series of five, treats of the general properties of a little known commercial reagent which is now made available through the development work carried out by the Carbide & Carbon Chemicals Corporation, at Clendenin, W. Va. Part I was published Nov. 16, 1921, p. 907.

²Wetherill, *Ann.*, vol. 66, p. 117 (1848).

³Claesson, *J. prakt. Chem.*, (2) vol. 19, p. 257 (1879).

⁴Lassar-Cohn, 4th ed. (1907) *Spez. Teil*, p. 301.

⁵Th. Weyl, "Die Methoden der Organischen Chemie" (1911), vol. 2, p. 1268.

⁶Merck, Ger. Pat. 133,542 (1902).

⁷Lilienfeld, U. S. Patent 1,074,633 (1913).

⁸Wolf, U. S. Patent 1,101,373 (1914).

⁹H. R. Curme, U. S. Patent 1,339,947 (1920).

¹⁰Weber, *Archiv. exp. Path. Pharm.*, vol. 47, p. 113 (1901).

a hygienic standpoint, diethyl sulphate is no more dangerous to handle than organic liquids such as aniline, benzene, etc. It has been the writers' experience, as well as that of others who have used this material on a large scale, that, observing only the most usual precautions against inhalation of the fumes of the heated material, it is possible for workmen to handle diethyl sulphate continuously without any evil effects whatsoever. It has been stated erroneously in previous publications that the toxic effect of the dimethyl sulphate is also characteristic of the diethyl sulphate. Accordingly, in order not to limit the usefulness of this reagent, it is well to correct this error which has gained admission to the literature. It is also worthy of attention that the toxicity of the dimethyl sulphate itself has been overemphasized, as has recently been pointed out by Mueller.¹⁰ Undoubtedly, a closer knowledge of such substances will provide a safe working procedure that also permits the full utilization of their valuable properties.

ADVANTAGES AS ETHYLATING AGENT

By means of this commercially new reagent it is possible to accomplish, almost without exception, the ethylation of any material which has heretofore been ethylated by any means whatsoever. Moreover, this ethylation may be brought about in plant operation with greater ease and simplicity than heretofore possible. Owing to its low volatility (b.p. 208 deg. C.), it is not necessary to use autoclaves for carrying on such reactions; any closed vessel fitted with a simple reflux and operating at atmospheric pressure will suffice. Also, as this reagent is quite neutral and is commonly used under neutral or alkaline conditions, a wider choice of materials for construction of equipment is possible than in many ethylations where strong acids are present. The material is non-flammable and therefore avoids any fire risk in its use.

In comparison with ethylation by means of ethyl bromide, the use of diethyl sulphate recommends itself both on grounds of simplified procedure, as well as economy of operation. In addition to avoiding the use of an autoclave, as above mentioned, the losses, in handling and storing of a volatile material, are eliminated, and the troublesome necessity for working over the bromine residues is entirely avoided. All of the value of the ethyl sulphate lies in the ethyl groups and the sulphate radical in most cases is not worth recovery.

A further important advantage, particularly in the case of diethyl sulphate derived from ethylene, is that only the purest ethyl derivatives are formed, containing no trace of homologous methyl or propyl compounds. Commercially this is equivalent to the use of tax-paid alcohol derivatives, although, of course, no alcohol is used in the production of the products.

GENERAL CONDITIONS FOR USE

The conditions under which reaction proceeds most smoothly are, of course, different in each separate case. However, in general, it is desirable to operate in the absence of water, if possible, as was suggested by Ullmann¹¹ for such alkylations as early as 1902. With diethyl sulphate it is generally desirable to use a slightly higher temperature than with dimethyl sulphate in order to get a similar velocity of reaction; but otherwise conditions are similar. Some reactions,

such as in the ethylation of aniline, need no heating whatsoever, but warm up from room temperature so as to need cooling. In most cases at temperatures between 100 and 125 deg. C. the reaction is quite rapid, and at temperatures above that it is possible that the reaction will become too violent. In all cases by controlling the temperature, or both temperature and rate of addition of the reagent, it is possible to maintain any desired rate of reaction. Frequently it is desirable to mix the finely powdered—if solid—material to be ethylated with the diethyl sulphate and then to heat the charge gently until reaction is complete. In other cases an inert anhydrous solvent, such as benzene or solvent naphtha, gives excellent results. As the reagent is miscible in all proportions with most organic liquids, the reaction can be brought about by simple admixture, in the case of ethylating a liquid. Usually the previous formation of the sodium salt of a material to be ethylated is desirable when such can easily be done, and in other cases the presence of an equivalent amount of caustic soda is desirable to prevent the formation of free acid.

Under the general conditions just described it is usually possible to get a great intensity of ethylation with the first of the two ethyl groups and a practically theoretical yield, both reckoned on this ethyl group and on the other material. The second ethyl group reacts exactly as the ethyl group of sodium ethyl sulphate and consequently with less intensity. With some reactions, such as the production of volatile ethyl esters, it is possible to get a high yield with this second ethyl group also, although in other cases it is best to stop the reaction when the first ethyl group has reacted, and to make use of the residual sodium ethyl sulphate, or ethyl hydrogen sulphate, for some other purpose.

COMMERCIAL ETHYL COMPOUNDS PREPARED

It is beyond the scope of this résumé to give complete directions for making all ethyl compounds, or even a list thereof, for it is realized that this work is still largely incomplete. It will be of interest, however, to mention some of the commercial products which have to date been successfully produced by means of ethylation with diethyl sulphate. Ethyl chloride, ethyl bromide and ethyl iodide have been prepared with great ease and in almost quantitative yields. The esters of the weaker inorganic acids, such as ethyl nitrite, ethyl sulphite, ethyl mercaptan and ethyl sulphide, are readily produced in highest purity and good yields. The esters of all organic acids attempted have been produced easily, and in such cases as ethyl cinnamate, where the value of the acid radical is relatively great, a highly pure derivative has been obtained with negligible loss of material. The ethyl esters of the higher fatty acids, such as ethyl laurate, ethyl oleate, ethyl stearate, etc., have been prepared easily, and through this means the pure fatty acids themselves have been readily isolated by redistillation of the esters. Ethylated phenols may be obtained quantitatively. Ethylated amino compounds are very easily prepared indeed, although care must be taken to get proper conditions to prevent the formation of complex mixtures of mono-, di- and tri-ethyl derivatives, as is common with all ethylations of amines. Finally, starch and even cellulose have been ethylated to give ethers,¹² in general similar to the esters of the

¹⁰CHEM. & MET. ENG., vol. 23, p. 833 (1920).

¹¹Ullman, *Ber.*, vol. 35, p. 322 (1902).

¹²Lilienfeld, Brit. Pats. 12,854 (1912) and 149,320 (1920); U. S. Pats. 1,217,027 (1917); 1,217,028 (1917). Clarke, U. S. Pat. 1,357,614 (1920). Worden, "Technology of Cellulose Esters," Van Nostrand, (1916), vol. 8, p. 2505.

same materials, but naturally more stable and less subject to hydrolysis and corrosion of metal in contact with the material thus produced.

The possible applications of this reagent in our future developments of chemistry are difficult to predict at this time; but, in view of the undeveloped possibilities which suggest themselves in the fields of dyestuffs, pharmaceuticals, solvents, plastics, varnishes and films, it would be safe to expect that the technical application of ethylene in the production of commercial diethyl sulphate will be of importance in the chemistry of the future.

SUMMARY

In brief, the advantages which this commercially new ethylating agent offers are:

1. It permits rapid and complete ethylation without pressure vessels or autoclaves.
2. It has a high intensity of reaction, thus economizing valuable material.
3. It avoids the necessity of recovering any expensive acid radical.
4. It may be handled and stored without loss due to its low volatility.
5. It is non-toxic, non-flammable and non-corrosive.

A Symposium on Industrial Management

VARIOUS phases of industrial management were discussed by well-known experts at the annual convention of the Industrial Relations Association of America, held in New York on Nov. 1-4. Secretary of Commerce Hoover, Secretary of Labor Davis, B. Seeborn Rowntree, president of the large British cocoa works of Rowntree & Co., Ltd., and many officials and employment managers for prominent American industries spoke on labor conditions, personnel work and such closely related subjects as departmental costs, living conditions, wages, seasonal production, and unemployment.

Space limitations prevent an extended account of the open meetings and sectional conferences, but a few papers of more intimate interest to our readers have been abstracted in the paragraphs which follow:

Human Relations in Industry.—A discussion of the fundamental principles of human relations in industry by L. A. Osborne, president of the Westinghouse International Electric Co., was well received by the convention. Mr. Osborne divided industrial relations into two categories, economical and ethical, and analyzed these according to his own viewpoint. He made a plea for cordial relations between employer and employee, saying that on no other basis could industry thrive. On the subject of wages he stated as his opinion that wages should be based on production.

Taking the Mystery Out of Business.—S. R. Rectanus, personnel director of the American Rolling Mills Co., explained how his company is winning the confidence of its employees by "taking the mystery out of business." Advisory committees are elected by secret ballot, the privilege of voting and holding office being confined to employees who have been with the company a year. These committees take up problems of production, working conditions and other matters which affect both the company and the workers. The objects of the company, the way in which it conducts its business, the conditions of the market in general and the eco-

nomics of business are discussed and made clear so that every man and woman in the plant has, or can have, a clear understanding as to the methods and practices of the company.

It is this company's belief that practically all of the mystery which has surrounded business so far as its employees are concerned is not only unnecessary but is a direct cause of much distrust and misunderstanding.

Use of Graphic Charts.—Along this same line, E. K. Hall, vice-president, American Telephone & Telegraph Co., stated that one of the principal causes of industrial unrest is the fact that working men and women feel that they have no standing in the industry, but are simply small cogs in a huge machine. One of the ways in which this misconception is being overcome is by the preparation of organization charts which include everyone in the central station or district, from the manager down to the janitor, making them all feel that they are part of the family. This is in distinct contrast to the usual organization chart which shows only the heads of various departments and leaves all the rest in an unclassified mass. The result of this change has been increased confidence and an excellent spirit of co-operation among the employees of the company.

Hoover's Analysis of Labor Unrest.—The third session of the convention was held in conjunction with a dinner meeting of the Academy of Political Science. Herbert Hoover, presiding officer, in pointing out the value of good will and co-operation in industry, gave a brief analysis of labor conditions as they exist today.

Mr. Hoover referred to the universal desire for the limitation of armament, not only internationally but industrially, stating that warfare is becoming more destructive year by year. He also referred to altercations between employer and employee, declaring that it was wholly idle to deny the existence of conflicting interests between these parties. "But," he added, "there are wide areas of activity in which their interests coincide. It is the part of statesmanship to recognize identity of interest where it exists in order to reduce the area of conflict."

Unemployment was given as largely responsible for industrial unrest. "One of the causes of ill will that weighs heavily upon the community," said the speaker, "is the whole problem of unemployment. I know of nothing that more filled the mind of the recent conference, while dealing mainly with emergency matters, than the necessity to develop further remedy, first, for the vast calamities of unemployment in the cyclic periods of depression, and, second, some assurance to the individual of reasonable economic security—to remove the fear of total family disaster in the loss of the job."

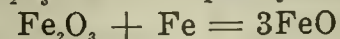
Viewpoint of the British Employer.—B. Seeborn Rowntree, president of Rowntree & Co., cocoa works, York, England, spoke on "Conditions Essential to Industrial Co-operation from a British Employer's Point of View." He complimented American business men upon the efficiency with which they have handled their material problems, but stated that the same effort is not being exerted on the human problems. Industrial unrest, according to Mr. Rowntree, is a reflection on the ability and intelligence of the employer. To secure industrial peace, he must pay the price, consisting of commensurate wages, sufficiently short hours, a guaranteed economic security to the worker, and possibly a proper share of the profits of the work.

Solid Solutions of Oxygen in Iron

TWO papers were read on this subject before the British Iron and Steel Institute's spring meeting, 1921, one by Dr. J. E. Stead and the other by J. H. Whiteley. In the former Dr. Stead notes that in general solid solutions in iron are electro-positive to pure iron, and therefore when in contact with the latter remain white on brief attack by a cupric reagent. However, many attempts to verify Le Chatelier and Bogitch's statement that iron and its oxide or oxygen formed such a solid solution were fruitless, even when electrolytic iron was burned on a magnesia-lined base in such a way that the fused iron was shot full of minute black globules and covered with thick layers of cinder. However, if strips of electrolytic iron or commercial soft steel were heated to 1,000 deg. C. in air, a thin sheath of finely crystalline iron (which resisted cupric attack) is found to separate the base and the adherent scale. White "resist" lines also appear at welded junctions.

More recently, Dr. Stead examined a steel casing very low in phosphorus from a hot blast stove, heated many years in an oxidizing atmosphere. It was extremely brittle; shock fracture commenced as intercrystalline at the surface, but deeper in was transgranular. Veins of oxide of iron completely separated the surface

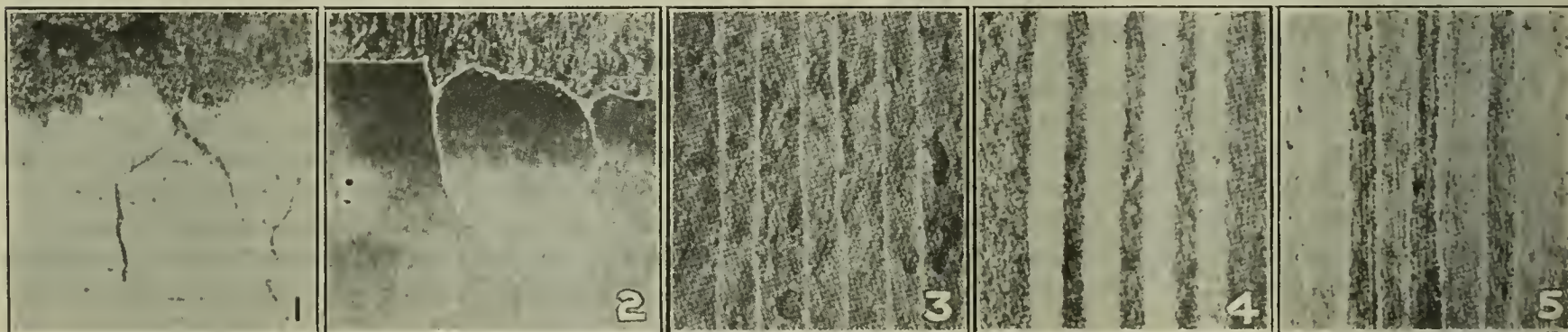
He then investigated the effect of oxygen, phosphorus remaining constant. Very pure electrolytic iron was oxidized to scale in an electric muffle. This oxide was used to pack other pieces of iron into a small steel cylinder, the latter tightly plugged, cased in a strong silica tube and the whole heated 2 hours in a gas furnace to approximately 1,350 deg. C. On opening, the oxide had fused to a solid mass, and chemical analysis indicated that Fe_2O_3 had been partly reduced, as follows:



Unetched sections showed the metal to contain a number of new globular particles, thought to be of the same composition as the packing material. It is unknown whether this material worked itself in at high temperature, or separated from solid solution on cooling.

A pile consisting of several alternate layers of this oxidized and the original iron was prepared, placed in a tightly plugged steel cylinder containing nitrogen, heated and hammered down until the whole had welded together. Fig. 3 shows a cross-section of the weld after etching, which is not comparable with the least variation in phosphorus (Fig. 4).

Armco iron was then deoxidized by heating in H_2 for 2½ hours at about 1,350 deg. C., a pile of deoxidized and original strips made, and welded in a tube containing H_2 . Temperature was held below 900 deg. C., and



FIGS. 1 TO 5.

Figs. 1 and 2. Oxidized steel plate, showing scale at top, steel below, intergranular oxides and globular inclusions. $\times 50$. Fig. 1 etched with dilute acid. Fig. 2 etched with cupric reagent.

Fig. 3. Welded alternate strips of oxidized and pure electrolytic iron. $\times 70$. Etched with Stead's reagent.

Fig. 4. Weld of phosphorized electrolytic iron plates. Analysis of strips: 0.005, 0.13, 0.005, 0.07, 0.005, 0.045, 0.005, 0.023, 0.005. $\times 60$. Etched with Rosenhain's reagent.

Fig. 5. Welded alternate strips of Armco iron. Etched with Stead's reagent. $\times 70$.

crystals, as shown in Fig. 1 (unetched), while white "resist" lines appeared after cupric etching (Fig. 2) at the surface, and on down, outlining the crystals, even below the point where oxide accumulations were formerly observable. This latter fact suggests that oxygen penetrates sound steel at the crystal boundaries, forming solid solutions, which, when supersaturated, produce insoluble oxide. Annealing in H_2 at 1,200 deg. C. removed the foreign material entirely at the grain borders, and with them the ability to form "resist" lines on cupric attack, either there or further down.

In view of the low P content (0.007 per cent), it was thought that phosphorus might have migrated to the scale, but chemical analysis failed to reveal any there. Instead S 0.80 per cent was found, evidently absorbed from the furnace gases. The globules within the iron crystals had the characteristic dove color of manganese sulphide—quite different from those at the grain boundaries—and indicates that this S may have been absorbed from the exterior.

Whiteley, in the second paper mentioned ("Cupric Etching Effects Produced by Phosphorus and Oxygen in Iron"), first shows that the cupric reagent clearly distinguishes phosphorus differences of no more than 0.018 per cent in oxygen-free electrolytic iron (Fig. 4).

welding was quickly done to prevent reduction of oxide in the original metal, and to avoid melting the $\text{FeO}:\text{FeS}$ eutectic present. After etching with picric acid, the reduced strips plainly have lost their oxide spots. The same, etched with Stead's reagent, is shown in Fig. 5. Here the deoxidized material is more resistant than the original, which gathered most of the copper. White resist lines appear at the junctions, but always in the original material. Crystallization can clearly be seen at high magnifications to take place across these resist lines, from piece to piece—a complete weld has formed, even though a heterogeneous solid solution remains. No such white resist lines occur after welding unoxidized electrolytic strips.

Apart from this effect, oxygen in uneven distribution has not been found by Whiteley to yield effects similar to those given by even the smallest variation of phosphorus.

Rubber Used During the First 6 Months of 1921

Data compiled by the Rubber Association of America show that during the first 6 months of this year 131,979,361 lb. of crude rubber was used in the manufacture of rubber products, and that 33,527,306 lb. was reclaimed from 45,669,424 lb. scrap rubber.

Structure and Properties of Alternately Electrodeposited Metals*

If Relatively Thin Layers of Nickel Are Interposed During the Deposition of Copper, the Growth of the Copper Crystals Is Restrained, and the Tensile Strength of the Deposit Is Increased—Applications of the Process

By WILLIAM BLUM
Chemist, Bureau of Standards

A FEW years ago attempts were made by the U. S. Bureau of Engraving and Printing to reproduce its printing plates by electrodeposition. It was then found that plates 0.25-in. thick, consisting entirely of electrodeposited copper (with nickel printing face) did not possess sufficient strength—i.e., they bent when in service upon the presses. George U. Rose, Jr., chief of the Engraving Division, who was conducting these experiments, conceived the idea of “re-enforcing” the copper plates by the deposition of layers of nickel at intervals through the copper. He then found that plates so produced possessed the necessary strength to meet the requirements. This process of depositing alternate layers of nickel and copper, which has been patented by Mr. Rose, is employed in the new electrolytic plant of the Bureau of Engraving and Printing.¹

PRINCIPLES INVOLVED

The purpose of this paper is to show that in so apparently trivial an innovation as the alternate deposition of two metals a new principle possibly of wide application is involved. Consideration by the author of the effect of the layers of nickel led to the thought that this is probably due not so much to the higher tensile strength of the nickel as to the influence of the nickel layers upon the structure and properties of the intervening copper. A few simple experiments and photographs showed that such is the case.

It has long been recognized that in the deposition of a metal the initial deposit is usually fine grained but that the crystals become larger as the deposit increases in thickness. This was well illustrated in the photographs showing the structure of electrotyping copper.² If, as may generally be assumed, fine-grained deposits have the greatest hardness and tensile strength, conditions leading to the formation of fine crystals are usually desirable, especially high current density, low temperature and agitation. For the thickness used in regular electrotyping—i.e., up to 0.25 mm. (0.010 in.)—there is no difficulty in obtaining relatively hard copper deposits by the application of these principles. When, however, as in the case in question, a thickness of 6 mm. (0.25 in.) or more is required, the use of a high current density leads to the excessive formation of “trees.” Moreover, with large plates the degree of agitation is practically confined to that obtainable by compressed air, and usually it is not feasible to apply artificial cooling to the solution. In consequence most of the thick cop-

per plates produced electrolytically in various plants have been deposited at low current densities and have had relatively low hardness and tensile strength.

EXPERIMENTS

If the effect of each layer of nickel is due to its influence in preventing further growth of the copper crystals, the actual change in mechanical properties—e.g., tensile strength—should be determined not so much by the relative thickness of the nickel and copper layers as by the frequency with which the nickel layers are interdeposited. In order to determine whether such is the case, a number of plates were prepared in which both the frequency and the thickness of the nickel layers were varied. For purposes of comparison a number of plates of pure copper were deposited. The plates were machined and ground to a smooth surface, after which specimens were cut and tested for tensile strength and elongation.³ The test results are shown in Table I.

On all these specimens an initial coat of nickel (about 0.025 mm. or 0.001 in.) was deposited. All the nickel layers were produced without agitation at a current density of 2 amp. per sq.dm. (19 amp. per sq.ft.) in “Watts’ solution” containing

	G. per Liter	Oz. per Gal.
NiSO ₄ ·7H ₂ O.....	240	32
NiCl ₂ ·6H ₂ O.....	15	2
H ₃ BO ₃	30	4

(from which as determined in subsequent experiments, relatively soft nickel is obtained). The copper deposits were made in an agitated solution containing:

	G. per Liter	Oz. per Gal.
CuSO ₄ ·5H ₂ O.....	200	27
H ₂ SO ₄	100	13

From the data in Table I it is evident that of those deposits which contained copper and nickel in the ratio of 10 to 1 (by thickness) by far the greatest strength was produced when the nickel layers were introduced most frequently. On the other hand the presence of twice the above proportion of nickel produced only a slightly increased strength. It is interesting to note the beneficial effect of increasing current density upon the strength and structure of the pure copper deposits, as has been pointed out by Bancroft⁴ and recently illustrated by the author.⁵ Thus in Fig. 1, it may be observed that as the current density is increased the long crystals in A are broken up appreciably at the higher current density used in B; which finally leads to the

*Paper presented at the Lake Placid meeting of the American Electrochemical Society, Oct. 1, 1921. Published by permission of the Director of the Bureau of Standards.

¹See also CHEM. & MET. ENG., vol. 25, p. 320, Aug. 24, 1921.

²W. Blum, H. D. Holler, and H. S. Rawdon. *Trans. Am. Electrochem. Soc.*, 1916, vol. 30, p. 159.

³The author is indebted to Dr. L. B. Tuckerman of this bureau, who kindly conducted these mechanical tests.

⁴*Trans. Am. Electrochem. Soc.*, 1904, vol. 6, p. 27.

⁵*Trans. Am. Electrochem. Soc.*, 1919, vol. 36, p. 57.

FIG. 1. STRUCTURE OF HEAVY COPPER DEPOSITS ($\times 100$)

Current Density	Ultimate Tensile Strength
A — 30 amp. per sq.ft.	12,300 lb. per sq.in.
B — 60 amp. per sq.ft.	24,000 lb. per sq.in.
C — 90 amp. per sq.ft.	26,600 lb. per sq.in.

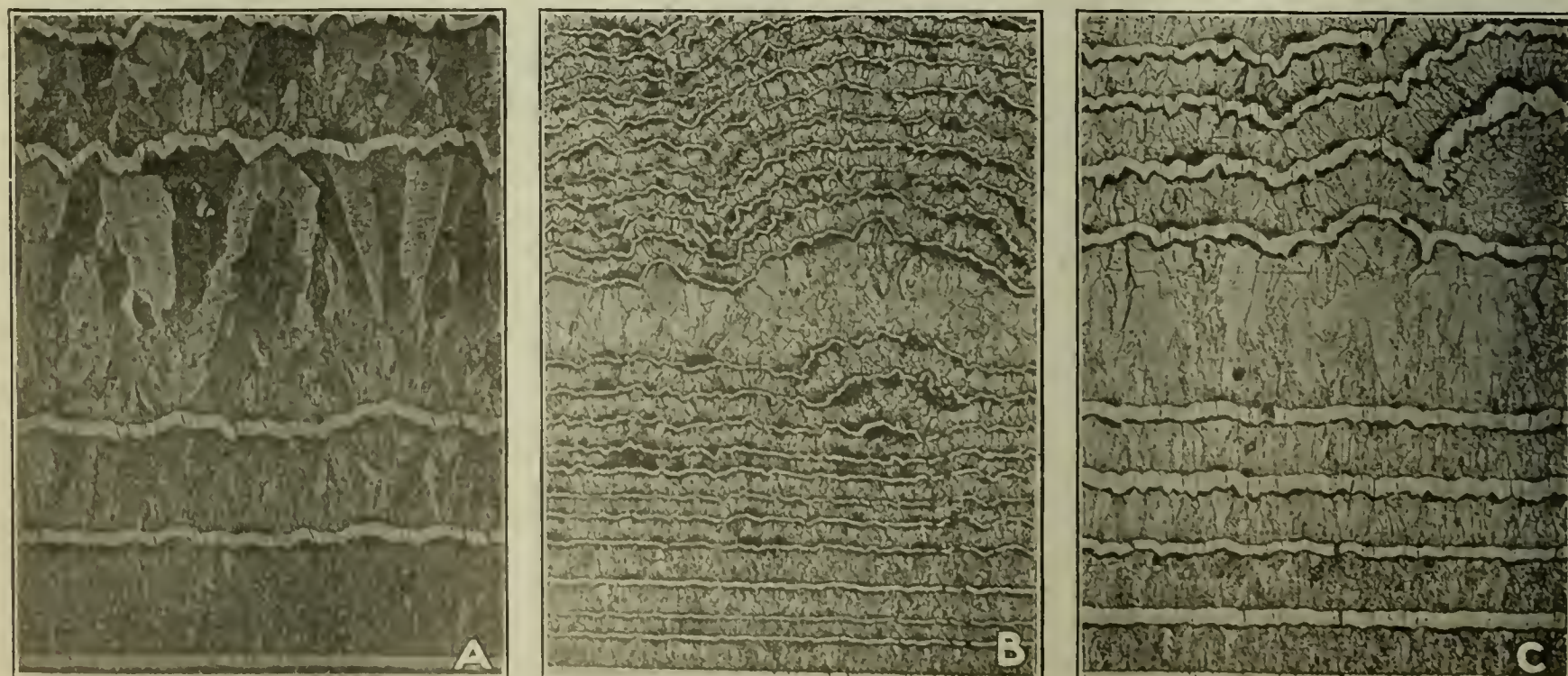
TABLE I. MECHANICAL PROPERTIES OF ELECTROLYTIC COPPER AND COPPER-NICKEL PLATES

Plate No.	Current Density		Copper Thickness of Each Layer		Nickel, Thickness of Each Layer		Thickness Ratio Cu:Ni	— Ultimate Tensile — Strength		Per Cent Above No. 2	Elongation per Cent (in 5 Cm. or 2 In.)
	Amp. per Sq. Dm.	Amp. per Sq. Ft.	Mm.	In.	Mm.	In.		Kg. per Sq. Cm.	Lb. per Sq. In.		
1	3	28	....	.....	.....	.....	....	870	12,300	..	1
2	6	56	....	.....	.....	.....	....	1,690	23,990	..	10
3	9	84	....	.....	.....	.....	....	1,870	26,600	11	10
4	6	56	0.25	0.001	0.025	0.001	10:1	2,240	31,900	33	8
5	6	56	0.125	0.015	0.0125	0.0005	10:1	2,480	35,300	47	9
6	6	56	0.063	0.0025	0.0063	0.00025	10:1	2,890	41,100	71	13
7	6	56	0.125	0.005	0.025	0.001	5:1	3,010	42,900	79	7

formation of twinned crystals at still higher current densities. However, even at 6 amp. per sq.dm. (56 amp. per sq.ft.) marked treeing occurred, which was still more pronounced at higher current densities.

That the changes in strength produced by the nickel layers were caused principally by a decrease in the average size of the copper crystals is illustrated by the photographs of Fig. 2. In each case it may be observed that the copper crystals increase in size as de-

position continues, but that when a layer of nickel is interposed, further growth ceases and new fine crystals are deposited. Also it is obvious that in Fig. 2, B, in which the nickel layers are most frequent, the average size of the copper crystals is smaller than in A or C. It is true, however, that the copper crystals become slightly coarser in each layer as the deposition continues, which explains why the nickel layers do not entirely eliminate the roughness of the deposits. No

FIG. 2. STRUCTURE OF ALTERNATE DEPOSITS OF COPPER AND NICKEL ($\times 100$)

Thickness Ratio Cu:Ni	Layers of Each per Inch	Ultimate Tensile Strength
A — 10:1	90	32,000 lb. per sq.in.
B — 10:1	360	41,000 lb. per sq.in.
C — 5:1	170	42,000 lb. per sq.in.

attempt was made in these experiments to determine the extreme effects which might be produced by very frequent alternation as, for example, in a mechanically operated continuous process.

In addition to increasing the strength of the deposits, the presence of the nickel layers reduces materially the tendency to treeing. This is to be expected, as in effect a "tree" is simply a large crystal or series of crystals caused by favorable conditions. Among these is the high potential drop through the solution, which, under otherwise similar conditions, must accompany a high current density. Any procedure which will decrease the formation of trees is very helpful in permitting the use of higher current densities in the production of thick deposits.

That the above effects of alternation are not confined to these two metals is shown by Fig. 3, in which layers of silver (from the usual cyanide solution) are alternated with layers of copper from the sulphate solution. The choice of the two metals is limited only by the condition that, in the solutions employed, neither must cause deposition of the other by immersion to such an extent as to prevent proper adhesion of successive layers. (Where there is only a slight tendency for such deposition, it can be prevented by having the cathode connected in the circuit before introducing it into the solution.)

If the process depends upon the different structure of the interdeposited metal, the same result should be accomplished if both layers are composed of the same metal, provided they have different crystalline structures. It is well known that copper deposited from a cyanide solution is much finer grained than that from sulphate solutions. Accordingly in one experiment layers of copper from a cyanide solution were interdeposited between the layers from the sulphate solution. As seen in Fig. 4, the structure of the "sulphate copper" deposits is affected in just the same way, but not to so marked a degree, by the layers of "cyanide copper" as by nickel. No tensile strength tests were made on this deposit, but there is no reason to doubt that the change in structure was accompanied by an increase in strength.

APPLICATIONS

The possible applications of this process may extend to many operations in which the presence of another metal or of layers of the same metal is not objection-

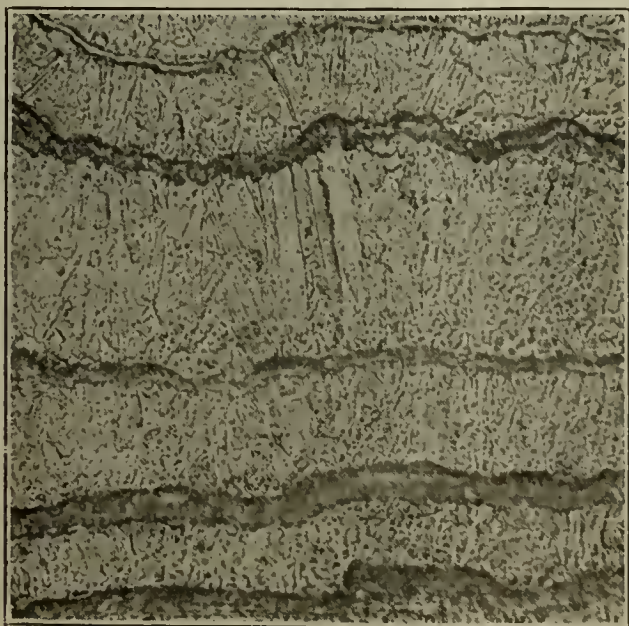


FIG. 3. STRUCTURE OF ALTERNATE DEPOSITS OF COPPER AND SILVER ($\times 500$)

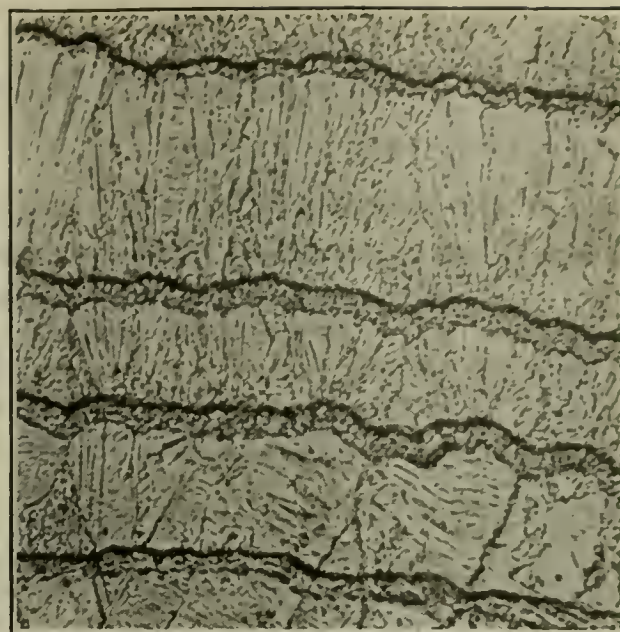


FIG. 4. STRUCTURE OF ALTERNATE DEPOSITS OF COPPER FROM SULPHATE AND CYANIDE SOLUTIONS ($\times 500$)

able. Copper is especially adapted to galvanoplastic operations, such as electrotyping, the reproduction of engraved plates, the manufacture of phonograph records, and of tubes and other irregularly shaped articles. In all of these processes the introduction of nickel layers may be found advantageous, in producing greater strength, and permitting the use of higher current densities, and possibly of thinner deposits.

Of even greater interest than the immediate industrial application of this principle is its possible bearing upon other problems in electrodeposition. If macroscopic layers of one metal produce such a decided effect upon the structure of the layers of another metal, it is entirely reasonable to expect that if the layers were much thinner, and ultimately molecular, still more marked effects would be produced. In other words, we would expect an electrodeposited alloy to have a much finer crystalline structure than either of its constituents deposited under similar conditions. This has been recently found by the author and his associates to be the case with lead-tin alloys.⁶

Similarly it is known that even small amounts of foreign metals in deposited metals, arising either from accidental impurities or from intentional additions to the bath, may exert profound effects upon the structure of electrodeposits. It appears reasonable to assume that at least part of their effect is due to hindering the normal crystal growth in the above described manner. Thus viewed, these observations are at least in general accord with the theory of the "wandering diaphragm moving boundaries" as proposed by Engelhardt,⁷ according to which the effect of colloids is caused by their migration to the cathode, accumulation upon points of (momentarily) highest current density and consequent retardation of crystal growth at those points. - The whole question presents a fascinating subject for investigation, and emphasizes the importance of a more extended study of the internal structure of electrodeposits.

The author is indebted to his associates, especially W. E. Bailey, H. E. Haring and L. D. Hammond, for assistance in the preparation and study of the plates described in this paper, and to H. S. Rawdon for the preparation of the photographs.

⁶W. Blum and H. E. Haring, "The Electrodeposition of Lead-Tin Alloys," *Trans. Am. Electrochem. Soc.*, 1921, vol. 40.

⁷*Trans. Am. Electrochem. Soc.*, 1912, vol. 21, p. 332.

Recent Developments in the Sulphuric-Acid Industry—III*

A Survey of Novel Features in Design and Operation of Recently Developed Equipment for Nitration Process Plants, Including Acid Eggs, Mechanical Acid Pumps, Tank-Car and Storage Tank Unloading Devices, Acid Valves and Gas Fans

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IT IS the purpose of the present paper to discuss, in the light of recent advances, a few of the accessories of a modern nitration process acid plant, with especial attention to the types of acid eggs, pumps and valves, gas fans and acid coolers which have been developed in recent years.

Acid eggs have been for many years the established means of elevating acid to the tops of towers. The deficiencies of the eggs have long been recognized. The power cost is high; they require the constant attention of an operator, involving the expense, day and night, of pumper's wages; the eggs must be placed several feet below the supply tanks, which means the acid must be permitted to flow to a lower elevation than necessary otherwise; the acid must be delivered into a "splash-egg" above the top tanks, which means that all the acid pumped must be elevated higher than necessary otherwise; the supply line must have a check-valve, which is troublesome, or a hand valve, which is worse; the operation of the eggs is intermittent, involving fluctuations in the depth of acid in the top tanks, and fluctuations in the quantity fed into the towers per unit of time; there is much wastage of compressed air; and the violent escape of acid mist in the tower house damages tanks, floors and roofs.

Some improvement in these conditions was brought about by the appearance of the Bihn-Jones automatic air device, first marketed by the Schutte & Koerting Co., of Philadelphia, in July, 1915. By means of this device, shown in Figs. 17 and 18, the pumper could be eliminated part of the time, the wastage of compressed air was diminished, and the splashing at the top tank was reduced to almost *nil*. The valve is applicable to use with any flowing liquid, but its chief use, as developed, has been for circulating the acids over the towers in chamber-process sulphuric-acid plants.

Referring to Figs. 17 and 18, this air device is composed of:

First, a base (V), which contains a seat (L), to which a number of ports for the admission of compressed air lead from an air chamber, which completely surrounds the seat.

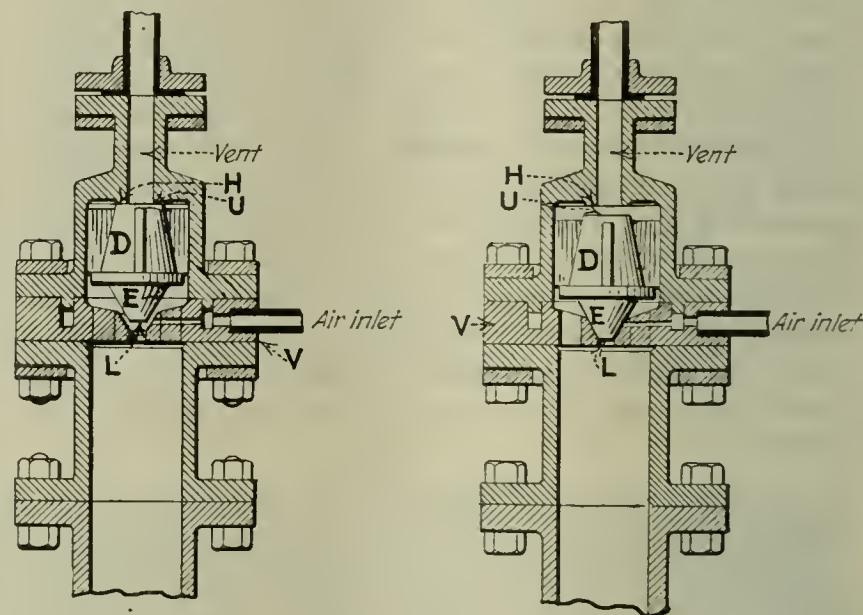
Second, a plunger (D) having a conical seat (E) on its lower surface, which contacts with the seat (L) in the base, thus completing the compressed air valve. There is also a flat circular exhaust valve seat (U) on the upper surface of this plunger.

Third, a hood which is bolted to the base, thus forming a cover for the apparatus, and a cylinder in which the plunger (D) moves. This hood contains an exhaust port, which connects with a vent pipe. Around the exhaust port of the hood there is formed a flat circular

seat (H), which contacts with the seat (U) on the upper surface of the plunger (D), and thus completes the exhaust air valve.

The operation of the device can best be understood by considering the arrangement shown in Fig. 19.

Liquid from a supply tank (A) flows by gravity through a check valve (C) into the blow-case (J) and rises until it reaches the base of the plunger (D), (Fig. 18) of the automatic air device (F), which it raises slightly, permitting compressed air to enter. The sudden release of the compressed air forces the plunger upward against its upper seat (U), thus closing the exhaust valve to the vent pipe (Fig. 17). The air thus prevented from escaping exerts its pressure on the top of the liquid, closes the check valve (C) and forces the liquid through the discharge pipe (G) to its destination. When the surface of the liquid falls below the



FIGS. 17 AND 18. BIHN-JONES AUTOMATIC AIR DEVICE

Fig. 17—Showing blow-case pumping. (Note raised position of plunger D.)

Fig. 18. Showing blow-case filling. (Note lowered position of plunger D.)

opening of the discharge pipe at the bottom of the blow-case, the compressed air follows the liquid out through the discharge line (completely clearing it of liquid), and escapes momentarily at the upper end of the line. The expansion of the air in the blow-case, due to the decreasing load as the liquid is forced out of the discharge line, causes a reduction in pressure in the blow-case sufficient to permit the plunger of the air device to drop into its lower seat by its own weight. This simultaneously closes the ports of the compressed air valve and opens the exhaust air valve, thus releasing the exhaust air in the blow-case. The check valve (C) now opens due to the head of the liquid in the tank (A) and the blow-case begins to fill, thus repeating the operation.

During the filling of the blow-case the exhaust air

*For Parts I and II see CHEM. & MET. ENG., vol. 25, Nos. 19 and 20, pp. 861 and 917, Nov. 9 and 16, 1921.

or gas which remains after pumping is displaced by the incoming liquid and escapes through surge-holes in the base of the air device, passes through openings at the side of the plunger and escapes through the exhaust port and the vent pipe (I) (Fig. 19). Fig. 17 shows plunger *D* in the raised position while the egg is pumping, and Fig. 18 shows plunger *D* in the lowered position while the egg is filling.

The manufacturers have recommended the use of

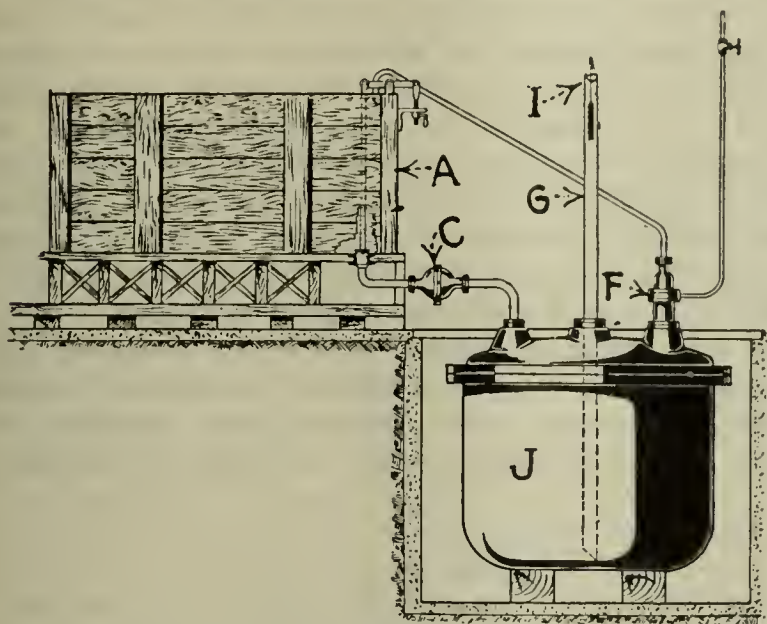


FIG. 19. AUTOMATIC VALVE MOUNTED ON ACID EGG AND CONNECTED TO ACID SUPPLY TANK

small eggs in combination with the Bihn-Jones equipment. However, it has been found in practice that the use of very small eggs with this device results in a very frequent up-and-down movement of the plunger, with resultant excessive wear on the seats. The result of this has been undue expense for mechanical repairs to the air device, which tends to offset to some extent its advantages. Where the egg is of reasonable capacity (4 tons 60 deg. acid or more) and the quantity of acid to be pumped is moderate, this device has proved to be a real asset. As the device, with its small air ports, reduces somewhat the normal speed of filling and discharging the egg, it may not be suitable for pumping very large tonnages of acid.

At the plants of the Tennessee Copper Co., where the quantity of circulating acid is exceptionally large, the supply and discharge lines for the eggs are of wrought iron, the former being 6-in. pipes, and the latter 4-in. At these plants the usual lead splash eggs at the top tanks have been replaced by cast-iron splash eggs, which have proved much more durable and less expensive to maintain.

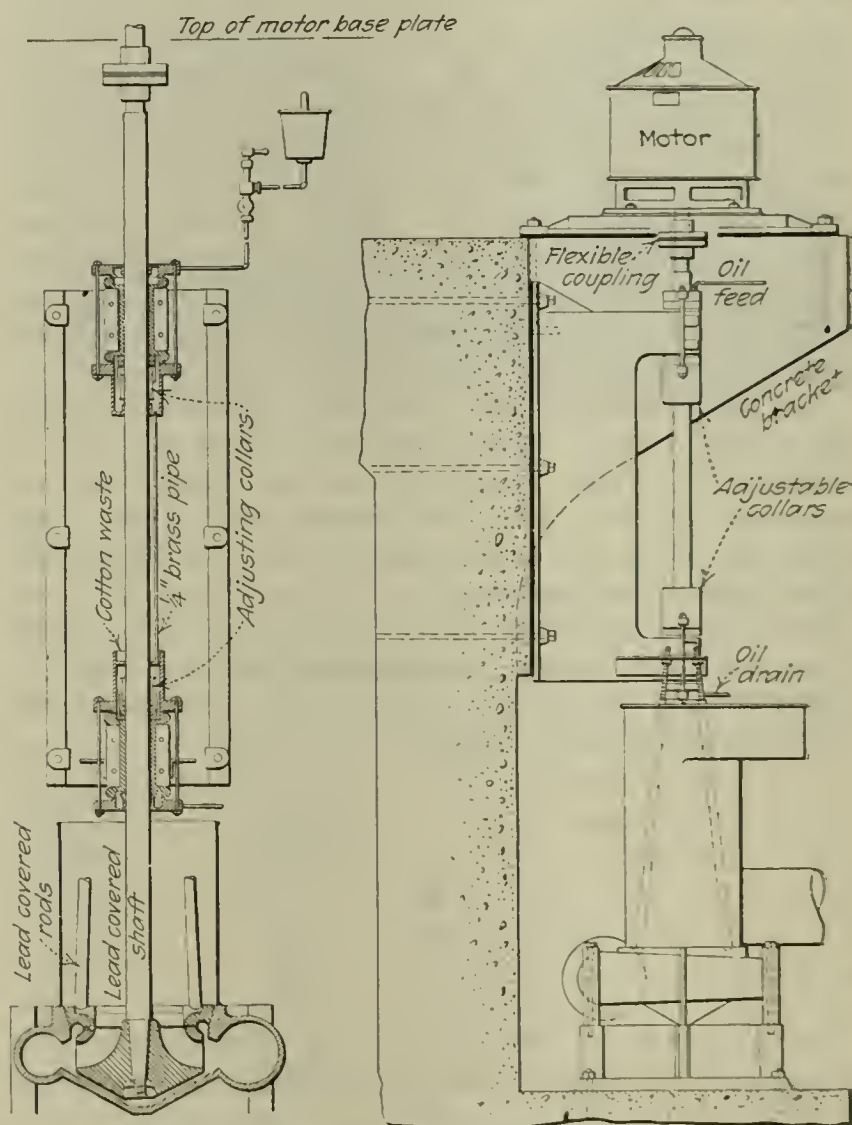
On account of the deficiencies of the acid eggs, many attempts have been made to develop a satisfactory mechanical acid pump. These attempts have for the most part had negative results until recently. A number of acid pumps are now on the market, each with its peculiar claims to merit and each with its deficiencies. Four of these will be briefly described.

The Antisell pump, manufactured by the Chemical Pump & Valve Co., is of the packingless type, and the horizontal impeller, attached to a vertical shaft, is submerged in a body of acid at the bottom of a boot having a supply pipe directly connected to the supply tank.

Fig. 20 is a vertical section through one of these packingless pumps. This particular pump was designed to handle sulphuric acid against a head of 100 ft. with an efficiency of 45 per cent. The acid by gravity

enters the boot surrounding the vertical shaft and proceeds to the pump impeller through the annular opening in the pump cover. The acid itself thus forms a perfect seal against the admission of air and dispenses with the troublesome packing glands and packing of horizontal-shaft pumps.

Fig. 21 shows a type of lead packingless pump designed for handling solution containing 24 per cent sulphuric acid at the rate of 3,500 gal. per minute against a head of 40 ft., developing an efficiency, it is claimed, of 73 per cent. A distinct advantage of this make of pump is that any element of the pump may be taken apart for cleaning, repairs or renewal without disturbing the adjacent parts of the pump or disconnecting feed or discharge lines. The manufacturers state that the actual time required to change an impeller is less than 1 hour. The figure illustrates one of twenty pumps furnished the New Cornelia Copper Co., of which it is



FIGS. 20 AND 21. TWO VIEWS OF ANTISELL PACKINGLESS PUMPS

Fig. 20. Vertical section of pump.

Fig. 21. Special pump designed for handling dilute acid in large quantities.

stated that several have operated for 3 years without repairs. The acid pumped, however, was, as stated, weak and probably cold. In this pump the packing trouble inherent in all horizontal-shaft pumps has certainly been eliminated, the parts of the pump are easily accessible for replacement or repair, and the capacities claimed for the pump have been realized. Possible objections to the pump may be that the power efficiency is less than with the packed pumps, that the expense of installation, with massive concrete pillar, is excessive, and that the long overhang, without bearings at bottom of shaft to keep the revolving impeller in alignment, may result in undue vibration or excessive wear on the bearings and other parts of the pump.

The Ceco pump was first used in the chemical indus-

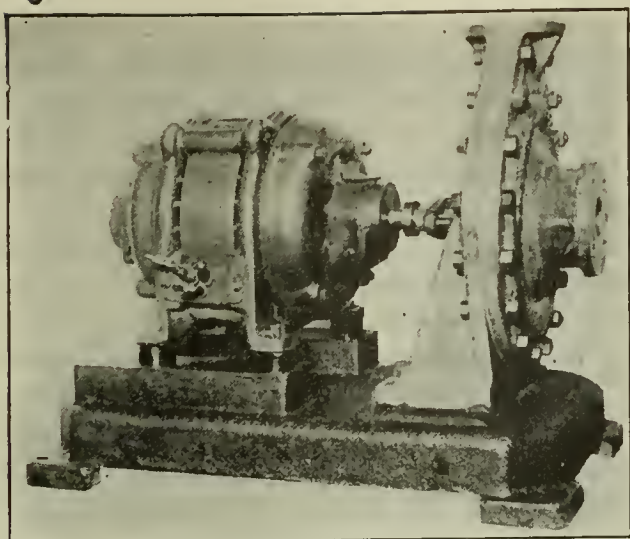


FIG. 22. CECO ACID PUMP WITH DIRECT-CONNECTED MOTOR

try in connection with the manufacture of phosphoric acid in the plant of the Victor Chemical Works, at Chicago Heights, Ill. On account of the corrosive nature of the phosphoric acid, together with the heavy scale which formed in pumps, valves, pipe lines and all other equipment in use for handling the crude acid, the conveying of this material was a difficult problem. After a thorough trial of the pump all other means of conveying phosphoric acid at this plant were abandoned, and it is said that this company has at the present time more than 100 of these pumps in use.

The first pump of this type was installed in 1914. The manufacturers (the Chemical Equipment Co., of Chicago, Ill.) state, however, that the pump was not perfected and put upon the market until 1918. The pump was patented under date of Oct. 19, 1920, and other patents are pending.

Ceco pumps are made of antimonial lead or of other alloys, according to the requirements, and are made in four standard sizes, with suction and discharge diameters respectively as follows:

Size	Suction Diameter, In.	Discharge Diameter, In.
A.....	1.5	1.0
B.....	2.0	1.5
C.....	2.5	2.0
D.....	3.0	2.5

The capacities of the several sizes depend of course upon the head against which the pumps are working.

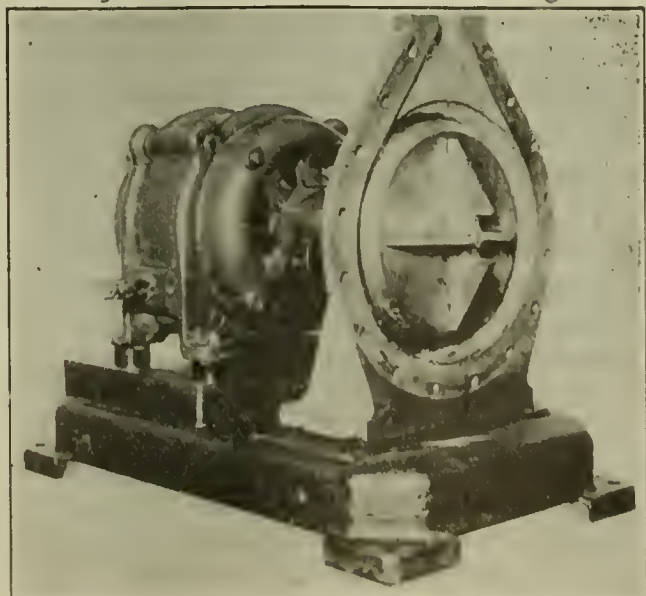


FIG. 23. CECO ACID PUMP SHOWING SUCTION HEAD REMOVED

The pump can be arranged for either belt drive or for direct-connected motor as in Fig. 22.

While the Ceco pump is generally classified as a centrifugal pump, it might more properly be termed a displacement pump, inasmuch as there is no volute, and the liquid is merely forced out of a center compartment, or pressure chamber, into an annular space of uniform cross-section, or discharge chamber. These two chambers are clearly shown in Fig. 23, a photograph of a Ceco pump with suction head removed. The discharge of the pump proper is at the top of the discharge chamber, which slopes equally to each side of the pump, and is thus designed to eliminate pockets for the accumulation of gases and to render the pump proof against gas-binding. As long as there is sufficient liquid within the pump to seal the clearance on each side of the impeller, the pump is said to handle a mixture of liquid and gas without difficulty.

An interesting application of the Ceco pump has been made possible by the development of a special "priming system," patented under date of Sept. 2, 1919. By means of this priming system and without the use of

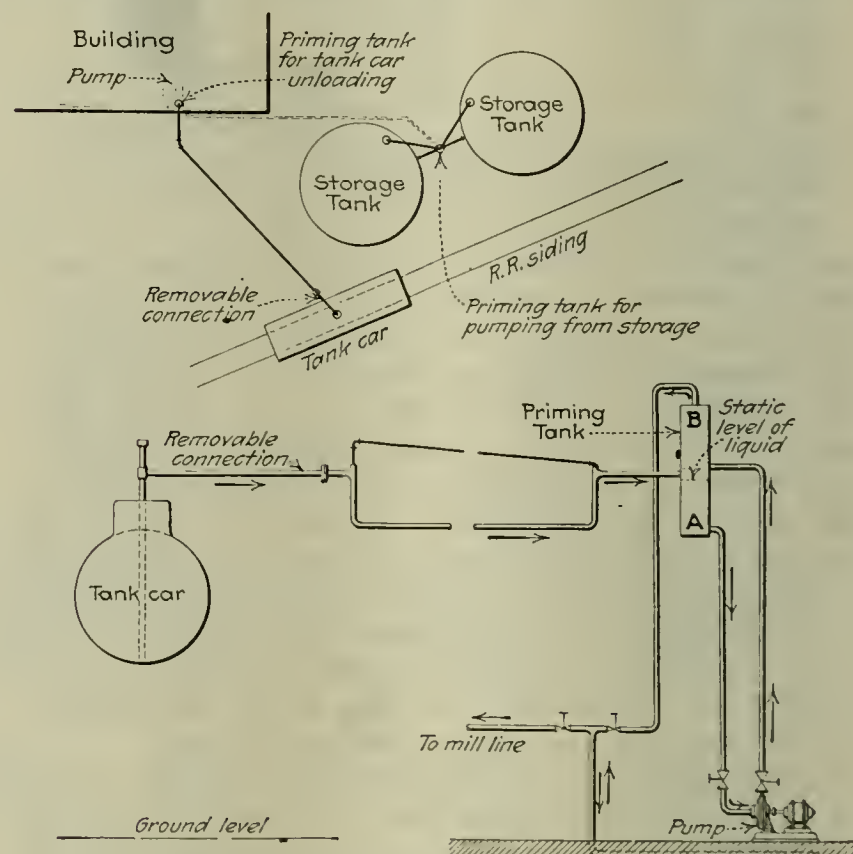


FIG. 24. DIAGRAM OF PRIMING SYSTEM FOR UNLOADING TANK CARS OR STORAGE TANKS

check valves or other moving parts, the pump with primer attached will withdraw acid through the dome of tank cars or storage tanks, thus dispensing with the need of bottom outlets. The greatest vertical distance that acid of 60 deg. Bé. can be lifted by means of the suction effect of the priming system is 16 ft. After entering the pump the acid can be elevated, by pump pressure, a vertical distance of 40 to 90 ft. more, according to the capacity of the pump used. Fig. 24 is a diagram of a priming system for unloading tank cars. Referring to this drawing, tank B is superposed above tank A, and these two tanks are called the priming tanks. A pipe connects the upper part of tank A with a tank car, and another pipe connects the lower part of tank A with the pump. The discharge of the pump is connected by a pipe with the bottom of tank B, and from the top of the latter another pipe conveys the acid to any place desired.

When this apparatus is first installed, tank A is

first filled with acid to the static level just below the discharge end of the suction pipe from the tank car. On this pipe a suction effect is produced by the act of starting the pump, caused by the emptying of the contents of tank A by gravity into the pump. This suction effect pulls the acid out of the tank car, through a pipe inserted through the dome, and the outflow of acid continues until the tank car is emptied. When this happens, air enters the pump and the pumping operation ceases. The pump is then stopped, and the acid flows from tank B through the pump into tank A, whereby the latter is automatically primed for unloading the next tank car.

Another use for the primer is in connection with the withdrawal of acid through the dome of deep storage tanks. Wherever the acid manufactured contains much sediment, which may be allowed to settle to the bottom of the storage tank and leave a body of clear supernatant acid, this device may prove useful in withdrawing the latter for shipment without disturbing the sediment at the bottom of the tank.

Acid pumps made of antimonial lead are open to the objections that the metal is relatively soft, is readily corroded by sulphuric acid and nitrous vitriol, and is subject to erosion by the particles of scale or other solids held in suspension by the acid, and thus the life of the lead pumps is comparatively brief. Duriron is well known to the chemical industry as a hard, brittle metal, much more resistant to the corrosive and erosive actions of acids than any of the lead alloys. Duriron acid pumps have been on the market for a number of years, but they have never come into general use for circulating acids over Gay-Lussac and Glover towers, due, no doubt, to the trouble experienced in keeping the stuffing box suitably packed.

In June, 1920, a Duriron acid pump of new design was placed on the market by the Duriron Co., Inc., of

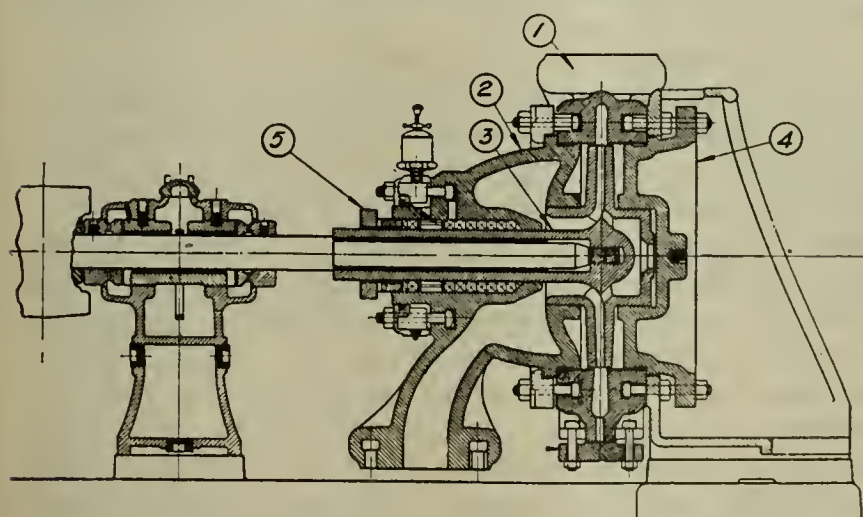


FIG. 25. ASSEMBLY DRAWING OF DURIRON CENTRIFUGAL PUMP

1—Volute. 2—Suction elbow. 3—Runner. 4—Pump cover. 5—Packing gland.

Dayton, Ohio. The main features of this pump are: (1) Packing under slight vacuum while pump is in operation. (2) A helical impeller. (3) Accessibility of revolving parts without disturbing either suction or discharge line. (4) Rotatability of both volute and suction elbow to any position desired, in order to fit existing pipe lines.

Fig. 25 shows an assembly drawing of this new centrifugal pump, with 2-in. suction line and 1.5-in. discharge. In this pump it is claimed that the packing cannot be touched by the acid while the pump operates, inasmuch as the stuffing box is under a slight vacuum.

However, if the pump should be stopped without first closing a valve at the bottom of the discharge line, it is likely that here, as with all other horizontal-shaft pumps, some acid might enter the stuffing box and cause slight leakage. The pump is furnished for either direct-connected motor or for belt drive.

Fig. 26 shows the belt-driven type of pump. The capacity of this pump is stated to be 20 tons 60 deg. Bé. acid per hour at a head of 80 ft., with power consumption of less than 7 hp.

The speed of the pump can be regulated to deliver any quantity up to the maximum capacity. After removing the cover plate from that side of the pump opposite the stuffing box, the runner and shaft can be removed without disconnecting either the inlet or the outlet pipe. The shaft is of machine steel, and is covered by a Duriron shroud projecting through the

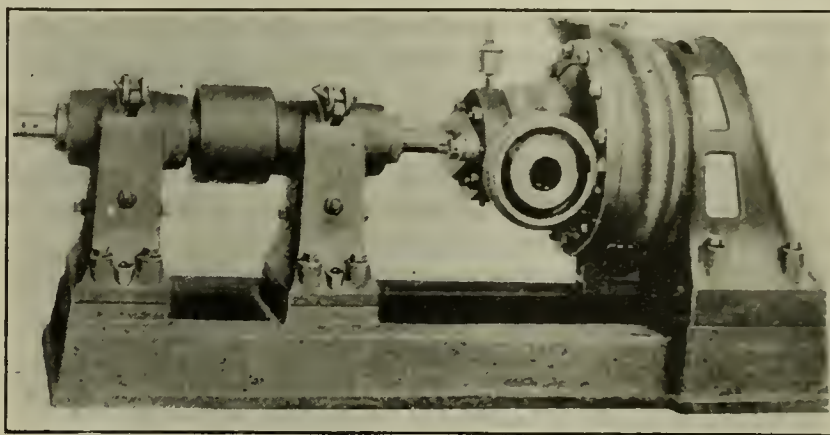


FIG. 26. DURIRON CENTRIFUGAL PUMP FOR BELT DRIVE

stuffing box. A web, cast between the top of the volute and the discharge flange, is designed to permit the escape of trapped air and prevent air-binding.

The Lewis centrifugal acid pump, like the Antisell pump, is a vertical packingless pump. The primary business of its manufacturers, the Charles S. Lewis Co., of St. Louis, Mo., was the manufacture of pumps for the circulation of cooling water or brine in refrigerating systems. The company's first pump for the elevation of acid was built in the early part of 1913. It was designed for pumping 60 deg. acid from the base of a Glover tower to the tank on top of a Gay-Lussac tower, and all parts were of cast iron except the shaft and casing bolts, which were of steel and wrought iron, respectively. This pump, of the vertical submerged type, was driven by a direct-connected motor. Fig. 27 is a photograph of this unit. This pump had 2-in. pipe connections, and, driven by a 4-hp. vertical motor, was good for a head of 70 ft. when pumping 60 deg. acid. It is now obsolete.

The principal features aimed at in designing this pump are listed below in the order of their importance: (1) Elimination of stuffing boxes and packing. (2) Production of a self-contained unit capable of being completely assembled in perfect alignment before installing at the acid plant. (3) Reliability and durability. (4) High power-efficiency. The first of these conditions was wholly satisfied by this first submerged pump. The acid entered the pump at the center on the upper side and was discharged below at the side. The second condition was also satisfactorily met. The pump was assembled and connected to the motor by means of the cast-iron frame which tied the pump to the main plate supporting the motor. The fourth condition was also complied with by this pump (which was a two-

stage machine), inasmuch as the power efficiency, with the pump delivering 10 tons per hour against a head of 70 ft. with power consumption of about 2.5 hp., was computed to be 45 per cent.

The third condition—reliability and durability—was the only one which this first pump did not fully satisfy. The pump discharged more acid than was being fed to its supply tank, with the result that it pumped all the acid out of the lower tank and drew considerable air into the impeller. Then the pump was shut down to install a throttle valve, and the next day, on attempting to start it, the impeller was found to be firmly cemented to the stationary parts of the pump. In trying to loosen the impeller, several of the small internal parts were broken and had to be replaced, and the pump then operated satisfactorily. Further experience showed that the pump could be stopped and permitted to stand for some time, without its sticking, provided it was kept submerged and free from any admission of air. It was assumed that the film of acid adhering to exposed parts of the pump absorbed from the air some moisture which diluted that acid to a strength capable of corroding the iron parts to which it adhered, and that a sulphate of iron formed, which caused the troublesome cementing of the moving parts to the fixed parts. By carefully excluding air and by keeping the acid up to 60 deg. strength, very reliable service was obtained, and it is said that this pump would do continuous duty 24 hours a day for eight or nine months before it was necessary to change the impeller or repair internal parts.

The development of the Lewis pump of today has proceeded from this original design. By placing a sub-

The new design was a single-stage pump, and it was found that the additional power required to operate it on the same duty as the former two-stage submerged pump was more than compensated for by simplicity of assembling and repairing. Fig. 28 shows the present type of Lewis centrifugal pump with 5-hp. direct-connected motor, embodying these improvements.

No attempt was made by the Lewis company to handle acid weaker than 60 deg. Bé. until 1916, when it built its first hard lead pump. The main difficulty to be overcome was to find suitable material for guide-bearings at the lower end of the shaft, which the

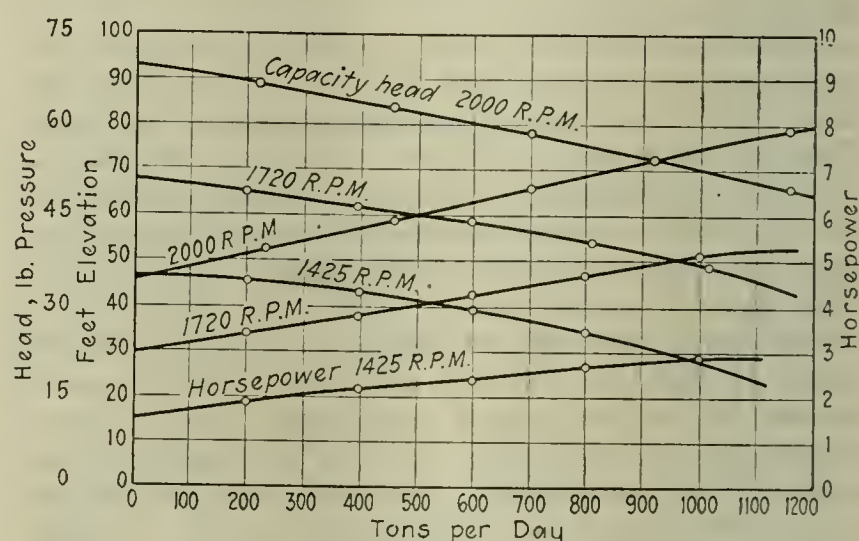


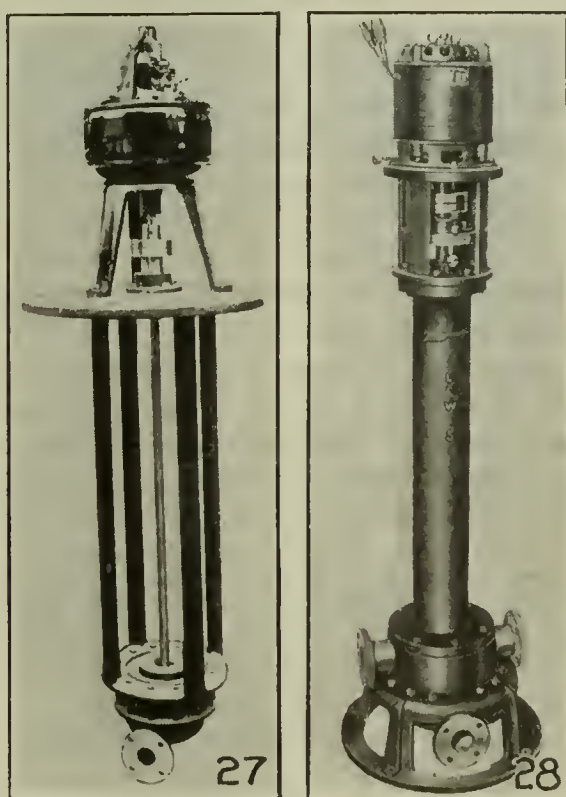
FIG. 29. PERFORMANCE CURVES FOR LEWIS PUMP HANDLING 60 DEG. ACID

company considered desirable, to hold the shaft and impeller true and free from vibrations. The problem was finally solved by Duriron bearing bushings in the lead pump casing, and by covering the shaft, at the parts revolving within these bushings, by Duriron sleeves. These Duriron bushings and sleeves were ground and polished to obtain adequate bearing surfaces. The lubrication afforded by the acid pumped was found to be sufficient.

Other obstacles, such as unsound lead castings and coarse-grained Duriron, were gradually eliminated, and the manufacturers now state that indications point to a life for the hard lead casings of this pump, when operating on weak sulphuric acid or nitrous vitriol, of three or four years. The wearing surfaces in the pump, however, do not last that long, their life being from six months to two years, depending on the amount of grit or sediment in the acid pumped. These wearing surfaces can be renewed at small proportional cost without renewing the casing. Practically no change has been made in the design of the hard lead pump during the past four years. The improvements have been confined to the quality of the materials entering into the parts of the pump.

In Fig. 29 are given performance curves showing capacity and head at various speeds, also brake horsepower. The curve shows that the pump will deliver 400 tons per day against a 62-ft. head equal to 46 lb. pressure when operating at a speed of 1,720 r.p.m. The horsepower required is 3.8.

The outstanding feature distinguishing this pump from the Antisell pump lies in the centering of the lower part of the shaft in fixed guide bearings. This very feature, while it keeps the shaft always in perfect alignment, exposes the pump to the criticism that these guide bearings have to be frequently renewed. The internal parts are rather inaccessible. To get at them the pump has to be completely dismantled and turned



FIGS. 27 AND 28. LEWIS ACID PUMPS

Fig. 27. Vertical submerged type (now obsolete).

Fig. 28. Modern type vertical acid pump for direct-connected motor.

stantial cast-iron boot around the acid inlet to the pump, the submerged pump has been converted into an outside vertical pump without losing any of the advantages of the submerged type and with the advantage gained that only the internal surfaces of the pump are exposed to acid, all bolts and nuts being kept on the outside, free from acid corrosion.

over on its side. The maintenance cost of these pumps, given by the manufacturers as about \$24 per month per pump, is high as compared with the maintenance cost of acid eggs. The net saving, however, due to lower pumping costs for power and operating labor, is said to more than compensate for the higher repair costs.

A number of new acid valves have been developed since 1914, and among these three important types will be discussed.

As was the case with the Ceco pump, the Ceco valve

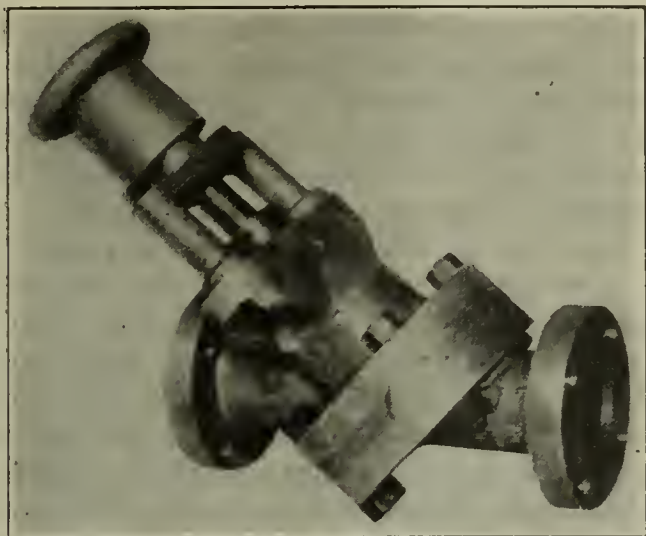


FIG. 30. CECO ACID VALVE ARRANGED FOR STRAIGHT-WAY CONNECTION

was developed at the plant of the Victor Chemical Works, Chicago Heights, Ill., because of the difficulty experienced by this company in finding on the market a valve suitable for contact with crude phosphoric acid. In designing this valve, the features aimed at were: (1) A removable seat which could be withdrawn without disconnecting the entire valve and which could not corrode in place. (2)

(3) A seat which would not accumulate scale. (4) Flexibility as to angle of installation. (5) Operating mechanism inaccessible to acid or acid fumes. (6) A packing gland without studs.

Fig. 30 is a photograph of a 3-in. valve of this type, and it is seen to be of peculiar design. The removable seat is made of a flat slab of metal held in place between two flanged faces on the valve body. The seat is identical as to shape on both sides, thus making it reversible, and it can be removed without disconnecting the valve from the line. Only a few minutes are required to reverse or replace a seat.

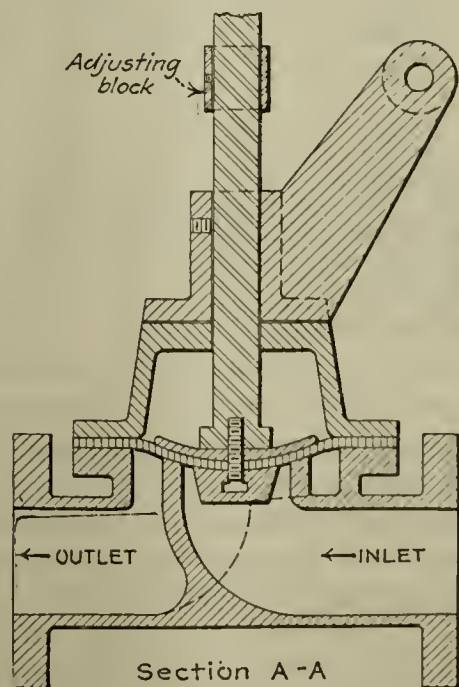
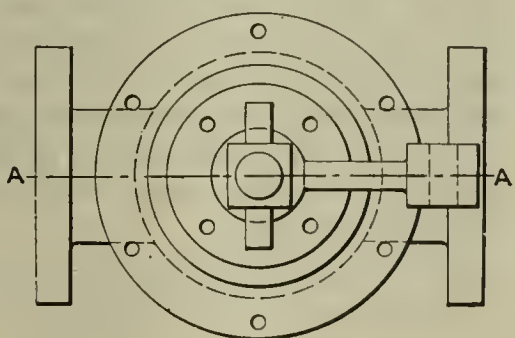


FIG. 31. SECTION AND PLAN OF PACKINGLESS VALVE

In the ordinary valve, a tapered plug fits into a tapered seat, and any accumulation of scale or sediment on either plug or seat prevents effective closing of the valve. In the Ceco valve, the hole within the slab seat is cylindrical, and on a new valve the seating edge is quite sharp. Even after a valve has seen considerable service, the manufacturers claim, the seating is virtually a line contact. This means a minimum of area for the deposit of scale or sediment, and if scale does form on either of the seating members, it is said that the act of closing the valve tends to break away the scale. To prevent sticking of the plug, a relieving taper is provided thereon. A taper is machined also on the upper side of the plug, and at the top of the valve body another seat is machined, so that when the valve is wide open, the upper part of the plug is again seated on a line contact, the object being to seal the stuffing box against leakage, and permit the repacking of the valve while under pressure.

In order to broaden the scope of application of this valve to service, the body of the valve is divided into two parts at an angle of 45 deg. This permits of assembling any valve in either a straight or an angle position. Thus, using the same valve parts, the straight-way valve shown in the figure can be changed into a right-angle valve by turning that part which is on the left of the removable seat 180 deg., so that the valve stem and handle are below the left-hand flange, instead of above it.

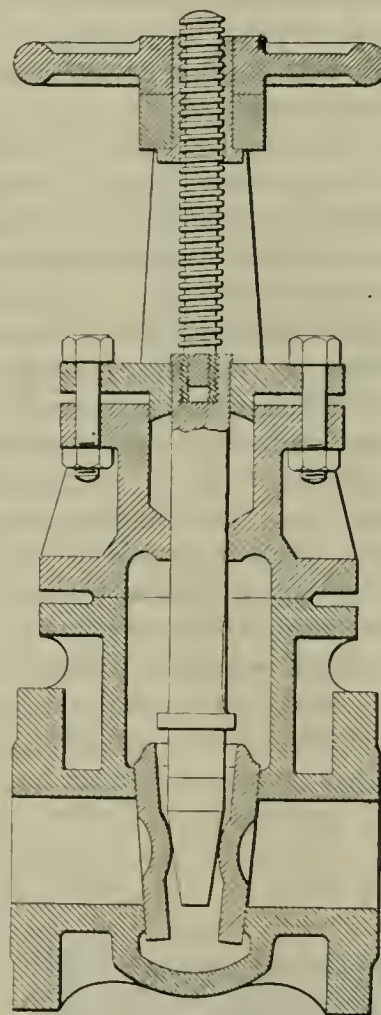


FIG. 32. SECTION OF DURIRON GATE VALVE

Fig. 31 is a section and plan of a float valve of the packingless type manufactured by the Chemical Pump & Valve Co. The valve is provided with a flexible diaphragm which walls off the acid from the bearing of the valve stem. There is consequently no need of a stuffing box or packing. The flexible diaphragm is of lead, if the valve is to be used with sulphuric acid. The manufacturers state that owing to the limited movement of the diaphragm, the valve may be opened many hundreds of times before the lead cracks. When the lead does crack, it becomes necessary to drain the line, open the valve and put in a new diaphragm. It should be noted that owing to the design of the valve, the line cannot be drained unless the valve, when installed, is placed on its side. This valve is made in all sizes from 1 in. to 18 in., the capacity of the latter being 5,000 gal. per minute.

Fig. 32 shows a section of a Duriron gate valve which was first put on the market in June, 1920. It is a valve of the rising stem type. As the metal is highly resistant to corrosion, it is claimed that this valve will not stick under the most trying conditions. Gate valves of the ordinary type are inefficient as a positive shut-off for acid, particularly if the acid handled contains solids in suspension. This valve has double-hinged disks which

the manufacturers claim afford positive closure on both seats, and the valve can be used against pressure from either direction. The wedge action of the stem eliminates any wear on disks or seats, and the valve is so positive in its action that it is said to be useful with gases as well as with liquids. The valve can be packed while under pressure.

LARGE GAS FANS

The construction during the war of acid-making units of large capacity led to a demand for larger gas fans. This demand was recognized by the Pratt Engineering & Machine Co., of Atlanta, Ga., which in 1918 developed a fan which has a rated capacity of 15,700 cu.ft. of free air per minute against a pressure of 1.75 in. water gage, at a speed of 450 r.p.m. This compares with a rated capacity for the company's next largest fan of 10,000 cu.ft. per minute against the same pressure, at a speed of 560 r.p.m. The large acid plant built for the Government at Little Rock, Ark., was equipped with the larger Pratt fans. A large capacity acid-gas fan is also manufactured by the Buffalo Forge Co., Buffalo, N. Y., and has been on the market for some time. The Schutte & Koerting Co., Philadelphia, has designed some improvements to its acid-gas fan, and the new model was first marketed in 1916. The features distinctive of the new type are: (1) A blast wheel webbed so as to close entirely the spaces between blades at the side opposite the gas intake, the webbing being continuous from tip of blade to hub. (2) A blast wheel housing, cone-shaped at the side opposite the gas intake, so as to conform to the shape of the webbing between fan blades, and with smallest practicable clearance between webbing and cone-shaped part of housing, from tip of blades to hub.

This new model, like the Pratt and Buffalo fans and like most other fans designed for use beyond the Glover tower, is made of antimonial lead. On account of the low tensile strength and relatively low resistivity to corrosion by acid gases of this alloy, the need has long been felt for a material, applicable for use in the blast wheels and housings of acid plant gas blowers, which would be more durable in service. The Duriron Co., of Dayton, Ohio, has endeavored to supply this need with a Duriron fan, first marketed in January, 1920. It is made as yet in small sizes only, from 3 in. to 12 in. The 12-in. fan is said to be able to handle all the gas produced by burning 17 tons of sulphur in 24 hours, and can be operated safely at a speed of 1,800 r.p.m.

The impeller wheel will withstand erosion as well as corrosion, and the manufacturers recommend it for handling gases containing solid particles in suspension. Wherever this fan is used, the brittleness of the metal must never be overlooked, in tightening bolts or in moving the runner or the cap. One moment's carelessness in handling Duriron shapes has often caused the instant destruction of an expensive casting.

CAPACITY OF GAS FANS

Considerable uncertainty is found among sulphuric-acid manufacturers regarding the actual capacity of the various types of acid-gas blowers for moving gases. The capacity figures quoted by the blower manufacturers are received with a great deal of skepticism. It appears that the matter of determining the true capacities of the blowers for moving acid gases at the temperatures of such gases in an operating plant, and making due deductions for such items as air leakage at the shaft, steam coming over from the Glover tower with the gas,

etc., has not been attacked by the blower manufacturers in the scientific and convincing way which the problem deserves. To determine the capacity of a blower for delivering free air is a difficult problem in itself. To determine the capacity of a blower for moving hot moist acid gases is more difficult still. The problem should not, however, be neglected, and the sooner the blower manufacturers begin to determine scientifically the real acid-gas-moving capacities of their machines the sooner may the industry expect improvement in their efficiency.

IMPROVEMENTS IN ACID COOLERS

No recent developments of merit in acid coolers have appeared. The large rectangular acid coolers of the Calumet & Arizona Mining Co., described and illustrated by Wells and Fogg,¹⁸ while they conserve ground space and accommodate a very large linear length of lead pipe which affords a high area of external cooling surface, are not regarded as efficient coolers. In order to avoid regions of stagnant acid within a cooler of such large dimensions (capable of containing 5,000 linear ft., or nearly one mile, of 1½-in. coiled lead pipe), numerous baffle walls, dividing the cooling tank into numerous small compartments, and alternate top and bottom acid outlets between adjacent compartments, are needed, thus forcing the whole volume of acid, in its progress through the cooler, to take an alternate up and down movement along the vertical length of each coil, and come into direct contact with a maximum area of water-cooled lead pipes. The manner of connecting the coils to obtain a counter-current flow of water to acid needs special study.

Atlanta, Ga.

(Part IV will appear in a subsequent issue.)

Imports of Iron and Steel From Europe

Up to the end of August United States imports of iron and steel from Europe this year have aggregated 17,104 tons. More than 60 per cent of the total has been pig iron and semi-finished steel, with bars and sheet and plates making up the bulk of the remainder. Belgium alone sent nearly 60 per cent of the imports.

The following table shows in detail how the different products imported were divided among the various countries of origin.

IMPORTS OF IRON AND STEEL FROM EUROPE, EIGHT MONTHS OF 1921

Articles	All Europe, Tons	Belgium, Tons	Sweden, Tons	United Kingdom, Tons	Germany, Tons	Czechoslovakia, Tons	France, Tons	Other, Tons
Pig iron.....	7,896	7,191	130	400	125	...	50	..
Billets.....	2,736	2,422	265	...	48	...	..	..
Steel bars.....	2,685	348	1,171	588	141	344	35	58
Sheets and plates.	1,867	100	113	1,367	281	3	3	..
Iron bars.....	1,103	128	910	53	3	9	..	..
Wire rods.....	502	.....	466	26	1	6	1	2
Tin plate.....	276	.....	.....	276	..	...	..	..
Structural steel...	39	.....	.....	8	31	...	..	..
Total.....	17,104	10,189	3,055	2,718	630	362	89	61

Belgium has been the chief factor in supplying pig iron and billets, but other lines from Belgium have been relatively unimportant. Sweden has been strongest in imports of bars and wire rods, and the fact that Sweden stands next to Belgium in total tonnage has not generally been recognized by current reports regarding competition of European steel in domestic markets.

¹⁸Op. cit., pp. 116, 121.

Pulverized Coal in the Iron and Steel Industry

BY F. P. COFFIN
General Electric Co.

THE principal application of pulverized coal in the iron and steel industry are for the following classes of furnaces:

Heating furnaces:

Heating, reheating and forging.

Continuous heating, for blooms and billets.

Annealing malleable iron and steel castings and plates.

Sheet and pair (steel bars are heated for rolling into pieces).

Busheling and puddling (malleable iron).

Tin pots.

Galvanizing pots.

Melting furnaces:

Open-hearth steel.

Malleable iron.

For rough work the fuel is often burned in the same compartment with the work. For more finished work, where ash and slag may have a deleterious effect, a separate combustion chamber is frequently provided, and the two compartments are separated by a low bridge-wall. A large part of the ash collects in the bottom of the combustion chamber while the flame plays over the bridge-wall, and is long enough to extend over the work and to heat it by direct radiation. When substituted for natural gas, increased thermal efficiencies have been attained owing to the greater proportion of radiant heat emitted by the flame.

TYPES OF FURNACES

In small forging furnaces the coal and air are sometimes introduced through opposed tuyeres in order to avoid the impingement of the flame on the wall opposite the burner. A typical small forging furnace is shown in Fig. 1. This is equipped with opposed tuyeres and the secondary or volume air is divided between the two, while the coal is fed into one side only, being carried by the primary air which forms a small proportion of the air required for combustion. When warming a cold furnace, a hot spot is visible where the blasts impinge. As the brickwork becomes heated, this spot fades to a uniform glow which fills the whole interior. It is claimed that the introduction of all the coal on one side gives the best results. This furnace is located in the drop forge shop of the American Locomotive Co., in Schenectady, N. Y.

One of the most modern installations for burning pulverized coal in a sheet-rolling mill is to be found in the plant of the Newport Rolling Mill Co., at Newport, Ky.¹ Natural gas was formerly used as fuel.

The output, when burning pulverized coal, so greatly exceeded expectations that it was only necessary to re-equip six furnaces to handle the same output as eight stoker-fired annealing furnaces of the same size.

The following figures have been submitted as average production data attained at the plant: On the slab-heating furnaces, maximum fuel consumption of 180 lb. of coal per ton of product, though it is stated that considerably less than this amount per ton may be

taken as the average run. On the sheet and pair furnaces, fuel consumption covering long periods has not exceeded 275 lb. of powdered coal per ton of sheets produced. On the annealing furnaces, fuel consumption using powdered coal is reported well under 170 lb. of coal per ton of sheets annealed. On the galvanizing pots, fuel consumption below 110 lb. per ton, on the average, and considerably less than this average for favorable weight sheets.

Furnaces for melting and refining steel by the basic open-hearth process are fired with pulverized coal in a number of plants. A furnace of this type is shown in Fig. 2, equipped for firing with pulverized coal by the Bonnot system. The practice is to fire the fuel from both sides of the furnace on the reversing principle with a high velocity blast. In some installations the air required for combustion is delivered to the burner at a pressure of 1 lb. per sq.in. by a centrifugal compressor, in others by a fan blower at 8-oz. pressure.

According to N. C. Harrison² of the Atlantic Steel Co., Atlanta, Ga., "the hearth of a pulverized coal open-hearth furnace is practically the same as the hearth of any other open-hearth furnace; the uptakes, slag pockets and checker chambers, however, are entirely different. The uptakes are made as small as possible so as to hold the gases in the furnace as long as possible without blowing, and the slag pockets are made as large as possible so that the gases will have a slow velocity going through them, thereby depositing a large percentage of the heavy particles that are in the outgoing gases. On account of this heavy deposit, removable slag pockets, or very deep stationary pockets, should be used to collect this accumulation. Where removable slag pockets are used, they are taken out and cleaned and replaced about every two weeks. Only one checker chamber is needed on each end of the furnace. If the checker chamber is large enough, these chambers should be built up with large tiles and laid in such a manner as to form vertical flues, having openings of at least 6 x 9 in., or, better, 9 x 11 in. In some cases no checkers are

²Consult "Pulverized Coal as a Fuel," *Mechanical Engineering*, August, 1919.

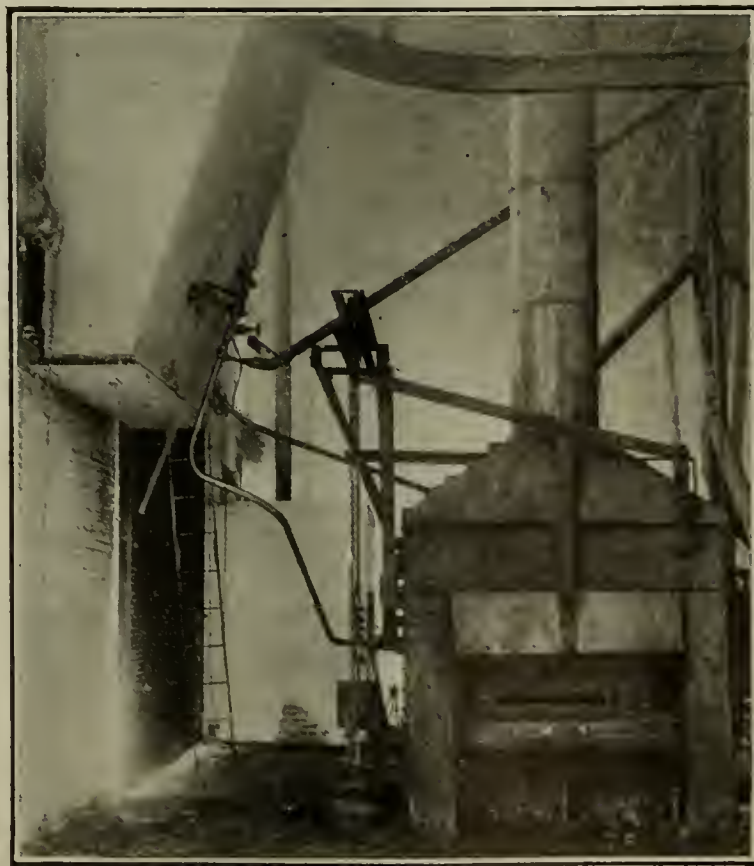


FIG. 1. VIEW OF A SMALL FORGING FURNACE WITH PULVERIZED COAL BURNER

Excerpt (by permission) from material prepared for Bacon and Hamor's "American Fuels," now in press of McGraw-Hill Book Co.

¹Consult "Burning Pulverized Coal in a Sheet Mill," *Iron Age*, Dec. 11, 1919. "Burning Powdered Coal in a Rolling Mill," by H. T. Matthew, *Combustion*, April, 1920.

used at all, but the chambers are filled with baffle walls with openings from the outside so that the accumulation between these baffle walls can be raked out. All passages from slag pockets to stack must be as straight as possible and, wherever bends must be made, some agitating device should be installed. The reversing valves are usually of the mushroom and damper slide type.

"The best coal for use in pulverized form in open-hearth practice is a bituminous coal as high in volatile matter as possible, and preferably low in ash. It should never contain below 32 per cent of volatile nor more than 8 per cent of ash. It is necessary that the coal be as finely ground as possible so that about 97 per cent will pass through the 100-mesh sieve; preferably 90 to 93 per cent, and not less than 85 per cent through the 200-mesh sieve, and from 70 to 75 per cent through the 300-mesh sieve. This is necessary for quick combustion and for the elimination of sulphur. By this very fine pulverization we attempt to have complete combustion before the flame strikes the bath, thereby burning out the sulphur in the coal to SO_2 gas, which passes up the stack. Some 6 or 8 ft. is necessary from the end of the burners to the bath.

"The advantages and disadvantages from the use of pulverized coal, as compared with hot producer gas, as

alterations we expect to get much longer life out of the checkers, and, consequently, longer runs out of the furnace. As a result of this continued development, we believe that inside of six months we will obtain a 25 per cent increase in production over the gas producer furnaces of the same size.

"Sulphur does not give any trouble as long as there is a good draft and the furnace is working hot. We are now using coal with over 1 per cent of sulphur and getting good results. If checkers get clogged up and the furnace begins to blow, due to lack of draft, we have trouble with the bath taking up sulphur. The furnace is under complete control of the first helper, as to amount of coal being used, as well as the air blast and temperature. The flame, using the same coal as on gas producer, is hotter, which allows us to use a greater percentage of scrap per ton of steel, thus reducing the consumption of high-priced pig iron; also it enables us to obtain a greater number of heats per week.

"The finished steel is quieter in the molds, due to not being overoxidized, as the coal coming directly in contact with the bath has a greater reducing action. We feel reasonably certain that the oxidation losses are less with pulverized coal than with producer gas. All gas house troubles are eliminated (clearing fires, burning-out

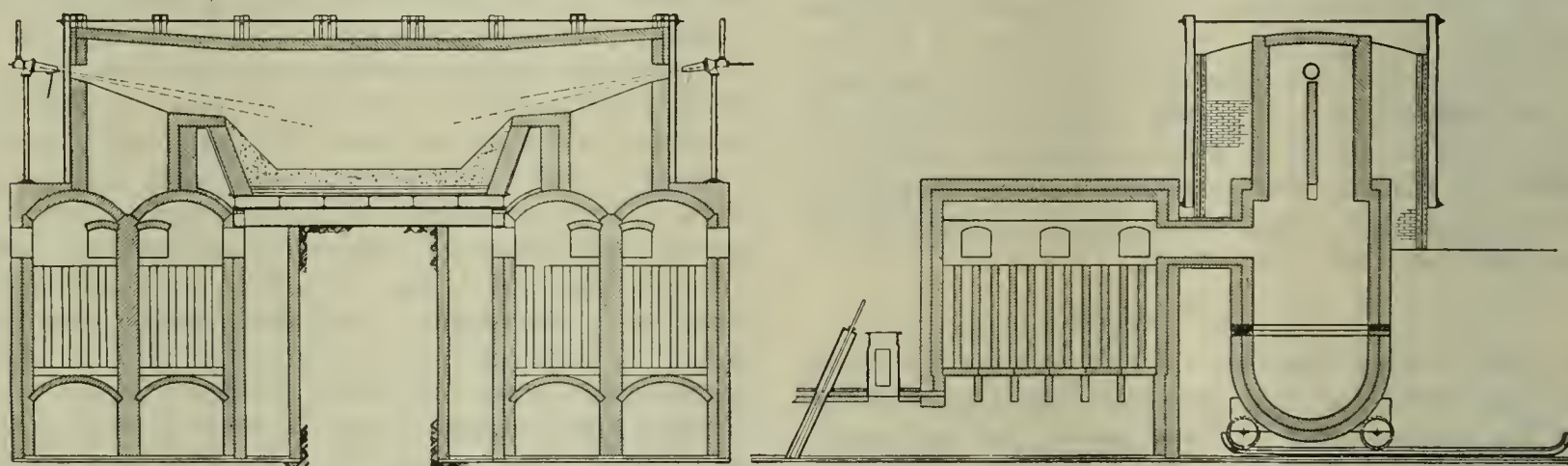


FIG. 2. TYPICAL OPEN-HEARTH FURNACE WITH PULVERIZED COAL BURNER

a fuel for open-hearth furnaces, from observation of its use up to date are as follows:

"All the heat is generated in the furnace, while in the case of the gas producer, from 18 to 25 per cent of the heat units are lost in the producer itself when converting the coal into gas. The higher flame temperature results in a greater number of heats per week. Open-hearth furnaces using powdered fuel operated on a very low fuel consumption fully equal to the best producer gas practice, and much better than the average of the older plants in this country; at the Atlanta plant the coal consumption is about one-third less than with producer gas. Coal can be pulverized in plants of about 100 tons daily capacity and delivered to the furnace for approximately 50c. per ton, which is about the same as the costs for gasifying coal in gas producers.

"The use of this fuel in metallurgical furnaces has been developed to only about 75 per cent of its ultimate value. In our plant this open-hearth furnace has been shut down oftener than the producer gas furnaces of the same size, due to checkers and slag pockets filling up with cinders and slag after about 80 heats. We believe, however, that we are gradually overcoming these troubles by decreasing the size of the uptakes and enlarging the slag pockets as mentioned above. Now, only the fine particles are going to the checkers and are being blown off daily by compressed air. By these

flues, etc.), although the pulverizing plant must be given attention as to dryness and fineness. Refractory costs have been greater on the furnace using pulverized coal than on gas producer furnaces. I believe, however, that our steadily increasing familiarity with the use of this fuel will enable us to reduce this item nearly to the corresponding cost in producer gas furnaces."

The pioneer installation for firing basic open-hearth steel furnaces was made by the National Malleable Castings Co., at Sharon, Pa., about 1914, and has been operated successfully since that time. Pulverized coal has displaced fuel oil without any sacrifice of tonnage or quality of the product and with gratifying results.³

In some recent open-hearth furnace installations, built from designs made by the Quigley Furnace Specialties Co., vertical baffle walls have been used in the regenerative chambers in place of checkers.

A number of basic open-hearth installations have been made at plants of the United States Steel Corporation. Pulverized coal has been applied to the acid open-hearth process, but has not been found suitable.

Pulverized coal has been used in a number of malleable iron foundries for annealing castings, some of the installations dating from the earlier period when more

³Consult also "Pulverized Coal Systems in America," by L. C. Harvey, Fuel Research Board Special Report No. 1, London, 1919. Also "Pulverized Fuel, Its Use and Possibilities," by W. J. Dick, Commission of Conservation of Canada, Ottawa, 1919.

coarsely powdered coal was used. Until recently, however, it had not been successfully used for melting purposes.

What is probably the pioneer installation for melting malleable iron⁴ was made in 1919 at the malleable foundry of the General Electric Co., at Erie Pa. (Fig. 3.) This is an air melting furnace with a capacity of 10 or 15 tons and is equipped with a 22-in. burner. Considerable experimenting was necessary at first to obtain the most satisfactory arrangement and the furnace has recently been greatly simplified by discarding three features which were considered necessary at the start.

The first was a water-cooled damper, at the back bridge wall, which was thought necessary for controlling the stack draft. The second was a combustion chamber between the burner and the furnace. This was thought necessary to obtain complete combustion of the coal. The third was a top blast which was installed because it was used in all malleable iron foundries.

successful operation by the Combustion Economy Corporation, with pulverized coal as fuel in one of the largest malleable iron foundries in the United States. This furnace was of 10-ton capacity and was formerly fired by hand. Only a few slight changes were necessary in the firebox, such as filling the ash pit, lowering the front bridge wall, removing the top blast and altering the firebox front to provide for the burner pipe.

The general dimensions of the furnace are as follows: Length between bridge wall 15 ft. 6 in., width at tap-holes 5 ft. 6 in., firebox 40 x 59 in.; diameter of stack 29 in., height of walls at tap holes 31 in., depth of metal at tap holes 9 in. This is considered a very small furnace. On larger furnaces the results should be even more favorable.

The method of introducing the burner into the furnace is illustrated in Fig. 3.

A comparison of the operation of this furnace with hand-firing and with powdered coal is as follows:



FIG. 3. VIEW OF A 15-TON AIR-MELTING FURNACE FOR MALLEABLE IRON WITH PULVERIZED COAL BURNER

The company's engineer, however, considered this custom to be the result of superstition rather than necessity and the top blast was finally discarded. These sweeping changes have added greatly to the efficiency and simplicity of operation of the furnace.

Two heats are run off per day. The first is started with a cold furnace and tapped off in about 4.5 hours after lighting the burner. The second heat is started with a hot furnace and is poured in about 3.5 hours after starting the burner the second time.

The advantages derived in melting malleable iron with pulverized coal, as compared with hand-firing, are:

- (1) Increased economy. The ratio of coal to iron in hand firing, under the best conditions, was not over 1 to 2.5, while with pulverized coal the ratio is 1 to 4.5.
- (2) Owing to complete control of the melting conditions and of the speed of the operation, the heats may be tapped at exactly the time set in advance. This does not vary from day to day more than 5 minutes.
- (3) A hotter and more fluid iron is obtained which is very desirable in malleable iron practice. This cuts down the losses from misrun castings.
- (4) The cost of repairs to the furnace has been reduced approximately 50 per cent.
- (5) The labor saving, in running the furnace, is about 1½ men.

In 1919, a malleable melting air furnace was put in

	Hand-Fired Coal	Powdered Coal
Air pressure at furnace, oz.....	2 to 3	½ to 1
Diameter main blast pipe, in.....	18	15
Volume of main blast, cu.ft. per min.....	3,500	3,500
Time of melt, hours:		
Hot furnace.....	5.5	3.5-4
Cold furnace.....	6.5-7	4.5-5
Coal per ton of iron melted, lb.....	940	600

PERCENTAGE OF SAVING

Coal.....	31
Pig iron replaced by scrap.....	18
Time of melt.....	30
Labor.....	60
Skimming bars.....	30
Cost of repairs.....	29

In comparing the pulverized coal-fired furnace with the hand-fired furnace there are a number of other outstanding advantages which cannot be expressed in figures.

These have been summed up as follows:

- Less slag to dispose of, including all melted ash.
- Practically no ashes to dispose of.
- No cleaning clinkers from firebox.
- No grate bars. No top blast.
- No smoke at any time.
- More uniform analysis of castings.
- Cleaner furnace surroundings.
- Easier on workmen, making them more satisfied, as there is less poking, leveling and skimming.
- Decreased oxidation of metal.

It is suggested that in malleable iron foundries where it has not paid to pulverize the fuel required for annealing alone it should now be possible to use pulverized fuel on a sufficient scale to prepare it economically.

Schenectady, N. Y.

⁴The writer is indebted to H. E. Bailey of the Erie Works of the General Electric Co. for information.

Enameled Products Research Laboratory

Layout of Departments, With Enumeration of Laboratory Equipment—Organization Involving Services of Ceramic, Chemical and Metallurgical Engineers in Manufacture and Development of Uses for Enameled Apparatus—Method of Control and Research Applied to Orders and Inquiries

By EMERSON P. POSTE

Director of Laboratories, Elyria Enameled Products Co., Elyria, Ohio

THE keen interest which has recently been taken in the relation of the research laboratory to industry, together with complimentary remarks which have been made by persons who have visited the Elyria Enameled Products Laboratory, have suggested that it might be worth while to present the manner in which the manufacture of enamel-lined equipment depends upon the research laboratory for meeting the demands of the trade.

The field served by enamel-lined equipment is very large, including all phases of the dairy industry, the

The department of ceramic engineering has supervision over the preparation as well as the processing of the enamel in the factory. Its particular duty is to see that a given piece of apparatus leaves the factory properly enameled. This involves the improvement of existing commercial formulas and the development of new ones.

The chemical engineering department functions in co-operation with the sales department in specifying the proper equipment to meet the conditions of a given inquiry and also in developing new uses of enamel-lined equipment.

The metallurgical department has to do with metallurgical problems in the factory, which include foundry control, selection of proper steel for the construction of equipment and the effect of the enameling operation on the metal in the apparatus.

EQUIPMENT

With these general features in mind, it will be of interest to consider in detail the laboratory and its equipment. Fig. 1 shows a floor plan of the building. In the front portion of the building are the laboratory offices and library, which includes a well chosen set of references bearing on the problems of interest to the organization.

The analytical laboratory, a corner of which is shown in Fig. 2, occupies the remainder of the front wing. This laboratory is thoroughly equipped for the analysis of iron and steel, enamel raw materials, enamels and the various substances which may be submitted by the chemical engineering department in connection with its work.

The engineering laboratories are found in the main portion of the building, ceramic engineering to the east

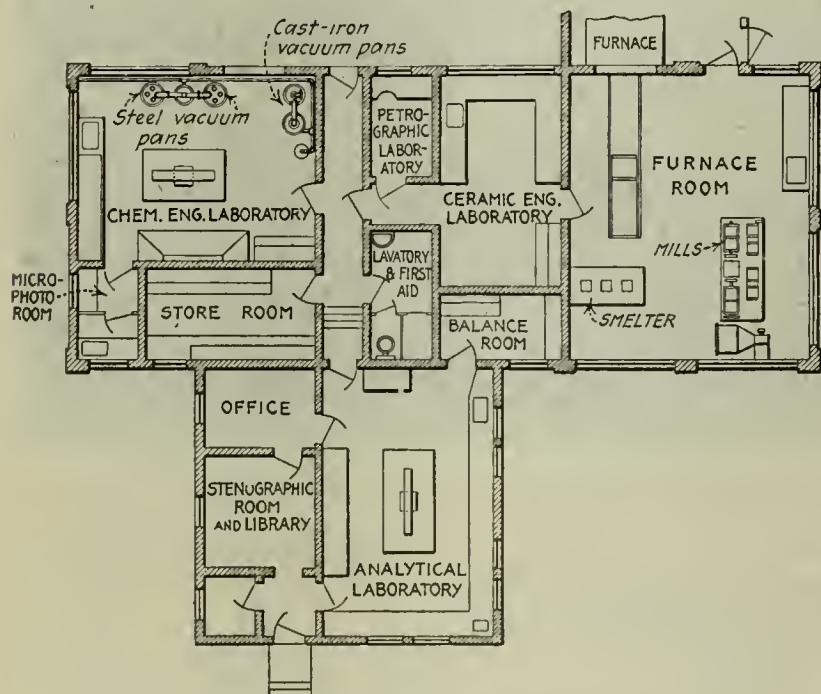


FIG. 1. FLOOR PLAN OF CHEMICAL LABORATORY

processing of edible fats and oils, the preparation of canned foods and beverages and the manufacture of various pharmaceutical and chemical products.

If the equipment supplied to the trade is to prove satisfactory, two fundamental requirements must be realized; the apparatus must be of such a quality from a mechanical point of view that it will stand up under the service to be met and it must be so designed as successfully to carry out the operations for which it is intended.

The laboratory plays a very important part in the realization of these fundamental requirements both as to the manufacturing of the equipment and the proper design to meet the specific purposes. Besides these routine matters, there are many research problems which constantly call for attention bearing on actual factory processes as well as the use of equipment.

The laboratory organization necessary to meet the above functions includes the following departments: Ceramic engineering, chemical engineering and metallurgical engineering. In addition to these, the analytical department serves the three other departments as occasion may demand.



FIG. 2. A CORNER OF THE ANALYTICAL LABORATORY



FIG. 3. A CORNER OF THE ENGINEERING LABORATORY

and chemical engineering to the west of the hall. The ceramic laboratories include a general laboratory in which are found various electric furnaces, drying ovens and miscellaneous equipment for the control and study of enameling operations, and a mixing table for the preparation of experimental enamel batches. A corner of this room is shown in Fig. 3. Adjacent to the general ceramic laboratory is a petrographic laboratory, equipped with the latest model of petrographic microscope and refractometer for the study of the optical properties of enamel raw materials and enamels. A corner of this room can be seen in the background of Fig. 4.

The furnace room, adjacent to the general ceramic laboratory, contains a complete experimental enameling plant. Experimental batches which have been mixed in the ceramic laboratory are smelted in the crucible furnace shown in Fig. 5. The frit obtained from this furnace is ground in Abbe and Patterson jar mills and the resulting enamel is sprayed onto the experimental ware by the use of a Paasche spraying equipment. The grinding and spraying apparatus are shown in Fig. 6.

The burning equipment consists of a 3-ft. muffle furnace, the front of which, together with the charging machine, is shown in Fig. 7. This department also includes various miscellaneous pieces of equipment, such as crushers and Rotap sieve shaker.

The laboratory pyrometric equipment consists of a Leeds & Northrup potentiometer, Leeds & Northrup

optical pyrometer, Thwing radiation pyrometer and Brown portable pyrometer. This equipment is used for checking factory pyrometric equipment as well as in connection with experimental work.

The equipment of the ceramic engineering department makes possible the experimental processing of any type of enamel which may be of interest, together with a thorough study of the physical and chemical properties of enamel raw materials and enamels.

The chemical engineering laboratories are equipped with the necessary apparatus for studying field problems from the initial to the semi-commercial stage. The equipment includes the usual glass and porcelain units and a variety of semi-commercial models of agitation, emulsification and similar apparatus.

In addition to various small enameled units, there are available in the laboratory a 2-gal. jacketed enamel-lined unit, an open-top 5-gal. enamel-lined kettle and two sets of semi-commercial vacuum pans.

Fig. 8 shows the steel vacuum pans so assembled as to make possible the processing of various materials under different methods of heating. The pan at the



FIG. 5. EXPERIMENTAL CRUCIBLE FURNACE

left is equipped with silver-plated copper coils as a heating medium and the one at the right with a steam jacket. The condenser and receiver are shown in the center. Either pan can be attached to the condenser and various types of agitating devices can be used as indicated on the pan at the right.

Fig. 9 shows the cast-iron jacketed vacuum pan with condenser and receiver. This particular unit is used in connection with problems involving mineral acids necessitating the use of the more acid-resisting cast-iron enamel. The vacuum requirements of the entire laboratory are served by a Crescent rotary vacuum pump with a capacity of 50 cu.ft. of free air per minute.

The chemical engineering department also has available for the testing of actual commercial units a portion of the testing floor of the factory and carries on such tests on full-sized units as may be desirable.

The metallurgical equipment includes such apparatus as is necessary for physical tests on the various materials of construction and metallographic studies in connection with the enameling operations. The work of this particular nature is done in the microphotography room opening off the chemical engineering laboratory.



FIG. 4. A CORNER OF THE PETROGRAPHIC LABORATORY

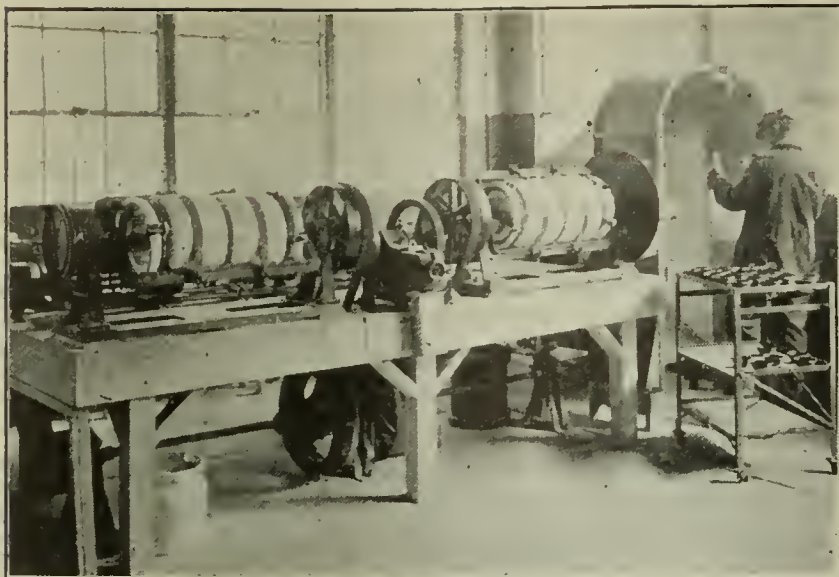


FIG. 6. GRINDING AND SPRAYING APPARATUS

The laboratory building also contains a store room and comfort room in which first aid work is given to factory employees.

THE LABORATORY AND THE FIELD

With this equipment in mind, we may assume that the reader will be interested in knowing how the laboratory functions in connection with an inquiry which may be received from the sales department.

The original information submitted to the salesman is turned over to the chemical engineering department for consideration. If there is on file a sufficient amount of information to cover the case, definite action is taken. It may be necessary, however, to carry on additional experimental work in the laboratory or to send a laboratory representative to the customer to make a more detailed study of his problem. If the laboratory comes to a definite conclusion as to the feasibility of furnishing the proposed equipment, it makes a report specifying the exact equipment which should be furnished for the case in hand, the engineering department co-operating in working out the actual design. If, on the other hand, the laboratory, through previous information or by further experiment, finds that enameled equipment would not satisfactorily serve the purpose in mind, a report to this effect is submitted to the sales department.

When the order is reached by the manufacturing department, it first goes to the laboratory, is correlated with previous experimental work on record, and the

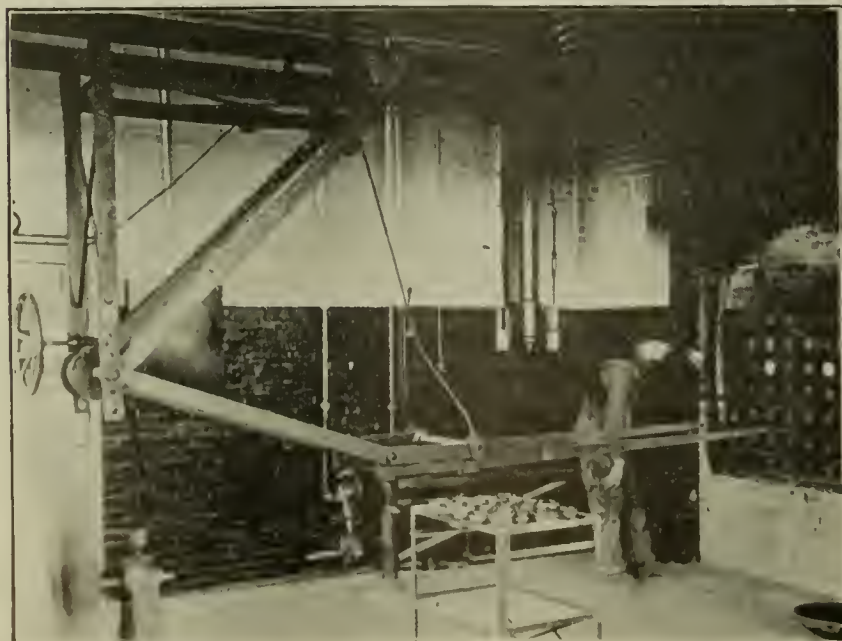


FIG. 7. MUFFLE FURNACE AND CHARGING MACHINE

proper enamel to meet the requirements is specified. A memorandum goes to the ceramic engineering department with the specifications for inspection. This department is then responsible for the proper processing of the piece through the shop and the inspection thereof in accordance with the specifications received.

Records bearing on every specific piece of equipment include the composition of the metal used in the unit, the formula and actual batch number of the enamel, and the condition of the tank when finally inspected, as well as a full record of the specific information as to the intended use. Field observations in connection with the particular unit are correlated with these factory records later.

It will be of further interest to consider briefly some typical research problems which are at present on the laboratory schedule. The ceramic engineering depart-

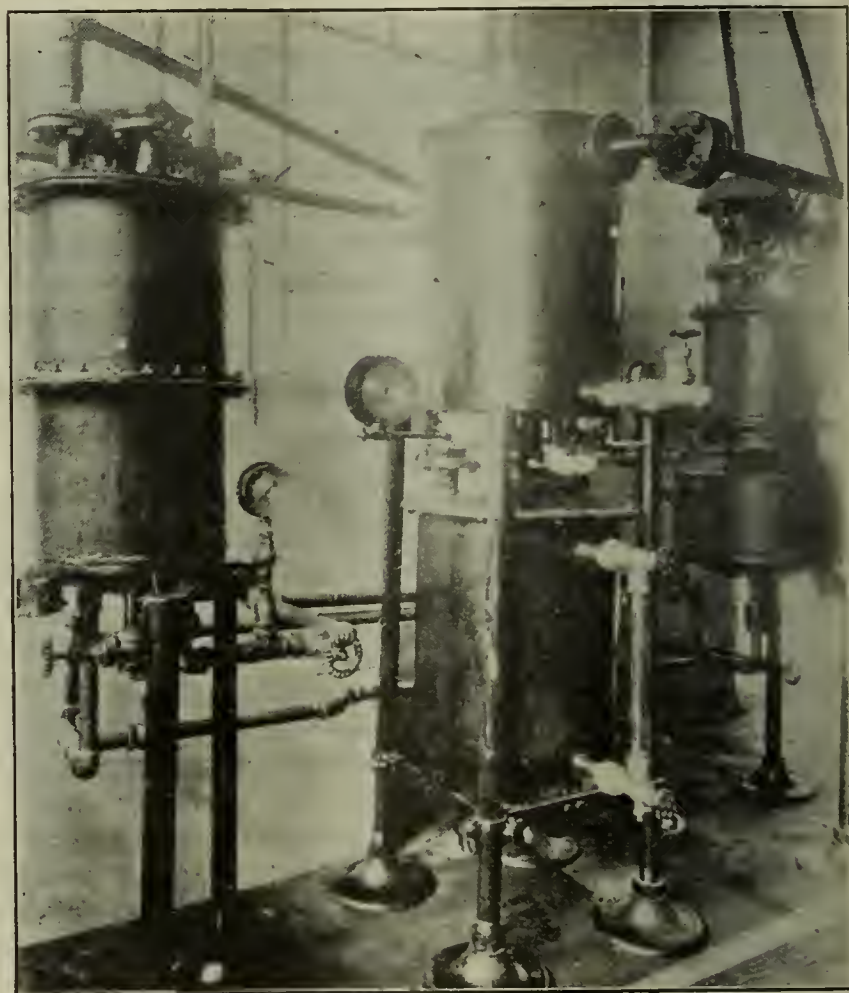


FIG. 8. STEEL VACUUM PANS

ment is making a very thorough study of the properties of enamel raw materials and the general behavior of each when incorporated in an enamel mix. The chemical engineering department has recently obtained some intensely interesting data as to the action of metals on milk, bringing forth some very striking arguments against the use of metallic milk containers. The metallurgical department has recently demonstrated that the enameling operation furnishes a very thorough annealing of the oxyacetylene weld used in the fabrication of steel units.

The laboratory is under the direction of Emerson P. Poste, who was graduated in chemical engineering from Carnegie Institute of Technology in 1910 and after two years with that institute as instructor in chemistry assumed his connection with the laboratory.

Bryan A. Rice, who is in charge of the ceramic engineering department, was graduated from the department of ceramic engineering of Ohio State University in 1917. After two years of commercial experience

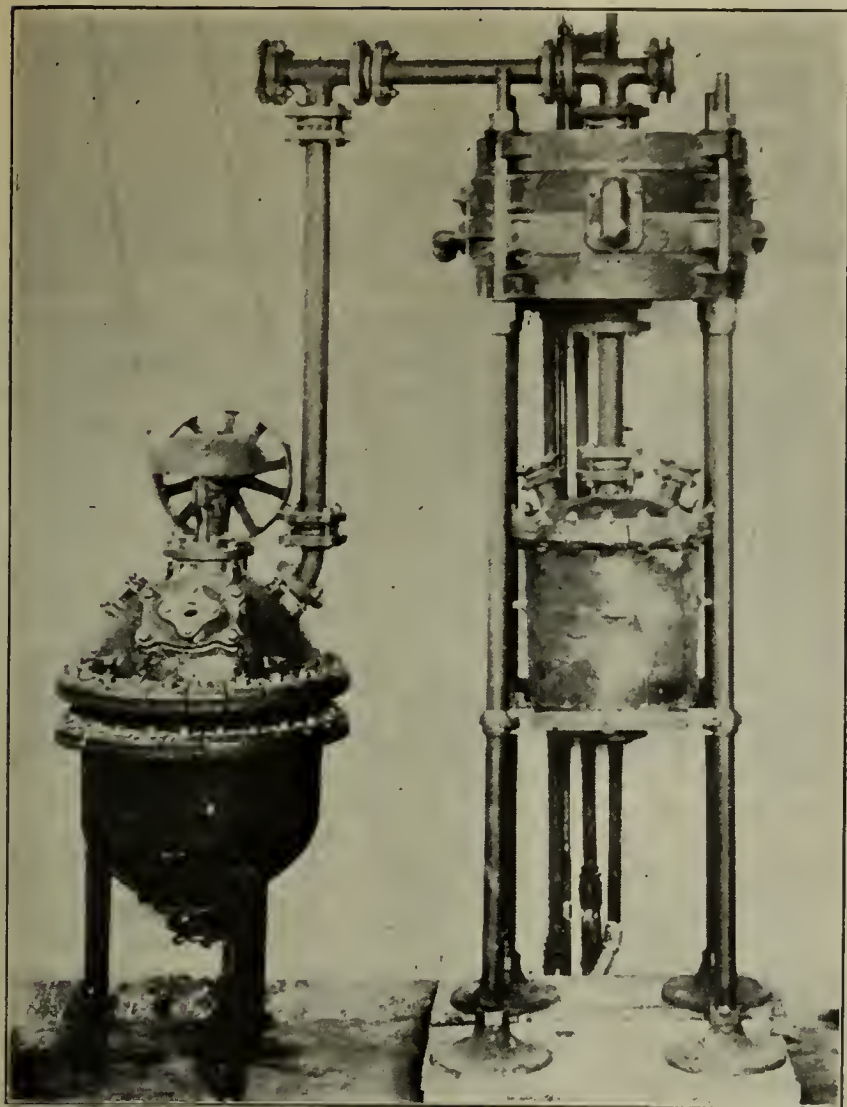


FIG. 9. CAST-IRON JACKETED VACUUM PAN WITH CONDENSER AND RECEIVER

with the company, he returned for post-graduate work in connection with certain problems of enamel technology.

The chemical engineering department is in charge of Max Donauer, who after his graduation from the department of chemical engineering of the University of Minnesota has had a considerable commercial experience along his line, including very responsible duties in charge of the Ordnance Control Laboratory of Philadelphia during the war. He has held his present position for the past two years.

In addition to the above heads of departments the laboratory staff includes several assistants who perform the analytical and other routine work.

Zinc Cyanide Plating Solutions

Zinc coatings furnish by far the best protection against corrosion of steel, and for this reason zinc plating or electrogalvanizing was extensively applied to all sorts of machinery during the war. Satisfactory zinc deposits can be secured from either sulphate or cyanide solutions, but the latter possess the advantage of "throwing" the deposit better into deep depressions or upon the surface of irregularly shaped articles. The cyanide solutions were, therefore, given first consideration in the investigations conducted by the Bureau of Standards. It is hoped later to extend this study to include the sulphate solutions. It was found that satisfactory zinc cyanide plating solutions can be made by using zinc oxide to replace part or all of the zinc cyanide formerly employed for this purpose.

Technologic Paper 195 of the Bureau of Standards describes the above work and gives formulas for satisfactory solutions and general directions for their use.

Book Reviews

CONCENTRATION BY FLOTATION. By T. A. Rickard. New York: John Wiley & Sons, Inc. 692 pp. Illus. Price \$7.

Just at the time that T. A. Rickard returned to San Francisco from London to assume the management and editorship of *Mining and Scientific Press*, flotation was assuming a position of importance in the United States. Mr. Rickard immediately perceived that here was just such an opportunity as, if taken hold of, would give his paper such renewed impetus as it appeared to him just then was so essential.

With this end no doubt largely in view, but also on account of his own keen personal interest in all subjects of vital importance to the profession, he made "flotation" the slogan of his journal and thus attracted to it, in advance of others, a series of interesting articles upon this new subject; his paper having become, for the time, the repository of its newly making literature. It was therefore most natural that such a series of articles as appeared in the *Press* should find more ready means of access in book form.

Two volumes comprising reproductions of these articles which had appeared in *Mining and Scientific Press* have been published previously. This third volume, however, is presented as more complete, and contains, besides twenty-two articles which were in the previous volumes, eighteen later articles. As the preface to this third states, it does not profess to be complete or final. The subject matter is somewhat confusing in its sequence of articles, as what is practically the same topic appears in widely separated chapters, by different writers and without apparent arrangement.

It would take one far beyond the limits of such a book review as this to attempt any comparison of one of these chapters with another, or to note differences and similarities of opinions given, or to discuss what the reviewer feels to be regrettable misconception as to some important matters. However this may be, it is a convenient collection of much that is most interesting, and references cited add greatly to its scope.

R. C. CANBY.

* * *

AMERICAN CHEMISTRY. By Harrison Hale. 215 pp., 63 illustrations. New York: D. Van Nostrand Co. Price, \$2.

Dr. Hale has chosen to review American chemistry in such a way as to interest both the layman and the student in the achievements of our chemical industry and its inviting possibilities for future developments. Considered from this point of view, his book must be regarded as a very creditable attempt to serve an excellent and worthwhile purpose. That it falls short of its goal in a number of outstanding instances is to be regretted, especially so when it is realized that some of its faults are inexcusable. In the first place there is abundant evidence of careless writing, loose construction and generally inefficient use of English. It is apparent, too, that the author has not been altogether successful in adopting the non-technical style, which is so essential if he is to attract and hold the interest of the general reader. There are many technical expressions and unfamiliar words which might well have been avoided or at least given some explanation for the benefit of the layman. If, however, we consider the second purpose of the book—namely, "for use either as collateral reading along with a course in general chemistry or as a short separate study"—some of reviewer's criticisms do not apply. Certainly, it is a laudable desire to acquaint the student with the industrial importance of the science he is studying. His interest in his immediate task is stimulated, his viewpoint is broadened, and, if he is a red-blooded American, his patriotism is stirred by the record accomplishments of American chemistry. The author has done much to encourage the student's interest in current literature and the technical press, and the frequent reference to these sources of information will undoubtedly prove very useful. Furthermore, the many well-chosen illustrations add materially to the value of the book.

S. D. KIRKPATRICK.

Current Events

in the Chemical and Metallurgical Industries

More Plants Resume Operations

Leather. The New Castle Leather Co., Wilmington, Del., has added about 100 men to its working force, increasing production to approximately 90 per cent of normal.

Rubber. The Firestone Tire & Rubber Co., Akron, Ohio, is increasing its working force with intention of developing production to a point of about 18,000 tires a day.

Acid. The Marion Extract Co., Chattanooga, Tenn., manufacturer of tanning extracts, resumed operations at its plant on Nov. 7, following a curtailment for some time.

Coke. The Domestic Coke Corp., Fairmont, W. Va., has resumed production on a basis of about 40 per cent of normal, following curtailment for a considerable time.

Ceramic. About 250 kiln drawers employed at East Liverpool, Ohio, potteries who recently declared a strike against a wage reduction of 7 per cent, have returned to work pending a settlement with employers.

Iron. The Ulster Iron Works has reopened its plant at Dover, N. J., following a shut-down dating from last spring. Substantial wage reductions have been placed in force. Puddlers heretofore receiving \$9 for a 10-hour day, will be paid \$5.50; and helpers \$4.01, as compared with \$6 when the plant closed.

The Reading Iron Co., Reading, Pa., has resumed production at its puddle furnaces at the Ninth St. mill, and seventeen units have been placed in service. The larger portion of the plant has been idle for a number of months.

The Carnegie Steel Co., Youngstown, Ohio, has blown in another blast furnace at its local mills, making four out of seven units now in service.

The United States Cast Iron Pipe & Foundry Co., Chattanooga, Tenn., has resumed operations at its local plant, following a shut-down since last January.

The Republic Iron & Steel Co., East Chicago, Ind., has opened its local plant, following a period of inactivity for about three months past. About 200 men will be employed at present, and which number will be increased gradually as conditions warrant.

Steel. The United States Steel Corporation, New York, N. Y., is now operating at about 51 per cent capacity at its various mills, the highest production record since last March. At one time in July a low point of 18 per cent of normal was reached.

The Bethlehem Steel Co., Bethlehem, Pa., has resumed operations at its 20-in. rolling mill at the Steelton, Pa., works, following a shut-down for several weeks through lack of orders.

The Carnegie Steel Co., Pittsburgh, Pa., is giving employment to about 5,600 men at its various plants at the present time, as compared with a normal working force of 6,800 men.

Metal. The International Silver Co., Meriden, Conn., has adopted an overtime operating schedule at its Factory L, Wallingford, Conn. With a 55-hour week in force, about 250 operatives will work four nights a week until 9 o'clock. A number of new workers are being employed.

Tinplate. The American Sheet & Tinplate Co. has resumed full operations at its Elwood, Ind., plant, placing twenty mills in service Nov. 7, with employment of about 1,500 men.

Laboratory Car for Brick Kiln Tests

Arrangements have been made in connection with the co-operative agreement between the associations of brick manufacturers and the Bureau of Mines to fit up a laboratory car which will be used in testing kilns at brick works. This will make possible a much more expeditious handling of this very necessary phase of the work and will permit its being done in a very thorough manner.

To Consider Chemical Warfare at Arms Conference

While the simple and direct proposal of Secretary of State Hughes probably will make it unnecessary for the Conference on the Limitation of Armament to consider the economic phases of international relationships, it is certain that chemical warfare will receive consideration. Seven members of the American advisory committee already have been designated to make a special study of the relation of chemical warfare to the limitation program. Carmi A. Thompson, of Cleveland, the general manager of the Great Northern Iron Ore Properties, was designated as chairman of the sub-committee. Other members are Mrs. Katherine Phillips Edson, John L. Lewis, Gov. John M. Parker, General Pershing, Admiral Rogers and Theodore Roosevelt. Mr. Parker is Governor of Louisiana; Mr. Lewis is president of the United Mine Workers of America. At the time of this writing, the other duties of the advisory committee had been such as to preclude any meeting of the Thompson sub-committee. For the same reason the technical staff of the American delegation has had no opportunity to discuss chemical warfare or any of the other subjects coming within its jurisdiction.

American Gas Association Meets in Chicago

The third annual convention of the American Gas Association met in Chicago during the week ended Nov. 12. General sessions were held each morning at the Congress Hotel, while the five sectional meetings were held during the afternoons in rooms at the Congress and Auditorium hotels. These sections are the accounting, commercial, publicity and advertising, the technical, and the manufacturers' section. At the same time exhibits of gas appliances and gas-plant apparatus were shown by the manufacturers in both the Elizabethan Room and the Florentine Hall of the Congress Hotel. Entertainment features of the convention included the president's reception, the annual banquet followed by a dance, arrangements for golf fans, and a trip to the new plant of the Chicago Byproduct Coke Co.

GENERAL SESSION

President Charles A. Monroe opened the general session with an address on the progress of the association. It was organized in June, 1918, in New York City to promote and develop the gas industry and effect the best service to the public. The year 1920 was the darkest for the industry and the strain has humbled every man in the business. This has been a great thing, because it has driven the members to seek co-operation. The gas industry was one of the first to feel the effects of tax exemption on government and state securities. The association has made progress in arousing public sentiment against tax on public utility securities. In co-operation with the National Electric Light Association and the American Electric Railway Association a committee has been organized to support the Smoot bill.

There is a general need as regards specifications for a general lowering of the calorific standard for national conservation of our fuel. Conservation of life in the industry through new resuscitation methods has been effected, and particularly good work has been done by the committee operating under the direction of Dr. Cecil Drinker, of Harvard University.

Increased cost of producing gas has called for increased rates if the utilities are to survive. The public understands the gas industry situation better than ever before. The association must continue to point out to the universities the need of technical men trained in the gas industry. The University of Michigan now has a 3-year course in

gas engineering. The Natural Gas Association of America should amalgamate with the American Gas Association, because in the course of time as the supply of natural gas becomes less, the problems of both associations will become identical and duplication may thereby be avoided. The reports of the various committees showed the association to be in good shape as regards its business affairs. It now has a surplus of \$92,849. Officers elected for the coming year were: President, D. D. Barnum, of Boston; vice-president, R. D. Brown, of Milwaukee, and treasurer, H. M. Brundage, of New York.

Among other talks of interest at the general session was one by R. P. Perry, vice-president of The Barrett Co., on "Why Should Gas Companies Sell Their Tar to Distillers Instead of Working It Themselves?" Mr. Perry pointed out the wide variations which exist in the physical and chemical properties of tars from different sources, and emphasized the difficulty of producing marketable tar and pitch products from the tar of a single gas plant.

Other speakers of note at the general session were: George B. Courtelyou, national counsel of the Consolidated Gas Co., New York; R. M. Searle, president of the Rochester Gas & Electric Corporation, and Samuel Insull, chairman board of directors, People's Gas Light & Coke Co., Chicago.

TECHNICAL SECTION

At the Wednesday afternoon session, M. E. Benesh presented a paper on "What Goes On in a Water-Gas Machine," in which he described an apparatus for indicating the percentage decomposition of steam during a run. Partially decomposed steam leaving the generator is passed at constant temperature (checked by a dry-bulb thermometer) over a wet-bulb thermometer. Since the dry-bulb temperature is constant, the wet-bulb thermometer may be graduated directly in per cent decomposition of steam.

A. W. Warner, as chairman of the committee on complete gasification of coal, presented a review of several methods of complete and partial gasification. A brief on the gas oil situation was submitted by the committee appointed to consider this subject. Results of tests on refractory materials for use in lining water-gas generators were given by the committee on refractory materials. In spite of the rather negative character of the results obtained to date, the committee stated that it was not pessimistic over the probability of finding more suitable refractories for generator linings than fireclay blocks.

On Thursday afternoon J. T. Griffin discussed a method of removing stoppages of rust in gas lines by the use of cylinders of compressed air at a pressure of 1,500 lb. per square inch. The committee report on the progress made in the research investigations on gas purification problems was supplemented by an excellent selected and annotated bibliography on gas purification. Another phase of purification was treated by W. A. Dunkley in a paper on "The Effect of Moisture on the Activity and Capacity of Iron Oxides for Gas Purification." Practical results in the removal of hydrogen sulphide by the Seaboard liquid process were described at length in a very interesting paper by F. W. Sperr, Jr., which will be treated more fully in a subsequent issue.

"Some Experiments With the Mixing of Different Gravity Gases in Holders" was the title of the first paper presented before the section on Friday. The author, H. E. Bates, called attention to the increasing importance of the problem of the proper mixing of gases, and gave curves showing the results of tests made with a small holder.

One of the most important reports presented at the meeting was that of the carbonization committee. The operators' section submitted standard carbonization data for nineteen plants. The low-temperature carbonization section reviewed the present status of carbonization at low temperature. This report will be considered in more detail in a subsequent issue. Eleven manufacturers of carbonizing apparatus reported in the builders' section, giving interesting data on recent improvements and new designs.

The report of the committee on the disposal of waste from gas plants closed the meeting of the technical section.

Postmaster General Hays Discusses the Tariff

In the course of an address before the Fifth Avenue Association in New York, Nov. 15, Will H. Hays, the Postmaster General, made significant references to the tariff situation. His utterance in some quarters at least is interpreted to mean that there will be no effort to hurry the enactment of the tariff bill. An extract from Mr. Hays' speech follows:

Before 1914 we were a debtor nation—the largest in the world. Today we are precisely the opposite. We are the largest creditor nation in the world. Just what is the effect of the enormous importance of this change in our economic and commercial position in relation to the rest of the world I do not pretend to know. I merely point out that no thorough or open-minded or candid consideration of the tariff question can be complete without including consideration of this new factor. Regardless of what an investigation of this point might reveal—omitting this factor altogether—it is a fact that to thoughtful men there must be approval of a certain hesitation and disposition to be cautious and a determination to be sure-footed in the consideration of the whole subject of the tariff. Conditions throughout the world are so chaotic that it's difficult to foretell exactly what is needed. The very basic condition on which a tariff is built—the cost of manufacturing in various European countries with relation to our own cost of manufacture and the value of the currency of the various European countries with relation to the value of our own currency—is at the present moment as fluctuating as quicksand. To build a dependable tariff on such a foundation is difficult, of course. It has been thought by many that we could overcome these handicaps by a device which is called American valuation and which provided that all customs duties shall be estimated upon the value of goods at the time when they arrive in the United States and in terms of American money. The Congress in a proper eagerness for information has made an appropriation of \$100,000 to investigate the device and otherwise determine what might be done to help us toward writing a permanent tariff. This was proper, but a much better arrangement and one which is very definitely in the mind of the administration for accomplishment, is to make the Tariff Commission a really useful and functioning institution which will constantly study the situation and with sufficient authority, which ought to be given it, be able to meet any and all conditions which obtain or emergencies which may arise. The work of the special investigation has been going on and with the adjustment of our international relations by the accomplishment of the steps which the President has in mind we may expect relief from some of the conditions of fluctuation and instability so that proper permanent tariff making is possible.

Washington Section Officers Selected

R. C. Wells, of the U. S. Geological Survey, will be president of the Chemical Society of Washington for the coming calendar year, as a result of the election of this section of the American Chemical Society, held on Nov. 10. Other officers selected were: J. B. Reed, secretary; H. W. Houghton, treasurer; W. D. Collins, R. B. Sossman, W. W. Skinner, W. M. Clark and William Blum, councilors; and C. W. Bacon, V. K. Chestnut, L. H. Adams, F. C. Cook, C. O. Appleman and R. O. E. Davis, members of executive committee. The past presidents of the section addressed the meeting during the course of the election on various interesting developments in their several fields and regarding some interesting events in the earlier history of the society and the Washington section.

New Gas-Fired Kiln to Be Demonstrated

Arrangements are being made for a number of demonstrations in this country of a new gas-fired kiln for ceramic products, and primarily pottery, invented by Arthur G. Shaw of the Shaw Glazed Brick Co., Ltd., Glasgow, Scotland. Mr. Shaw, who recently arrived in the United States, states that the new kiln shows a saving of from 66 to 85 per cent in fuel and about 30 per cent in labor. P. Wylie Rodger of the Gartgraig Fire Clay Co. and Walter Bakewell of the Cauldon Potteries are accompanying Mr. Shaw.

International Labor Conference Discusses White Lead and Anthrax Poisoning

Much discussion has resulted from the consideration of the question of prohibiting the use of white lead in painting, by the International Labor Conference, now in session in Geneva, at which thirty-nine governments and the workers' and employers' organizations of those countries are represented.

Early in the conference the question was referred to a commission which was to study the subject and prepare a report to the conference. According to cabled information received at the Washington office of the International Labor Office, this commission has now returned a majority report opposing the prohibition of the use of white lead in painting, and stating that it is the opinion of the commission that the prohibition is not necessary in the interests of the painters, nor desirable in the interests of the users or producers of white lead. The commission recommended a draft convention for the regulation of the use of white lead in painting, such as measures for avoiding danger from dust in dry scraping, dangers of spraying with white lead pigments, provision of adequate washing facilities for those using white lead pigments, etc.

A minority report was also presented by members of the commission, which calls for the complete prohibition, or at least for the prohibition in interior work, of the use of white lead in painting.

The question of the disinfection of wool infected with anthrax spores, which appears on the agenda of the conference, has been disposed of by the unanimous adoption of a resolution to refer this question to a special committee to be appointed by the governing body of the international labor organization. It was suggested in the resolution that the British Government be asked to nominate the chairman of this committee. The resolution further stated that "the International Labor Conference is of the opinion that the co-operation of the United States of America should be invited on this question."

Chemical Salesmen Meet in New York

The Salesmen's Association of the American Chemical Industry held a dinner meeting in New York on the evening of Nov. 15, at which a number of important matters of business were transacted. It was announced that the plan to organize local chapters was proceeding satisfactorily. It seemed wise and opportune for the New York members to organize as a chapter and accordingly this was done by electing the following officers: Ralph Dorland, of the Dow Chemical Co., chairman; George H. Short of Wilckes, Martin & Wilckes, secretary, and Spencer Levy, editor of the *American Perfumer*, treasurer.

Charles B. Hall, of the Cleveland-Cliffs Iron Co., chairman of the Cleveland local chapter, made a brief address expressing the spirit of good will and co-operation that the Cleveland members hold toward all other members of the association. Theodore R. L. Loud, of the New York Quinine & Chemical Works, Inc., gave a brief but inspiring review of some of the early characters and traditions of the medical chemical industry in this country. He mentioned specifically such men as Weightman, Rosengarten and Squibb. This was followed by an address by Saunders Norvell, of McKesson & Robbins, in which he gave the members of the association very helpful business advice.

New Chemical Companies Organized

During the month of October twenty-six new companies in the chemical, drug and affiliated fields were organized with a capitalization of \$50,000 or greater, as compared with the formation of thirty-five such companies in September. The October aggregate shows a combined capitalization of \$6,675,000, as against the September total of \$7,450,000. During the month of October a year ago the aggregate capitalization of new companies was \$4,825,000.

The first 10 months of the present year shows a combined authorized capitalization of \$98,515,000 for new chemical companies; in the corresponding period for 1920 the aggregate reached \$180,467,000.

Excess Varieties of Paving Brick Eliminated

An indication of what may be accomplished in the elimination of waste and of excess variety was had when manufacturers and consumers of paving bricks perfected an arrangement in a 2-hour conference whereby fifty-five varieties of paving brick were eliminated from the sixty-six styles now being manufactured. The meeting at which this was accomplished was held in Washington Nov. 15 under the auspices of the Department of Commerce. While shrinkage of clay and other ceramic phases of brick-making came in for some discussion in the matter of variations from the dimensions fixed as standards, these technical questions are to be handled by special committees now working in co-operation with the Bureau of Standards. Similar conferences are planned to consider other types of brick.

The work begun at the Washington conference is to be carried on by a committee to be composed of representatives of the following organizations: National Paving Brick Manufacturers Association, Chamber of Commerce of the United States, American Society of Civil Engineers, American Association of State Highway Officials, American Society of Municipal Improvement, American Society for Testing Materials, Federated American Engineering Societies, Bureau of Public Roads, Bureau of Standards.

Alloy Work Discussed

The work on alloys being done by the Bureau of Mines was reviewed at a meeting between bureau officials and the standing committee of the American Institute of Metals. It was decided that the standing committee would meet twice a year in the future at the Bureau of Mines. Those in attendance at the meeting were H. Foster Bain, director, Bureau of Mines; W. M. Corse, Monel Metal Products Corp.; R. B. Moore, chief chemist, Bureau of Mines; William B. Price, Scovill Manufacturing Co.; W. H. Bassett, American Brass Co.; R. J. Anderson, Bureau of Mines; L. W. Olson, Ohio Brass Co.; C. H. Bierbaum, Lumen Bearing Co.; George C. Stone, New Jersey Zinc Co.; W. R. Webster, Bridgeport Brass Co.; H. W. Gillett, Bureau of Mines; DeCourcy Browne; Paul D. Merica, International Nickel Co.; J. L. Jones, Westinghouse Electric & Manufacturing Co.; John F. Thompson, International Nickel Co.; William A. Cowan, National Lead Co.; Andrew Stewart, Bureau of Mines; Dorsey A. Lyon, Bureau of Mines; E. L. Mack, Bureau of Mines.

Directors' Meeting American Electrochemical Society

At a meeting of the directors of the American Electrochemical Society held in New York on Nov. 16, Dr. Colin G. Fink was elected secretary to fill the unexpired term of Dr. Joseph W. Richards, deceased. The directors received an exhaustive report of the finance committee and considered various ways and means for putting the society on a sound financial basis. From its inception the society has maintained dues at \$5, but it may be necessary to increase this sum in order to get more revenue. Temporarily an increase in revenue will be obtained by charging \$3 per annum instead of \$5 per annum for the bound volumes of the society's *Proceedings*, but a constitutional amendment will be initiated to increase the dues from \$5 to \$8. If this is accomplished, the price of bound volumes will be restored to \$5. The treasurer of the society was authorized to use his discretion in disposing of assets in the form of bonds to meet current expenses.

Further Hearings to Be Held on Water Pollution Bills

Recognizing that it has before it a very knotty problem and one likely to cause hardship to manufacturing enterprises, the Rivers and Harbors Committee of the House of Representatives has determined to hold further hearings on the various bills proposing remedies for the pollution of coastal waters and the waters of streams. The hearings are to be reopened on Dec. 7.

American Electrochemical Society Honors the Memory of Dr. Joseph W. Richards

The meeting of the New York Section of the American Electrochemical Society held at Rumford Hall Nov. 16, 1921, was devoted to addresses and reminiscences on the life and work of the late Dr. Joseph W. Richards, who had been the society's first president.

Dr. Charles Doremus, acting as chairman, introduced Acheson Smith, the president of the society, who related some of the outstanding incidents in the work of Prof. Richards as president and secretary of the American Electrochemical Society and expressed the gratitude due his memory for his ever active interest in the welfare and usefulness of the society.

DR. RICHARDS AS EDITOR AND AUTHOR

The work of Dr. Richards as an editor and author was outlined by H. C. Parmelee, editor of *CHEMICAL & METALLURGICAL ENGINEERING*. He commented on Dr. Richards' part in founding the monthly magazine, *Electrochemical Industry*, in 1902, and his activities as president of the Electrochemical Publishing Co. of Philadelphia, which published this magazine until the end of 1912, when it was purchased by the McGraw Publishing Co. During this period and even up to within a few days of his death, Dr. Richards made many valuable contributions to this magazine, which has since become *CHEMICAL & METALLURGICAL ENGINEERING*. In the field of authorship Dr. Richards contributed abundantly to the technical literature, the most widely known works being his book on Aluminum and the revised Metallurgical Calculations. Mr. Parmelee then related some intimate reminiscences of his early connection with Dr. Richards in editorial matters and referred to him as an indefatigable worker and an inspiration and example to all.

DR. RICHARDS AS PRESIDENT AND SECRETARY OF THE SOCIETY

Dr. Carl Hering, one of the founders of the society, gave a historical review of the conferences in Philadelphia among a handful of men enthusiastically interested in the growth of the electrochemical industry, which led to the foundation of the monthly *Electrochemical Industry* with Dr. Richards as president and Dr. E. F. Roeber as editor. He then outlined the history of the foundation of the Electrochemical Society with Dr. Richards as the first president. He spoke highly of the services rendered to the society by Dr. Richards, who, it is worth recording, was the only member twice honored with the presidency of the society, and his tireless work as secretary from 1907 to the time of his death.

Dr. Hering then conveyed the messages he had received from Dr. C. J. Reed, another member of the still living handful of founders of the society, and from C. O. Mailloux, the president of the American Institute of Electrical Engineers.

In the telegram, dated Nov. 13, from San Francisco, Dr. Reed said: "Distance prevents my attending the Joseph W. Richards memorial service. I desire to express through you my feeling of what must be the universal feeling that in the death of Dr. Richards the American Electrochemical Society has suffered the irreparable loss of one whose original interest and subsequent self-sacrificing devotion made possible the organization and perpetuation of the society."

Dr. Mailloux' message, dated Nov. 12, reads: "At the moment when I am leaving my office to go to the pier to take the steamer for Europe, I receive the announcement of the meeting which is to be held Nov. 16 in memory of the late Dr. J. W. Richards. This letter, which is dictated in haste and which will have to be signed for me by my secretary, has for its object to let you know that I will be with you in spirit and would have liked very much to have been able to be physically present at the meeting. I knew Dr. Richards very well indeed. My acquaintance with him ripened into friendship many years ago when I was a non-resident lecturer at Lehigh University. I had the greatest respect and admiration for him. It may be truly said of

him that he possessed learning, culture and refinement to the highest degree. In certain fields of knowledge which he made his own, he did splendid work which will long keep his memory green in the scientific world. Great as is the loss to the world, the loss to the friends who admired and loved him is much greater; in fact, it is irreparable."

DR. RICHARDS AS TEACHER, MAN AND ARTIST

Dr. W. S. Landis chose to speak on the subject of "Dr. Richards as a Teacher at Lehigh University." He reviewed the latter's life from the time when he came as a lad from England until he became instructor at the Lehigh University, and then gave an account of his great educational service, first as instructor and then for over thirty years as professor of metallurgy at the Lehigh University.

William Richards, the only son of Dr. Richards, spoke of his father in filial and touching appreciation. Dr. Richards' sister told with glowing enthusiasm some of her reminiscences of her brother as the artist and the lover of music and of all that is beautiful and artistically recreative.

Status of Chemists in the Navy

The recent revision of the salary and wage scale in the Navy brought into prominence what is regarded as the very unfortunate status of chemists in the Navy. Chemists as such are scarcely recognized by that department of the Federal Government. The chemists in the Navy service are rated in exactly the same way as are draftsmen, mechanics, blacksmiths and other artisans. They are treated as artisans on the per diem basis.

It is stated by those in close touch with the situation that the Navy has failed to recognize the increased importance of chemistry in warfare. The situation is very different in the War Department, which has a Chemical Warfare Service, in which a large number of chemists are employed, all of whom are given full professional status—exactly the same recognition accorded professional medical men in the Medical Corps.

Unemployment Diminishing and Fewer Inquiries Being Cancelled

Statistics compiled by the Engineering Agency, a technical employment bureau, show that the number of inquiries for technical help in manufacturing, construction, industrial and commercial work steadily decreased from February, 1920, to June, 1921, and since the low month of June has shown an increase. In other words, the average minimum was reached in June and a slow but comparatively steady increase has been in evidence since then. Also, during the declining period many employers were forced to cancel their inquiries due to the falling off of their work, whereas since June there have been very few inquiries cancelled.

Personal

C. H. BRANDES, formerly chief mechanical engineer and general purchasing agent of the American Metal Co., New York, and its domestic and foreign subsidiaries, has severed this connection and announces the opening of offices at 42 Broadway, New York, for the conduct of business on his own account.

NELSON COURTLANDT BROWN has returned to his former position as head of the Department of Forest Utilization, New York State College of Forestry, at Syracuse University.

G. G. CREWAN, who was mechanical engineer with E. I. du Pont de Nemours & Co., Wilmington, Del., is now plant manager for the Refractory Products Corporation, Wilmont, Va.

F. E. DODGE, formerly of The Barrett Co., has recently

been made vice-president and manufacturing manager for the Protexol Corporation, Kenilworth, N. J.

M. L. DOLT, formerly research chemist with the American Cotton Oil Co., Chicago, Ill., is now in charge of food colors and pharmaceuticals at the Calco Chemical Co., Bound Brook, N. J.

GEORGE V. DOWNING, formerly research chemist for I. P. Thomas & Son, Paulsboro, N. J., manufacturers of fertilizers, has become chief chemist for Leas & McVitty, Inc., and the Buena Vista Extract Co., Salem, Va., in the tanning extract departments.

DR. COLIN G. FINK, formerly director of the research laboratory of the Chile Exploration Co., has opened an office as consulting engineer at 101 Park Ave. Dr. Fink was also recently elected secretary of the American Electrochemical Society for the unexpired term of the late Prof. Joseph W. Richards.

KUNO B. HEBERLEIN, formerly president and general manager of the Penoles Mining Co., Mexico, a subsidiary of the American Metal Co., New York, announces that he has severed this connection and opened offices at 42 Broadway for the transaction of business on his own account.

J. W. KIMBALL, formerly research chemist at the Delta Laboratory, Arlington, N. J., has joined the staff of the National Aniline & Chemical Co., Marcus Hook, Pa.

R. B. MOORE, chief chemist of the Bureau of Mines, addressed the New Jersey Chemical Society at Newark on Nov. 14. He discussed the chemical work of the Bureau of Mines and reviewed the work which has been done on helium.

H. C. PARMELEE addressed the Chicago section of the American Chemical Society Nov. 18 on "The Technical Paper and Its New Relation to Industry." Mr. Parmelee also addressed the students of the chemical department of Northwestern University, at Evanston.

R. T. STULL, superintendent of the Bureau of Mines Ceramic Station at Columbus, Ohio, conferred last week in Chattanooga with officials of the Central of Georgia R.R. concerning the co-operative work being done on Georgia kaolins.

LOUIS J. TROSTEL, who for the past two years has been stationed with the U. S. Bureau of Mines at Pittsburgh, Pa., engaged on problems relating to industrial gases and dusts, resigned on Nov. 1 to take a position with the Bureau of Chemistry as assistant chemical engineer. He will be associated with the work of that bureau on the chemical problems relating to explosions from starch and other carbonaceous dusts.

PROF. ARTHUR L. WALKER, professor of metallurgy in the School of Mines of Columbia, was elected a member of the board of Engineering Foundation. Prof. Walker succeeds the late Joseph W. Richards of Lehigh University, who died recently. He will represent the American Institute of Mining and Metallurgical Engineers on the board of the Foundation.

DR. E. R. WEIDLEIN, director of the Mellon Institute, Pittsburgh, spoke before the Philadelphia section of the American Chemical Society Nov. 17 on savings in fuel effected by covering pipes with insulating material.

Obituary

FRANK A. LANE, whose formula made possible quantity manufacture of "mag," a chemical necessary to the perfection of gas masks for American troops in the World War, died in St. Mary's Hospital, Passaic, N. J., Nov. 16, following an operation for an intestinal ailment. His home was 26 Oak Crest Place, Nutley, N. J. Mr. Lane was an expert practical chemist, assistant to the president of the Kalbfleisch Corporation, with offices in New York. After the armistice the Government Bureau of Information declared that no American soldier was killed by gas while using an American mask, according to a statement issued recently by the Kalbfleisch Corporation.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, Nov. 21, 1921.

After an interruption of a series of holidays, the chemical market has become settled again and improvement along the entire list was noted. Business is not being booked for large quantities, but the volume of small orders is quite large and this in itself is a very encouraging feature. Leading consumers have shown some inclination toward contracts over next year and are eager to receive shipments on standing contracts. Increased activity has recently been noted at some of the more important chemical plants. Offerings on spot have noticeably diminished, with prices all around well maintained. Present railroad conditions have led leading factors to believe that the remainder of the year will find the chemical market quite active. Price changes during the week have not been of any special importance. Caustic soda and soda ash have remained rather quiet, with ash sales a fraction lower for carload lots. Bichromate of soda retained its former price and found occasional buyers at this level. Bleaching powder continued to move steadily and indications point to a normal market on this commodity for the rest of the year. Cream of tartar is very scarce on the spot market and prices are well sustained around the recent advance. Barium chloride is another chemical that has shown a remarkable comeback, with shipment material practically unobtainable. Yellow prussiate of soda is somewhat easier on spot, but shipment material is still commanding a premium.

CHEMICALS

Bichromate of soda consumers are buying spot goods at 8@8½c. per lb. The demand is chiefly for small quantities and this has kept the general market in a steady position. Imported *chlorate of potash* has been offered in the open market at prices ranging from 5½@6c. per lb. Domestic producers are still quoting unchanged figures and report a better inquiry from new directions. The call for imported goods has been decidedly better in the past week. Sales of imported *caustic potash*, 88-92 per cent, were reported at 5¾@6c. per lb. on spot. Shipment material was offered at 5½c. per lb. Orders have reached the market in better volume for small quantities, with the bulk of imported shipments going to consumers holding large contracts. *Caustic soda* was offered in various directions at 4c. per lb. f.a.s. New York. There were sales reported down to \$3.90 per 100 lb. for carload quantities and up to \$4.15 for lesser lots. Although prices have eased up somewhat, leading factors stated that the inquiry was fairly active with buyers' views a shade under the general quotations. Producers of *sal soda* offered spot material a trifle lower. A fair inquiry was reported, with prices ranging from \$1.80@\$2 per 100 lb., according to seller and quantity. Spot *prussiate of soda* was offered a fraction lower and interest was not as keen as a few weeks ago. There were sellers offering imported material at 14¾@14½c. per lb. Shipment material was quoted at 14½c. per lb. Conditions in *nitrite of soda* continued somewhat dormant with an occasional sale recorded at 6¾c. per lb. The regular quotation heard around the trade ranges from 6¾@7c. per lb. There were some large holders that intimated shading on round lot business. Light *soda ash* in single bags moved at \$2@\$2.10 per 100 lb. There were rumors of sales down to \$1.95 for carload quantities. Barrels were sold at \$2.35@\$2.45 per 100 lb., according to quantity and seller. Producers of *acetate of lime* are taking on business at 1¾c. per lb. This is the lowest price recorded on this commodity since the beginning of the year. Prices on *barium chloride* continued to show a stronger tendency and it is very doubtful if much spot material can be purchased. Shipment figures are quoted higher with \$55 per ton heard as the minimum selling price. Spot quotations range from \$58@\$65 per ton. Sellers of *barium nitrate* report sales at 7½c. per

lb., with a general quotation of 7½@8c., depending on quantity. The market is rather quiet and devoid of any special features. Spot *cream of tartar* is very scarce and doubt is expressed among leading factors of domestic material if better than 28c. per lb. can be done on imported goods. Prices range all the way up to 30c. Imported *sulphide of soda*, fused, was offered at 4½c. per lb. Consumers are showing a moderate interest at the lower figure and sales are reported in better volume. Sellers of *aluminum sulphate* reported a better inquiry, with sales recorded at 2¾c. per lb. for the iron free variety. Shipment material was quoted at 2½c. per lb. The commercial variety brought 1¾c. per lb.

COAL-TAR PRODUCTS

The coal-tar products market during the past week has been practically without any noticeable features, although prices throughout the list were well maintained. The garment strike has meant a setback to manufacturers of fur dyes and also to several textile mills. Hope is expressed, however, of a speedy settlement and producers seem optimistic about the general outlook. The extension of the emergency tariff has had a stabilizing influence on many consumers who had been doubtful about future protection for the industry and there is a more pronounced tendency to take on forward commitments at right prices. The demand for phenol has eased off a bit, but prices are being held firm. *Benzene* production is increasing as the steel output continues to grow. Refiners are quoting 27@33c. per gal., but are accepting business for future delivery only. Consumers seem more optimistic about their requirements and are now fairly well assured that their contracts will be filled. Resale lots are almost impossible to locate. Although buying on *phenol* has not been as active as a week ago, the general tone of the market is strong and prices are being well maintained at 10c. per lb. and upward for prime white crystals. There were some sales recorded at slightly lower prices for round lots, but 10c. seemed to be the general quotation. A moderate amount of business is being done in *alpha naphthol*, but buyers do not feel inclined to purchase in bulk lots. The crude is held at \$1.10 per lb., and the refined variety is quoted at \$1.25 per lb. Resale stocks of *aniline salt* are light and makers are firm at 24@26c. per lb. with a fair demand reported. Producers of *benzyl chloride* are firm at 20@25c. per lb. for the technical and 25@30c. per lb. for the refined. Demand for *diethyl-aniline* is fairly good and as first hands practically monopolize the market, prices are being held at \$1@1.10 per lb. A fair amount of business is passing in *benzoic acid* at 50@60c. per lb. for the technical and 62@65c. per lb. for the U.S.P. grade. Makers are holding figures at these levels. Producers of *H acid* are asking \$1@1.10 per lb., but sales have been made below these prices. Competition among sellers remain quite keen and has kept some producers out of the market. Competition among sellers of *paranitraniline* is resulting in price shading and sales down to 75c. per lb. were made during the week. Resale stocks have been cleared from the market and makers seem to have things well lined up.

The Chicago Market

CHICAGO, Nov. 18, 1921.

There has been but little change in the general condition of the chemical market in this section during the past two weeks. Practically all factors are enjoying a good volume of business, and with a few exceptions, prices are quite firm. The teamsters' strike delayed deliveries for a couple of days this week, but now everything is moving smoothly. It is noticeable that stocks of quite a few items are getting low and no one seems overstocked on anything.

GENERAL CHEMICALS

Caustic soda is very firm with only a moderate supply available on spot. The ground, 76 per cent, is offered at \$4.75@\$5 per 100 lb. and the solid at \$4.25@\$4.50. *Soda ash* is moving in a fair way and supplies are available at \$2.60 per 100 lb. for barrels. *Ammonium chloride* is very firm, with supplies scarce. It is doubtful if 8½c. per lb. on the white granulated could be bettered on material for

immediate delivery. *Barium chloride* is moving in a routine way at \$60@\$65 per ton for the imported white material. *Carbon tetrachloride* is in good demand, with 11c. per lb. the general quotation. *Carbon bisulphide* is very firm, with supplies light. The lowest offer noted for spot material was 7½c. per lb. in drum lots. *Formaldehyde* is very quiet and is quoted generally at 12c. per lb. for barrels. It is very possible that this price could be slightly shaded with firm business. *Glycerine* prices were advanced this week by refiners to 14½c. per lb. for drums. There was no noticeable large movement of this material. *Iron sulphate* is steady, with a fair demand at \$1.75 per 100 lb. *Epsom salts* are quiet and unchanged as to price. The U.S.P. material is offered by first hands at 2¾c. f.o.b. warehouse. *Lead acetate* is quiet, with supplies available at 12½c. for the white granulated.

The bichromates are steady, with only moderate supplies available. The *potassium bichromate* is quoted at 14c. per lb. and the *sodium* at 8½@9c. *Caustic potash* is enjoying a fair demand and is available at 6½c. per lb. for the 88-92 per cent material. *Bicarbonate of soda* continues to move in a fair way at \$2.60 per 100 lb. The demand for *hyposulphite of soda* has fallen off somewhat, but the price is unchanged at \$4.05 per 100 lb. for the pea crystals. *Zinc chloride* is in fair demand and a wide variety of prices is quoted, ranging from 7½c. to 11c. for the granulated in casks.

ACIDS

There were no new developments in the acid markets during the past two weeks, the prevailing tone being firm. *Acetic acid* is in fair demand, the 28 per cent commercial being offered at \$2.50 per 100 lb. in barrels. *Glacial acetic* is not moving so well, although there is a noticeable improvement. Prices are quoted ranging from 9@10½c. per lb., depending on quantity and seller. *Oxalic acid* is moving in a fair way at 16@17c. per lb. The heavy acids are moving in a satisfactory way, according to the producers, and are very firm as to price. *Muriatic acid* is quoted in carboys at 1½c., with the same price for *sulphuric*.

VEGETABLE OILS

There is only a fair movement of linseed oil and supplies are plentiful. The boiled oil in 10-bbl. lots is quoted today at 74c. per gal. and similar quantities of the raw at 72c.

NAVAL STORES

Business in the naval stores market is good and most factors report a satisfactory volume. *Turpentine* is moving in a fair way at 80c. per gal. in 5-drum lots. The *rosin* market is in a fair shape and the "H" grade is quoted at \$7.90 per 280 lb. for less than carlots.

The Iron and Steel Market

PITTSBURGH, Nov. 18, 1921.

Buying of steel products has decreased somewhat and prices are a trifle softer. There is merely a continuation of the new trend that developed at about the middle of October, not so much a decreasing in demand as an arrest of the increase that had been practically continuous for four months.

Fundamental conditions affecting the steel market have not changed for the worse, and in one respect there is an improvement, in that railroad buying on a scale that amounts to something has begun. Superficially the steel market presents an unfavorable appearance, but the condition results from two factors to which no one can object, one being that the increase in demand that resulted from the gradual depletion of stocks ended because the stocks were all liquidated, the other being that requirements of buyers always fall off somewhat toward the close of the year.

The requirements of the country have not decreased and there is no accumulation of steel to be worked off. All the evidence is that the steel made and shipped in recent weeks was actually needed by buyers for their current operations. As long as that is the case the steel industry has not lost ground.

A few thousand freight cars have been contracted for in the past 10 days, and more are in the market. Undoubtedly all orders as placed will be for prompt execution, causing

an immediate demand upon the steel mills for plates and other materials. The absence of car buying for so long a time past has not been due entirely to lack of funds, an important factor having been the impossible prices once asked for cars. Prices of cars are now moderately well liquidated, by car shop wages coming down and labor becoming more efficient, by prices of the various appurtenances getting into reasonable bounds and by steel prices declining farther. Nearly all of the decline in steel prices occurred months ago. Plates for car building would not have cost more than \$5 a ton more on Aug. 1 than they cost now, and that is a small item considering that an ordinary car had advanced from less than \$800 in 1914 to \$3,500 or thereabout in 1920.

Steel ingot production is at a rate between 40 and 45 per cent of capacity, there having been little if any decrease thus far from the 44 per cent rate shown for the month of October. A slight decrease from now to the end of the year is not an improbability, but a rate below 35 per cent is not to be expected. The 20 per cent rate seen last July was a special phenomenon, due to buyers liquidating stocks. Nothing of the sort can occur again unless buyers pile up stocks again.

Naturally there are predictions of decided improvement in the steel trade within the next few months. It has been said that one cannot really foresee the future of the steel industry more than about 6 months ahead, hence when demand is poor one has no reason to allow more than 6 months for a decided improvement. What is reasonably certain is that no very great improvement is to be expected before Feb. 1, because December and January are normally dull on account of the season.

STEEL PRICES

The slight sagging tendency noticed in steel prices, considered as a whole, in the past few weeks is a trifle more pronounced, and prices may be said to have distinctly softened in the past week, although no clear-cut declines have occurred. In not a few commodities it can be said that a carload can now be bought at the price it would have required a 500-ton inquiry to bring out a fortnight ago. Of the entire tonnage of bars, shapes and plates sold in the past week the average was probably nearer 1.60c. than 1.50c., some carload business being done at above 1.60c. In sheets the shading of 3c. for black and 4c. for galvanized is more general, and now it sometimes extends beyond \$2 a ton. On a very attractive order 2.75c. and 3.75c. are distinct possibilities, these being prices that were done freely before the advance at about the middle of September, \$5 a ton.

Tubular goods lists of Sept. 16 are being shaded by the majority of independents. A little shading developed soon after the reduced lists of that time were issued, and this shading has become more widespread rather than deeper. The leading interest maintains the list prices, with the usual qualification as to line pipe. Demand for tubular goods has increased somewhat in the past two or three weeks, in contrast with the condition in steel products generally.

PIG IRON AND COKE

Pig iron, long presenting a stagnant market, is now showing a disposition to yield in price whenever any competitive business of importance arises. Southern foundry has dropped from \$19 to \$18 Birmingham. In the local market, a buyer of a few hundred tons of foundry secured a price of \$20.50 valley, the market previously having been largely nominal at \$21. Basic is still quoted by furnaces at \$19 valley, but resale iron seems to be available at enough below this to attract orders away from furnaces. Bessemer is steady at \$20 valley, the price for more than three months.

Connellsville coke prices have weakened on account of an obvious overproduction, due to operators blowing in ovens on a too optimistic appraisal of the increase in demand, and in the past two weeks merchant ovens have been returning to the idle list. Spot coke is about \$3@3.15 for furnace and \$4@4.50 for foundry, being off in the week 10c. or 15c. in furnace and 25c. in foundry.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots	Less Carlots
Acetic anhydride.....lb.	—	\$0.40 - \$0.45
Acetone.....lb.	\$0.12½ - \$0.12½	.13 - .13½
Acid, acetic, 28 per cent.....100 lbs.	2.75 - 3.00	3.25 - 3.50
Acetic, 56 per cent.....100 lbs.	6.00 - 6.25	6.50 - 7.00
Acetic, glacial, 99½ per cent, carboys, 100 lbs.	10.00 - 10.50	10.75 - 11.00
Boric, crystals.....lb.	.12½ - .12½	.13 - .13½
Boric, powder.....lb.	.13 - .13½	.14 - .14½
Citric.....lb.	—	.45 - .47
Hydrochloric.....100 lb.	1.25 - 1.50	1.60 - 1.75
Hydrofluoric, 52 per cent.....lb.	.12 - .12½	.12½ - .13
Lactic, 44 per cent tech.....lb.	.09½ - .10	.10½ - .12
Lactic, 22 per cent tech.....lb.	.04½ - .05½	.06 - .07
Molybdic, C.P.....lb.	3.25 - 3.50	3.60 - 4.00
Muriatic, 20 deg. (see hydrochloric).....	—	—
Nitric, 40 deg.....lb.	.06½ - .06½	.06½ - .07
Nitric, 42 deg.....lb.	.06½ - .07	.07½ - .07½
Oxalic, crys. tals.....lb.	.13 - .13½	.14 - .15
Phosphoric, 50 per cent solution.....lb.	.13 - .13½	.14 - .18
Picric.....lb.	.20 - .25	.27 - .35
Pyrogallol, resublimed.....lb.	—	1.90 - 2.00
Sulphuric, 60 deg., tank cars.....ton	—	11.00 - 12.00
Sulphuric, 60 deg., drums.....ton	—	13.00 - 15.00
Sulphuric, 66 deg., tank cars.....ton	17.00 - 18.00	—
Sulphuric, 66 deg., drums.....ton	21.00 - 22.00	22.50 - 23.00
Sulphuric, 66 deg., carboys.....ton	—	—
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	21.00 - 22.00	—
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	23.00 - 23.50	24.00 - 24.50
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	31.00 - 32.00	33.00 - 34.00
Tannic, U. S. P.....lb.	—	.75 - .85
Tannic (tech.).....lb.	.45 - .48	.50 - .55
Tartaric, imported crystals.....lb.	—	.26½ - .27½
Tartaric acid, imported, powdered.....lb.	—	.27½ - .28½
Tartaric acid, domestic.....lb.	—	—
Tungstic, per lb. of WO.....lb.	—	1.10 - 1.20
Alcohol, Ethyl.....gal.	—	4.65 - 5.00
Alcohol, Methyl (see methanol).....gal.	—	—
Alcohol, denatured, 188 proof.....gal.	—	.37 - .38
Alcohol, denatured, 190 proof.....gal.	—	.35 - .36
Alum, ammonia, lump.....lb.	.03½ - .03½	.04 - .04½
Alum, potash, lump.....lb.	.03½ - .04	.04½ - .04½
Alum, chrome lump.....lb.	.08½ - .08½	.08½ - .09
Aluminum sulphate, commercial.....lb.	.01½ - .02	.02½ - .02½
Aluminum sulphate, iron free.....lb.	.02½ - .03	.03½ - .03½
Aqua ammonia, 26 deg., drums (750 lb.) lb.	.07½ - .07½	.08 - .08½
Ammonia, anhydrous, cyl. (100-150 lb.) lb.	.31 - .32	.33 - .35
Ammonium carbonate, powder.....lb.	.07 - .07½	.08 - .09
Ammonium chloride, granular (white salammontac).....lb.	.07 - .07½	.07½ - .07½
Ammonium chloride, granular (gray salammontac).....lb.	.07 - .07½	.07½ - .07½
Ammonium nitrate.....lb.	.07½ - .07½	.07½ - .08½
Amylacetate tech.....gal.	—	2.40 - 2.70
Arsenic oxide, (white arsenic) powdered lb.	.06½ - .06½	.06½ - .07
Arsenic, sulphide, powdered (red arsenic) lb.	.11 - .11½	.12 - .13
Barium chloride.....ton	58.00 - 60.00	62.00 - 70.00
Barium dioxide (peroxide).....lb.	.20 - .21	.22 - .23
Barium nitrate.....lb.	.07½ - .07½	.08 - .08½
Barium sulphate (precip.) (blanc fixe) lb.	.04 - .04½	.04½ - .05
Bleaching powder (see calc. hypochlorite).....	—	—
Blue vitriol (see copper sulphate).....	—	—
Borax (see sodium borate).....	—	—
Brimstone (see sulphur, roll).....	—	—
Bromine.....lb.	.27 - .28	.28½ - .30
Calcium acetate.....100 lbs.	1.75 - 2.00	—
Calcium carbide.....lb.	.04½ - .04½	.05 - .05½
Calcium chloride, fused, lump.....ton	23.50 - 24.00	24.50 - 25.50
Calcium chloride, granulated.....lb.	.01½ - .02	.02½ - .02½
Calcium hypochloride (bleach'g powder) 100 lb.	2.25 - 2.30	2.35 - 3.00
Calcium peroxide.....lb.	—	1.40 - 1.50
Calcium phosphate, tribasic.....lb.	—	.15 - .16
Camphor.....lb.	—	.85 - .90
Carbon bisulphide.....lb.	.06½ - .06½	.07 - .07½
Carbon tetrachloride, drums.....lb.	.10½ - .10½	.11 - .12
Carbonyl chloride, (phosgene).....lb.	—	.60 - .75
Caustic potash (see potassium hydroxide).....	—	—
Caustic soda (see sodium hydroxide).....	—	—
Chlorine, gas, liquid-cylinders (100 lb.) lb.	.08 - .09	.09½ - .10
Chloroform.....lb.	—	.40 - .43
Cobalt oxide.....lb.	—	2.00 - 2.10
Copperas (see iron sulphate).....	—	—
Copper carbonate, green precipitate.....lb.	.20 - .20½	.21 - .22
Copper cyanide.....lb.	—	.50 - .62
Copper sulphate, crystals.....lb.	.05 - .05½	.05½ - .06
Cream of tartar (see potassium bitartrate).....	—	—
Epsom salt (see magnesium sulphate).....	—	—
Ethyl Acetate Com. 85%.....gal.	—	.80 - .90
Ethyl Acetate pure (acetic ether, 98% to 100%).....gal.	—	.95 - .12½
Formaldehyde, 40 per cent.....lb.	.11 - .11½	.11½ - .12½
Fusel oil, ref.....gal.	—	2.50 - 3.00
Fusel oil, crude.....gal.	—	1.50 - 1.75
Glauber's salt (see sodium sulphate).....	—	—
Glycerine, C. P. drums extra.....lb.	—	.14½ - .15
Iodine, resublimed.....lb.	—	3.50 - 3.60
Iron oxide, red.....lb.	—	.12 - .18
Iron sulphate (copperas).....ton	18.00 - 19.00	20.00 - 23.00
Lead acetate.....lb.	—	.10½ - .12½
Lead arsenate, powd.....lb.	.15 - .15½	.15½ - .16½
Lead nitrate.....lb.	—	.15 - .20
Litharge.....lb.	.07½ - .08	.08½ - .09
Lithium carbonate.....lb.	—	1.40 - 1.50
Magnesium carbonate, technical.....lb.	.08 - .08½	.09 - .10
Magnesium sulphate, U. S. P.....100 lb.	2.50 - 2.75	—
Magnesium sulphate, technical.....100 lb.	—	1.10 - 1.75
Methanol, 95%.....gal.	—	.66 - .68
Methanol, 97%.....gal.	—	.70 - .72
Nickel Salt, double.....lb.	—	.12 - .12½
Nickel salt, single.....lb.	—	.14 - .14½
Phosgene (see carbonyl chloride).....	—	—
Phosphorus, red.....lb.	.40 - .41	.42 - .45
Phosphorus, yellow.....lb.	—	.30 - .35
Potassium bichromate.....lb.	.11 - .11½	.11½ - .12

	Carlots	Less Carlots
Potassium bitartrate (cream of tartar)..... lb.	\$.04 - \$.05	\$0.28 - \$0.30
Potassium bromide, granular..... lb.	.15 - .16	.15 - .20
Potassium carbonate, U. S. P..... lb.	.04 - .04	.17 - .20
Potassium carbonate, 80-85%..... lb.	.04 - .04	.05 - .05
Potassium chlorate, crystals..... lb.	.06 - .06	.07 - .12
Potassium cyanide..... lb.	.05 - .06	.40 - .45
Potassium hydroxide (caustic potash)..... lb.	.05 - .06	.06 - .08
Potassium iodide..... lb.	.07 - .07	2.60 - 2.75
Potassium nitrate..... lb.	.07 - .07	.08 - .09
Potassium permanganate..... lb.	.19 - .20	.21 - .22
Potassium prussiate, red..... lb.	.28 - .29	.29 - .30
Potassium prussiate, yellow..... lb.	.21 - .21	.21 - .22
Rochelle salts (see sodium potas tartrate)		
Sal ammoniac (see ammonium chloride)		
Salt soda (see sodium carbonate)		
Salt cake (bulk)..... ton	20.00 - 22.00	
Silver cyanide..... oz.	1.35 - 1.38	
Silver nitrate..... oz.	.46 - .47	
Soda ash light..... 100 lb.	2.00 - 2.10	2.15 - 2.50
Soda ash, dense..... 100 lb.	2.35 - 2.40	2.45 - 2.70
Sodium acetate..... lb.	.04 - .04	.04 - .05
Sodium bicarbonate..... 100 lb.	2.00 - 2.25	2.50 - 2.75
Sodium bichromate..... lb.	.08 - .08	.08 - .08
Sodium bisulphate (nitre cake)..... ton	5.00 - 5.25	5.50 - 6.50
Sodium bisulphate powdered, U.S.P..... lb.	.04 - .05	.05 - .06
Sodium borate (borax)..... lb.	.05 - .06	.06 - .07
Sodium carbonate (salt soda)..... 100 lb.	1.80 - 1.90	2.00 - 2.20
Sodium chlorate..... lb.	.07 - .07	.08 - .08
Sodium cyanide..... lb.	.28 - .28	.29 - .30
Sodium fluoride..... lb.	.11 - .12	.12 - .14
Sodium hydroxide (caustic soda)..... 100 lb.	4.00 - 4.10	4.15 - 4.50
Sodium hyposulphite..... lb.	.06 - .07	.07 - .07
Sodium nitrite..... lb.	.25 - .26	.27 - .30
Sodium peroxide, powdered..... lb.	.04 - .04	.04 - .05
Sodium phosphate, dibasic..... lb.	.14 - .14	.14 - .15
Sodium potassium tartrate (Rochelle salts) lb.	.95 - 1.00	1.10 - 1.25
Sodium silicate, solution (40 deg.)..... 100 lb.	2.30 - 2.40	2.45 - 3.00
Sodium silicate, solution (60 deg.)..... 100 lb.	1.50 - 1.75	2.00 - 2.25
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	.04 - .04	.05 - .05
Sodium sulphide, fused, 60-62 per cent (conc.) lb.	.03 - .03	.04 - .04
Sodium sulphite, crystals..... lb.	.13 - .14	.14 - .20
Sodium sulphite, powdered..... lb.	.05 - .05	.05 - .06
Sulphur chloride, red..... ton	18.00 - 20.00	
Sulphur, crude..... lb.	.08 - .08	.09 - .10
Sulphur dioxide, liquid, cylinders extra..... lb.		2.25 - 3.10
Sulphur (sublimed), flour..... 100 lb.		2.00 - 2.75
Sulphur, roll (brimstone)..... 100 lb.	.09 - .09	.09 - .10
Tin bichloride..... lb.	.16 - .16	.17 - .17
Tin oxide..... lb.	.09 - .09	.09 - .10
Zinc carbonate, precipitate..... lb.	.42 - .44	.45 - .47
Zinc chloride, gran..... lb.	.11 - .11	.11 - .12
Zinc cyanide..... lb.	.07 - .07	.08 - .09
Zinc dust..... lb.	3.00 - 3.25	3.30 - 3.50
Zinc oxide, XX..... lb.		
Zinc sulphate..... 100 lb.		

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude..... lb.	\$1.10 - \$1.15
Alpha-naphthol, refined..... lb.	1.25 - 1.30
Alpha-naphthylamine..... lb.	.27 - .30
Aniline oil, drums extra..... lb.	.18 - .20
Aniline salts..... lb.	.24 - .26
Anthracene, 80% in drums (100 lb.)..... lb.	.75 - 1.00
Benzaldehyde U.S.P..... lb.	1.35 - 1.45
Benzidine, base..... lb.	.90 - 1.00
Benzidine sulphate..... lb.	.75 - .85
Benzoic acid, U.S.P..... lb.	.62 - .65
Benzoate of soda, U.S.P..... lb.	.52 - .55
Benzene, pure, water-white, in drums (100 gal.)..... gal.	.27 - .32
Benzene, 90%, in drums (100 gal.)..... gal.	.25 - .28
Benzyl chloride, 95-97%, refined..... lb.	.25 - .27
Benzyl chloride, tech..... lb.	.20 - .23
Beta-naphthol benzoate..... lb.	3.75 - 4.00
Beta-naphthol, sublimed..... lb.	.70 - .75
Beta-naphthol, tech..... lb.	.30 - .34
Beta-naphthylamine, sublimed..... lb.	1.75 - 1.85
Cresol, U. S. P., in drums (100 lb.)..... lb.	.16 - .17
Ortho-cresol, in drums (100 lb.)..... lb.	.25 - .27
Cresylic acid, 97-99%, straw color, in drums..... gal.	.70 - .80
Cresylic acid, 95-97%, dark, in drums..... gal.	.65 - .70
Cresylic acid, 50%, first quality, drums..... gal.	.45 - .50
Dichlorobenzene..... lb.	.06 - .09
Diethylaniline..... lb.	1.00 - 1.10
Dimethylaniline..... lb.	.45 - .60
Dinitrobenzene..... lb.	.23 - .27
Dinitrochlorobenzene..... lb.	.20 - .25
Dinitronaphthalene..... lb.	.30 - .35
Dinitrophenol..... lb.	.35 - .40
Dinitrotoluene..... lb.	.25 - .30
Dip oil, 25%, ear lots, in drums..... gal.	.30 - .35
Diphenylamine..... lb.	.60 - .70
H-acid..... lb.	1.00 - 1.10
Meta-phenylenediamine..... lb.	1.15 - 1.20
Monochlorobenzene..... lb.	.12 - .14
Monochlorobenzene..... lb.	1.65 - 1.70
Naphthalene crushed, in bbls..... lb.	.06 - .08
Naphthalene, flake..... lb.	.06 - .08
Naphthalene, balls..... lb.	.08 - .09
Naphthionic acid, crude..... lb.	.70 - .75
Nitrobenzene..... lb.	.12 - .15
Nitro-naphthalene..... lb.	.30 - .35
Nitro-toluene..... lb.	.15 - .17
Ortho-amidophenol..... lb.	3.00 - 3.10
Ortho-dichlor-benzene..... lb.	.15 - .20
Ortho-nitro-phenol..... lb.	.75 - .80
Ortho-nitro-toluene..... lb.	.15 - .20
Ortho-toluidine..... lb.	.20 - .25
Para-amidophenol, base..... lb.	1.40 - 1.45
Para-amidophenol, HCl..... lb.	1.70 - 1.80
Para-dichlorobenzene..... lb.	.12 - .15
Paranitroaniline..... lb.	.75 - .80
Para-nitrotoluene..... lb.	.80 - .85
Para-phenylenediamine..... lb.	1.70 - 1.75
Para-toluidine..... lb.	1.25 - 1.40
Phthalic anhydride..... lb.	.40 - .50

Phenol, U. S. P., drums..... lb.	.10 - .12
Pyridine..... gal.	2.00 - 3.50
Resorcinol, technical..... lb.	1.50 - 1.60
Resorcinol, pure..... lb.	2.00 - 2.25
Salicylic acid, tech., in bbls..... lb.	.20 - .21
Salicylic acid, U. S. P..... lb.	.22 - .23
Salol..... lb.	.70 - .72
Solvent naphtha, water-white, in drums, 100 gal..... gal.	.25 - .28
Solvent naphtha, crude, heavy, in drums, 100 gal..... gal.	.14 - .16
Sulphanilic acid, crude..... lb.	.27 - .30
Tolidine..... lb.	1.30 - 1.35
Toluidine, mixed..... lb.	.43 - .45
Toluene, in tank cars..... gal.	.25 - .28
Toluene, in drums..... gal.	.28 - .31
Xylidines, drums, 100 gal..... lb.	.40 - .45
Xylene, pure, in drums..... gal.	.40 - .45
Xylene, pure, in tank cars..... gal.	.45 - .45
Xylene, commercial, in drums, 100 gal..... gal.	.33 - .35
Xylene, commercial, in tank cars..... gal.	.30 - .35

Waxes

Prices based on original packages in large quantities.

Bayberry Wax..... lb.	\$0.20 - \$0.21
Beeswax, refined, dark..... lb.	.24 - .25
Beeswax, refined, light..... lb.	.28 - .30
Beeswax, white pure..... lb.	.34 - .38
Candellila wax..... lb.	.25 - .25
Carnauba, No. 1..... lb.	.45 - .46
Carnauba, No. 2, North Country..... lb.	.23 - .23
Carnauba, No. 3, North Country..... lb.	.14 - .15
Japan..... lb.	.21 - .21
Montan, crude..... lb.	.04 - .04
Paraffine waxes, crude match wax (white) 105-110 m.p..... lb.	.04 - .04
Paraffine waxes, crude, scale 124-126 m.p..... lb.	.04 - .04
Paraffine waxes, refined, 118-120 m.p..... lb.	.04 - .04
Paraffine waxes, refined, 125 m.p..... lb.	.04 - .04
Paraffine waxes, refined, 128-130 m.p..... lb.	.04 - .04
Paraffine waxes, refined, 133-135 m.p..... lb.	.05 - .05
Paraffine waxes, refined, 135-137 m.p..... lb.	.05 - .06
Stearic acid, single pressed..... lb.	.09 - .09
Stearic acid, double pressed..... lb.	.09 - .09
Stearic acid, triple pressed..... lb.	.10 - .10

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl..... 280 lb.	\$5.80 - 5.80
Rosin E-I..... 280 lb.	5.85 - 5.90
Rosin K-N..... 280 lb.	6.40 - 6.85
Rosin W. G.-W. W..... 280 lb.	7.10 - 7.30
Wood rosin, bbl..... 280 lb.	6.25 - .
Spirits of turpentine..... gal.	.82 - .
Wood turpentine, steam dist..... gal.	.80 - .
Wood turpentine, dest. dist..... gal.	.78 - .
Pine tar pitch, bbl..... 200 lb.	. - 6.00
Tar, kiln burned, bbl. (500 lb.)..... bbl.	. - 10.50
Retort tar, bbl..... 500 lb.	. - 10.50
Rosin oil, first run..... gal.	.36 - .
Rosin oil, second run..... gal.	.39 - .
Rosin oil, third run..... gal.	.46 - .
Pine oil, steam dist., sp.gr., 0.930-0.940..... gal.	\$1.90 - .
Pine oil, pure, dest. dist..... gal.	1.50 - .
Pine tar oil, ref., sp.gr. 1.025-1.035..... gal.	.46 - .
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla..... gal.	.35 - .
Pine tar oil, double ref., sp.gr. 0.965-0.990..... gal.	.75 - .
Pine tar, ref., thin, sp.gr., 1.080-1.060..... gal.	.35 - .
Turpentine, crude, sp. gr., 0.900-0.970..... gal.	1.25 - .
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990..... gal.	.35 - .
Pinewood creosote, ref..... gal.	.52 - .

Solvents

73-76 deg., steel bbls. (85 lb.)..... gal.	\$0.37 - .
70-72 deg., steel bbls. (85 lb.)..... gal.	.35 - .
68-70 deg., steel bbls. (85 lb.)..... gal.	.34 - .
V. M. and P. naphtha, steel bbls. (85 lb.)..... gal.	.23 - .

Fertilizers

Ammonium sulphate, bulk and d. bags..... 100 lb.	\$2.60 - 2.90
Blood, dried, f.o.b., N. Y..... unit	4.00 - .
Bone, 3 and 50, ground, raw..... ton	30.00 - 32.00
Cyanamide, f.o.b. works..... unit	4.50 - .
Fish scrap, dom., dried, f.o.b. works..... unit	2.90 - 3.00
Nitrate soda..... 100 lb.	2.40 - 2.45
Tankage, high grade, f.o.b. Chicago..... unit	3.00 - 3.10
Phosphate rock, f.o.b. mines, Florida pebble, 68-72 p.c..... ton	4.50 - 6.50
Tennessee, 78-80 p.c..... ton	8.50 - 9.00
Potassium muriate, 80 p.c..... ton	37.00 - 40.00
Potassium sulphate..... unit	1.00 - 1.10

Crude Rubber

Para—Upriver fine..... lb.	\$0.23 - .23
Upriver coarse..... lb.	.13 - .14
Upriver caucho ball..... lb.	.13 - .14
Plantation—First latex crepe..... lb.	.18 - .18
Ribbed smoked sheets..... lb.	.18 - .18
Brown crepe, thin, clean..... lb.	.18 - .
Amber crepe No. 1..... lb.	.19 - .

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls..... lb.	\$0.10 - \$0.10
Castor oil, AA, in bbls..... lb.	.11 - .12
China wood oil, in bbls. (f.o.b. Pac. coast)..... lb.	.13 - .13
Cocoonut oil, Ceylon grade, in bbls..... lb.	.09 - .09
Cocoonut oil, Cochon grade, in bbls..... lb.	.10 - .10
Corn oil, crude, in bbls..... lb.	.09 - .09
Cottonseed oil, crude (f. o. b. mill)..... lb.	.06 - .07
Cottonseed oil, summer yellow..... lb.	.08 - .08
Cottonseed oil, winter yellow..... lb.	.09 - .09

Linseed oil, raw, car lots (domestic)	gal.	.67	—	.68
Linseed oil, raw, tank cars (domestic)	gal.	.62	—	.63
Linseed oil, in 5-bbl lots (domestic)	gal.	.70	—	.71
Olive oil, Denatured	gal.	\$1.15	—	\$1.20
Palm, Lagos	lb.	.07 ³ / ₄	—	.08
Palm, Niger	lb.	.06 ³ / ₄	—	.06 ¹ / ₂
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.08	—	.08 ¹ / ₂
Peanut oil, refined, in bbls.	lb.	.11 ¹ / ₂	—	.11 ³ / ₄
Rapeseed oil, refined in bbls.	gal.	.84	—	.86
Rapeseed oil, blown, in bbls.	gal.	.92	—	.94
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.08 ³ / ₄	—	....
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.07 ¹ / ₂	—	....

FISH

Light pressed menhaden	gal.	\$0.40	—	....
Yellow bleached menhaden	gal.	.42	—	....
White bleached menhaden	gal.	.45	—	....
Blown menhaden	gal.	.48	—	....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	\$23.50	—	28.00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	20.00	—	24.00
Barytes, crude, 88% @ 94% ba., Kings Creek	net ton	10.00	—	12.00
Barytes, floated, f.o.b. St. Louis	net ton	23.00	—	24.00
Barytes, crude, first grade, Missouri	net ton	7.00	—	....
Blanc fixe, dry	lb.	.04	—	.04 ¹ / ₂
Blanc fixe, pulp	net ton	45.00	—	55.00
Casein	lb.	.07	—	.10
Chalk, Precipitated, domestic, extra light	lb.	.04 ¹ / ₂	—	.05
Chalk, Precipitated, domestic, light	lb.	.04	—	.04 ¹ / ₂
Chalk, Precipitated, domestic, heavy	lb.	.03 ³ / ₄	—	.04
Chalk, Precipitated, English, extra light	lb.	.04 ¹ / ₂	—	.05
Chalk, Precipitated, English, light	lb.	.04 ¹ / ₂	—	.05
Chalk, Precipitated, English, dense	lb.	.04	—	.04 ¹ / ₂
China clay (kaolin) crude, f.o.b. mines, Georgia	net ton	6.50	—	8.50
China clay (kaolin) washed, f.o.b. Georgia	net ton	9.00	—	10.00
China clay (kaolin) powdered, f.o.b. Georgia	net ton	13.00	—	20.00
China clay (kaolin) crude f.o.b. Virginia points	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points	net ton	13.00	—	20.00
China clay (kaolin), imported, lump	net ton	12.00	—	20.00
China clay (kaolin), imported, powdered	net ton	25.00	—	30.00
Feldspar, crude, f.o.b. Maryland and North Carolina points	net ton	5.00	—	7.50
Feldspar, crude, f.o.b. Maine	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore	net ton	27.00	—	30.00
Fullers earth, f.o.b. Mines	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Pa.	net ton	15.00	—	18.00
Fullers earth, powdered, f.o.b. Fla.	net ton	18.00	—	....
Fullers earth, imported, powdered	net ton	24.00	—	27.00
Graphite, Ceylon lump, first quality	lb.	.06	—	.07
Graphite, Ceylon chip	lb.	.04 ¹ / ₂	—	.05
Graphite, high grade amorphous crude	lb.	.00 ³ / ₄	—	.02 ¹ / ₂
Kieselguhr, f.o.b. mines, Cal.	per ton	40.00	—	....
Kieselguhr, f.o.b. N.Y.	per ton	55.00	—	60.00
Magnesium, calcined	per ton	60.00	—	65.00
Pumice stone, imported	lb.	.03	—	.40
Pumice stone, domestic, lump	lb.	.05	—	.05 ¹ / ₂
Pumice stone, domestic, ground	lb.	.06	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore	net ton	....	—	10.00
Quartz (acid tower) 1 ¹ / ₂ @ 2 in., f.o.b. Baltimore	net ton	....	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore	net ton	....	—	17.00
Quartz, lump, f.o.b. North Carolina	net ton	5.00	—	7.50
Shellac, orange fine	lb.	.68	—	.70
Shellac, orange superfine	lb.	.78	—	.80
Shellac, A. C. garnet	lb.	.58	—	.60
Shellac, T. N.	lb.	.68	—	.70
Soapstone	ton	12.00	—	15.00
Sodium chloride	long ton	12.50	—	13.00
Talc, paper-making grades, f.o.b. Vermont	ton	11.00	—	18.00
Talc, roofing grades, f.o.b. Vermont	ton	8.50	—	13.00
Talc, rubber grades, f.o.b. Vermont	ton	11.00	—	18.00
Talc, powdered, Southern, f.o.b. cars	ton	7.50	—	11.00
Talc, imported	ton	30.00	—	40.00
Talc, California talcum powder grade	ton	18.00	—	25.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh	per ton	\$50.00		
Carborundum refractory brick, 9-in. { less than earlot	1,000	1250.00		
Carborundum refractory brick, 9-in. { earload lots	1,000	1100.00		
Chrome brick, f.o.b. Eastern shipping points	net ton	52-55		
Chrome cement, 40-45% Cr ₂ O ₃	net ton	30-32		
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in ear lots, f.o.b. Eastern shipping points	net ton	33-35		
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	35-40		
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	30-35		
Magnesite brick, 9-in. straight	net ton	65-70		
Magnesite brick, 9-in. arches, wedges and keys	net ton	77		
Magnesite brick, soaps and splits	net ton	98		
Silica brick, 9-in. sizes, f.o.b. Chicago district	1,000	40-42		
Silica brick, 9-in. sizes, f.o.b. Birmingham district	1,000	42-45		
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.	1,000	35-38		

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	\$200.00	—	225.00
Ferrochrome per lb. of Cr. contained, 6-8% carbon, earlots	lb.	.11	—	....
Ferrochrome per lb. of Cr. contained, 4-6% carbon, earlots	lb.	.11	—	.12
Ferromanganese, 76-80% Mn, domestic	gross ton	58.00	—	60.00
Ferromanganese, 76-80% Mn, English & German	gross ton	58.00	—	59.00
Spiegelisen, 18-22% Mn	gross ton	25.00	—	27.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo	lb.	2.25	—	....
Ferrosilicon, 10-15%	gross ton	38.00	—	40.00
Ferrosilicon, 50%	gross ton	57.00	—	59.00
Ferrosilicon, 75%	gross ton	120.00	—	125.00
Ferrotungsten, 70-80%, per lb. of contained W	lb.	.40	—	.45
Ferrouvanium, 35-50% of U, per lb. of U content	lb.	6.00	—	....
Ferrouvanadium, 30-40% per lb. of contained V	lb.	4.25	—	4.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content	net ton	\$8.00	—	\$10.00
Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃	ton	22.00	—	23.00
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard	ton	22.00	—	23.00
Coke, foundry, f.o.b. ovens	net ton	4.25	—	4.50
Coke, furnace, f.o.b. ovens	net ton	3.25	—	3.50
Fluorspar, gravel, f.o.b. mines, New Mexico	net ton	15.00	—	....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	20.00	—	22.00
Ilmenite, 52% TiO ₂ , per lb. ore	lb.	.01 ¹ / ₂	—	.01 ¹ / ₂
Manganese ore, 50% Mn, c.i.f. Atlantic seaport	unit	.23	—	.24
Manganese ore, chemical (MnO ₂)	net ton	55.00	—	60.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.	lb.	.45	—	.50
Monazite, per unit of ThO ₂ , c.i.f., Atlantic seaport	unit	30.00	—	....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.12	—	.12
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport	unit	.13	—	.13
Pyrites, domestic, fines, f.o.b. mines, Ga.	unit	.11	—	.12
Rutile, 95% TiO ₂ per lb. ore	lb.	.15	—	....
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal)	unit	2.50	—	2.75
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.	unit	2.75	—	3.00
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	1.25	—	1.75
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.25	—	2.50
Vanadium pentoxide, 99%	lb.	12.00	—	14.00
Vanadium ore, per lb. of V ₂ O ₅ contained	lb.	1.00	—	....
Zircon, washed, iron free, f.o.b. Pablo, Florida	lb.	.04 ¹ / ₂	—	.13

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	13.25
Aluminum, 98 to 99 per cent	24.50 @ 25.00
Antimony, wholesale lots, Chinese and Japanese	4.80 @ 5.25
Nickel, ordinary (ingot)	41.00
Nickel, electrolytic	44.00
Monel metal, shot and blocks	35.00
Monel metal, ingots	38.00
Monel metal, sheet bars	40.00
Tin, 5-ton lots, Straits	28.875
Lead, New York, spot	4.65 @ 4.70
Lead, E. St. Louis, spot	4.35
Zinc, spot, New York	5.15
Zinc, spot, E. St. Louis	4.70

OTHER METALS

Silver (commercial)	oz.	\$0.67 ¹ / ₂
Cadmium	lb.	1.00-1.25
Bismuth (500 lb. lots)	lb.	1.50 @ 1.55
Cobalt	lb.	3.00 @ 3.25
Magnesium (f.o.b. Philadelphia)	lb.	1.25
Platinum	oz.	85.00
Iridium	oz.	150.00 @ 170.00
Palladium	oz.	55.00-60.00
Mercury	75 lb.	40.00-41.00

FINISHED METAL PRODUCTS

	Warehouse Price—Cents per Lb.
Copper sheets, hot rolled	20.50
Copper bottoms	28.00
Copper rods	19.00 @ 19.75
High brass wire	16.75
High brass rods	14.25
Low brass wire	18.25
Low brass rods	18.75
Brazed brass tubing	25.00
Brazed bronze tubing	29.75
Seamless copper tubing	19.50
Seamless high brass tubing	18.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current	Cleveland	Chicago
Copper, heavy and crucible	9.75 @ 10.25	9.25	9.50
Copper, heavy and wire	9.25 @ 9.50	8.50	8.50
Copper, light and bottoms	7.50 @ 8.00	7.50	7.25
Lead, heavy	3.50 @ 3.75	3.25	3.25
Lead, tea	2.25 @ 2.35	2.25	2.25
Brass, heavy	4.25 @ 4.50	4.50	5.00
Brass, light	3.25 @ 3.50	3.25	3.50
No. 1 yellow brass turnings	4.00 @ 4.25	4.25	4.50
Zinc	2.00 @ 2.25	2.00	2.25

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by 1/2 in. and larger, and plates 1/2 in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes	\$2.88	\$2.88	\$2.88
Soft steel bars	2.78	2.78	2.78
Soft steel bar shapes	2.78	2.78	2.78
Soft steel bands	3.42	3.48	3.48
Plates, 1/2 to 1 in. thick	2.88	2.88	2.88

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

California

OAKLAND—The American Petroleum Co., 343 Sansom St., San Francisco, has awarded a contract to Hannah Bros., 142 Sansom St., for the erection of a 2-story plant on the waterfront at Oakland, estimated to cost close to \$25,000. Carl Werner, Humboldt Bank Bldg., San Francisco, is architect.

LOS ANGELES—Fire, Nov. 4, destroyed a portion of the plant of the Elaterite Co., manufacturer of rubber composition products, entailing a loss which is estimated at about \$85,000.

OAKLAND—The National Lead Co., 485 California St., San Francisco, Cal., has awarded a contract to the Cahill-Vensano Co., 110 Suter St., for the erection of a 3-story plant at East 10th St. and 41st Ave., Oakland, to cost \$49,000.

Connecticut

PLAINVILLE—The Plainville Castings Co. has awarded a contract to the Torrington Building Co., Torrington, Conn., for the erection of a 1-story brick addition, 62 x 160 ft.

BRIDGEPORT—The Crane Co., manufacturer of steam specialties, metal products, etc., is taking bids and will soon award contract for the erection of a 1-story addition to its local plant on South Ave. It will be 75 ft. x 175 ft., and will be used for the most part as an annealing works. The installation will comprise 10 new annealing furnaces, oil-fired, with auxiliary operating equipment.

Florida

FERNANDINA—The Florida Terminal Co. is perfecting plans for the erection of a new analytical chemical laboratory for phosphate and other analysis. It will be equipped with crushing machinery, pulverizing machinery, and general operating apparatus. Ernest Molnar is chemist for the company; R. M. Martin is plan superintendent.

Illinois

ELGIN—The Woodruff & Edwards Co., manufacturer of metal castings, etc., has awarded a contract to the Illinois Hydraulic Stone & Construction Co., 24 South 21st St., for the erection of a new 1-story foundry addition, 50 x 100 ft., to cost about \$15,000.

CHICAGO—The Diamond Red Paint Co., 2750 North Lincoln St., is taking bids for the erection of a 1-story side addition at its plant, 30 x 80 ft. Frederick C. Teich, 305 South La Salle St., is architect.

Louisiana

GRETNA—The United States Flour Milling Co., Kansas City, Mo., is planning for the construction of a new branch plant at Gretna. Work will be commenced at an early date.

Maryland

BALTIMORE—The American Oil Co., American Bldg., is considering the construction of a new 1- and 2-story building on Haines St., 130 x 300 ft., estimated to cost in excess of \$250,000.

BALTIMORE—The Chesapeake Paper Board Co., Key Highway, is perfecting details for enlargements in its plant to increase the output from 50,000 to 100,000 lb. of paper board products per day. Considerable new machinery will be installed, estimated to cost close to \$50,000. A new power house will be constructed. J. S. Smith is president.

BALTIMORE—Richard K. Meade & Co., 11 East Fayette St., engineers, have plans well under way for the proposed lime plant to be erected at the paper and pulp mills of the Bathrust Co., Ltd., Bathrust, New Brunswick, N. S. The plant will include two large kilns, provided with automatic stokers and operating under induced draft. A platform elevator for limestone handling will be installed.

Massachusetts

BOSTON—The Revere Sugar Refinery, 327-53 Medford St., has filed plans for the erection of a 1-story melter plant addition at its works.

BOSTON—The Eastern Salt Co., care of Shepard & Stearns, 65 Franklin St., architects, has awarded a contract to the Scully Co., 118 First St., Cambridge, Mass., for the erection of a new 1-story building.

ARLINGTON—The Frost Insecticide Co., 20 Mill St., has awarded a contract to the Holt-Fairchild Co., 248 Boylston St., Boston, for the erection of a 1-story building at its plant, 45 x 100 ft., to cost about \$40,000. Work will be placed under way at once.

Michigan

MOUNT PLEASANT—The National Portland Cement Co., 516 Book Bldg., Detroit, will defer the erection of its proposed new 2-story cement mill on Coldwater Lake, near Mount Pleasant, until early in the coming year. Preliminary plans are being drawn. The plant is estimated to cost close to \$500,000, including machinery. H. C. Shields is manager.

PORT HURON—The Port Huron Sulphite & Paper Co. will commence the immediate construction of additions to its paper mill to cost in the neighborhood of \$750,000 with machinery.

ST. JOSEPH—The Industrial Rubber Co. is said to be planning for the rebuilding of the portion of its plant, recently destroyed by fire with loss estimated at \$65,000.

OTSEGO—The Mac Sim Bar Paper Co. will call for bids before the close of the month for the construction of its proposed new 1-story power plant for paper mill service, 85 x 140 ft., estimated to cost about \$300,000 with machinery. Billingham & Cobb, Press Bldg., Kalamazoo, Mich., are architects. A. B. Thomas is president and general manager.

CHEBOYGAN—The Cheboygan Tile & Roofing Co. has commenced production at its new local plant and plans for extensive operations. The plant will be devoted to the manufacture of brick and tile products, and it is proposed to develop an output of about 30,000 bricks and tiles per day. The company has secured large clay properties in this section.

Minnesota

MANKATO—The Carney Cement Co. will defer further work on the construction of additions to its local mills, foundations for which recently have been laid. A total of eight buildings will be erected, and plans for the superstructures have been drawn. It is expected to proceed with the expansion as soon as conditions in the industry warrant. Richard K. Meade & Co., 11 East Fayette St., Baltimore, Md., are engineers.

Montana

MILES CITY—The Miles City Refining Co. has preliminary plans under way for the construction of a new oil refinery to cost about \$40,000. R. H. Daniels is secretary.

New Jersey

LINDEN—The Warner-Quinlan Co., 79 Wall St., New York, has commissioned George Gifford, engineer, 227 Fulton St., New York, to prepare plans for the rebuilding of its asphalt refining plant at Linden, recently destroyed by fire with loss estimated at close to \$2,000,000, including tanks, stills, manufacturing and mechanical buildings, power plant, etc. W. W. McFarland is general manager.

New York

NEW YORK—Goldberger Bros., 842 Third Ave., manufacturers of plate glass, have leased the 5-story building at 27th St. and First Ave., on site 74 x 95 ft., comprising about 30,000 sq. ft. of floor area, for a new works.

OGDENSBURG—The Bob White Chemical Co., 39 Broadway, New York, has completed plans for extensions and improvements in its plant at Ogdensburg, 1-story and basement, 80 x 145 ft., to cost about

\$25,000. The work will include laboratory enlargement. W. T. Smith is vice-president.

Ohio

WOOSTER—The Wooster Rubber Co. has preliminary plans under way for the erection of a 2-story plant, 40 x 85 ft.

Oklahoma

OKMULGEE—The Interstate Glass Co. is considering the erection of a new plant to cost about \$100,000, including machinery. H. J. Walter is president.

Pennsylvania

SCRANTON—The Diamond Oil & Paint Co., 211-19 South Seventh Ave., has awarded a contract to the R. D. Richardson Construction Co., Connell Bldg., for the erection of its proposed 2-story building on Seventh Ave., estimated to cost close to \$60,000. Edward J. Lynott is president.

ERIE—The Keystone Rubber Mfg. Co., 1413 East 11th St., has commenced the rebuilding of its plant destroyed by fire several months ago. It will be 3-story, 65 x 125 ft., located at 11th and French Sts. A. W. Tuttle, 618 East Seventeenth Ave., is the building contractor. Joseph B. Mooney is president.

SHARON—The Carnegie Steel Co., Pittsburgh, has commenced the dismantling of its local plant, comprising 6 basic open-hearth furnaces, heating furnaces, blooming and finishing mills. The blast furnace at the site will be left intact. The plant has been closed since May 1st of last year and under normal operations gave employment to about 700 men. The equipment will be used by the company at its other works.

Rhode Island

PROVIDENCE—The Charles S. Tanner Co., 250 South Water St., manufacturer of starch, etc., will break ground at once for the erection of its new 2-story plant, 50 x 76 ft., at South Water and Coin Sts.

Tennessee

CHATTANOOGA—The Southern Cotton & Paper Co. has plans under way for the erection of a 1-story plant, 50 x 160 ft., on site recently acquired, totalling about 2 acres of land. The mill will be equipped to specialize in the manufacture of bond and other papers from cotton linters, with initial daily output of about 15 tons. Mercer Reynolds heads the company.

Texas

ROCKDALE—G. C. Holmes & Co., Houston, have presented a proposition to the local Chamber of Commerce for the erection of an oil-refining plant, the cost to be equally divided between the two interests.

Washington

SPOKANE—The Consolidated Diamond Oil & Refining Co., with temporary offices in the Spokane Hotel, is arranging for the early construction of a new refinery on property acquired at Dishman, near Spokane.

SEATTLE—The Washington Cord Tire Co. has acquired a site totalling about 10 acres of land at Vancouver, Wash., for the erection of a new plant for the manufacture of automobile tires and other rubber products. F. C. Plouf is president.

West Virginia

RICHWOOD—The Cherry River Paper Co. has broken ground for the erection of a 1-story and basement power plant for general paper mill service, 40 x 150 ft., estimated to cost in excess of \$250,000. George Snyder is assistant superintendent.

Wisconsin

MILWAUKEE—The American Hide & Leather Co., 14th St., is having plans prepared by Lockwood, Greene & Co., 38 South Dearborn St., Chicago, Ill., engineers, for the rebuilding of its local tannery on Commerce St., recently destroyed by fire with loss in excess of \$200,000.

Weightman & Steigley, 3420 Parker Ave., Chicago, are preparing plans for a group of buildings for a canning factory in northern Wisconsin to cost a total of \$250,000. The buildings include a 2-story building, 96 x 48; a 1-story building 36 x 38; a 1-story building 60 x 60, one boiler house 32 x 32 to contain high pressure boiler for process steam for cooking purposes. Other buildings will include a two-section warehouse, each section 96 x 48, two stories in height, and one reinforced-concrete antiseptic tank. The architects are receiving bids for these structures, as well as the apparatus to be used in the process.

New Companies

THE PRODUCERS PAPER Co., 208 South La Salle St., Chicago, Ill., has been incorporated with a capital of \$32,000, to manufacture paper products. The incorporators are Robert J. Magill, R. W. and Herbert S. Nock.

THE GENERAL GALVANIZING CORP., New York, N. Y., has been incorporated with a capital of \$50,000, to manufacture galvanized metal products. The incorporators are A. Ross, C. and L. Pervitali. The company is represented by Henry Gerson, 30 East 42d St.

THE KEAN LEATHER Co., Woburn, Mass., has been incorporated with a capital of \$50,000, to manufacture leather products. Carl R. Bedell is president; and Frederick C. Kean, 40 Arlington Rd., Woburn, treasurer.

THE CALIFORNIA-CAROLINA OIL Co., Los Angeles, Cal., has been incorporated with a capital of \$500,000, to manufacture petroleum products. The incorporators are J. L. Bird, W. A. Love, and Carlisle Williams. The company is represented by W. and L. M. Chapman, 1015 Citizens' National Bank Bldg., Los Angeles.

THE HABERLAND MFG. Co., Jersey City, N. J., has been incorporated with a capital of \$1,200,000, to manufacture chemicals and chemical byproducts. The incorporators are Paul Haberland, William H. Fain and Paul C. Whipp. The company is represented by the United States Corporation Co., 15 Exchange Pl., Jersey City.

THE TUCKER WATERPROOFING & INSULATING Co., Brockton, Mass., has been incorporated with a capital of \$95,000, to manufacture insulation specialties, waterproofing products, etc. William R. Tucker is president; and George Tucker, Brockton, treasurer.

THE ILLMO OIL Co., Murphy Bldg., East St. Louis, Ill., has been incorporated with a capital of \$25,000, to manufacture oil products. The incorporators are Edward C. and William F. Friedewald, and Thomas B. Edwards.

THE STAR DUST PRODUCTS CORP., New York, N. Y., has been incorporated with a capital of \$100,000, to manufacture composition mineral products. The incorporators are J. Andrews, Jr., D. Worth and E. Freeman. The company is represented by Pease & Mason, 120 Broadway, New York.

THE CHEMICAL OIL REFINING Co., Wilmington, Del., has been incorporated under state laws with capital of \$300,000, to manufacture refined oil products. The company is represented by the Colonial Charter Co., Ford Bldg., Wilmington.

THE AMERICAN PRODUCTS Co., Jacksonville, Fla., has been incorporated with a capital of \$1,000,000, to manufacture chemicals and chemical byproducts. B. F. Williamson is president, and J. T. McCarthy, vice-president, both of Gainesville, Fla.

THE NOTTINGHAM RUBBER Co., Trenton, N. J., has been incorporated with a capital of \$500,000, to manufacture rubber products. The incorporators are Samuel H. Bell, I. Alexander and C. Francis Fisk, 150 East State St., Trenton.

THE NORTHERN PENNSYLVANIA CHEMICAL Co., Coudersport, Pa., has been incorporated under Delaware laws with capital of \$100,000, to manufacture chemicals and chemical byproducts. The incorporators are E. P. Huntingdon and J. T. Mansfield, Coudersport; and Frederick Walker, Knoxville, Pa. The company is represented by the Capital Trust Co., Dover, Del.

THE HATHAWAY OIL Co., New Bedford, Mass., has been incorporated with a capital of \$30,000, to manufacture oil products. John M. Hathaway is president, and R. Eugene Ashley, New Bedford, treasurer.

THE TRUAMAN FERTILIZER Co., Jacksonville, Fla., has been incorporated with a capital of \$200,000, to manufacture fertilizer products. R. B. Trueman is president; J. J. McGrath, vice-president; and G. R. Needham, secretary-treasurer, all of Jacksonville.

THE BRAENDER RUBBER & TIRE Co., Wilmington, Del., has been incorporated under state laws with capital of \$1,100,000, to manufacture automobile tires and other rubber products. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington.

THE SUSH LEATHER Co., New York, N. Y., has been incorporated with a capital of \$16,000, to manufacture leather products. The incorporators are S. S. Sush, I. Levin and J. E. Rivlin. The company is represented by Harry Levin, 132 Nassau St., New York.

THE DAVIS CHEMICAL Co., 12 West Park St., Providence, R. I., has filed notice of

organization to manufacture chemical products. George D. Mitchell heads the company.

THE AMERICAN MICA MINING Co., Newport News, Va., has been incorporated with a capital of \$250,000, to operate mica properties and manufacture mica products. Allan D. Jones, Newport News, is president; and H. C. Field, Axton, Va., secretary.

THE BLACK SEAL LUBRICANT Co., INC., 1305 Maryland Ave., Baltimore, Md., has been incorporated with a capital of \$100,000, to manufacture oils, greases and other lubricants. The incorporators are James G. Paugh, Frank H. Kelley and Peter Peck.

THE KALCO PRODUCTS Co., INC., New Haven, Conn., has been incorporated with a capital of \$10,000, to manufacture alkalis, chemicals and affiliated products. The incorporators are David Kaltman, Henry Zatulove and S. A. Skiff, 19 Congress Ave., New Haven.

THE ROSS LABORATORIES, INC., Philadelphia, Pa., has been incorporated with a capital of \$100,000, to manufacture chemicals, dyestuffs, colors and affiliated products. The company is represented by the Corporation Guarantee & Trust Co., Land Title Bldg., Philadelphia.

New Publications

"HANDLING LIQUID CHLORINE" is the title of a four-page leaflet containing D. K. Bartlett's paper read before the National Safety Council Congress at Boston, Sept. 28, 1921.

NEW BUREAU OF STANDARDS PUBLICATIONS: Circular 8, Testing of Thermometers; Circular 114, Standard Specifications for Cotton Rubber-Lined Fire Hose; Sci. Paper 410, Thermal Expansion of Copper and Some of Its Important Industrial Alloys, by Peter Hidnert; Sci. Paper No. 413, A Portable Vacuum Thermopile, by W. W. Coblentz; Sci. Paper 414, Interference Measurements in the Spectra of Argon, Krypton and Xenon, by W. F. Meggers; Sci. Paper 416, Preparation of Galactose, by E. P. Clark; Tech. Paper 190, "Black Nickel" Plating Solutions, by George B. Hogaboom, T. F. Slattery and L. B. Ham; Tech. Paper 191, Some Factors Affecting the Life of Machine-Gun Barrels, by W. W. Sveshnikoff; Tech. Paper 192, Tests of Centrifugally Cast Steel, by George K. Burgess; Tech. Paper 195, Zinc Cyanide Plating Solutions, by William Blum, F. J. Liscomb and C. M. Carson.

NEW BUREAU OF MINES PUBLICATIONS: Bull. 186, Investigations of Zirconium, With Especial Reference to the Metal and Oxide. Historical Review and Bibliography, by J. W. Marden and M. N. Rich; Bull. 206, Petroleum Laws of All America, by J. W. Thompson; Tech. Paper 261, Oil-Camp Sanitation, by C. P. Bowie.

THE COLORADO SCIENTIFIC SOCIETY, Denver, Col., has issued booklets on "Aspects of Colorado's Oil Shale Industry," by Arthur J. Hoskins, and "The Manufacture of Lubricating Products From Wyoming and Colorado Crude Oils," by L. C. Welch.

THE MILWAUKEE ASSOCIATION OF COMMERCE has just issued vol. 1 under date of August, 1921, of *Milwaukee*, a magazine for business leaders. C. B. Traver is editor and K. H. MacArthur business manager. Editorial contents are devoted to the forwarding of local industries.

BAYLEY MFG. Co., of Milwaukee, Wis., has issued a new folder on the Bayley Thermo-unit for heating and ventilating. This device is a new one and peculiarly adaptable for heating dye houses and small industrial buildings of all kinds. It is a complete indirect heating system with a heating surface consisting of individual spiral radiators, so valved that one or more coils may be cut out as temperature variations demand. The fan takes the air from the floor line, forces it through the heating coils into the room at about 6 ft. above the floor and returns it to the coils as it cools, thus forming a continuous cycle as long as heating is required. If desired, all or part of the air can be taken from the outside, thus combining ventilation with indirect heating.

THE UNIVERSITY OF MONTANA has issued a bulletin on "Geology and Oil and Gas Prospects of Central and Eastern Montana," by C. H. Clapp, Arthur Bevan and G. S. Lambert.

THE STATE OF LOUISIANA, DEPARTMENT OF CONSERVATION, has issued Bull. 9, on "The Monroe Gas Field," by H. W. Bell and R. A. Cattell, petroleum engineers of the U. S. Bureau of Mines.

"THE USE OF POWDERED FUEL UNDER STEAM BOILERS" is the title of a pamphlet recently published by the Combustion Engineering Corp., N. Y.

Capital Increases, Etc.

THE MERLIN KEILHOLZ PAPER Co., 296 Broadway, New York, N. Y., has filed notice of increase in capital from \$150,000 to \$250,000.

THE MUTUAL OIL Co., Adrian, Mich., has filed notice of increase in capital from \$45,000 to \$100,000.

THE IROQUOIS FOUNDRIES, INC., Utica, N. Y., has filed notice of dissolution under state laws.

THE DOVAN CHEMICAL Co., a Delaware corporation, has filed notice of intention to operate in New Jersey for the manufacture of chemical products. Kenneth A. Christian, 441 Riverside Ave., Newark, N. J., represents the company.

THE MAYWALD RUBBER Co., Nutley, N. J., manufacturer of rubber products, has arranged for the sale of a preferred stock issue, the entire distribution to total \$250,000. The proceeds will be used for expansion. Frederick J. Maywald is president, and George C. Plummer, vice-president and treasurer.

THE OLYMPIC CHEMICAL Co., 954 Leggett Ave., New York, N. Y., has filed notice of increase in capital to \$20,000.

THE BRADSTREET OIL Co., Tulsa, Okla., has filed notice of increase in capital from \$200,000 to \$1,000,000.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its seventy-fourth meeting at Toronto, Canada, Dec. 27 to 31, 1921.

AMERICAN CERAMIC SOCIETY will hold its twenty-fourth annual meeting at St. Louis, Feb. 27 to March 2, 1922.

AMERICAN ENGINEERING COUNCIL will hold its next meeting in Washington, Jan. 5-6.

AMERICAN FOUNDRYMEN'S ASSOCIATION will hold its next convention and exhibit at Cleveland, O., during the week of April 24, 1921. Meetings will be held in the spring instead of in the fall as heretofore.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its annual winter meeting at Baltimore, Md., Dec. 6 to 9. Headquarters will be at the Emerson Hotel.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its spring meeting in New York the week of Feb. 20, 1921.

AMERICAN PETROLEUM INSTITUTE will hold its second annual meeting at the Congress Hotel, Chicago, Dec. 6, 7 and 8.

COLLEGE OF THE CITY OF NEW YORK, department of chemistry, will give public lectures under the auspices of the City College Chemical Society in the Doremus Lecture Theater, at 4:30 p.m., as follows: Nov. 30, "Afterthoughts of the War," by Leland L. Summers, of the War Industries Board; Dec. 6, "America in Chemistry," by Dr. Edgar F. Smith, provost emeritus, University of Pennsylvania, and president, American Chemical Society.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stettens Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

The following meetings are scheduled to be held in Rumford Hall, the Chemists' Club, New York: Dec. 2—Society of Chemical Industry, regular meeting; Dec. 9—American Chemical Society, regular meeting; Jan. 6—American Chemical Society, regular meeting; Jan. 13—Society of Chemical Industry, Perkin Medal; Feb. 10—American Electrochemical Society (in charge), Society of Chemical Industry, Société de Chimie Industrielle, American Chemical Society, joint meeting; March 10—American Chemical Society, Nichols Medal; March 24—Society of Chemical Industry, regular meeting; April 21—Society of Chemical Industry (in charge), American Electrochemical Society, Société de Chimie Industrielle, American Chemical Society, joint meeting; May 5—American Chemical Society, regular meeting; May 12—Société de Chimie Industrielle (in charge), American Chemical Society, Society of Chemical Industry, American Electrochemical Society, joint meeting; May 19—Society of Chemical Industry, regular meeting; June 9—American Chemical Society, regular meeting.

CHEMICAL & METALLURGICAL ENGINEERING

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A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY and IRON & STEEL MAGAZINE

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Industrial Editor
J. S. NEGRU
Managing Editor

Volume 25

New York, November 30, 1921

Number 22

Can Mild Steel Have

750,000 Lb. Ultimate Strength?

SOMETIMES theoretical reasoning leads to results of peculiarly "practical" significance. As an instance, in a recent number of the *Philosophical Transactions* of the Royal Society of London, A. A. GRIFFITH presented a study of "The Phenomena of Rupture and Flow in Solids," giving especial attention to the influence of cracks. Mathematical studies of the problem of elasticity are complex enough, one would think, without complicating the matter by analyzing the stresses in a cracked plate, and the results expressed in double integrations and partial differentiations are absolutely unintelligible to almost all engineers. Fortunately, however, Mr. GRIFFITH, who is an engineer himself, interpreted his algebraic results into understandable words, and then commented upon their application to phenomena observed every day, but about which we really know very little.

His mathematics indicated that fatigue strength should be nearly independent of the depth of surface scratches. That is to say, a sharp bottomed scratch 0.0001 in. deep left by finest emery cloth should weaken a specimen about as much as a visible scratch of the same shape, a conclusion evidently at variance with carefully executed tests. Considering this discrepancy from many viewpoints, the author holds fast to the theoretical deduction that rupture in an isotropic elastic material always occurs at a certain maximum tension. In the limit, the maximum strength would be given by a single string of molecules, and should be from 1,000,000 to 1,500,000 lb. per square inch for hard glass. As a matter of fact such glass has an ultimate strength of 24,900 lb. per square inch when tested in small rods.

Here is a variation between theory and practice which would doubtless excuse the conservative and unimaginative from remarking, "That's about as close to the ground as those theoretical chaps ever get!" But it only urged GRIFFITH and his friends to redouble their efforts to bring the two into agreement. In fact, it was not long before he was able to prepare thinner and thinner filaments of this same glass bearing greater and greater and greater loads, until finally the perfectly amazing strength of 491,000 lb. per square inch was attained in a hair 0.0012 in. in diameter! Extrapolating to molecular dimensions, the maximum strength was estimated to be 1,600,000 lb. per square inch, a result which agrees with their theoretical deduction fairly well, considering the fact that one estimate was extrapolated and the other computed by the aid of approximate figures for surface tension of solid glass at room temperature.

A plausible reason for the comparative weakness of ordinary test specimens is that the usual tests impose stresses which are far from uniform, and that the non-uniformity of stress is similar to that set up

were a supposedly homogeneous material full of minute flaws. Mathematical analysis again shows that these flaws should be relatively large as compared to molecules, having a width of the order of ten thousand times the molecular distances.

The nature of these "flaws" is somewhat speculative, since this size is large enough to be seen under a good microscope. At any rate, the author remarks that "the effective strength of technical materials might be increased ten to twenty times at least if these flaws could be eliminated." Perhaps Mr. GRIFFITH would regard the strengthening of metal by cold work—most commonly observed in high strength wires—as a suppression of flaws in metals; a conclusion somewhat at variance with accepted ideas as to the nature of cold work. Even so, his experimental results on glass filaments show that his theoretical deductions are within reason and his suggestions worthy of careful consideration. Soft iron having a strength of 750,000 lb. per square inch is a goal for the ambitious.

Canada and

The Tariff

THE story is told of a body of Northern Indians that set out once upon a time on a long mush, resolved to follow the North Star until they came to the end of the world. So they marched and marched until finally they reached a great open place where there was nothing but ice and snow, where there were neither trees nor vegetation that they could see or use for tepees or where game might abound. It was a frozen desert where no man could live, and so it must be the end of the world. Then they turned back toward the south again.

There was also a troop of adventurous Esquimaux who likewise sought the end of the earth, and they set out to go as far as man could travel with the North Star directly back of them. And they went on and on until at last, after many weeks, they came to a place where the land was all covered with trees; where they could find no open plains and there was not snow enough to build an igloo for human habitation. It was a desert of woods and vegetation; there were neither seals nor polar bears nor any source of blubber. It was surely the end of the world, and so they turned back to the north again.

We like the story because the scene and *dramatis personæ* are suggestive of the United States and our friendly neighbor Canada. And we can imagine the Indians and Esquimaux crossing the international boundary in their search, that boundary which has been happily referred to as a "thin, invisible border which is not a line of division so much as one that shows where the United States and Canada are united." We like the idea. If Canada were in Siberia, we should not be united; as it is we are. We move backward and forward across the line without think-

ing of each other as foreigners. We speak the same language, even the same accent; we intermarry; have family reunions and family squabbles, and whatever custom or habit establishes itself in one place is likely to be adopted in the other.

We haven't the same government and we don't want it, for each country has all that it can handle in managing its own affairs. What they would do with some of our Texas and Oklahoma Congressmen in Ottawa or what we should do with some of their French Canadian Deputies in Washington are, thank GOD, problems that do not call for solution. But when the Great Northern Railway needed to be developed there came JAMES J. HILL from Canada, and he did it. When they wanted ideals of life and duty depicted on the walls of the House of Parliament at Winnipeg they came to New York and got AUGUSTUS V. TACK to do it, and there they are, supreme in their loveliness and nobility. Were these things done because HILL was born in Canada and TACK in Pittsburgh? Not for a minute!

They have lots of coal in Canada, but it isn't developed, and they need coal from here. We need lumber and wood pulp and nickel and cobalt and lots of other things from there. We have had general discussions about free trade between the two countries, but they grew rather nasty and somewhat cantankerous, so we learned from that that we are not ready for it in this generation. Let's pass it by. But when it comes to writing a tariff bill it behooves us to bear in mind that we are dealing with our nearest neighbor, and that we have neighborly obligations. If the Great War has not taught us that obligations count in great affairs as well as in personal behavior, then indeed do the poppies bloom in vain on the fields of Flanders.

The Hon. JOSEPH W. FORDNEY is chairman of the Ways and Means Committee of the present House of Representatives and author of the so-called Fordney tariff bill. As it stands it is probably a dead issue; but some kind of a statute must be passed in the next session, and we think it fair to state that the proposed measure is neglectful of our neighborly obligations to Canada. Mr. FORDNEY lives in Saginaw, Mich., and is a considerable owner of timber lands. Over the border, in Canada, other persons own timber lands, and this Canadian lumber reduces Mr. FORDNEY's profits, which he does not like. We shall not discuss the relation of Canadian lumber to the rest of us; we are not considering our own welfare; we are trying to be sympathetic with Mr. FORDNEY. Canadian lumber is a real trouble to him, just as anything that stands in the way of our own profits is a trouble to us. Now these habitual troubles establish something like grooves in the mind, and we think through them, time and again, often unconsciously.

We do not say this in criticism of Mr. FORDNEY in general. Like the rest of us, he has his faults and his prejudices. But we urge upon Congressmen to bear this disposition of the chairman of the Ways and Means Committee in mind when the tariff bill comes up for discussion again; to remember that Canada is our nearest neighbor and that we have just as many obligations as we have rights and privileges; that we have the same borders, and very much the same kinds of trouble; that we are the same kind of people, and that we cannot strike Canada without hitting ourselves. We need each other.

A Misleading

Advertisement

IN THE current number of a leading textile journal we read the following advertisement: "Tell the truth! American chemists and manufacturers are entirely competent to shape their own destiny if afforded proper support and encouragement, without building a Chinese wall around themselves. Why becloud the issues and delude the public with threadbare 'war-talk' and similar bunk? Straight-thinking Americans are not afraid of 'ghosts' no matter from what country they come." Then follows advertising matter as to dyes for sale, and the signature is that of H. A. Metz & Co., Inc.

At the Farbwerke vorm, Meister Lucius und Brüning, at Hoechst, the company Mr. METZ represents can produce dyes at from one-third to one-half the cost of the same dyes made here. Their salaries and wages are one-sixth to one-seventh of those paid in the United States. They have large stocks of dyes and chemicals on hand ready for shipment to the United States against the lifting of the embargo. The Hoechst establishment is part of the Interessen Gemeinschaft, and despite the sore straits of the German Government and people, this great trust and its branch at Hoechst are reputed to be rich; they are reputed to have made vast quantities of high explosives and poison gases for the German army during the war and to have been paid for it. Suppose the "proper support and encouragement" which Brother METZ—for whose immense ability and shrewdness we have profound respect and whom we cannot help liking even though to our minds he is engaged in an effort that, if successful, will utterly destroy the synthetic organic chemical industry in the United States—suppose "encouragement" to the tune of 100 per cent or over 200 per cent duties were levied on German dyes, what would he and his partners do? They know the American dye and chemical markets as well as anybody else alive. Would they not underbid and underbid and get that trade at any cost for at least a year, until American competition was killed? Then wouldn't they and the Badische and Bayer and other people have it right in their own hands?

Brother METZ is an American, born here in New York, and we are willing to admit for his benefit all the loyalty he claims. But how about his friends over in Germany? We don't trust them. While HERMAN would be trying to save American industry, they would overrule him, we are sure; and he does not control the I. G. or even the Farbwerke Hoechst. It is the people back of him that we have reason to fear, and we reason from experience.

Now let's "tell the truth" again. American chemists and business men are not so competent that they can get away with costs of three or two to one against the Germans. American chemists have yet a great deal to learn with only five years' experience against the Germans' fifty. And as for the American manufacturers who are in the business they have still more to learn. In fact, if we only had HERMAN on our side with all his heart and all his interest, instead of representing interests that want to "serve" both German and American industries in that fine German brotherly fashion whereby the advantage and proceeds all go to Germany, we should feel better.

Suppose the Interessen Gemeinschaft gets into the saddle; gets control just as German manufacturers

once had control, then Brother METZ will fight in vain for his American customers. We know those Germans and we do not trust them as he does.

The only way to avoid German control is to do just as England and France and Italy and Japan have done: to put on an embargo and get what we need from Germany under license. That not only saves the industry here and keeps our chemists at work, but gives us also a complete arsenal of defense for chemical warfare in case Germany or any other country should get obstreperous again. And it will cut down our war taxes.

Underdevelopment

And Overdevelopment

BEFORE the war when there was an industrial depression the cry always was that the country was "overdeveloped." The development was all right in its way, but it had gone too far and it would require a period of time for people to catch up and require all the facilities that had been provided. Now we have a sort of industrial depression—at least nearly everyone claims there is one—and we do not hear the old familiar cry. Rather everyone is telling everyone that the country needs a great deal of developing, that it is far behind in its "program." Curious, isn't it?

The one thing common to all the times is the disposition to pick out something to blame it on. That is human nature. No one is disposed to indulge in introspection and confess his own faults when found. Some of the claims made as to what is wrong just now will not bear analysis, but it is not customary to analyze things that are said by everybody, although they are usually the things one should be wary of.

The difficulty arises largely from a loose method of thinking, a disposition to regard "development" as something that necessarily proceeds along fixed lines, so that we must be either underdeveloped or overdeveloped or developed just right. Nobody ever admits that things are just right! Obviously, however, development is of various kinds, and styles or demand may change. We may have gone too far in one direction and not far enough in another.

There can scarcely be overproduction of everything that men want, for the average man is willing to spend his income, but there may easily be an excess of capacity for making things that men do not want a great deal, and a lack of capacity to produce things men would like to have once they knew of their existence. It does not follow that because our rate of producing a given thing, whether portable property or fixed property, used to increase at a certain rate, perhaps by a geometrical progression, it should continue to do so until doomsday. Fourteen years and more ago we were building steel freight cars at the rate of 150,000 to 250,000 a year, but it does not follow that we need to build them at that rate throughout the future. A third of a century ago there was a year in which we built 13,000 miles of railroad, but we do not have to do that now. Often in the past the production of coal doubled in less than a decade, and it more than doubled in the 16 years from 1902 to 1918, but we certainly do not have to keep up that particular sort of thing indefinitely.

In 1873 there began the severest industrial depression in the history of the United States. The country was "overdeveloped," of course. Then somebody brought roller skates to the attention of the public,

and old timers insist that the building of roller-skating rinks all over the country did much to curtail unemployment. The country was overdeveloped in methods and means to get from one city to another, but underdeveloped in means for skating around a circle. Nowadays there is a vast amount of money being spent in admissions to "movie" shows by people who simply refuse to buy steel beams and channels.

We are going to keep on developing, but not necessarily along the same lines as formerly. We need some new highways to be marked out and as they are marked out men will travel them. A couple of decades hence it will look very simple in the retrospect. We shall not have built 4,000,000 or even 2,000,000 freight cars in the 20 years, or laid 100,000 miles of new railroad or doubled our production of coal or quadrupled the number of skyscrapers or provided one automobile per capita—but we shall have made a great deal of progress, chiefly along new lines, making life more interesting.

The Banker

And Research

"OUR industry will spend any amount for lawyers, but almost nothing for chemists." This was the complaint of a very prominent technical man who has striven tirelessly for several years past to "sell" his industry the idea of the importance of fundamental research. He has frequently had the experience that any threatened attack upon that industry, which happens to be one very much in the public eye, will promptly bring any necessary sums for co-operative effort in a legal or economic contest to prevent successful inroads upon the industry's interests. However, just recently one prominent corporation in this industry experienced great difficulty because of unsuspected poisoning of a large number of plant employees. It was obvious to any technical observer that a careful study of the characteristics of the vapors coming from the process would undoubtedly give the cause and probably suggest a remedy for this danger. Nevertheless it proved almost impossible to get the small appropriation needed for this study despite the fact that neglect of the situation promised to result in serious consequences to workmen and damage claims far in excess of the amount needed for the research.

Altogether too many misunderstandings exist between business on the one hand and science and educational institutions training scientists on the other. This misunderstanding is simply the result of radical difference in point of view, a difference for which both parties are about equally to blame. Science has taken too little pains to find out just what industry by and large needs and can use and has all too often taken the stand that results should in themselves be accepted and appreciated at their face value. Neither of these stands can be justified.

On the other hand, industry has been, and still often is, to blame for its unwillingness to use that which is of real value in science. Practically every industry is based upon scientific methods and can advance only as new knowledge can be applied in industrial operations. The last word in business management generally is spoken by the banker. It is a doubly welcome event, therefore, which shows that the banking interests are more and more appreciating chemical science in its fundamentals. It is to be hoped that the science will be increasingly deserving of such appreciation.

Readers' Views and Comments

Boiler Feed Water Purification

To the Editor of Chemical & Metallurgical Engineering

SIR:—In a letter which appeared in your issue of Oct. 5, 1921, William M. Taylor criticizes an article by the writer on "Boiler Feed Water Purification." In brief he makes the following assertions:

(1) Zeolite softeners do not produce water of zero hardness and by the very nature of the chemical reactions involved are not capable of producing water of zero hardness.

(2) Sodium salts in the raw water in slight amount prevent the complete softening of the water.

(3) The molecular weight of the sodium salts in the zeolite softened water exceeds the molecular weight of the calcium and magnesium salts present in the raw water by about 68 per cent instead of only 5 per cent, which the writer sets forth in his article.

The assertions are not in accordance with the facts for the following reasons:

(1) Any chemist can very quickly and easily prove that a zeolite softener, if properly operated and constructed, will soften water to absolute zero hardness, as defined in the "Standard Methods for the Examination of Water and Sewage."

Mr. Taylor claims to have analyzed the effluent from various zeolite softeners, and found slight amounts of hardness up to about 0.5 grain per gallon, expressed as calcium carbonate. But he does not mention that he examined the conditions under which the said softeners were assumed to be operating, and whether the operation was being cared for properly. The general statement that he did not find a water of "zero hardness," without giving further pertinent details of the operating conditions, does not prove anything. It would be just as logical to claim that an engine or turbine could not possibly meet the manufacturers' guarantee for economy because in some particular test, without checking up operating conditions, it did not do so.

(2) The amount of sodium salts in the raw water has an influence on the capacity of the softener—that is, the amount of "zero hardness" water produced—but it does not prevent the production of "zero hardness" water. The softener should be designed properly with a sufficiently greater excess of the zeolite to take care of such conditions. This is in accordance with the law of mass action of most reactions. But Mr. Taylor has exaggerated this inhibitive tendency of sodium salts in the raw water. Zeolite plants have successfully handled waters containing over 1,000 parts per million of sodium chloride.

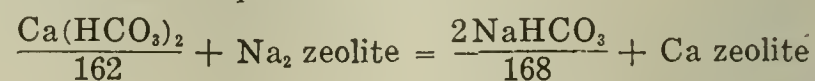
(3) Regarding the relative molecular weights of the sodium salts in the softened water and the weights of calcium and magnesium salts in the raw water, Mr. Taylor states, "His chemical arithmetic is not accurate," and then proceeds to fall into an inexcusable error. He compares calcium carbonate on one side of the reaction with sodium bicarbonate on the other side. According to Mr. Taylor's comparison a reaction must be assumed analogous to the following formula. Thus:



A glance at the formula shows that it is not an equa-

tion and does not balance. There is an extra CO_2 and H_2O on the right side which are not on the left.

The correct equation is:



Now, 168 is only 6 more than 162, which is $6 \div 162 = 3.7$ per cent excess.

This is less than 5 per cent, which was the figure stated by the writer in the original article, and it is certainly not 68 per cent, which Mr. Taylor claims.

Mr. Taylor mentions that " CaCO_3 is held in solution by half-bound CO_2 " but then does not apply the idea in the calculation. Hardness is frequently expressed in terms of CaCO_3 for convenience, but CaCO_3 , as such, is relatively insoluble in water, and it is only when the water contains CO_2 that CaCO_3 is dissolved in the form of $\text{Ca}(\text{HCO}_3)_2$. That is how limestone is dissolved and how this form of hardness enters our natural water supplies.

The Permutit Co.,
New York, N. Y.

S. B. APPLEBAUM,
Assistant Technical Manager.

Communications With Russian Scientists

To the Editor of Chemical & Metallurgical Engineering

Sir:—I have read with great interest and appreciation your editorials concerning Russian scientists in general and my professor Ipatieff in particular.

Prof. Ipatieff is a graduate of Michael Artillery School and later of Michael Artillery Academy. Several years before the last war he attained the rank of general in the Russian artillery. He held the chair of professor in organic chemistry in Michael Academy and at the same time delivered lectures in Michael Artillery School and in the University of Petrograd.

So far as I know he continued his work during the period of the revolution and, as I understand it, he even published some of his works in the recent publications of the Russian Academy of Science.

I think that the best way to communicate with him as well as with other Russian scientists is in care of the Russian Academy of Science. Proper address would be as follows, both in English and Russian:

Russia, Petrograd,
c/o Academy of Science,
Professor Ipatieff.

Россія. Петроград.
Академія Наук.
Профессору Ипатьеву.

Mt. Rainier, Md.

COLONEL A. I. KRYNITZKY.

A Notable Movement in Metallurgical Education

To the Editor of Chemical & Metallurgical Engineering

Sir:—I have just read with much interest the editorial entitled "A Notable Movement in Metallurgical Education" that appears in the Nov. 6 issue of CHEMICAL & METALLURGICAL ENGINEERING. There is one exception that I have to make and that is in connection with my membership in the New Haven Chapter. New Haven has a very active and creditable chapter in the American Society for Steel Treating, but it is my good fortune to be a resident of Hartford and a member of the Hartford Chapter, which we believe ranks second to none in the Society.

Hartford, Conn.

F. P. GILLIGAN,
President, American Society for Steel Treating.

Italian Chemical Industries

From Our Special Correspondent

GENOA, Italy, Nov. 2, 1921.

STRIKES have occurred in the chemical industries during the past month, owing to the refusal of the workmen to accept the reduced scale of wages arranged for the winter months. The workmen contended that the cost of living had increased owing to the higher foreign exchange. This condition and the fact that the demand for chemicals on the part of consumers and speculators has increased would naturally lead to the expectation that prices would be higher, but such is not the case. The price of a few articles rose, but the great quantities of borax, camphor, ammonium carbonate, calcium chloride, magnesium chloride, cream of tartar, formaldehyde, acetone, caustic soda and the like coming in from Germany kept the price of these chemicals down. This has injured the export business from nations having a higher rate of exchange, such as the United States and Great Britain.

ITALIAN CITRIC ACID INDUSTRY

Because the government fixed the price of citrate of lime at 10,000 lire per ton, the Italian citric acid industry, with works at Palermo, Messina and Vercelli, is having a difficult time, being no longer in a position to produce the acid at a price to compete against tartaric acid, and has been obliged to reduce orders. Besides this, the industry found it difficult to sell citrate of lime at the new price to foreign works producing citric acid. The exportations of this product had risen in 1920 to 8,777 tons, 5,738 tons being destined to the United States, 1,634 tons to England, 746 tons to France and the remainder to Germany and other countries. The exportations during 1919 amounted to only 3,458 tons.

ITALIAN SUGAR PRODUCTION

Owing to favorable weather conditions and to the greater beet-root acreage cultivated, the production of sugar will be greatly increased this year, surpassing 200,000 tons; last year it was only 100,000 tons. The internal consumption, calculated at 220,000 tons, will therefore be nearly covered and the importations will be greatly reduced. These reached 66,160 tons during the first six months of this year. In 1918 there were thirty-four sugar works in Italy and the average yearly production was between 100,000 and 150,000 tons. The importance, therefore, of this year's increase can be realized.

ITALIAN SHALE DISTILLATION

So far very little has been accomplished in Italy in the distillation of bituminous or asphaltic rock to obtain mineral oil for combustible purposes. What little has been done has been limited to a single works, the Società Italiana Asfalti, Bitumi, Catrami e Derivati, which has constructed a plant for producing 15,000 tons of mineral oil per annum. After the success of this concern was assured, a number of Italian economists started a campaign to utilize the great abundance of asphaltic rock and lignite throughout continental Italy. It has been sought to interest the government in a plan for the protection of the new industry, but little is expected from this quarter, owing to the fact that the government is already

occupied with enough to keep it busy for some time. Neither is much to be expected from Italian capitalists, because of their present financial difficulties. It has been suggested that this would be a field worthy the attention of American financiers, taking advantage of the present low value of the Italian lire. It is contended that whereas now the shale deposits are powdered and exported for road-making purposes, they could with comparatively little expense be distilled in Italy. In 1920 Italy imported 182,004 tons of mineral oil, valued at 235,000,000 lire, most of which came from the United States, Mexico, Great Britain and France.

HYDRO-ELECTRIC DEVELOPMENTS

The electric substation of Predare started operation during October. This is the first of a group of hydro-electric power substations to be constructed by the Società dell'Ozola in the Reggio Appenines, and is also the first to distribute on a very large scale electric energy between different Italian regions. For the present it will transmit electric energy of the Società Adamello toward the Tuscan region, but later it will also include a hydro-electric power-generating station. The lines of the Società Adamello are already connected with those of the Società Edison, Società Conti and others, and will be connected during the next few months with the lines of the Società Adriatica, and later with plants in Piedmont. In this way will be formed a large inter-regional distribution of the electric energy produced in the power stations of the Nerina, Adamello and Aosta Valleys to points in all portions of northern and central Italy.

ITALIAN IMPORTS AND EXPORTS

The financial difficulties suffered in Italy by all classes and which were rendered more serious by the heavy taxes reduced all importations during the first six months of this year, as can be seen from the following figures:

	Jan.-June, 1921 Tons	Jan.-June, 1920 Tons
Chemicals	60,500	133,041
Acids	7,049	14,143
Paints and varnishes	3,942	6,454
Wood pulp	19,530	37,329
Malt	1,436	869
Petroleum	32,798	65,636
Cottonseed oil	11,254	9,288
Metallie minerals	15,099	15,052
Cast iron and steel scrap	20,832	90,290
Pig iron, cast iron and steel ingots.	35,678	96,028
Iron and steel (sheets, bars, wire)	107,121	126,048
Galvanized and lead covered steel and iron plates	10,338	22,163
Copper, brass and bronze	10,630	7,575

Despite the efforts of Italian producers to increase their exports, success could be attained in only some cases. This is demonstrated by the following export statistics, which are those available for the first six months of the present year:

	Jan.-June, 1921 Tons	Jan.-June, 1920 Tons
Chemicals	43,327	28,454
Acids	5,188	5,515
Paints and varnishes	1,521	1,204
Wood pulp	653	None
Metallie minerals	7,082	8,184

Heavy importations of war reparation coal permitted an increase of exportations of coal from this country, that reached 102,802 tons in the first six months of this year, against 36,582 in the corresponding months of last year. The importations of coal were reduced to 2,346,914 tons during the six months, against 2,594,612 in the corresponding months last year.

The Manufacture of Naval Stores From the Dead Wood of the Southern Pines

Recent Industrial Development of the Process for the Extraction of Turpentine, Rosin and Pine Oil From Stumps and Other Dead Wood of Cut-Over Pine Lands—Solvent Treatment and Recovery—Chemical and Physical Properties of Products

By C. M. SHERWOOD

Naval Stores Division, Hercules Powder Co.

THE extraction of rosin, pine oil and turpentine from dead pine wood is a comparatively recent process. The first plant was erected at Gulfport in 1909 by the Yaryan Naval Stores Co. and had a capacity of about 90 tons of wood per day; in 1911 this was increased to 175 tons. In 1912 the same company built an additional plant of a much greater capacity at Brunswick, Ga. Since that time several other installations have been made until at present there is a total of eight plants, ranging in capacity from 20 to 550 tons of wood per day.

In May, 1921, the Hercules Powder Co. assumed control of the Yaryan Rosin & Turpentine Co., a reorganization of the older company, and also about that time completed a plant at Hattiesburg, Miss. The combined maximum capacity of these plants is approximately 1,000 tons of wood per day, making this company the largest producer of naval stores by the extraction process in the world.

Up to the present time it cannot be said that this industry has been profitable. The Yaryan company was in receivers' hands during a large part of its existence and it would probable have been a total loss to the original investors but for a short period of abnormally high prices due to the war. Plants cannot be operated profitably at prices which have prevailed in 1921. The development of the industry will require very large capital expenditures, certainly without immediate return, and with little chance of a fair ultimate return unless the investment in physical properties is followed by chemical research on a scale that few organizations are equipped to undertake.

The wood is obtained from cut-over land, and is

chiefly the Southern long-leaf pine (*Pinus palustris*). This dead wood may be divided into two general classes—namely, stump and top wood. The stump wood is richer in extractable products and is correspondingly more valuable. Top wood is the upper part of the dead tree. It is a curious fact that the section of the tree from about 10 ft. above the ground to the first limbs



FIG. 2. PILED WOOD READY TO BE HAULED TO THE PLANT

is generally very poor and is culled, while above the first branches the rosin and oils are found in both the branches and body of the tree in considerable amounts. It seems to be generally true that the twisted grain wood is richer than the straight grain. This is explained, in a rather unscientific way it is true, on the ground that the oils and rosins passing through the interior of the tree are held back by the bends and gradually accumulate there. At any rate, whenever there are any twists and knots one finds extractable products in large amounts.

The distribution in the roots is also interesting. The *Pinus palustris* has two types of roots, lateral and tap. The lateral roots are close to the surface of the ground and are very rich in rosin, turpentine and pine oil; the tap root, each tree usually having but one, goes straight down into the ground. It is soft and spongy and contains practically no valuable products—in fact it is almost worthless even as fuel. It is the general belief that the tree obtains most of its moisture from this source.

In wood operations the top wood is simply cut into 4-ft. lengths and split if too large in diameter for milling. Stumps are generally blown out with dynamite. The pieces are hauled by wagons to a tram line or railroad and loaded into box or rack cars on which the wood is transported directly to the plant.



FIG. 1. BORING STUMPS JUST PREVIOUS TO BLASTING OUT WITH DYNAMITE



FIG. 3. RESERVE OF WOOD SUPPLY AT BRUNSWICK PLANT, SHOWING STACKS OF THE POWER HOUSE IN THE DISTANCE

In order for wood to be suitable for use it should age for several years; top wood requiring at least 5 years and stump wood 2 or 3 years longer. "Green" or insufficiently aged wood has been tried from time to time, but the difficulty experienced in milling is so great that its use is impractical. Furthermore, the yields are not so great as with the well-seasoned material.

Good land yields 8 to 15 tons of wood per acre, depending on the section of the country. Therefore a plant having 500 tons per day capacity would receive daily the wood from about 50 acres of land. From these figures one can obtain some idea as to the magnitude of the wood operations and of the benefits Southern agriculture will derive from this wholesale removal of stumps.

PRELIMINARY PROCESSES OF GRINDING AND STEAMING

In all the plants under the control of the Hercules Powder Co. the steam-solvent or extraction process is used. The wood is unloaded from the cars onto a conveyor which takes it to a hog or chipper, where it is cut into pieces about 2 in. long and $\frac{1}{2}$ to 1 in. thick. The hogged wood then passes directly into a hammer mill of the Jeffrey or Williams type, where the milling is completed, the wood being reduced to sizes varying from dust to pieces which will not pass through a 4-mesh screen. This milled wood is carried by belt conveyers to upright cylindrical steel tanks called extractors. These extractors vary in size at different plants but generally hold from 7 to 14 tons of wood. Charging is accomplished by means of doors at the top. A perforated plate about 3 ft. above the bottom of the extractor serves to hold up the chips. Each extractor is equipped so as to permit the use of both coils and live steam. A bottom outlet permits the solution to be "dropped" as desired.

After the extractor is filled, the first operation is to steam for turpentine and pine oil. Live steam is used on account of the high boiling point of these compounds. Each extractor is steamed for 3 or 4 hours, depending on the amount and temperature of the steam used. During this operation practically all the turpentine and about half the pine oil are distilled off, the distillate being condensed and run to a separator, where the pine oil and turpentine, being immiscible with water, are decanted off the top. This solution of "crude turpentine" has a specific gravity of about 0.880 at 15.5 deg.

C. and consists of approximately 70 per cent of turpentine and 30 per cent of pine oil. It is fractionated into commercial turpentine and pine oil by repeated distillation in ordinary pot stills. During this distillation it is necessary to use live steam, as the high temperature needed for direct distillation had a tendency to break down both compounds, causing them to darken and giving unpleasant, empyreumatic odors.

TREATMENT WITH SOLVENT

The steamed wood still contains the rosin. To remove this and whatever oils are left in the wood it is boiled with a solvent. At present gasoline is commonly used, although coal-tar products, such as benzene and toluene, have been tried to a limited extent. The great difficulty with the latter class of solvents is that they not only take out the rosin but also dissolve a large quantity of oxidized rosin, pitch and coloring matter, which renders the resulting rosin so dark that it is unfit for nearly all uses. It is evident, therefore, that the petroleum distillate has a sort of selective solubility; leaving the dark products behind in the wood and extracting only the lighter colored resinous matter.

The solvent treatment is a countercurrent proposition in which the fresh solvent comes in contact with the most exhausted chips. This solvent then goes to the chips containing a little more rosin until finally the solution is run onto wood which has been steamed for turpentine only and from which no rosin has been extracted. The resulting solution is then dropped through the bottom outlet of the extractor to the settling tank, where chips, dirt, etc., settle out.

By this process the wood is in contact with the solvent for 4 or 5 hours. The final solution usually contains about 15 per cent of rosin, although of course many factors, such as the volume of gasoline used, the percentage of rosin in the original wood and the completeness of extraction, may cause this percentage to vary greatly. It is advisable to have this solution as strong as possible so as to prevent the handling of large volumes of weak liquor.

From the settling tank the solution is pumped to evaporators. These evaporators are generally ordinary still pots equipped with steam coils and sparge pipes. During the first part of the distillation the solvent distills off and is run back to a storage tank, from which it is used again for extraction. The other frac-

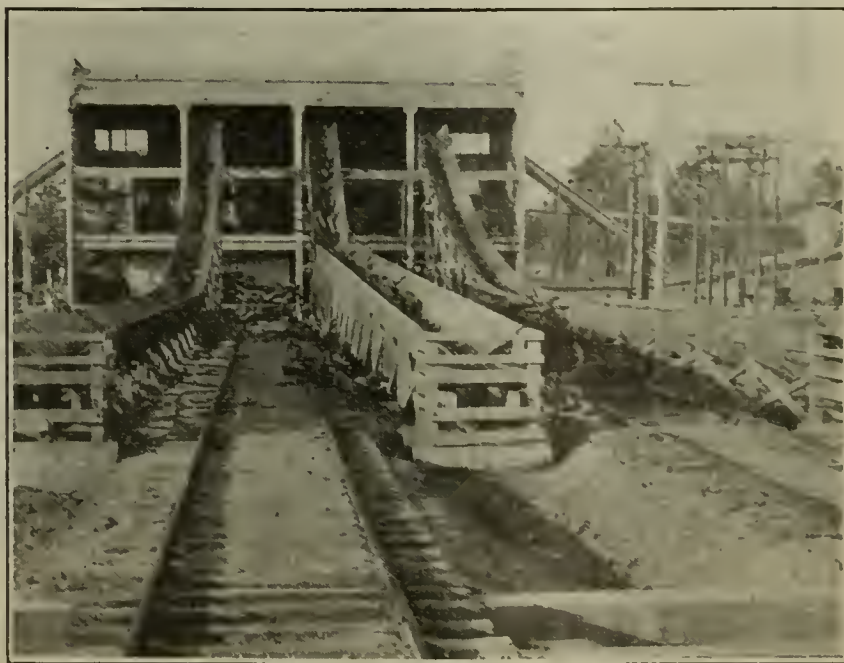
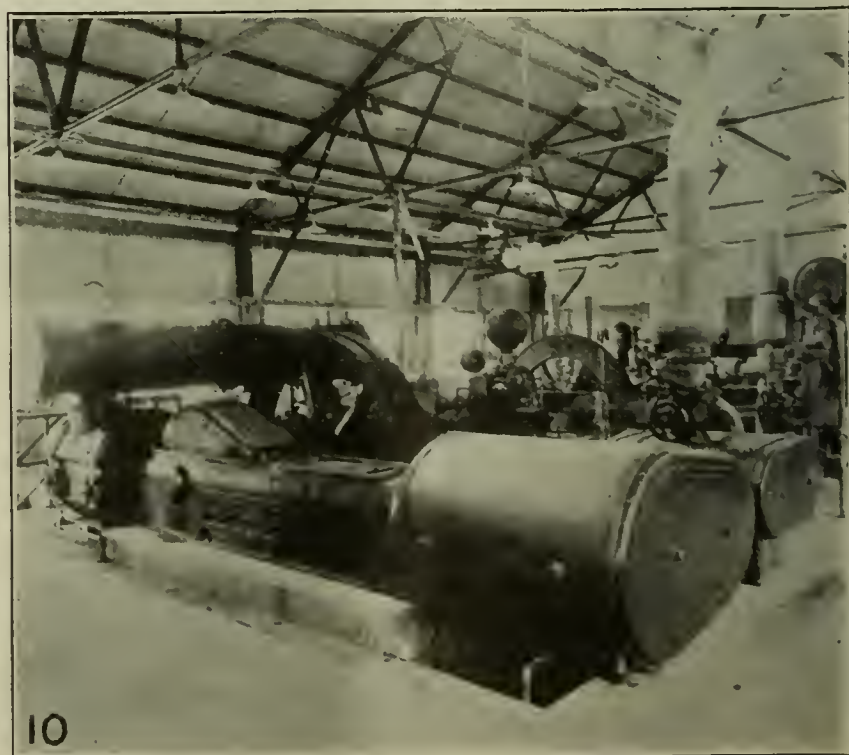
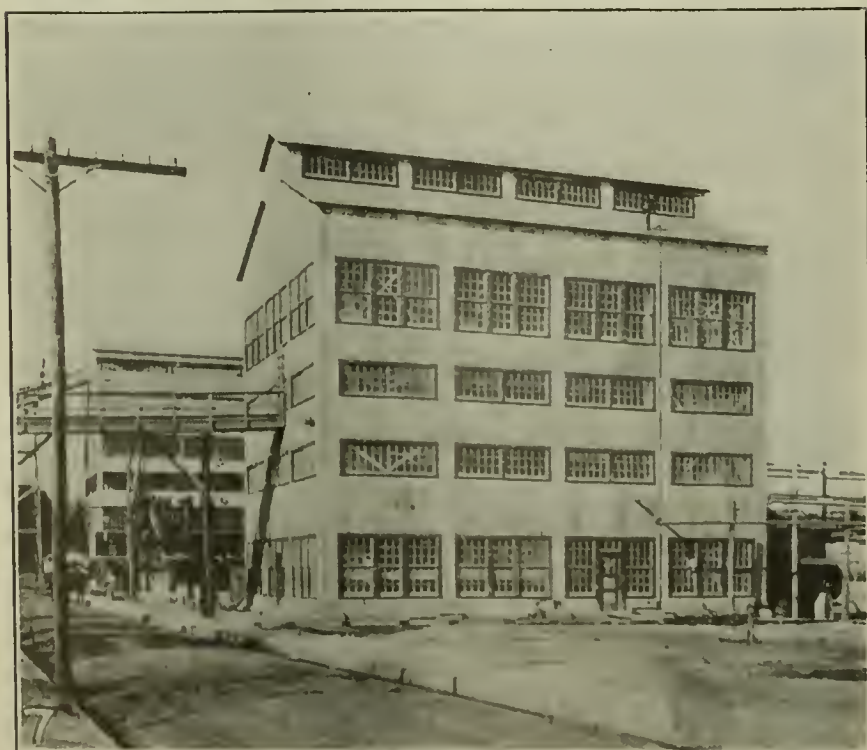
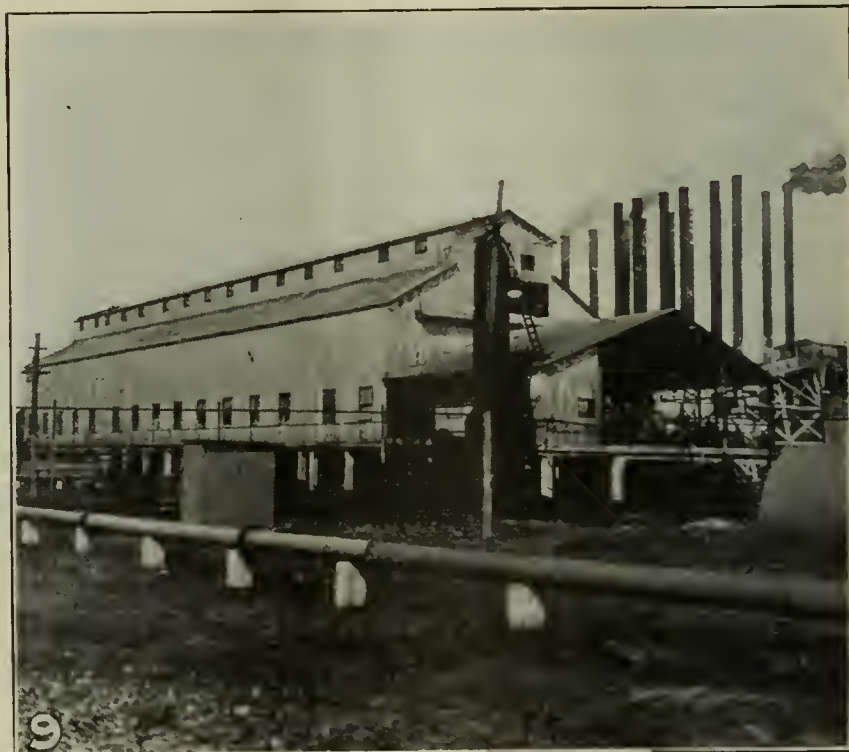
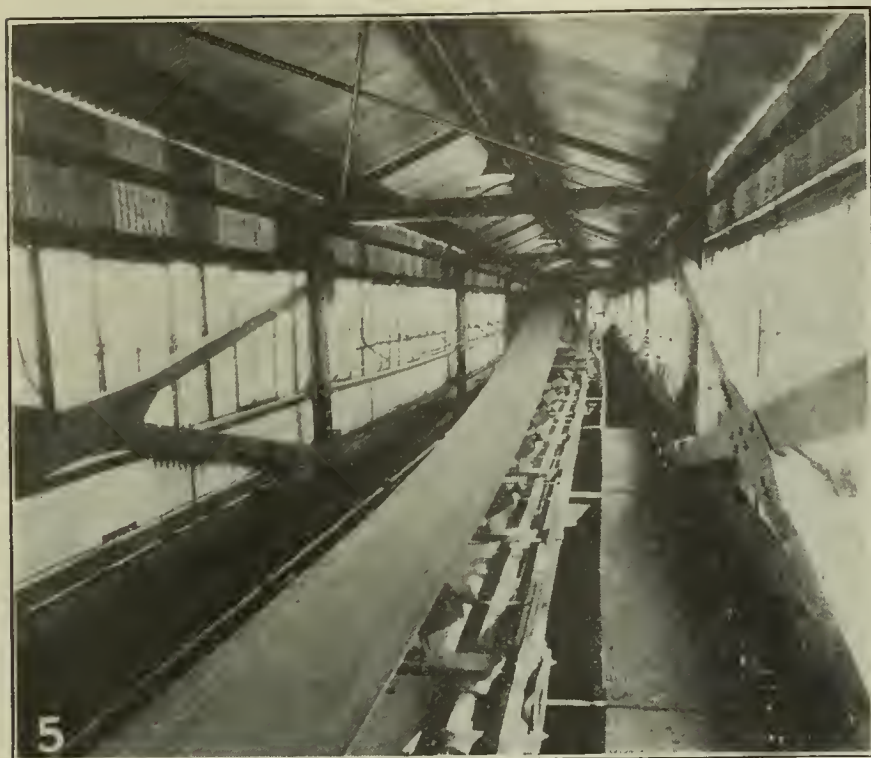


FIG. 4. CONVEYOR SYSTEM AT HATTIESBURG PLANT, WITH MILL ROOM IN THE BACKGROUND



FIGS. 5 TO 10

Fig. 5. Belt conveyors used for carrying milled wood to the extractors, Hattiesburg plant.

Fig. 6. Interior of extractor building, Hattiesburg plant.

Fig. 7. Refinery building, Hattiesburg plant, with extractor building in the background.

Fig. 8. Interior refinery building, showing rosin stills, Hattiesburg plant.

Fig. 9. Extractor building, Brunswick plant.

Fig. 10. Air compressors at the Hattiesburg plant.

tions are high boiling and consist of mixtures of solvent and pine oil. They are redistilled to yield more solvent and an inferior grade of pine oil. The rosin remains behind in the still as a residue and is run out and poured into wooden barrels holding about 50 gal. With this type of apparatus one must use an intermittent or batch process.

In some of the plants of the Hercules Powder Co. Yaryan evaporators are used instead of pot stills. With this equipment a continuous two-stage operation is carried on, the majority of the solvent being taken off in an evaporator operating at about 50 lb. steam pressure and 20 in. vacuum, while the higher boiling liquids are evaporated at about 100 lb. steam pressure and 25 in. vacuum. The rosin is continually pumped out of the bottom outlet of the evaporator to vats, from which it is barreled as described above.

RECOVERY OF SOLVENT

After the extraction of the wood is completed, the spent chips contain about 40 per cent of their weight of solvent. This is removed by injecting live steam into the chips in a manner similar to that used in the turpentine extraction. Usually 4 or 5 hours' steaming is needed to drive off the solvent, the great difficulty being to remove the last traces. Even after this steaming there is still considerable solvent in the wood.

Analysis of samples immediately after steaming

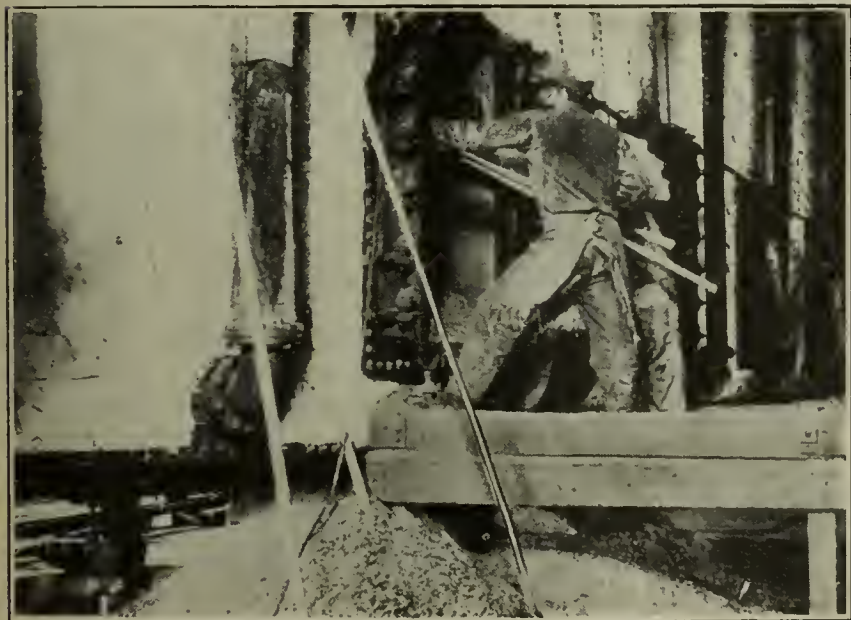


FIG. 11. "PULLING" AN EXTRACTOR. THE SPENT WOOD GOES DOWN THROUGH THE FLOOR TO A MOVABLE BELT CONVEYOR WHICH TRANSPORTS IT TO THE FUEL BIN

have shown as high as 10 gal. of solvent per ton of spent wood, although the average is much less than that, being probably 2 or 3 gal. per ton. The accurate determination is very difficult due to the fact that when the hot chips are withdrawn from the extractor the solvent evaporates very rapidly. The loss of solvent at this point is probably the chief single source of loss in all the operation, and much valuable work can undoubtedly be done to improve this condition.

The spent wood is then "pulled" through the front door in the side of the extractor and falls to a conveyor, which carries it to the fuel bin, from which it is transported to the power house as needed. Under normal conditions the spent wood is about sufficient to give all the fuel necessary for the operation of the plant.

It may be seen from the above description that the whole operation is by no means simple. Provision must be made for an adequate supply of wood at all times. To do this it is necessary to have a wood force double

that required to operate the plant. On account of the frequent rains which slow down the wood operations for weeks at a time, the plant should always have a large supply of reserve wood on hand. The same may be said of solvent. Under normal conditions about 8 to 10 gal. of solvent is lost per ton of wood worked. This means that several thousand gallons must always be in reserve. In addition it may be roughly estimated that 200 gal. of solvent is required for every ton of wood worked—that is, for a hundred ton plant 20,000 gal. must be kept in the system. As both the solvent and manufactured products are very flammable, great care must be taken to prevent fires.

STEAM-DISTILLED WOOD TURPENTINE

The products obtained from this process are, as mentioned before, turpentine, pine oil and rosin. The turpentine is sold on the market as steam-distilled wood turpentine to distinguish it from the spirits of turpentine or gum turpentine, which is made from the gum of the living tree, and from destructive turpentine, which is made by the destructive distillation of dead pine wood. Formerly wood turpentine was looked upon with disfavor by the paint and varnish trade, but since the product meets the highest specifications required commercially, this prejudice has been almost entirely overcome.

One of the great advantages of the better grades of wood turpentine is its uniformity. This is especially true of the output from well-equipped plants where a careful chemical control is maintained. In the Hercules plant the present Navy specifications are used as a standard which the turpentine must meet. A typical analysis of this product is as follows:

Initial boiling point.....	154 deg. C.
Per cent boiling below 170 deg. C.....	90.5
Polymerization residue	1.0
Specific gravity at $\frac{15.5 \text{ deg. C.}}{15.5 \text{ deg. C.}}$	0.865
Color	W.W.
Flash point (Abel closed cup).....	34 deg. C.
Refractive index at 15.5 deg. C.....	1.469

A comparison of wood and gum turpentine is not particularly easy on account of the variation in both products. If, however, the above analysis is taken as typical of wood turpentine, one can say that the refractive index and specific gravity are in most cases higher in gum than in wood turpentine. Furthermore, gum turpentine, especially when freshly distilled, has a fragrant, sweet odor, absent from wood turpentine. This is supposed to be caused by certain esters and aldehydes present in the gum. Turpentine loses much of this fragrant odor on standing. Wood turpentine, due to the fact that it is always redistilled, generally has a better color than gum turpentine, which is barreled directly from the still without redistillation.

PINE OIL AND ITS CHARACTERISTICS

Pine oil is perhaps the most interesting of all the products. While in the gum industry no pine oil is obtained, yet in this process about 1 part of pine oil to 2 parts of turpentine is recovered.

This pine oil when first produced was considered practically worthless. In later years, however, it has become valuable in many ways. In the flotation field it is one of the best frothing oils known and great quantities are used yearly for this purpose. It is the basis of a variety of medicinal and disinfectant solutions. The rubber industry consumes quantities for various purposes. The paint and varnish industry has also made use of the

peculiar properties of pine oil. Toch¹ makes the following comments on the application of pine oil: "It has been used to a considerable extent for making paints which should dry without a gloss, and as a "flatting" material it has been successful. It has the excellent quality of flowing out well under the brush and of not showing brush marks, the latter because it evaporates so very slowly. It is a very powerful solvent, and many of the acid resins which have a tendency to separate when they are insufficiently cooled with drying oil will remain together when pine oil is added."

A high-grade commercial pine oil manufactured at Brunswick, Ga., had the following analysis:

Boiling range	180 deg. C.-225 deg. C.
Specific gravity at 15.5 deg. C.....	0.935
Color	Light straw
Refractive index at 15.5 deg. C.....	1.479
Polymerization residue	3 per cent

COMPOSITION OF PINE OIL

The composition of pine oil is rather uncertain. It was at first thought to be a hydrocarbon similar to pinene, but later Teeple² and Toch¹ showed that the pine oil was very similar to terpineol, $C_{10}H_{17}OH$.

Toch found that a pine oil of 0.942 gravity contained 78.1 per cent C, 11.5 per cent H and 10.4 per cent O, while the theoretical for terpineol is 77.68 per cent C, 11.77 per cent H and 10.38 per cent O. A sample of pine oil, analyzed at our experimental station, having a gravity of 0.933 and a boiling range of 180 deg. C. to 225 deg. C., showed 80.7 per cent C, 10.9 per cent H and 8.4 per cent O. It is probable that some hydrocarbons were present. In fact the commercial pine oil undoubtedly consists of several distinct compounds.

The origin of pine oil is still a mystery. Dr. Toch believes it is due to hydrolysis and oxidation as a result of exposure to the atmosphere. We are inclined to the belief that pine oil is present in the living tree as an essential oil, and is not a product of hydrolysis or oxidation. It is our intention to study this interesting problem very shortly.

¹J. Ind. Eng. Chem., vol. 6, No. 9, p. 722.
²J. Am. Chem. Soc., vol. 30, p. 412.



FIG. 12. DIPPING ROSIN FROM VATS INTO BARRELS. THIS IS THE GENERAL PROCESS USED IN BOTH GUM- AND WOOD-ROSIN INDUSTRIES

Rosin is the chief product extracted, since approximately a standard barrel of rosin (280 lb. gross) is recovered from 1 ton of wood. As usually obtained it is a ruby red product. The red color is peculiar to this grade of rosin, and many theories have been advanced as to its origin. We believe that the greater part of this red color has its origin in forest fires, with a resulting decomposition and oxidation of the wood and rosin. This theory is based on the following experiments:

If one removes the outer portion of a stump, extracts the inner part with gasoline and evaporates the solvent, the rosin obtained will have only a small amount of red coloration. If, however, the wood is charred and then extracted, it will give a rosin with the characteristic dark red color. Rosin extracted from the living tree will also show comparatively little of this red color, but it is not a lighter grade of rosin than that taken from the interior of a stump.

Rosin is considered to consist principally of abietic acid, the formula of which is generally given as $C_{20}H_{30}O_2$. Several ultimate analysis were made at our experimental station in order to learn how closely wood and gum rosins correspond to the above formula. These gave the following percentages:

Product Analyzed	C	H	O
Gum F	77.41	9.56	13.03
Gum W.W.	78.78	10.38	10.84
Wood rosin (Yaryan F).....	78.12	9.90	11.98
Abietic acid (prepared in lab.)....	79.34	10.18	10.48
Abietic acid (calculated $C_{20}H_{30}O_2$)...	79.41	10.01	10.58

These results show that both wood rosin and gum rosin correspond very closely to abietic acid. It is an interesting fact that, judging from these analyses, the wood rosin does not appear to contain as much oxygen as ordinary gum rosin and is not, as commonly supposed, a highly oxidized rosin.

COMPARISON OF WOOD AND GUM ROSIN

The following is a comparison of the common analytical constants of gum and wood rosin:

Rosin	Acid No.	Saponification No.	Ester No.	Unsaponifiable, Per Cent
Yaryan F...	147.7	162.7	15	7.3
Gum F.....	155.9	174	18	4.8
Gum W.W..	154.7	182.8	28.1	5.1
Gum F.....	162.4	176.4	12.0	5.2
Yaryan F...	150.5	170.9	20.4	6.0

As with wood turpentine, there has been some prejudice against wood rosin among users. Probably this objection has been justified in the past, as the earlier products in many cases were very inferior. By reviewing the process one can see that there is a possibility by careless operation both of contaminating the rosin with solvent, which will obviously soften it, and of unduly darkening the rosin by overheating. Both of these faults were of common occurrence during the pioneer work. With careful operation, however, one can be assured of a very uniform product, particularly free from foreign matter. While the color prevents its use for some purposes, yet under most other conditions it doubtless has an advantage over gum rosin because of its uniformity and cleanliness.

At present the production of naval stores from this source is only about 10 per cent of the total output, and is consequently of comparatively minor importance. However, with the growing shortage of living trees and the consequent diminution of the supply of gum product, this industry in the future will play an important part in the production of naval stores.

Brunswick, Ga.

Importance of the Olefine Gases and Their Derivatives

III—Ethylene Dichloride*

A Commercially New Extraction Agent Prepared From Ethylene and Liquid Chlorine, Having Properties Approaching Those of an "Ideal" Solvent—Chemical Stability—Sharp Boiling Range—Low Fire Hazard—Physiological Properties

By GEORGE O. CURME, JR.

WHILE ethylene dichloride stands as one of the earliest organic chemical compounds isolated and described, its application in the chemical industry to the purposes for which it seems by nature so well fitted has never reached proportions to make its name known among a majority of the industrialists. Why this should be is one of the unexplained mysteries of chemical technology; for, while this material has remained unrecognized technically, at the same time a wide search has been made by chemists for a substance of almost its identical properties to amplify the very restricted number of commercial solvents now at the command of our extraction industries. It was through the first synthesis of this substance from ethylene and chlorine by four Dutch chemists¹ that the name of "olefines" (oil-forming) was given to the entire series of homologous ethylene hydrocarbons. This name has lived, but the material itself has been pushed to the back shelves of our chemical museums, where it has been apparently overlooked in this search. It may be that a lack of knowledge of convenient technical processes for its production has caused this neglect. In any event, that this material is now on the market as a product of the rising olefine gas industry is an item which should interest many industrial chemists, seeking for new possibilities with new commercial materials.

Since the first production of ethylene dichloride in 1795, it has frequently been the subject of academic investigations. Its properties have been accurately catalogued, its sources of production have been described, and through the limited number of reactions which it has been shown to undergo its chemical stability has been demonstrated. This compound ($C_2H_4Cl_2$) has been variously known as "Dutch liquid," "elalylchloride," "ethylene chloride," "ethylene dichloride" and also by the more exact term "1,2-dichloroethane." Of these names, ethylene dichloride is perhaps the most used and is most descriptive of its method of preparation. When pure, it is a colorless liquid, with a pleasant, chloroform-like odor. It boils at 83.5 deg. C. at 760 mm. and on cooling to a low temperature forms crystals which melt at -36 deg. C. It has the density, $D_{40}^{20} = 1.2569$; the specific heat of 0.3054 at 30 deg. C.; and the latent heat of vaporization of 157.5 B.t.u. per lb. at 0 deg. C.

Of the various methods of preparation of ethylene dichloride the only one of commercial importance is

the direct combination of ethylene and chlorine. This reaction takes place readily under a variety of conditions, and different combinations of these conditions have formed the basis of recent patents,² which, however, do not seem to have been operated successfully to date. In the earlier described processes gaseous ethylene and chlorine were simply permitted to mix in a vessel, the liquid product condensing out as formed. In this procedure, however, the rather considerable heat of reaction caused the reacting gases to assume a temperature much above normal with an attendant continuation of the reaction to form higher chlorinated products, such as trichlorethane. Then, too, this reaction is slow and requires a large reacting volume for a given production. Modifications of this reaction have been suggested, such as to cool the reacting gases and to use catalysts such as moisture³ or calcium chloride.⁴

Brooks and Smith⁵ have suggested the use of chlorine dissolved in a solvent for the production of mixed ethylene and propylene dichlorides from oil gas and also the use of sulphuryl chloride as a chlorinating agent for unsaturated hydrocarbons from oil gas. In the writer's work it has been found that when dry ethylene and liquid chlorine are brought into contact with each other there is a rapid and exceedingly smooth formation of ethylene dichloride.⁶ This reaction is carried on preferably at temperatures somewhat below 0 deg. C. and at a pressure corresponding to the vapor pressure of chlorine. There is very little further chlorination of the ethylene dichloride, even though held for some time in an excess of liquid chlorine—an excellent example of the stability of this substance. As a byproduct, ethylene dichloride has been found in the production of other materials also produced by the chlorination of ethylene—e.g., ethylene chlorhydrin and mustard gas (β, β' -dichlorethyl sulphide). Also it has been described as occurring in the mixture found in the manufacture of carbon tetrachloride from carbon disulphide, and also from the chlorination of natural gas. A limited quantity of ethylene dichloride has been offered on the market within the past few years, but from just what source it is not known to the writer.

Investigations in the past have shown that chemical derivatives of ethylene dichloride can be made. Regnault described the production of vinyl chloride by action of alcoholic potash on this material.⁷ Matter,⁸

*A contribution from the Mellon Institute of Industrial Research of the University of Pittsburgh.

*This article, the third of a series of five, treats of the technical significance of a well known laboratory substance which is now made available commercially through the development work carried out by the Carbide & Carbon Chemicals Corporation at Clendenin, W. Va. Parts I and II were published Nov. 16, p. 907, and Nov. 23, p. 955, respectively.

¹Deimann, Troostwyk, Bondt and Louwrenburgh, *Crelle's Ann.*, vol. 2, pp. 195, 310 and 430, (1795).

²Mercereau, U. S. Pat. 1,224,485. Brooks and Smith, U. S. Pats. 1,231,123 and 1,235,283. Tinker, Br. Pat. 108,062. Harding, Br. Pat. 126,511.

³Brooks and Humphrey, *J. Eng. Ind. Chem.*, vol. 9, p. 750 (1917).

⁴Smythe, *J. Soc. Chem. Ind.*, vol. 35, p. 1,130 (1916).

⁵Brooks and Smith, U. S. Pat., *loc. cit.*

⁶G. O. Curme, U. S. Pats. 1,315,542 (1912) and 1,315,545 (1919).

⁷Regnault, *Ann.*, vol. 14, p. 30 (1835).

⁸Matter, U. S. Pat. 1,237,076 (1917).

Hough,⁹ Brooks¹⁰ and Hilbert¹¹ have shown that glycol can be made by hydrolysis with an alkali or alkali salt at elevated temperatures. Boehringer¹² describes the formation of ethylene diamine with liquid ammonia and at high temperatures. However, these extreme conditions necessary to bring about reaction in the above instances, as well as the method of production mentioned above, show clearly that it is among the most stable of the simpler organic compounds.

SOLVENT PROPERTIES

This characteristic of ethylene dichloride, in addition to its high solvent action on oils, fats, waxes and certain resins and gums, points clearly to its qualifications as a solvent. The solubility of these materials in the chlorinated solvents as a class is already too well known to need detailed description and for general purposes ethylene dichloride ranks among the best. Dr. L. H. Baekeland,¹³ in his Chandler Foundation lecture in 1914, speaks very highly of the value of this material as the chlorinated solvent of the future.

RESISTANCE TO HYDROLYSIS

In a comparison with other chlorinated solvents, the outstanding characteristic of ethylene dichloride is its chemical stability above mentioned and its resistance to hydrolysis under conditions of solution and extraction. The hydrolysis of carbon tetrachloride to break off hydrochloric acid in extraction work where water is present is well known, and has unfortunately resulted in serious damage to iron- and lead-lined extraction equipment. The commercial chlorinated solvents derived from acetylene—namely, acetylene tetrachloride, trichlorethylene and dichlorethylene—which must not be confused with the above, are also subject to the same objection, though to a lesser degree. Ethylene dichloride, alone of all the chlorinated solvents, may be safely handled in presence of water at a boiling temperature, in iron or other metal vessels without danger of damage from corrosion. In confirmation of this freedom from destructive effect, tests on corrosion by organic halides published by Doughty¹⁴ show ethylene dichloride as the only one of the commercial chlorinated solvents examined which did not reveal corrosive action under the condition of the tests made.

The relatively lower density of this solvent is favorable to its use, as the cost per volume of liquid used is thus lessened. The boiling point of 83.5 deg. C. is ideal for most purposes, permitting a complete removal of the solvent without excessive temperatures, and yet permitting easy condensation and giving minimum loss on handling. As a commercial product it can be supplied in high purity; therefore instead of boiling range of many degrees it will boil sharply at a given temperature. This feature avoids one of the main objections of most commercial solvents—namely, that of leaving a "heavy end" in the extract as well as in the residue.

Again the stability of ethylene dichloride is shown in its resistance to oxidation. Many of the chlorides of carbon when kept in a partly filled container split off hydrochloric acid and give an oxidized product; for instance, in the cases of chloroform and carbon tetrachloride the poisonous phosgene is formed under such conditions. With ethylene dichloride this oxidation does

not occur to a noticeable extent; accordingly no preservative is needed, it may be re-used indefinitely, and no unpleasant odor or flavor is given to edible products.

The above characteristics recommend this solvent particularly for the extraction of edible oils and other products where highest purity is a prime requisite. A further application in the extraction of grease from wool seems to offer promise as well.

In quite another line of solvent work where it is desirable to use a strongly reactive substance in solution, the stability of ethylene dichloride is of advantage. In such reactions where free chlorine, sulphuryl chloride, sulphur monochloride and other active reagents are to be used in solution, ethylene dichloride may safely be used as a solvent without being affected.

LOW FIRE HAZARD

It has been found that ethylene dichloride will support combustion when ignited in the air, but only with difficulty. It is a compound just on the border line of the fire-extinguishing chlorinated hydrocarbons and the combustible hydrocarbons. In many cases when ignited the draft from the combustion will blow out the flame, so weak is the tendency to burn. In any case, as regards industrial use, being heavier than water, it is therefore extinguished by water in contradistinction to benzene or gasoline.

PHYSIOLOGICAL PROPERTIES

The effect of inhaling the vapor of ethylene dichloride is not dangerous, although, as in the case of any organic solvent, it is to be avoided as far as possible in high concentrations and for extended periods. In earlier days of medicine this substance was in actual use as an anæsthetic,¹⁵ which of itself demonstrates that there need be no serious after-effects from its inhalation, even though carried to the extreme point of loss of consciousness.

It is interesting to note that in current articles on matters relating to the solvent extraction and related industries the matter of the solvent is given great importance. In particular, the need of an "ideal" solvent is emphasized. The writer is quite willing to admit that such perfection is not to be hoped for in any material of chemistry; but as a solvent that approaches the ideal, it is quite possible that it will be found that this has been contributed by the olefine gas industry in ethylene dichloride.

SUMMARY

The characteristics of ethylene dichloride which recommend it for use in extraction and solvent work are:

1. It is an excellent solvent for oils, fats and greases.
2. It is a pure chemical with constant boiling point.
3. It can be removed completely from both extracts and residue, leaving no unpleasant odor or taste.
4. Its density and heat of vaporization are low.
5. Its stability permits indefinite re-use and freedom from chemical action on materials treated.
6. It does not corrode metal, even in presence of water at the boiling point.
7. It may be used without danger to workmen.
8. It presents a very low fire hazard.

(Part IV, dealing with isopropyl alcohol, will be published in a subsequent issue.)

⁹Hough, U. S. Pat. 1,206,222 (1915).

¹⁰Brooks and Humphrey, U. S. Pat. 1,215,903.

¹¹Hilbert, U. S. Pat. 1,270,759 (1918).

¹²Boehringer, Ger. Pat. 218,466.

¹³Baekeland, *J. Ind. Eng. Chem.*, vol. 6, p. 774 (1914).

¹⁴Doughty, *J. Am. Chem. Soc.*, vol. 39, p. 2685 (1917).

¹⁵Gwathmey, ("Anesthesia," Appleton, New York, 1914, p. 749) states: "Its [ethylene dichloride] anæsthetic action was first studied by Simpson in 1846, Snow in 1848, Clover in 1848 and Richardson in 1851. The latter regarded it as a good anæsthetic, very much like chloroform in its action, although less rapid."

On the Theory of the Hardening of Metals

The Japanese Scientist Thinks That Hardness in Metals Is Due in Part to Forces Between Atoms and in Part to an Interlocked, Strained Crystalline Structure—Heat-Treatment of Duralumin Is Quite Similar to That of Steel

By KOTARO HONDA

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IN this journal for June 15, 1921, vol. 24, p. 1057, Zay Jeffries and R. S. Archer have written an interesting article entitled "The Slip Interference Theory of the Hardening of Metals," explaining by their theory many complicated phenomena regarding the hardening of steel by quenching, as well as the aging of duralumin after quenching. The essential feature of the theory lies in the assumption that the internal slip in the metal caused by stress is hindered by the presence of fine, hard particles scattered uniformly throughout the mass, and hence the metal is greatly hardened. However, this assumption is not very probable, when the quantity of hard particles amounts only to a few per cent of the whole mass.

To take a simple analogy, do we know how much gelatin becomes hardened when mixed with a few per cent of fine sand or fine grains of some compound? On the other hand, where hard particles contain only a few per cent of gelatin or other cementing material, the whole mass becomes considerably hard. In a solid solution, the solute is distributed, in particles no larger than an atom, among the atoms of the solvent according to the space-lattice of the latter, and hence the analogy between a metal containing hard particles of much larger size and the solid solution can no longer hold, as the conception denoted by the word "hard" is not applicable to the atoms themselves. Hence the slip interference theory should not be extended to the case of solid solution.

INTERMOLECULAR FORCES

In a solid substance, the molecular force exerted in an atom from one of its neighbors consists of an attraction and a repulsion; if it were mere attraction, all the atoms will collapse into a single compact mass. Thus the expression of the molecular force between two atoms will be given by an expression, for example, of the form

$$F = \frac{am}{r^\mu} - \frac{bm}{r^{\mu+\nu}}$$

where m is the mass of the atoms, r is the average distance apart, a and b are both positive constants characteristic of the substance, μ and ν are positive values probably greater than 3. Since atoms have a complex structure, it is easy to understand that μ and ν are not constant for wide variations in the separating distance and especially when the atoms are placed close together, their values depending on the distance and orientation of the atoms. At a very small distance the second term measuring repulsion predominates, while at a relatively large distance the first or "attraction term" prevails. When no external force acts on the substance, the resultant force acting on any one of the atoms is zero.

A hard substance may therefore be defined as one for which a small variation of the relative configuration of

the atoms causes large forces between atoms; that is, $\frac{dF}{dr}$, or a , b , μ and ν are large. It is also evident from this consideration that the hardness or strength of a substance changes when it undergoes an allotropic transformation. To take a concrete example, martensite, which may be considered as an allotropic modification of austenite, has a great hardness as compared to the latter. According to the result of X-ray analysis, the atomic distribution of austenite is as a face-centered cube, while that of martensite is a body-centered cube; thus the atoms in austenite are in the closest packing. As the hardness of a solid solution is largely measured by the value of $\frac{dF}{dr}$, it is quite possible that a distribution having a less close packing of the atoms—martensite—has a greater hardness than that of the closest packing—that is, of austenite.

TWO DISTINCT KINDS OF HARDNESS

The present author's theory of hardening¹ differs wholly or in some respects from some of the other existing theories—that is, β iron theory, the amorphous theory, the solid solution theory, the interstrain theory, and the slip interference theory.

It is first of all necessary to differentiate hardness into two classes according to its origin:

(I) Hardness due to molecular force.

(II) Hardness due to the crystalline structure of metals.

Consider Class I. A pure metal or solid solution is homogeneous; for such substances, the hardness must depend solely on the molecular force, as already explained above. In this case, Tammann's theory² of the hardness of solid solutions is quite correct. If two metals are able to mix with each other in all proportions, then the hardness of the alloy generally exceeds that of either of its components, and this hardness has a maximum in an alloy containing an equal atomic quantity of the components. The very fact of miscibility of two metals indicates that the molecular force and its gradient acting between the molecules of different metals are greater than those acting between atoms in the pure metal; and therefore if the two metals form an alloy, the molecular force due to the change of atomic configuration (that is, the hardness) will be greater than that in the respective metals and be maximum in the alloy corresponding to an equal atomic quantity of the components.

Next, let us consider that hardness due to the crystalline structure.

¹K. Honda, *Sci. Reports*, vol. 6, p. 95 (1917).

²Lehrbuch der Metallographie, p. 332 (1914).

Suppose a metal to consist of an immense number of acicular or needle-shaped crystals, which are imbedded in a homogeneous component or in a solid solution and have their lengths all parallel to one another. Such metal very strongly resists tension acting in the direction of the needle crystals, but only weakly the pressure acting perpendicularly to them. This can easily be understood from the analogy of a wire, which can resist a strong tension, though it bends by a small force acting perpendicularly to its length. If the direction of the axes of needle-shaped crystals be uniformly distributed in all directions, then the metal will resist indentation by the Brinell ball very strongly, for the compression will result in stretching a certain fraction of the whole number of needle-like crystals and therefore produce tension in these crystals. A good illustration will be found in the case of the wheels of a bicycle, in which a certain number of spokes radiate from a common center toward the circumference. It is well known that although the spokes are very thin, the wheel can resist a great tension or compression acting in any direction. Hence if a metal contains fine acicular or needle-shaped crystals and their axes are uniformly distributed in all directions, the metal is very hard. By this theory, a metal is harder as its structure is finer and the crystals are in a highly stretched state.

HONDA'S THEORY OF HARDNESS

The above theory may be briefly expressed in the following words: For a given substance having a definite molecular force, its hardness increases with the fineness and the strained state of structure; and for the same structure and the same degree of strain, the hardness of a substance increases with the strength of the molecular force developed by a given change of the configuration in the atoms. This theory, though it is very simple, explains many observed facts in a very satisfactory way. Thus the hardness of solid solution of cementite in iron is partly due to fine martensite or acicular crystals cemented together. These fine crystals will probably be left in highly strained states by rapid cooling, like tightened spokes of a bicycle, thus further increasing the hardness of the solid solution.

Hardening by cold-working or overstraining is also explained in a similar way. This process is analogous to that of tightening the spokes of the bicycle wheels to insure its solidity. Cold-working or overstraining puts fine crystals in a highly stretched state; this state corresponds obviously to the hard state of the substance. In this respect my theory coincides with the interstrain theory; the latter, however, does not explain why interstrain causes greater hardness of the substance, but in my theory this is explained by a well-known mechanical property of the material. By annealing a specimen which has undergone cold-working, the strained state of the minute crystals is released, grain growth takes place, and therefore the hardness decreases on both accounts.

WHAT IS MARTENSITE?

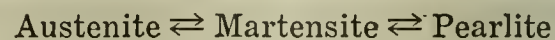
In the theory of hardening this important question arises: Why on quenching a steel in the austenitic state is a martensitic structure instead of an austenitic or pearlitic structure obtained? In metallurgical investigations we very often use the principle that by quenching a metal from a high temperature the structure at this temperature is preserved at room temperature, but the formation of martensite is an exception to this principle, and we feel a great uncertainty with

regard to the general result of many heat-treatments. Some metallurgists have considered martensite to be an indefinite semi-transformed substance; but considered from the result of recent investigations, we must consider it to be a perfectly definite phase. From X-ray analysis it is to be concluded that martensite is a different phase from austenite and also that although martensite has the same atomic distribution as ferrite, at least with respect to iron atoms, it contains carbon in solid solution, hence is different in phase from ferrite.

According to the result of some experiments made at the Tôhoku Imperial University which have not yet been published, the heat of transformation from martensite to pearlite is definite and proportional to the content of carbon, amounting to about one-third the heat liberated at the A_1 transformation. This also indicates that martensite has a definite structure. The fact that the hardness and specific volume of martensite are very large in magnitude as compared to both austenite and pearlite disproves the conception that martensite is an intermediate stage of the transformations from austenite to pearlite (or in a strict sense from austenite to troostite).

THEORY OF QUENCHING

Having thus far cleared the nature of martensite, we now proceed to consider the theory of quenching.³ According to my opinion, the so-called A_1 transformation is not a simple but a compound transformation consisting of



Thus, during a slow or rapid cooling, austenite is at first changed into martensite, which is then transformed into pearlite. During a slow cooling, austenite changes into martensite, and the latter, being at a very high temperature, changes immediately into pearlite. But during a very rapid cooling, such as quenching, the change from austenite to martensite is so far retarded that when this change is completed the specimen is nearly at room temperature, and therefore the next change from martensite to pearlite cannot progress, owing to the high viscosity of the material at that temperature. Hence quenching produces a hard martensitic structure. During heating, the A_1 transformation also consists of the reverse changes—that is, from pearlite through martensite to austenite.

In the above conception it is obvious that the general principle that quenching preserves the state stable at the elevated temperature is not violated in the least by the formation of martensite by quenching. If the quenching is too severe, even the first transformation from austenite to martensite is partly prevented, and therefore at room temperature we obtain a martensitic structure containing a certain amount of austenite. This austenite has a tendency to change into martensite, and in fact changes very slowly at room temperature. Hence the hardness of a severely quenched steel increases with the lapse of time, as has actually been observed.⁴

If the quenched steel be heated at 100 deg. C., the above transformation from austenite to martensite is accelerated, and therefore the increase of hardness goes on more rapidly than at room temperature. But if the heating temperature is too high, say 300 deg., not only the first change but also the second change from marten-

³K. Honda, *Sci. Reports*, vol. 8 (1919), p. 181; *Iron & Steel Inst.*, No. 1 (1920).

⁴K. Honda and S. Idei, *Sci. Reports*, vol. 9 (1920), p. 491.

site to pearlite begins to take place, and therefore the hardness decreases as a whole—that is, the steel is tempered.^{4,5}

It is quite natural that the A_1 transformation consists of a double change

Austenite $\rightleftharpoons$ Martensite $\rightleftharpoons$ Pearlite

as is readily seen from the following considerations: From the standpoint of X-ray analysis, it is highly probable that both austenite and martensite are solid solutions of carbon, but not cementite, in iron. But the separation of carbon from its solid solution takes place as cementite; hence for its separation (that is, for the A_1 transformation) austenite will first change into martensite, a configuration more favorable for the separation of carbon as cementite, and then follows the separation of cementite, or what is the same thing, the transformation of martensite to pearlite. As shown below, a similar stepped change also exists in the case of duralumin.

An investigation of duralumin by S. Konno⁶ resulted differently from those of P. D. Merica, R. G. Waltenberg and H. Scott⁷ in some important points. The following are the chief results of his investigation:

RESULTS OF INVESTIGATION OF DURALUMIN

1. In quenched duralumin, the softer the quenching the greater the immediate hardness increase, but the gain in hardness by aging as well as the final hardness decreases. In a quenching in oil at 100 deg. C. or higher temperature the aging effect vanishes. On the other hand, the more drastic the quenching the immediate hardness decreases, but the aging effect and the final hardness increase, their maximum values being obtained by quenching the alloy from 500 deg. C. in water.

2. The above effect of quenching is due to the precipitation of copper and magnesium compounds from the aluminum, the process of separation being very slow. Thus duralumin is in a somewhat hardened state; even if it is cooled very slowly from 500 deg. C., a perfect annealing is obtained only by heating the alloy at 350 deg. C. for 1 hour or more.

3. Up to about 6 per cent Cu, alloys of Al and Cu show by quenching an immediate hardening, but very little effect on aging. Hence the immediate hardness is partly due to the precipitation of CuAl_2 in Al.

4. With an addition of a small quantity of Mg (0.7 per cent) to the above alloys, an immediate hardening as well as an aging effect becomes prominent, and nearly of the same order as in duralumin. A further addition of manganese increased the quenching effect, viewed as a whole.

5. The aging after quenching is attributed to the precipitation of Mg_2Si from the solid solution of CuAl_2 in Al. It is not due to metallic magnesium, because a mere increase of Mg does not result in an increase of aging effect, but an increase of both Mg and Si in the proportion of the compound Mg_2Si magnifies the same effect. As a matter of fact a small quantity of Si (0.5 to 0.7 per cent) is always present in Al as an impurity. The content of Si being assumed to be 0.7 per cent, the effect of quenching, if Mg increases beyond 1 per cent, begins to diminish, and almost vanishes above 3 per cent Mg.

The last three results, 3, 4 and 5, differ from those by Merica, Waltenberg and Scott.

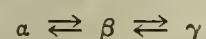
6. From the specific resistance versus temperature curves for quenched duralumin, we conclude that the quenched alloy is tempered at two steps beginning at 210 and 280 deg. respectively. The first step in the curves is due to the partial separation of CuAl_2 , and the second to that of Mg_2Si .

7. Quenched duralumin expands at room temperature as the aging proceeds, thus being similar to quenched low-carbon steels.

ESSENTIAL SIMILARITY IN PROCESS WHEN HARDENING STEEL AND DURALUMIN

The above effect of quenching and the accompanying change of physical properties are quite similar to those in severely quenched carbon steels. Hence we can explain the hardening by quenching in exactly the same way as in steels.

As stated above, duralumin contains two compounds, CuAl_2 and Mg_2Si . Hardening resulting from quenching may be considered as the effect of Mg_2Si in the solid solution of CuAl_2 in Al. The solubility of Mg_2Si begins at about 350 deg. and rapidly increases with the rise of temperature. Let us call CuAl_2 : Al solid solution containing dissolved Mg_2Si the γ state and that containing Mg_2Si as a mixture the α state. As in the case of cementite dissolved in iron, the separation of the compound is assumed to take place in two steps—that is, γ solid solution is at first changed into β solid solution, whose atomic configuration is favorable for the separation of the compound, and which is also very hard as compared to γ or α state, and then the separation of the compound from β follows. In conformity with the observed facts, the transformations



are assumed to progress very slowly.

According to the above theory, by quenching duralumin in water even the first transformation from γ to β is partly arrested, and we obtain β mixed with γ at room temperature. Gamma state, thus quenched, changes at room temperature very slowly into a hard solid solution β ; but β changes into α scarcely at all. The consequence is that by quenching, the alloy is hardened and its hardness increases with time. Thus the immediate effect of quenching is determined by the quantity of β present, and the aging effect by that of γ .

If the quenching is very severe, a larger part of γ is preserved at room temperature, only a small remainder being β , so that the aging effect is very large, but the immediate hardness effected is small. As the quenching becomes less drastic, the quantity of β at room temperature increases and that of γ decreases; hence the immediate hardness increases, but the aging effect decreases.

By heating the quenched specimen at a temperature higher than room temperature, say 100 deg. C., the transformation of quenched γ into β is accelerated, so that aging takes place in a comparatively short time, as actually observed. But if the heating temperature is too high, say 300 to 350 deg. C., not only quenched γ is changed into β , but also the second transformation of β into α takes place comparatively rapidly, so that the hardness decreases as a whole. This is a case of tempering. The above explanations are given by way of examples, but all results observed are equally well explained by the above theory.

⁴C. Grard, *Proc.*, Sixth Congress, International Association for Testing Materials, III.

⁵This paper will be published in the near future.

⁷Scientific Papers of the Bureau of Standards, vol. 15, pp. 105, 271; *CHEM. & MET. ENG.*, vol. 21, p. 551 (Oct. 29, 1919).

Auxiliary Electrochemical Developments for Hydro-Electric Plants

BY H. K. BENSON

AUXILIARY electrochemical plants offer many interesting possibilities for the utilization of the off-peak power of municipal hydro-electric developments. In the few instances where such combinations are in operation the load factor has been very favorably advanced.¹ For economic reasons there is always a certain reserve of power and always a certain amount of water going over the spillways. In the Pacific Northwest the seasonal water flow also offers an attractive inducement for an industry that can accommodate itself to the varying supply of power. The characteristics of such an industry are somewhat peculiar. First, there should be no heavy investment of money in machinery or plant, inasmuch as when the power site is fully developed there may be only a comparatively small amount of power for side consumption. Moreover, during certain years there will be no high water, a condition which would lead to the necessity of using all the storage water for power purposes for the regular load. Second, the industry must be of such a nature that it will run on intermittent power and the process must be such that it will be capable of regular shut downs. This is due to the fact that in most daily load curves of power plants there are three peaks or maximums and the power going to the side industry must lie in between these peaks.

An analysis² of the chemical processes utilizing electrical power shows only a limited number capable of operating under the conditions above enumerated. For convenience these processes may be divided into two general classes: electrolytic and electrothermal.

ELECTROLYTIC INDUSTRIES

The electrolytic industries consist of the following: (1) Refining processes in which crude metals are deposited on pure cathodes; (2) reduction and oxidation processes for the production of many organic materials; (3) fused metal processes such as the production of aluminum, calcium and sodium, and (4) the caustic potash and soda industries. Refining processes for the metals are carried out under acidic conditions and are not suitable for interrupted power, while the fused metal processes require cells of high heat capacity and consequently not adapted to variable power supply. The oxidation and reduction processes used in the manufacture of vanillin, hydroquinone, para-amidophenol, alizarine, saccharine, aniline blue, congo red and other organic chemicals might in some cases operate on the off-peak loads. But the most important processes which can utilize such loads are those involving the electrolysis of solutions as in the manufacture of caustics, hypochlorites, alkali metals, bromine, fluorine, chromium sulphates, perchlorates, hypochlorites, hydrogen and oxygen. In the caustic industry, for example, two factors are in its favor, since, first, all the extra capital requirement would be confined to the automatic valves to cut off the brine supply when the current from the power plant is needed for the peak load and second, these cells are capable of coming up to normal efficiency in from three-quarters of an hour to one hour.

These processes may be grouped under four classes

according to the manner in which electric energy is transformed into the heat energy required for the chemical reaction. These groups are: (1) The arc, which yields the highest temperature and confines the heat to a comparatively small region; (2) resistance furnaces used in the manufacture of abrasives and of iron; (3) the combination arc and resistance processes used in the manufacture of phosphorus and carbon disulphide, and (4) the induction furnaces used in steel manufacturing. Of these processes the arc seems the most suitable for the intermittent power load. It has been thus used successfully for the fixation of atmospheric nitrogen and has been recommended by the British Ministry of Munitions to the House of Parliament for use in England.³

In the selection of an industry for the utilization of off-peak power the first choice would lie in the arc process, because of the great advantage the arc process holds over all others due to its low heat capacity and the fact that the cost of production is largely dependent on the cost of power. Second choice rests in the electrolytic processes excepting only the refining of metals. Although their capital requirements are high, depreciation is small and the low price of off-peak power is quite a factor in their costs of production. The third choice lies with the processes using the combined arc and resistance furnace under conditions where seasonal power would be available to maintain the necessary heat capacity of the furnaces continuously or where the margin of reserve power could be similarly utilized.

RECOMMENDATIONS FOR SKAGIT PROJECT AT SEATTLE

A detailed study of the particular chemical industry to become an auxiliary of a given hydro-electric plant involves of course its location with respect to raw materials and markets for the products. A careful analysis of such conditions in the case of the new Skagit hydro plant under construction by the city of Seattle has led to the following conclusions:

1. The most suitable means for increasing the load factor of the Skagit project would be the fixation of nitrogen by the electric arc.
2. The production of phosphoric acid by electrochemical means would be the second choice.
3. Hydrogen and oxygen as produced in the electrolytic cell would rank third in suitability excepting only under the condition that there would be established in or near Seattle a hydrogenation industry, in which event this electrolysis would rank second if not first.
4. The electrochemical production of caustic and allied products or of organic chemicals takes fourth place in utilizing the power wastage of the Skagit project.

It is obvious from data gathered in this investigation that close co-ordination between the chemical and electrical engineers in the development of hydro-electric plants will bring forth results of mutual value in the development of these newer phases of industry.

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Extension of Japanese Government Steel Works

The Yawata (Government) Steel Works, in Kiushiu, is now building a mill to manufacture billets for private steel makers. Press dispatches state that the construction program calls for completion of the plant about April, 1924, when a productive capacity of 200,000 tons of billets per year is expected.

³Final Report, Nitrogen Products Committee.

¹*Elec. World*, vol. 67 (1916), pp. 581, 582.

²From data compiled by D. A. Somerville and A. H. Roos in an engineering thesis, University of Washington.

Recent Developments in the Sulphuric-Acid Industry—IV*

Description of Two New Types of Nitration Processes for Producing Sulphuric Acid Without the Use of Lead Chambers—Adsorptive and Catalytic Properties of Silica Gel—Conclusion

By ANDREW M. FAIRLIE
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THE first serious attempt to manufacture sulphuric acid by a nitration process without the use of lead chambers was the invention of Opl, of Hruschau, Austria, patented in the United States in 1911. The Opl process made considerable headway in Europe, but it received little attention, in a practical way, in this country. Recently two other nitration processes, without chambers, have been proposed, and at least one installation of each type has been erected. These two processes are the Kaltenbach pipe process and the so-called "packed-cell" process.

THE KALTENBACH PIPE PROCESS

M. Kaltenbach, after careful consideration of the thermal balances between the heat entering and leaving (a) the Glover tower; (b) the first two chambers out of a total of four; and (c) the last two chambers, came to the conclusion that the defects of the chamber process were the impossibility of obtaining throughout a set of chambers the most favorable reaction temperatures; the unsatisfactory contact between the reacting gases and liquids; the inefficiency of the lead surfaces for the dissipation of heat; and the bulky and expensive construction.¹⁶

To overcome these defects the pipe process was devised and patented by Kaltenbach. Its main characteristics are: (1) The dissipation of the evolved heat in the immediate vicinity of its generation. (2) The possibility of regulating both the reaction temperature and the acid concentration simultaneously to obtain the most favorable conditions. (3) Intimate contact between the reacting gases and liquids.

The apparatus consists of a multiplicity of pipes or tubes packed inside and water-jacketed outside. The gases leaving the Glover tower proceed through the tubes of successive systems, in counter-current to the acid, which is mixed as required with appropriate quantities of water. The gases are fed to the parallel tubes comprising any group in a series, through a common header, and devices are provided to assure the regular distribution of acids and gases in the tubes. The dimensions and the shape of the tubes have been carefully designed so that the cooling effect of the water jacket

may be felt at the center as well as at the walls. The number of tubes installed depends on the volume of gases to be treated.

The following description of the apparatus is taken from the abstract of Kaltenbach's paper:

"In the figure (Fig. 33), which is a diagrammatic representation of this apparatus for making sulphuric acid, 1 is the Glover tower which receives through the pipe 2 the hot gases coming from the furnaces and which discharges these gases through pipe 3 into the first piping system 4, which is made up of a number of tubes, all constructed alike, provided with interior packing of uniform resistance 5, and surrounded by a water jacket 6. The circulation of the water can be regulated by means of the admission valve 7. Each tube can be isolated from the rest of the apparatus by means of the dampers 8 and 9. The gases then pass through the rest of the tubes 10, which are constructed in a similar

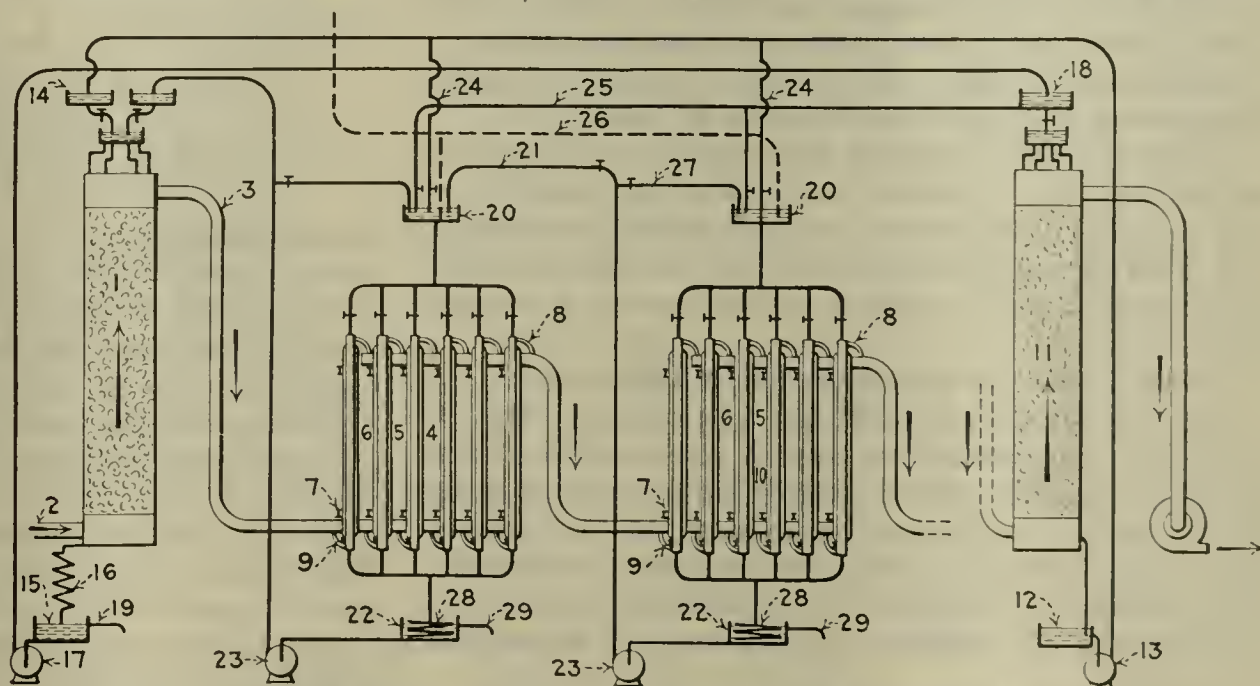


FIG. 33. DIAGRAM OF KALTENBACH PIPE PROCESS FOR THE MANUFACTURE OF SULPHURIC ACID

fashion, and finally through the Gay-Lussac tower 11, which may itself constitute the last pipe system of the series, the only difference being that the temperature is maintained therein at as low a point as possible.

"The nitro-sulphuric acid (60 deg. Bé.) recovered from the Gay-Lussac tower in the reservoir 12 is raised by means of the pump 13 to the supply tank 14, which feeds the Glover tower. The acid which comes from the tower and is collected in the tank 15, after having first passed through the cooler 16, is partly returned to the Gay-Lussac feed tank 18 by means of pump 17. The surplus acid is removed through the pipe 19 and forms part of the production.

"The pipe systems 4 and 10 are supplied with acid by means of the feed tanks 20, which may receive a regulated quantity of acid through the piping arrangement

*For Parts I, II and III, see CHEM. & MET. ENG., vol. 25, Nos. 19, 20 and 21, pp. 861, 917 and 964.

¹⁶*Chimie et Industrie*, vol. 3, No. 4, 1920; abstracted by Ismar Ginsberg in *Chemical Age*, vol. 28, p. 295.

21, which conveys the acid recovered in the corresponding system of tubes. The acid is collected in the reservoir 22, and is elevated by the corresponding pump 23 (1) through the pipes 24, connected to the line supply of nitro-sulphuric acid used in irrigating the Glover tower; (2) through the pipes 25, conveying the 60 deg. Bé. sulphuric acid used in irrigating the Gay-Lussac tower; (3) through the pipes 26, connected with the water supply; and (4) through the pipes 27, conveying acid from the catch-tank 22 of the same pipe system. This latter acid from the lower catch-tanks 22 can be cooled by means of an appropriate cooling system. The tanks are provided with outlet pipes, making it possible to remove acid which would correspond to any piping system in the series."

It will be observed that this process not merely tries to eliminate the heat of reaction by a more or less intense external cooling, which is claimed to be twenty times as effective as the cooling effect of air-cooled lead chambers, but that it also combines with that effort the practice used in the tower processes (such as the Opl and the packed cell processes), of circulating cooled acid through packed spaces, in counter-current to the flow of gases.

The advantages claimed for this process are:

1. Great ease of controlling the reaction temperature, by means of the circulation of water in the water jackets, and of cooled acid within the tubes.
2. Effective utilization of the surface of the tubes for the interchange of heat.
3. Reduction in the amount of lead and other materials of construction used, thus reducing first cost.
4. Ease of isolating one or more tubes for cleaning or repairing, without affecting rest of plant.
5. Possibility of limiting the number of tubes used to precisely what is needed for production required.
6. Complete independence of atmospheric conditions.
7. Less difficulty in concentrating the entire production to 60 deg. Bé. by making use of the heat generated in the reactions.
8. Elimination of water-atomizing apparatus.

It is apparent that such an apparatus as this is much more complicated, so far as construction details are concerned, than either a chamber plant or a tower plant. Announcement has been made that an installation of commercial size has been erected. Information as to details of construction, operating results, and durability of the apparatus in service will be awaited with interest.

"PACKED CELL" PROCESS

The "packed cell" process, described briefly in U. S. Bureau of Mines Bulletin No. 184,¹⁷ is the invention of E. L. Larison, of the Anaconda Copper Mining Co., Anaconda, Mont. The process is protected by U. S. Patent 1,342,024, issued June 1, 1920. Another patent, U. S. 1,334,384, covers special features of tower construction, designed by Larison.

The packed cell process is a nitration process, and in its use of acid-sprayed packed towers, or "cells," instead of lead chambers, for the reaction spaces it resembles more the European Opl process than any other. For the operation of the process a specially designed "packed cell plant" was needed.

In designing a type of plant which would give promise of being less costly, less bulky and more efficient than

the conventional chamber plant, two desirable features of operation were kept in mind, together with the idea of adapting to these features a recent development in chemical tower construction, previously referred to.¹⁸ These three ideas were: First, to construct an apparatus in such a way that the gas mixture from the Glover tower would be made to impinge vigorously on surfaces wet with sulphuric acid of specific gravity too low to effect appreciable absorption of oxides of nitrogen; second, to control the temperature of the reacting gases by circulating in direct contact with them quantities of cool weak acid; third, having provided for the removal of the reaction heat by means other than by radiation through metallic walls, to dispense altogether with lead chambers and adapt acid-proof masonry towers (now at a satisfactory stage of development), internally packed, to the new design.

These considerations led to a design of plant including essentially the following: (1) A Glover tower of

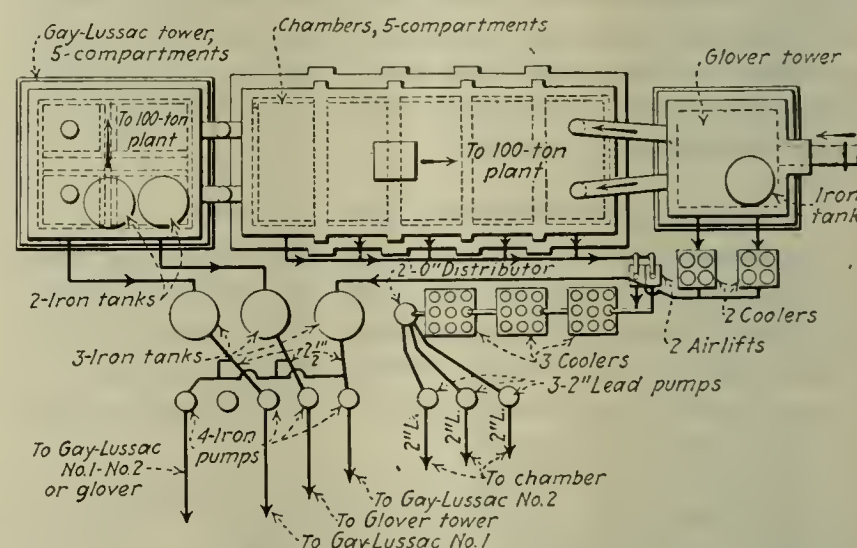


FIG. 34. PLAN OF ANACONDA PACKED CELL ACID PLANT. CAPACITY 21 TONS OF 60 DEG. BE. ACID PER DAY

conventional design. (2) A series of packed cells, or towers, built *en bloc*, exterior walls as well as interior walls of acid-proof masonry, the whole structure built in a lead pan, and the towers packed with checkerwork brick; the gas to take an alternately downward and upward course in passing through the cells; and each cell provided on the top with acid-distributing apparatus. (3) Gay-Lussac towers built *en bloc*, but as a separate structure from the packed cells. Construction similar to that of the latter structure, with the exception of provision of a gas downtake, unpacked, between Gay-Lussacs.

After experimenting on a small scale with this process, a plant of about 20 to 25 tons capacity was built at Anaconda. The plant consisted of one Glover tower, five packed cells in series and two Gay-Lussac towers, and is shown in plan and elevation in Figs. 34 and 35. Referred to the total packed cell space, the packed Glover space was about 15 per cent, and the packed Gay-Lussac space was about 60 per cent. At this plant the packed cell and Gay-Lussac structures were sheathed with 6-lb. lead. After the operating conditions were established, part of the lead sheathing was removed to determine whether acid or gas leakage through the acid-proof masonry was serious. It was found that gas leakage was negligible and acid leakage was slight. As the acid leakage made the wall wet, a 4-in. veneer wall was laid 2 in. away from the main wall and tied into the latter at suitable intervals with brick. This, it is said, made a gas-tight wall and a dry, clean outside.

The gas, derived from roasting copper concentrates,

¹⁷Wells and Fogg, "The Manufacture of Sulphuric Acid in the United States," pp. 111-114 (1920).

¹⁸See Part II, CHEM. & MET. ENG., vol. 25, No. 20, p. 917.

was forced into the acid plant by a Buffalo Forge Co. volume blower, with cast-iron housing, plate runner and water-cooled bearings, which was located between the burners and the Glover tower. For pumping the acids, direct-connected motor-driven vertical centrifugal pumps were installed, iron ones for 60 deg. acid and lead or lead protected pumps for weaker acid. Coolers of conventional design were provided for cooling the Glover acid and the cell acids; and provision was made for introducing warm acid into the later cells and cold acid into the earlier cells, with a view to maintaining favorable reaction temperatures throughout. The final cell of the series of five, however, was fed with generous quantities of cold acid, in order to cool the gas mixture prior to entry into the first Gay-Lussac tower. For hydration, neither steam jets nor water atomizers were used; but water, added to the circulating cell acids in the proportions required, was introduced into the acid-distributing boxes at the tops of the cells.

This plant was first operated in May, 1919. Operating on a rather irregular roaster gas, the actual acid production, over a period of several months, is stated to have been at the rate of (nearly) 4 lb. of 60-deg. acid per cu.ft. of packed cell space; or, in other words, 1 cu.ft. of gross packed cell space was employed per lb. of sulphur recovered as acid.

The actual capacity of the plant is given as 21 tons of 60-deg. acid per day.

In order to produce sulphuric acid in as small a reaction space as 1 cu.ft. per lb. sulphur per day, it was

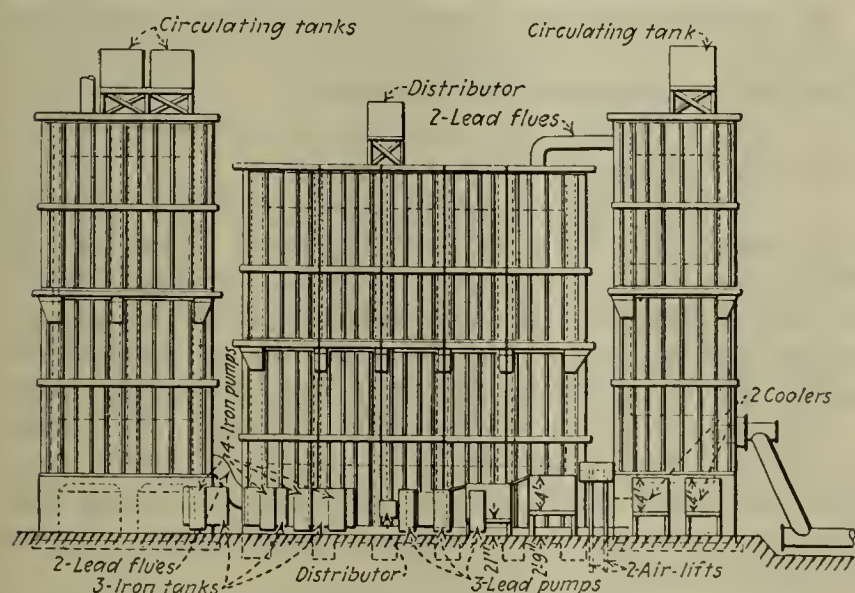


FIG. 35. ELEVATION OF ANACONDA PACKED CELL ACID PLANT

necessary, as had been expected, to increase greatly the concentration of nitrogen oxides in the gas mixture within the reaction spaces provided. The proportion of nitrogen oxides usually carried in circulation in the gas of a chamber plant, operating at the rate of 8 or 10 cu.ft. of chamber space, expressed in terms of nitrate of soda, is from 21 to 25 parts of nitrate of soda per 100 parts of sulphur. In the packed cell process the total amount of nitrogen oxides in circulation, expressed in the same terms, was about 70 parts of nitrate of soda per 100 parts of sulphur, or about three times the usual concentration. This feature of making sulphuric acid from a gas mixture containing oxides of nitrogen and oxides of sulphur in the proportion derived from not less than $\frac{1}{2}$ lb. of sodium nitrate per lb. of sulphur (a 50 : 100 ratio) appears prominently in Larison's patent claims. As compared with a chamber plant operating at the average rate of 10 cu.ft. of space per lb. of sulphur per day, the packed cell plant made acid, accord-

ing to the figures given, at an increase in reaction speed of 900 per cent. Just how much of this increase is attributable to the increase in concentration of nitrogen oxides in the gas mixture and how much is due to more vigorous impingement of the gases on the surfaces of the cell packing is not definitely known; but if we assume that the reaction velocity increases directly with the concentration of nitrogen oxides in the gases, the reaction space required per lb. of sulphur per 24 hours was reduced to 3.33 cu.ft. by increasing the niter concentration; and impingement of the gases on the cell packing was perhaps accountable for the further increase in reaction velocity, referred to the latter space (3.33 cu.ft.), of 2.33 per cent, bringing the required cell space down to 1 cu.ft. per lb. sulphur per 24 hours.

Wells and Fogg state¹⁹ that the niter consumption at this plant at the start of operations was 6 per cent, referred, presumably, to sulphur in acid made. Later advices give the niter consumption as 4.8 per cent on sulphur in acid made, and tests made on the Gay-Lussac exit gases indicate that with additional Gay-Lussac space the niter consumption might be brought down to a little under 4.0 per cent. The nitrosity of the nitrous vitriol is carried at 70 to 80 oz. NaNO_2 per cu.ft.

The optimum temperature of the acid fed into the several cells is not given, as it is stated to be variable with varying conditions. The quantity of water required for cooling the acids is given as about 2,500 gal. per ton of 60-deg. acid produced.

The gas pressure at the exit of the hot gas blower is carried at about 1.2 in. of water. No figures are available as to the power required to drive the gas through the resistance offered by the packing of the packed cells, as compared with the power required for moving gases at a chamber plant. The power used for pumps and fans combined amounts to about 2 hp. per ton of 60-deg. acid.

The quantity of acid circulated over the Gay-Lussac towers amounts to about 300 per cent of the daily production in terms of 60-deg. Bé. acid. The quantity of acid introduced into the packed cells amounts to about 10 tons of 50-deg. Bé. acid per ton 60-deg. Bé. acid.

The advantages claimed for this type of plant are a saving of 40 to 50 per cent in first cost, and a saving of 80 per cent in ground space. The Anaconda plant is not yet old enough to permit of giving figures as to maintenance expense; it is believed by the designer, however, that over a period of years both operating and maintenance costs will be somewhat lower than at the ordinary chamber plant.

SILICA GEL

Silica gel, prepared by treating a solution of silicate of soda, under special conditions, with dilute hydrochloric or sulphuric acid, followed by coagulation, drying, washing and partial dehydration, is an agent which has been proposed for a variety of uses in the sulphuric-acid industry.

The method of making silica gel is the invention of W. A. Patrick of Baltimore, Md., and is protected by U. S. Patent 1,297,724. A patent covering a method and apparatus for the separation of vapors and gases by means of silica gel (U. S. 1,335,348) has been issued to W. A. Patrick, B. F. Lovelace and E. B. Miller. Basic facts and observations relative to the adsorption of vapors and gases by silica gel, with special reference

¹⁹Op. cit., p. 112.

to the adsorption of sulphur dioxide, have been published by E. B. Miller in a paper presented before the American Institute of Chemical Engineers in 1920.²⁰

Silica gel is prepared under carefully standardized conditions, and when dried and "activated" by passing through it for 2 hours air heated to 125 to 150 deg. C. it has a moisture content of 5 to 7 per cent. It is a semi-transparent, glassy, brittle, highly porous solid.

Miller's paper describes and illustrates several types of bed absorbers, wherein gases or vapors may be adsorbed in granular gel; and also refers briefly to a pulverized-gel absorber, whereby the activated gel, ground to from 80 to 200 mesh, is fed into the stream of gas to be adsorbed, which escapes through a dust filter, and the adsorption takes place in the gas conduit and in the filter bags. The dust is shaken from the bags into a regenerator, in which by means of heat the adsorbed gas is recovered, and simultaneously the gel-dust is reactivated for use again.

Thus far the only practical application of silica gel to industrial use on a commercial scale has been for the adsorption of gasoline vapor in oil-refining processes, but the same type of apparatus is said to be adapted to the recovery of a variety of industrial gases. For some time the Davison Chemical Co., which holds the patent rights, has been experimenting with various propositions for using silica gel in the sulphuric-acid processes.

USES FOR SILICA GEL IN SULPHURIC-ACID INDUSTRY

Some of the ways in which it has been proposed to use silica gel for effecting economies in the manufacture of sulphuric acid are the following:

1. The adsorption of sulphur dioxide from gas mixtures containing only a small percentage of that gas, followed by the recovery of the sulphur dioxide from the gel, for the purpose of producing a gas mixture strong in sulphur dioxide. By this means it is stated that a gas mixture containing, for example, one-half per cent SO_2 , can be used for producing a gas mixture containing 8 per cent SO_2 or more.

Experiments have shown that the gel is capable of adsorbing, from a gas mixture containing 8.75 per cent SO_2 , 6.8 per cent of its weight of sulphur dioxide, at a mean temperature of 40 deg. C. Less concentrated gases are less efficiently adsorbed. For further data the reader is referred to Part I of Miller's article.²¹

2. The adsorption in silica gel of the SO_2 in the gas mixture of a chamber plant, after passage through only the first half of the chambers, and the recovery of the adsorbed SO_2 , to make a gas mixture strong in SO_2 to reintroduce into the first chamber. It is a well-known fact that the latter half of the chambers of a chamber plant do relatively little work, as compared with the first half, and by this means it is proposed to eliminate the inefficient latter half of the chamber space now employed, and cause all the oxidation and condensation to be done in the efficient first half.

3. The recovery of sulphur dioxide and nitrogen peroxide from the gas mixture escaping from the Gay-Lussac tower. Also the indirect recovery of nitric oxide from the same source, by oxidizing the latter to nitrogen peroxide, with subsequent adsorption in silica gel. The extent to which nitrogen peroxide in the gas mixture escaping from the Gay-Lussac tower can be adsorbed in a practical way in silica gel is now being

determined experimentally at the plant of the Davison Chemical Co.

4. The recovery of sulphur dioxide and nitrogen peroxide from the gas mixture issuing from the last chamber of a chamber plant as a substitute for the Gay-Lussac tower, thus eliminating the latter.

5. The conversion of SO_2 to SO_3 catalytically, by passing the gas through gel previously treated with special catalyzing agents, such as certain metallic salts. By means of platinized silica gel, such a conversion has been obtained experimentally. Experiments on the catalytic efficiency of a variety of metallic salts adsorbed into the pores of silica gel have been in progress for some time at the Davison laboratories. It seems premature at present to make any very definite claims for the future of metalized silica gel as a catalytic agent on a commercial scale.

CONCLUSION

In reviewing this series of articles it will be noted that the following recent developments in the sulphuric-acid industry have been considered:

1. A variety of new kinds of plant equipment, such as electrically driven acid pumps, acid valves and gas blowers of various designs and materials, and electrical apparatus for the precipitation of dust, all of which have been put on the market with a view to supplanting established equipment used for the corresponding purposes, considered to be less efficient, less durable or more expensive than the new.

2. All-Masonry Gay-Lussac and Glover towers, interchamber towers and a new type of sulphuric acid chamber, water-cooled on its outside.

3. Two proposed types of nitration processes, which dispense with lead chambers altogether.

4. A remarkably porous solid, having peculiar adsorption properties, including the quality of being able to adsorb into its pores metallic salts in such a finely divided condition as to effect catalytic oxidation of sulphur dioxide, but whose development, as a catalytic agent, has not yet emerged from the embryonic stage.

The salient points of each kind of plant, or of plant equipment, have been briefly described in such a way that the reader may compare them and that those who have to build or equip sulphuric-acid plants may be assisted in making their choice.

ACKNOWLEDGMENTS

For information, photographs and drawings used in the preparation of this series of papers the author is indebted to the following gentlemen: Peter S. Gilchrist, president, Chemical Construction Co.; J. N. Houser, manager, Tennessee Copper Co.; E. L. Larison, superintendent acid department, Anaconda Copper Mining Co.; E. B. Miller, vice-president, Davison Chemical Co.

For furnishing illustrations and detailed information relative to recent developments in sulphuric-acid plant equipment the author wishes to express his thanks to the following business houses: Chemical Equipment Co., Chicago, Ill.; Chemical Pump & Valve Co., Perth Amboy, N. J.; Duriron Co., Dayton, Ohio; Charles S. Lewis & Co., St. Louis, Mo.; Monarch Manufacturing Works, Philadelphia, Pa.; Packards & James Fison (Thetford), Ltd., Ipswich, England; Research Corporation, New York, N. Y.; Schutte & Koerting Co., Philadelphia, Pa. Other acknowledgments have been indicated at appropriate places in the text, and in footnotes. Atlanta, Ga.

²⁰CHEM. & MET. ENG., vol. 23, Nos. 24, 25 and 26, pp. 1155, 1219, 1251 Dec. 15, 22 and 29, 1920.

²¹CHEM. & MET. ENG., vol. 23, No. 24, p. 1155, Dec. 15, 1920.

Heat-Treatment of Brass and Brasses Containing Tin*

Brasses Containing a Little Beta Respond to Heat-Treatment—Tin-Brasses, Developing a Special Constituent Analogous to Delta in Bronzes, May Have Their Physical Properties Changed Very Notably by Proper Annealing and Quenching

BY LÉON GUILLET

IT IS known that certain industrial alloys of copper and zinc may be hardened by quenching. Under the microscope these alloys show both the α and β constituent, or if formed of pure alpha are practically saturated in zinc. Industry has not yet made use of this heat-treatment, no doubt because the most of those who use the metal completely ignore this property, and perhaps also because the hardening action is not very pronounced.

A systematic study has been made upon special brasses, which has led the author to form the general conception of the coefficient of equivalence.¹ Further

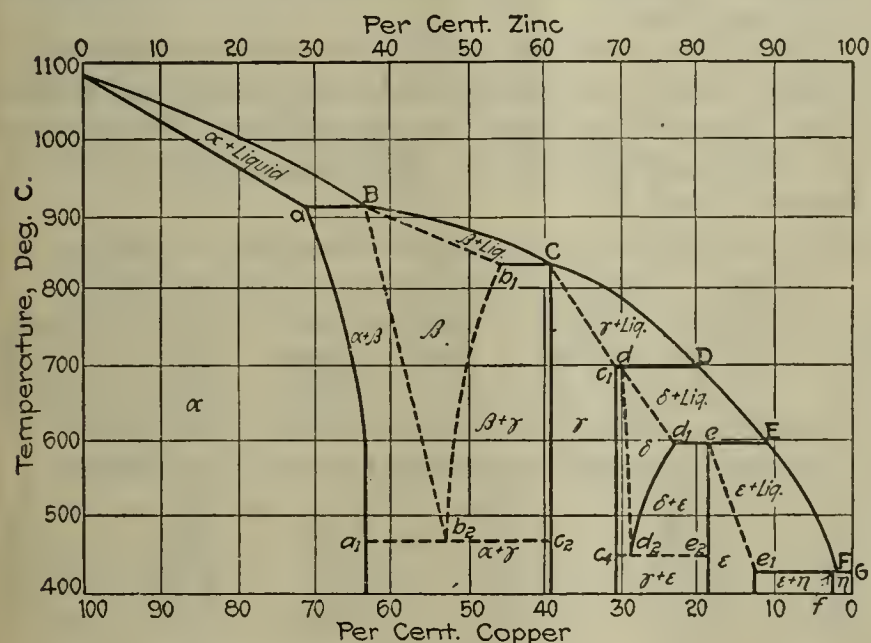


FIG. 1. EQUILIBRIUM DIAGRAM FOR COPPER : ZINC ALLOYS

After Gulliver, "Metallic Alloys," p. 267.

investigations on the influence of the different elements upon the properties of the heat-treated alloys should be useful, especially if the determinations are based upon an exact knowledge of the position of the transformation points. Attention has been attracted to brasses containing tin, for the following important reason:

The tin-brasses contain a special constituent which bears a strange resemblance to the delta constituent of bronzes (a solid solution very closely corresponding to the compound Cu_3Sn). This constituent is accompanied by hardness and brittleness; it injures the mechanical qualities of the alloy, especially when present in sufficient amount. Heat-treatment does not cause the disappearance of this constituent, and therefore does not materially improve the properties of the tin-brasses.

Quenching has a strong influence upon the structure of copper: zinc alloys which forecasts the equilibrium diagram, when taking into account the fact that the

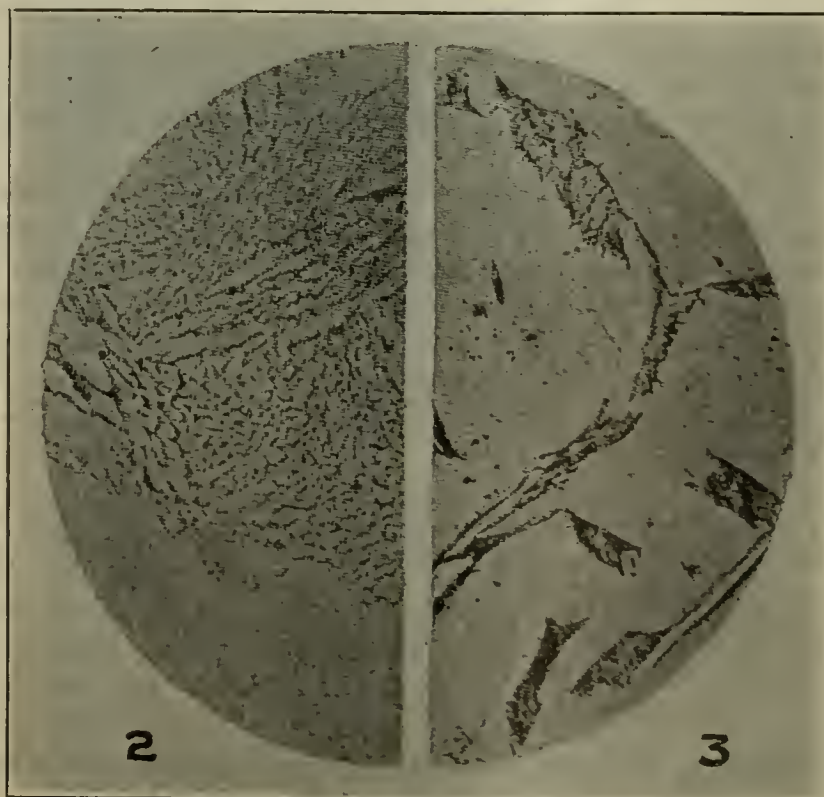
eutectoid is not resolved—a veritable troostite is found instead.

Brasses formed of α plus β solutions,² quenched from above 475 deg. C., have their content in α diminished, whereas the constituent that reminds one of troostite becomes more apparent; nevertheless, this constituent is less readily etched, and is present in a polyhedral form. No doubt quenching prevents the separation of the constituents of this metal, as seems to be indicated by its easy coloration, and the constituent thus obtained can be better compared to the gamma iron in steels than to the troostite of the same alloys. This seems to be β solution as it exists at a high temperature. (See Fig. 2.)

When the temperature is increased the α solution almost completely disappears and pure β is approached. It has been noted, however, that in the interstices of the grain boundaries there are some traces of α plus β in a finely divided state; complete solution appears to be difficult, at least for brass rich in α solution.

On the other hand, the equilibrium diagram shows a line aa_1 (Fig. 1) separating the region of pure α from that of α plus β , which is a curve bent toward the Y axis. It follows that alloys containing 63 to 72 per cent of copper, when carried to a proper temperature, are no longer in the α zone, but cross into the zone where some β solution is formed. Cooling quickly from

²In industrial brasses this comprises those containing from 55 to 63 per cent copper, and also includes those containing the unresolved constituent frequently called "apparent beta."



FIGS. 2 AND 3. BRASSES QUENCHED IN WATER FROM 850 DEG. C. ETCHED WITH ANHYDROUS IRON PERCHLORIDE

Fig. 2. 60 : 40 brass, $\times 50$. Fig. 3. 65 : 35 brass, $\times 430$.

*From *Revue de Métallurgie*, July 1921, pp. 445-58.

¹"Ternary Brasses," *CHEM. & MET. ENG.*,

such temperature, the resulting alloy will be formed of these two constituents. (Fig. 3.) This is a very interesting hardening (by quenching) by simply heating the specimen through a line in the diagram not belonging directly to a eutectoid.³

A little of the β is clearly to be seen in this quenched alloy (Fig. 3). Quenching does not affect the mechanical properties to a great extent; no doubt this is due to the non-resolution of the eutectoid, leading to the supposition of a "semi-quenched" state existing as a matter of course in alloys formed of α and "apparent β "; the "apparent β " seems to be a veritable troostite replacing the eutectoid between α and γ solutions. Besides, quenching does not produce a martensitic structure in brass, at least as far as is known.

In Table I is presented a series of Brinell tests⁴ published in 1914 bearing on this subject.

TABLE I. HARDNESS OF QUENCHED BRASSES

Cu, per Cent	Annealed at 750 Deg. C.	Quenched in Water at					
		420 Deg. C.	520 Deg. C.	620 Deg. C.	720 Deg. C.	820 Deg. C.	850 Deg. C.
56	126	134	136	121	124	126	Broken
58	109	102	116	124	131	128	135
60	88	92	94	101	114	134	137
62	81	82	84	82	100	115	110
65	59	62	60	63	63	76	81
70	59	63	62	61	62	56	57

Recently the following Brinell hardness tests have been made on a brass having 55 per cent Cu and formed therefore of "apparent β ," sensibly pure:

Annealed state, 111.
Quenched at 650 after heating for 10 minutes, 119.
Quenched at 750 after heating for 10 minutes, 118.
Quenched at 850 after heating for 10 minutes, 118.

The following conclusions may be drawn:

1. Quenching increases the hardness of brasses; the increase sometimes reaches 30 Brinell units, more often it does not exceed 10. Finally, certain brasses are not appreciably hardened by quenching.
2. In brasses showing α plus apparent β under the microscope, the hardening upon quenching is a function of the amount of α constituent; brass formed wholly of apparent β is hardly affected by quenching.
3. The necessary quenching temperature to obtain the maximum hardness is proportionally higher as the amount of alpha increases, exactly as the diagram indicates.
4. Alpha brasses containing less than 70 per cent Cu harden slightly on quenching; a certain quantity of β is formed.
5. These facts conform to the equilibrium diagram; the existence of a "troostitic" structure in place of the eutectoid between α and β constituents indicates a "semi-hardened" condition in the unquenched products.

TABLE II. MECHANICAL PROPERTIES OF 60:40 BRASS

	Tension Tests				Impact Tests		Hardness
	Ultimate Strength	Elastic Limit	Elongation	Contraction	Resilience	Angle, Deg.	
Rolled.....	54,000	17,100	48.0	51.7	14.3	110	93
Annealed at 800 deg. C....	52,000	14,600	50.0	62.2	17.5	110	78
Quenched at 600 deg. C.	51,500	?	36.0	52.7	13.3	139	92
in water.....							
Quenched at 800 deg. C.	53,000	33,100	8.0	11.5	7.8	153	145
in water.....							

Table II shows the mechanical properties of the alloy Cu 60.15, Zn 39.84, Sn 0, Fe and Pb traces.

There is a discrepancy between the hardness and the

tension tests after quenching at 800 deg. C. This must be attributed to overheating, since the fracture showed a coarse grain.

COMPOSITION OF THE TIN-BRASSES

For this investigation ingots cast with square lugs were used, a form which the author has described many times.⁵ The lugs are used for the tests on the cast metal, and the center of the ingot is to be rolled hot. All of the ingots had square lugs, 25 mm. on a side attached to a central round of 100 mm. diameter, 250 mm. long. A series of very pure alloys were made. Their analyses are given in Table III.

TABLE III. ANALYSES OF TIN-BRASSES (FIRST SERIES)

No.	Cu	Zn	Sn	Fe	Pb	Total
1	60.15	39.84	0.00	Traces	Traces	99.99
2	60.52	39.31	0.16	Traces	Traces	99.99
3	60.25	39.19	0.52	Traces	Traces	99.96
4	60.41	38.79	0.78	Traces	Traces	99.98
5	60.46	38.67	0.85	Traces	Traces	99.98
6	60.64	38.32	1.02	Traces	Traces	99.98
7	60.50	38.26	1.23	Traces	Traces	99.99
8	61.57	35.33	3.01	Traces	Traces	99.91
9	61.12	33.86	4.89	Traces	Traces	99.87

On the whole, in this series the amount of copper remained between 60.1 and 60.6, the tin increased from 0 to 5 per cent.

In addition three specimens were examined containing a larger amount of copper, and some others, much less pure industrial products, containing some lead and an increasing amount of tin. The analyses are given in Tables IV and V.

TABLE IV. PURE ALLOYS; HIGH COPPER (SECOND SERIES)

No.	Cu	Zn	Sn	Fe	Pb	Total
10	67.61	30.84	1.60	Traces	Traces	100.05
11	80.59	17.85	1.57	Traces	Traces	100.23
12	80.23	16.47	3.15	Traces	Traces	99.85

TABLE V. IMPURE INDUSTRIAL ALLOYS (THIRD SERIES)

No.	Cu	Zn	Sn	Fe	Pb
13	59.38	37.90	0.00	0.69	1.88
14	58.80	38.25	0.63	0.52	1.70
15	59.13	37.45	1.12	0.44	1.78
16	58.98	37.65	0.31	0.48	2.74
17	59.12	36.83	0.76	0.67	2.58
18	58.90	36.65	1.18	0.53	2.72

The studies have included (1) micrographic examination; (2) determination of transformation points; (3) mechanical tests in the cast state for the first and second series; mechanical tests in rolled, drawn and annealed state for the first and third series, with the exception of the 3 and 5 per cent tin alloys; mechanical tests on all alloys, in the quenched condition.

All ingots except 8 to 12 inclusive were rolled to 22-mm. round bars, and then drawn to 20 mm. diameter. Annealing was done at 800 deg. C. in oxide of iron (in order to avoid that loss by volatilization in a reducing atmosphere indicated in researches made in collaboration with M. Ballay). This relatively high temperature was adopted to secure greater homogeneity.

Quenching was done in water after heating 15 minutes at 600 or at 800 deg. C.

DETERMINATION OF CRITICAL POINTS

Critical points were determined with a Saladin-Le Chatelier double galvanometer; the comparison specimen was copper; temperature reached in the heating was from 800 to 850 deg. C.; heating time was 1 hour 15 minutes; cooling required 1 hour 30 minutes to pass

³This seems also to be the case with duralumin.

⁴Revue de Métallurgie, Memoirs, 1914, p. 1128.

⁵Revue de Métallurgie, Memoirs, 1906, p. 247.

TABLE VI. THERMAL ANALYSIS OF ALLOYS				
No.	Amount in		Transformation Points	
	Cu	Sn	Heating	Cooling
1	60.15	0.0	456, 750	705, 445
2	60.52	0.16	445, 760	720, 445
3	60.25	0.52	445, 740	690, 445
4	60.41	0.78	445, 745	700, 445
5	60.45	0.85	445, 740	700, 440
6	60.64	1.02	445, 480, 740	690, 445
7	60.5	1.23	445, 490, 730	680, 440
8	61.57	3.01	500, 760	720, 500
9	61.12	4.89	530, 710	630, 520
10	67.61	1.60	560	540
11	80.59	1.57	.....	.....
12	80.23	3.15	.....	.....

from 850 to 200 deg. C. The results obtained are given in Table VI. *Italic figures indicate abnormal points*—that is to say, those which are not found in tin-free brasses. Fig. 4 reproduces some of the curves obtained.

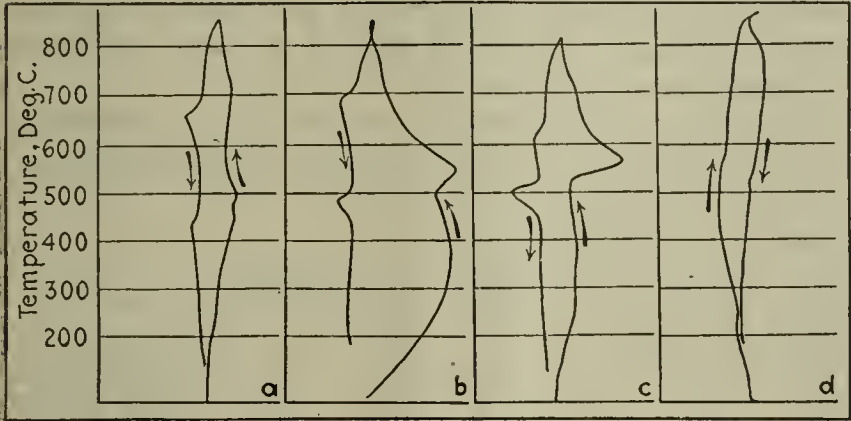
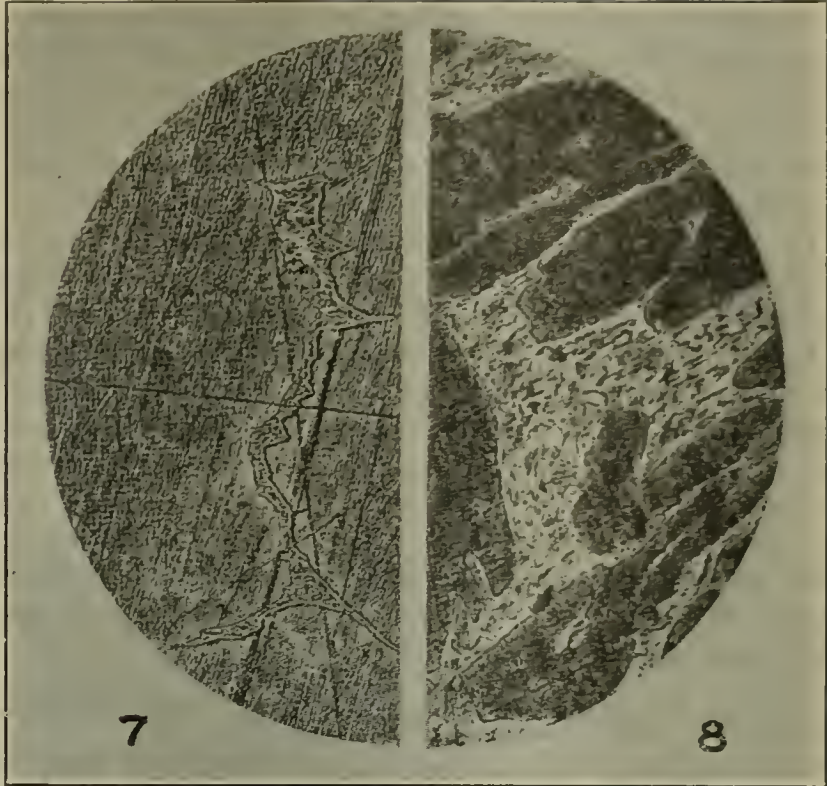


FIG. 4. HEATING AND COOLING CURVES
a, alloy 7; b, alloy 8; c, alloy 9; d, alloy 10.

These determinations lead to the following conclusions:

- 1. The first five specimens containing 60 per cent Cu and up to 0.85 per cent Sn possess no other transformation points than do normal brasses.
- 2. Alloys with 60 per cent Cu and 1 to 1.3 per cent Sn (Nos. 6 and 7) absorb a small amount of heat at 480 to 490 deg. C.; this thermal anomaly was not met in cooling; its disappearance may be attributed to the slowness of the operation. If the determination is repeated, the transformation reappears at each heating;



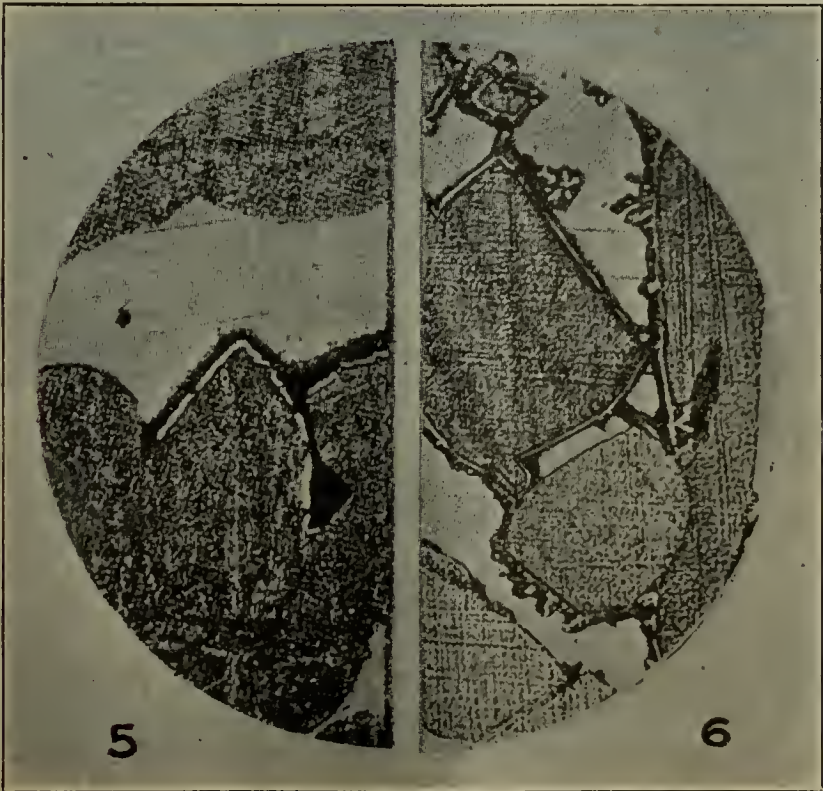
FIGS. 7 AND 8. DELTA CONSTITUENT IN EUTECTOID
IN HIGH-TIN BRASSES. $\times 200$
Fig. 7. Cu 67.6, Sn 1.50. Fig. 8. Cu 61.6, Sn 3.05.

it is not due, therefore, to the heterogeneity of the specimen.

- 3. The alloys containing 60 per cent Cu with 3 to 5 per cent Sn present two points, due to the presence of tin, since the micrographic examination shows that these products do not contain apparent β . It will be shown that these points correspond to the beginning and the end of solution of the special constituent. Furthermore, the anomalies increase as the tin increases.
- 4. As copper increases, the amount of tin necessary to induce unusual transformation points also increases; thus none were found in an alloy containing 80 per cent copper and 3 per cent tin.

MICROGRAPHS OF CAST OR ANNEALED SAMPLES

Microscopic observations made after etching with acid iron perchloride may be summarized as follows: Alloys 1 to 4 are formed of the α and β constituents



FIGS. 5 AND 6
Fig. 5. Cast brass; Cu 60.46, Sn 0.85; white is beta, gray is alpha constituent, rim is special delta constituent due to tin. $\times 430$.
Fig. 6. Annealed brass; Cu 60.50, Sn 1.23. $\times 430$.



FIGS. 9 AND 10. QUENCHED TIN-BRASSES. $\times 200$
Fig. 9. Cu 60.64, Sn 1.02; quenched from 600 deg. C.
Fig. 10. Cu 67.6, Sn 1.5; quenched from 650 deg. C.

of ordinary brass; the amount of α is a little less than that found in tin-free alloys having the same amount of copper. This is true for cast metal as well as after annealing at 800 deg. C., and confirms what the author has already written on this subject.⁶ The value of the coefficient of equivalence of tin is about 2.

On the other hand, the following phenomenon may be noted very clearly: Constituent β is attacked by the etching reagent with much more difficulty as the tin increases, so that after a prolonged attack the reagent may cause the β to appear white against a colored ground mass of α . This is perhaps one reason why tin-bearing brasses have been successfully used on account of their resistance to corrosion. Fig. 5 shows this fact for alloy 5 (0.85 per cent Sn). The same alloy, as cast, shows a little of the special constituent, located at the edge of the white β region. Polishing in low relief also shows this clearly.

⁶*Revue de Métallurgie, Memoirs*, 1906, p. 264: "Ternary Brasses," CHEM. & MET. ENG., vol. 24, p. 177, Jan. 26, 1921.

Annealing at 800 deg. C. for 2 hours causes this small quantity of special constituent to disappear; it may be designated by the letter δ .

When the amount of tin reaches 1 per cent, the constituent exists in the annealed metal as well as in the metal as cast (Fig. 6), and its proportion increases with tin, so that brasses 8 and 9, with 3 and 5 per cent Sn respectively (Figs. 7 and 8), have the same appearance as bearing bronzes.

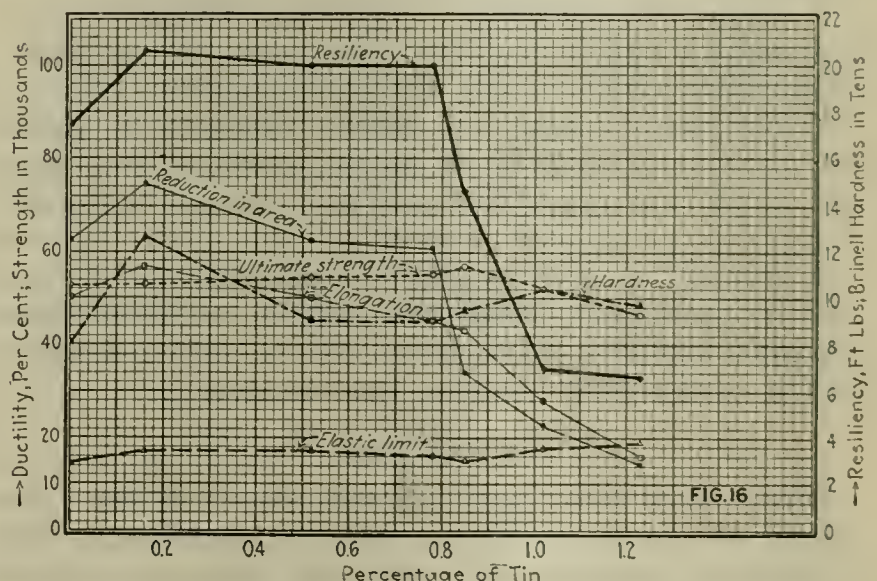
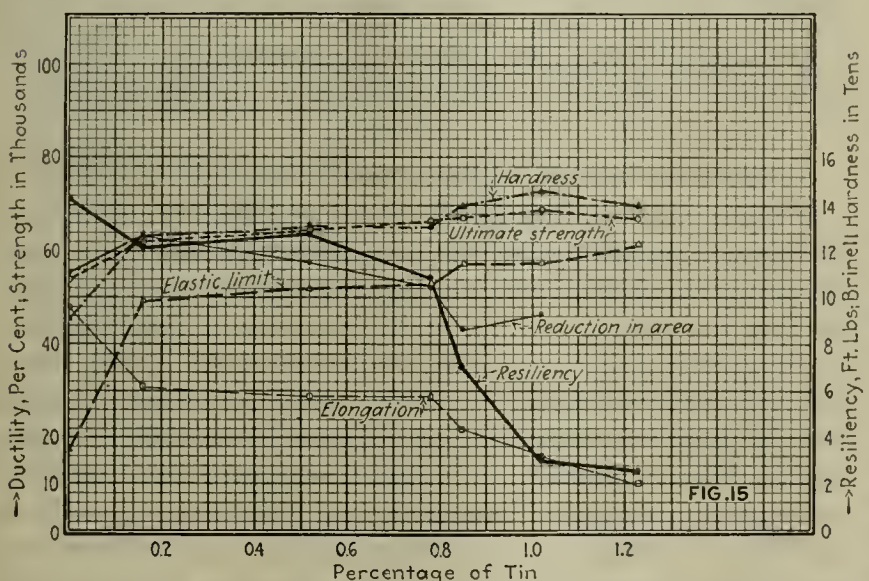
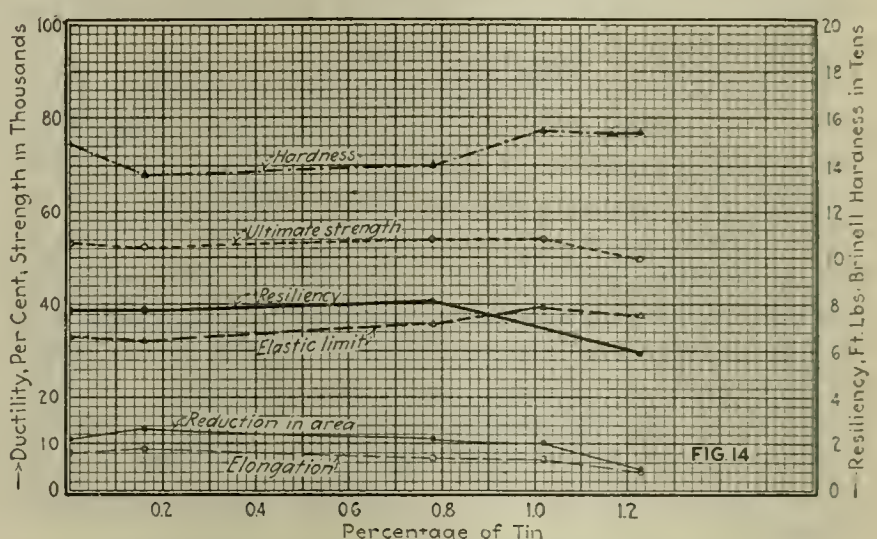
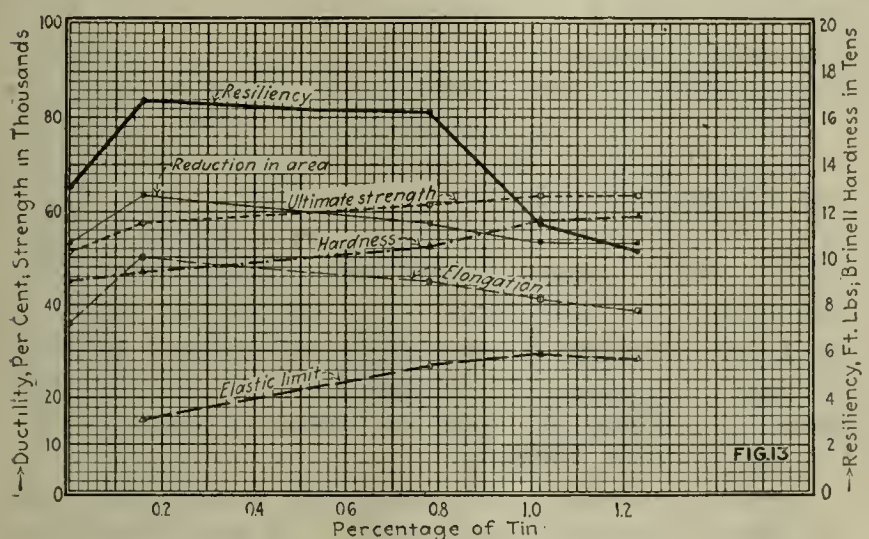
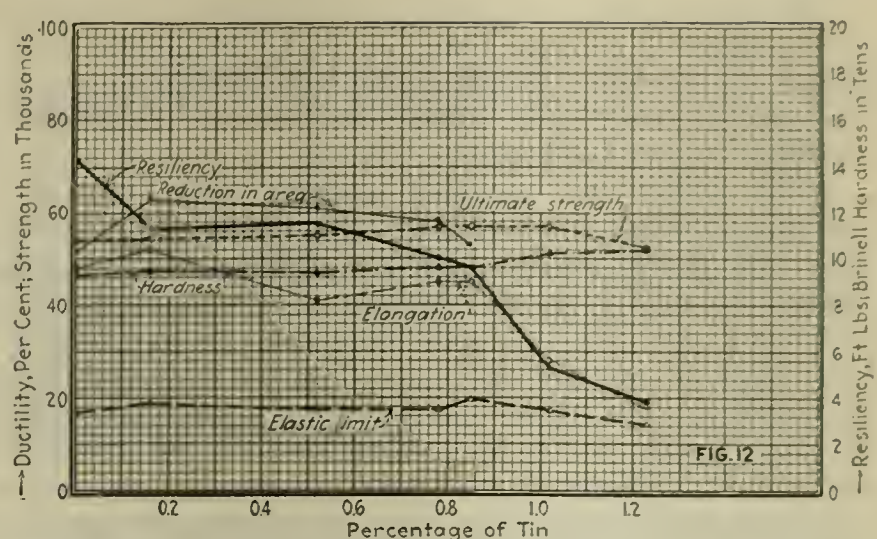
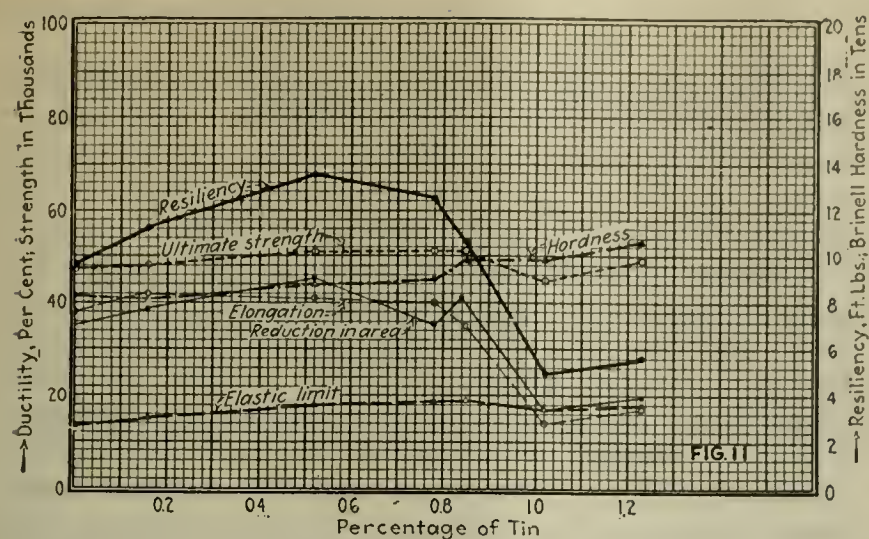
Examination of brass containing more than 60 per cent Cu shows that as the amount of zinc decreases a greater quantity of tin may enter into solution in the α constituent. For instance, with 67 per cent Cu, the amount of δ constituent is very slight for 3.6 per cent Sn; it is zero with 80 per cent Cu and 3 per cent Sn.

Absolute agreement should be noted between the appearance of the special constituent and the transformation on heating at about 480 deg. C., at least for alloys with more than 1 per cent Sn.

Tin-brasses not showing the special δ constituent,

TABLE VII. PHYSICAL PROPERTIES OF TIN-BRASSES

Alloy No.	Composition			Condition	Tensile Test				Red. in Area	Impact Test			Fracture
	Copper	Tin	Lead		Ultimate Strength	Elastic Limit	Elongation	Resilience		Angle	Brinell Hardness		
A. Pure Alloys. Copper Approximately 60 per Cent													
1	60.15	0.00	....	As cast.....	47,500	13,200	38.	35.4	9.7	126	83	Through the grain	
				Rolled.....	54,000	17,100	48.0	51.7	14.3	Bent	93	Through the grain	
				Drawn.....	54,000	17,100	48.0	54.7	14.3	Bent	93	Through the grain	
				Annealed.....	52,100	14,600	50.0	62.2	17.5	110	79	Through the grain	
				Quenched at 600 deg. C.....	51,400	?	36.0	52.7	13.3	139	92	Through the grain	
2	60.52	0.16	....	Quenched at 800 deg. C.....	53,100	33,100	8.0	11.5	7.8	153	145	Coarse grain	
				As cast.....	48,000	14,600	42.0	38.9	11.25	133	82	Through the grain	
				Rolled.....	54,500	18,900	52.0	63.0	11.25	137	87	Through the grain	
				Drawn.....	62,600	49,200	31.0	63.0	12.2	142	127	Through the grain	
				Annealed.....	53,500	17,100	57.0	74.3	20.6	Bent	126	Through the grain	
3	60.25	0.52	....	Quenched at 600 deg. C.....	57,700	15,100	50.0	63.9	16.8	Bent	94	Through the grain	
				Quenched at 800 deg. C.....	52,100	32,100	9.0	12.8	7.7	158	136	Coarse grain	
				As cast.....	50,900	17,900	41.0	45.5	13.5	140	88	Through the grain	
				Rolled.....	54,900	17,500	41.0	61.2	11.5	142	94	Through the grain	
				Drawn.....	64,400	52,000	29.0	57.5	12.8	153	134	Through the grain	
4	60.41	0.78	....	Annealed.....	54,500	17,100	50.0	62.2	20.0	Bent	92	Through the grain	
				As cast.....	50,700	18,900	40.0	35.4	12.5	137	90	Through the grain	
				Rolled.....	56,900	17,500	45.0	58.5	10.0	159	97	Through the grain	
				Drawn.....	66,300	53,100	29.0	52.7	10.9	160	136	Through the grain	
				Annealed.....	54,900	16,100	45.0	61.2	20.0	Bent	93	Through the grain	
5	60.46	0.85	....	Quenched at 600 deg. C.....	61,500	20,700	45.0	57.5	16.25	131	105	Through the grain	
				Quenched at 800 deg. C.....	54,000	36,000	7.0	10.8	8.1	164	140	Coarse grain	
				As cast.....	51,300	18,900	35	41.1	10.6	138	98	Coarse grain	
				Rolled.....	56,900	19,900	45.0	52.7	9.6	148	96	Coarse grain	
				Drawn.....	67,300	56,900	22.0	43.3	7.5	164	140	Coarse grain	
6	60.64	1.02	....	Annealed.....	56,900	15,100	43.0	34.3	15.0	126	95	Coarse grain	
				As cast.....	44,400	17,100	14	16.8	5	161	98	Through the grain	
				Rolled.....	56,900	17,100	28.0	...	5.62	164	102	Through the grain	
				Drawn.....	69,000	57,700	16.0	46.5	3.40	176	146	Through the grain	
				Annealed.....	52,100	17,900	28.0	23.3	7.1	151	104	Through the grain	
7	60.50	1.23	....	Quenched at 600 deg. C.....	63,400	29,300	41.0	53.7	11.5	143	116	Through the grain	
				Quenched at 800 deg. C.....	54,000	38,800	7.0	10.1	7.1	162	155	Coarse grain	
				As cast.....	49,000	17,900	17.0	19.4	5.6	157	106	Through the grain	
				Rolled.....	52,100	14,200	18.0	...	3.7	170	104	Through the grain	
				Drawn.....	67,200	61,600	10.0	...	2.5	176	140	Through the grain	
8	61.57	3.01	....	Annealed.....	46,300	18,900	16.0	14.2	6.5	153	97	Through the grain	
				Quenched at 600 deg. C.....	63,400	28,500	39.0	53.7	10.3	152	118	Through the grain	
				Quenched at 800 deg. C.....	49,200	37,800	4.0	4.5	5.9	159	153	Coarse grain	
				As cast.....	19,300	?	0	0	1	180	116	Coarse grain	
				Annealed.....	28,000	?	1.4	0	8.2	160	130	Coarse grain	
9	61.12	4.89	....	Annealed.....	12,100	?	0	0	1	180	150	Coarse grain	
				Quenched at 650 deg. C.....	15,900	?	1.4	0	2.5	160	143	Coarse grain	
B. Pure Alloys. High Copper Content													
10	67.61	1.53	....	Cast and annealed.....	22,300	9,000	21.0	18.1	12	12.5	63	Coarse grain	
12	80.23	3.13	....	Cast and quenched at 650 deg. C.....	18,500	9,000	22.0	?	3	....	58	Coarse grain	
				Cast and annealed.....	35,000	10,400	55.0	48.0	17	Bent	63	Coarse grain	
				Cast and quenched at 650 deg. C.....	13,200	8,200	12.0	....	11.5	Bent	60	Physical defects	
C. Commercial Alloys													
13	59.38	0.0	1.88	Rolled.....	63,200	26,000	27	26.4	7.5	160	107	.....	
				Drawn.....	71,100	61,500	17.0	42.2	5.6	172	142	.....	
				Annealed.....	55,500	?	42.5	47.6	11.3	140	94	.....	
				Quenched at 600 deg. C.....	64,600	?	40.5	46.5	8.6	159	112	.....	
				Rolled.....	67,400	24,200	28.5	28.3	9.4	158	121	.....	
14	58.80	0.63	1.70	Drawn.....	73,100	50,900	20.5	36.6	5.6	170	147	.....	
				Annealed.....	60,000	?	32.0	34.3	8.1	158	100	.....	
				Quenched at 600 deg. C.....	67,400	?	30.5	42.2	8.8	160	117	.....	
				Rolled.....	66,900	28,400	14.5	18.1	6.3	170	130	.....	
				Drawn.....	79,700	58,200	9	24.6	5.6	177	157	.....	
15	59.13	1.12	1.78	Annealed.....	55,200	24,600	15	16.8	6.2	163	112	.....	
				Quenched at 600 deg. C.....	70,300	31,500	36	40	8.1	163	125	.....	
				Rolled.....	60,600	28,400	23.5	24.6	6.3	165	107	.....	
				Drawn.....	69,200	58,200	22	37.7	4.4	173	136	.....	
				Annealed.....	54,800	?	40.5	28.3	10.0	143	92	.....	
16	58.98	0.31	2.74	Quenched at 600 deg. C.....	61,700	?	36.5	33	8.1	158	106	.....	
				Rolled.....	59,200	26,000	18	20.7	6.3	115	109	.....	
				Drawn.....	72,500	60,600	6.5	10.1	4.4	176	147	.....	
				Annealed.....	53,600	?	24.0	24.6	7.2	158	95	.....	
				Quenched at 600 deg. C.....	63,200	?	35.0	45.5	7.5	158	113	.....	
17	59.12	0.76	2.58	Rolled.....	61,700	28,400	10.5	15.5	5	174	125	.....	
				Drawn.....	74,000	52,000	9	23.3	3.8	176	155	.....	
				Annealed.....	49,400	19,000	11.5	15.5	5.6	166	104	.....	
				Quenched at 600 deg. C.....	69,400	30,600	37.5	40.7	7.5	162	120	.....	
				As cast.....	61,700	28,400	10.5	15.5	5	174	125	.....	
18	58.90	1.18	2.72	Drawn.....	74,000	52,000	9	23.3	3.8	176	155	.....	
				Annealed.....	49,400	19,000	11.5	15.5	5.6	166	104	.....	
				Quenched at 600 deg. C.....	69,400	30,600	37.5	40.7	7.5	162	120	.....	
				As cast.....	61,700	28,400	10.5	15.5	5	174	125	.....	
				Drawn.....	74,000	52,000	9	23.3	3.8	176	155	.....	



FIGS. 11 TO 16. PHYSICAL PROPERTIES OF TIN-BRASSES. ALLOYS 1 TO 7

Fig. 11. Physical properties of cast tin-brass containing 60 per cent Cu.

Fig. 13. Physical properties of cast tin-brass, quenched at 600 deg. C. (60 per cent Cu).

Fig. 15. Physical properties of drawn tin-brass containing 60 per cent Cu.

Fig. 12. Physical properties of tin-brass rolled and quenched at 600 deg. C. (60 per cent Cu).

Fig. 14. Physical properties of rolled tin-brass (60 per cent Cu), quenched at 800 deg. C.

Fig. 16. Physical properties of rolled and annealed tin-brass (60 per cent Cu).

when quenched, appear as ordinary brass. If it contains some δ this special constituent goes into solution at elevated temperatures, and after quenching at 600 deg. C. has disappeared. This is well shown in the photomicrographs, Figs. 9 and 10.

After quenching from 800 deg. C. there is a recurrence of a little α plus β at the boundaries of the α grains, as has already been remarked. But if alloys containing a large amount of tin such as shown in Figs. 7 and 8 are examined after quenching at 650 deg. C., it will be seen that the eutectoid has disappeared, δ having gone into solution, leaving only a white uniform constituent. Brass with 67.6 per cent Cu and 1.5 per cent Sn shows this phenomenon very clearly in Fig. 10; there is a little δ in the annealed metal, but after quenching at 650 deg. C., a white region may be observed, replacing the former eutectoid.

In conclusion it may be affirmed that the δ constituent is due to the presence of tin, and even if not identical it is allied to the δ constituent of bronzes. Both disappear after quenching under the same conditions.

MECHANICAL TESTS

All the results of mechanical tests are collected in Table VII, where the history of the test-pieces is briefly noted. Tension tests were performed upon a test-piece with diameter of 13.8 mm., 100 mm. in length. An autographic Amsler machine was used at a velocity of 1 mm. in 10 seconds. Impact tests were made with a rotating hammer, having a velocity at impact of 8.6 m. Test pieces were of the Mesnager type, 10 x 10 mm., notched 2 x 2 mm. with round bottom. Brinell hardness was tested by 20 seconds' loading.

Results obtained upon the pure alloys are assembled

in a series of curves, Figs. 11 to 16 inclusive, each graph representing a given physical condition.

From the curves and tables some interesting general conclusions may be drawn:

1. In rolled and annealed samples (Fig. 16), tin increases the ultimate strength slightly up to 0.8 per cent; affects the elastic limit but slightly; reduces the elongation, reduction of area and resilience, especially above 0.8 per cent Sn; and increases the hardness a little without making the alloys less readily machined or punched. The latter conclusion is at variance with common report, but is in conformity with the author's previous investigations.

2. Quenching the rolled bars at 800 deg. C. greatly increases the hardness (Fig. 14), but gives very bad results as to ductility and resilience.

3. Quenching at 600 deg. very slightly hardens brass formed of α and β without the δ constituent. The alloys containing the latter are improved in a truly remarkable manner, as is shown by the figures obtained with all alloys containing at least 1 per cent of tin. Graphs 11 and 13 should be compared. It will be seen that the average ultimate strength is increased from 50,000 to 64,000 lb. per square inch, the elastic limit from 17,000 to 28,400 lb. per square inch, the reduction of area from 40 to 60, the resilience from 12 to 16 and the hardness from 95 to 105. Such improvement is even more clearly marked in industrial alloys, especially alloy 18.

4. Alloy 10, containing 67 per cent copper, is not improved by quenching from 650 deg. C.; a white constituent still persists in the microstructure.

5. Comparing rolled and drawn products in Table VII and Fig. 15 to Figs. 12 and 14, it will be seen that cold work and quenching produces entirely different changes in the physical properties.

6. Finally, comparing alloy 1, containing no tin, and alloy 7, containing considerable tin, it is immediately apparent that the added element has a profound effect on the results obtained after heat-treatment.

CONCLUSIONS

First, these investigations emphasize that the part played by tin in brasses is not as injurious to the mechanical properties as is generally thought, at least when it does not exceed 1 per cent.

Next, attention is called to the remarkable action of quenching, which suppresses a hard and brittle constituent (very closely related to the δ constituent of the bronzes, if not identical with it) and considerably improves all the qualities revealed by mechanical tests.

Third, brasses with 60 per cent Cu containing 1 to 2 per cent of tin are less notable in the drawn or rolled state, apart from their known non-corrosive property, but they are very interesting in the quenched state.

Location of Electric Power Stations Shown on New Series of Maps

Manufacturers interested in the location of plants within reach of electric power will welcome the series of maps now in preparation by the United States Geological Survey, showing the location of power stations and electrical transmission lines used by public utilities.

The first of the series is a map of New York State, 64 in. long and 45 in. wide, scale 1 : 500,000, copies of which may be obtained for \$1 each from the Director, United States Geological Survey, Washington.

Reforestation of France

Before the war France possessed approximately 185,000,000 acres of productive forests. The bulk of these forests, about 177,000,000 acres, was in private ownership, while 3,000,000 acres was owned by the state, and 5,000,000 acres by the communes.

The war wrought great havoc with the French forests. Large areas were totally destroyed through fire, while the forests back of the fire zone were heavily drawn upon for firewood, trench timber and other necessities. After the armistice the Water and Forest Board of France, which is the national body clothed with authority over the forests and international waterways, took up the problem of reforestation. The authorities admit, however, that given the most favorable developments, it will take at least a century to bring France's forests back to their condition in 1914.

A survey after the armistice showed that in the territory occupied by the enemy 300,000 acres of state forests, 322,500 acres of parish forests and 922,000 acres of privately owned forests were subject to devastation. In over one-third of this territory the productive capacity of the forests was completely destroyed. Over half a million acres must be refitted and rewooded to make it of any use. Another area of 375,000 acres shows the effects of abusive, premeditatedly destructive or wasteful fellings.

The Water and Forest Board has established a special forest reconstitution service. In each department which suffered from the invasion there has been set up a so-called "Forest Reconstruction Inspection," with definite duties relating to the restoration of the forests.

Corrosive Action of Soil on Pipes to Be Studied

The Bureau of Standards has recently undertaken an extensive investigation of the corrosive action of soil on pipes used for gas and water mains and services. In this investigation the bureau has the co-operation of the Bureau of Soils of the Department of Agriculture, the pipe manufacturers and the public utilities through the Research Sub-Committee of the American Committee on Electrolysis. Forty locations have been selected as representative of the principal families of soils to be found throughout the United States and in them will be buried a number of samples of every kind of iron and steel pipe in commercial use. Some of the samples will be uncovered and examined from time to time to determine the rate of corrosion.

Complete data on the physical and chemical properties of the soil will be obtained, also the chemical analyses of the pipe, their microstructure and complete metallurgical heating will be determined. Extensive laboratory experiments will be conducted to determine the effects of variations in individual characteristics of both soils and pipe materials. Some tests of representative pipe coatings will also be undertaken.

The results of the tests should be of great value in determining the importance of soil corrosion and in selecting the kind of pipe best suited for use in any particular soil.

It is expected that a good deal of data as to the relative rates of corrosion of different kinds of pipes in the soils under observation will be obtained within two or three years, but the experiment will probably continue over a period of eight or ten years.

Progress reports will be published from time to time as developments warrant.

Uses for Industrial Enameled Equipment*

Nature of the Field—Properties of Enameled Linings Compared With Metals—Industries Preparing Food Products Are Large Users—Chemical and Pharmaceutical Manufacturers Employ Glass-Lined Apparatus—Considerable Work Ahead in Developing New Applications in Industry

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ENAMELED apparatus has long ago proved its usefulness, but the field of its possibilities is far from being fully explored. Indeed, each new problem solved points to another opportunity still more interesting. And since every achievement invites another, perhaps a review of some of the fields of industrial enameled equipment may point to newer and still greater possibilities.

Types of Equipment.—Glass-enameled units for manufacturing purposes may range in size from 25 gal. to 7,500 gal., 100 gal. to 1,000 gal. covering the average limits of variation. The weight of materials handled and also the problems involved in processing them demand apparatus of rugged construction, enamel lined on the inside only. Manufacturing processes usually are planned for continuous operation of one kind, which must be carried out as economically as possible. These conditions require building and perfecting apparatus for many varied types of industrial processes.

Enameled units may therefore be fundamentally alike and yet have certain variations which make each adaptable for only one purpose. With kitchenware, lamp fixtures and similar articles, this may not be the case, but the enamel lining is an important feature whatever the actual application.

Classes of Use.—In spite of the varied requirements which manufacturing processes demand, enameled apparatus may be advantageously grouped, according to use, into three general classes, depending on whether they are for food, pharmaceutical or chemical purposes: For food work perhaps sanitation is paramount; for pharmaceutical preparations probably freedom from contamination, and for chemical uses possibly acid resistance is the chief requirement. But the list of demands made in each case is much longer and it may be interesting to examine a little more closely the requirements of a manufacturer and whether or not enameled equipment meets them or has any advantages or disadvantages which might influence the user of industrial equipment.

Points Considered When Purchasing Equipment.—A commercial piece of apparatus is purchased as an investment, and as such is judged according to points similar to the following: (1) Cost—first cost and upkeep, (2) delivery, (3) life of equipment, (4) ease of repairing, (5) producing capacity, (6) operating requirements, (7) kind of labor required for operation, (8) value of the salvage, etc. How each particular type of equipment ranks according to such a list depends somewhat on the viewpoint of the purchaser. Suffice it to say the manufacture or repair of enameled apparatus is specialized work which can be done only at a factory equipped for that purpose. However, the completed unit

has a very long life, no upkeep and requires a minimum of labor for operation. An enameled unit occupies little floor space and yet has a large operating capacity. Such points as these and many similar facts prove that the use of enameled equipment is very economical.

Of all the things that a manufacturer prides himself upon, nothing ranks higher than the reputation of his product. He does everything to improve it and to produce a better product than his competitor. It is generally conceded that it is better to handle pure products in glass-lined rather than in metallic containers. The users of equipment know its advantages and shortcomings better than anyone else and their experience has pointed out interesting features concerning various types of equipment.

PROPERTIES OF ENAMELED EQUIPMENT

Fundamental Advantages of Enameled Equipment.—Enameled apparatus is easily cleaned and made sanitary. It presents a container with an inert and tasteless lining which does not discolor food products, nor is its own color changed. When cooling food products in enameled equipment, there are no adhering incrustations which cannot be easily removed. In metallic equipment these incrustations cannot be loosened without considerable scouring and if not removed become breeding places for bacteria. Enameled steel transmits heat more slowly than metals. While heating, this slowness can usually be overcome by a higher thermal head. The slower heat transmission, however, permits obtaining more uniform temperatures, and sometimes steam can be employed without local overheating under conditions in which metallic equipment requires the use of cumbersome methods of hot-water circulation. To hasten cooling is a more difficult problem. Cooled products introduced into enameled containers, however, can be stored at cold temperatures for considerable periods of time.

Comparison of Glass-Lined and Metallic Units.—There is also the problem of the presence of a metallic or a glass lining itself. All commercial metals and alloys such as aluminum, tin, copper, bronze and Monel metal are affected somewhat by weak organic acids. Some of the compounds formed when these metals



FIG. 1. ACTION OF MILK ON METALS

*Paper presented in abstract before the American Ceramic Society Annual Meeting, Columbus, Ohio, 1921.

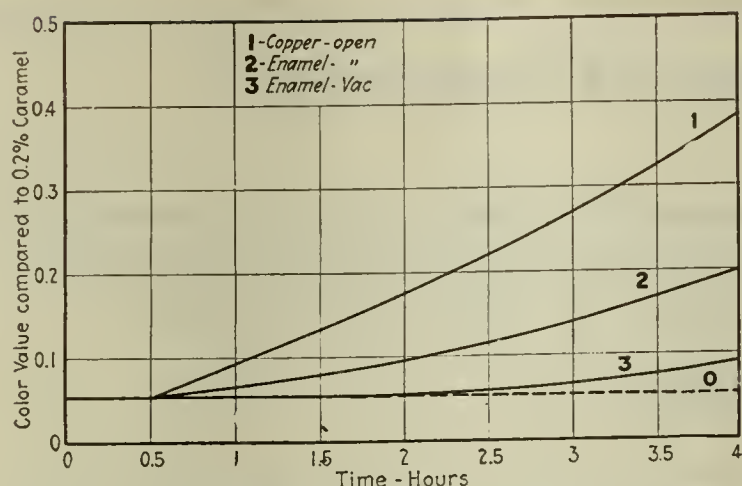


FIG. 2. DISCOLORATION OF LIGHT GRAPE JUICE CONCENTRATION

dissolve have strong metallic flavors, while others are rather tasteless. But such metallic compounds all tend to break up emulsions, to coagulate or bleach coloring matter and increase decomposition tendencies. It is interesting to note in this connection that sour cream while being made into butter will remove the tin lining in a processing vat in one week, and it has almost as vigorous an action on copper. Grape juice during vacuum concentration removes silver plating from a copper vacuum pan in a month's time.

As indicating in a general way the tendency for metals to corrode in contact with milk, Fig. 1 is shown.

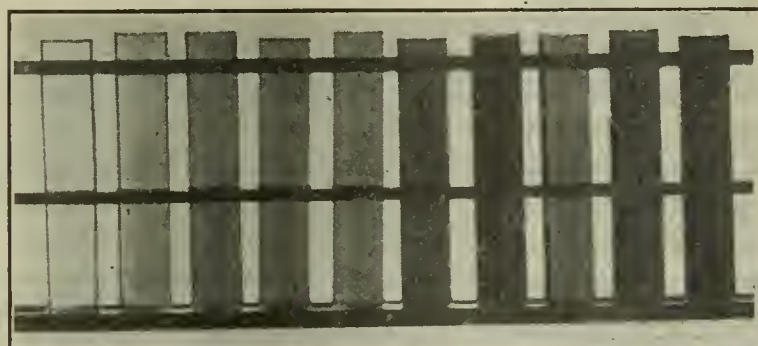


FIG. 3. DISCOLORATION OF COTTONSEED OIL ON HEATING

Order of tubes, left to right: Unmarked, E-1, C-1, S-1, E-2, C-2, S-2, E-3, C-3, S-3

The upper row of strips shows various metals which had not been immersed in milk, while the lower row shows strips of the same metals which have been immersed in milk at pasteurizing temperature for 24 hours. Of particular interest is the fact that the first metal, aluminum, did not materially discolor but was nevertheless corroded. Monel metal discolored very definitely as did zinc. Tin discolored somewhat and was very definitely pitted.

Silver in contact with fruit juices turns black in a

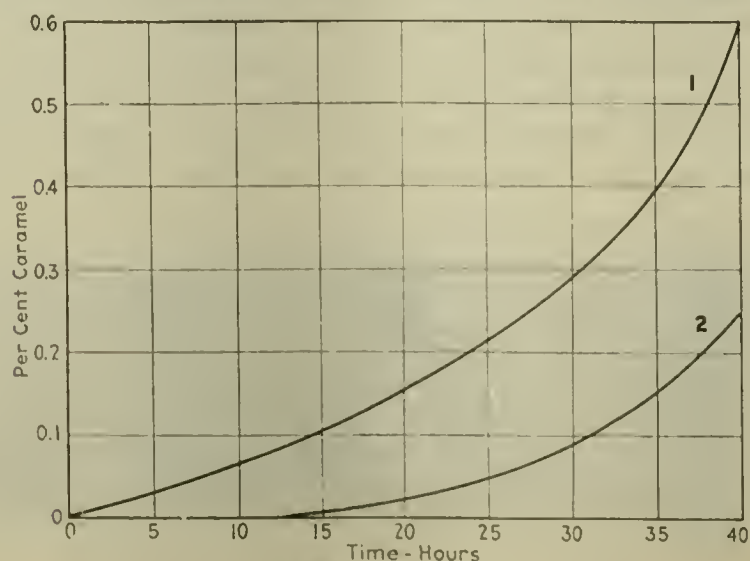


FIG. 4. CARAMELIZATION OF SUGAR

few days. In fact, most metals turn black when used for processing foods unless they are continually scoured. Aluminum is very easily affected by weak organic acids. The products of corrosion have little taste, but their coagulating tendency and the bleaching effect during processing are well known. Copper is also acted upon by many compounds and the resulting products are exceedingly bitter. An average grade of pie filling when prepared in copper utensils dissolves enough copper to permit its being detected in the product by ordinary analytical methods.

As indicative of the action of metals in producing color variations in fruit juices, a series of concentrations of light grape juice has been made under varying



FIG. 5. BEVERAGE INSTALLATION

conditions and the change in color noted by comparison with standard caramel solution. The results are shown in Fig. 2. The heating conditions in curves 1 and 2 were identical, the evaporation in one case being carried out in a copper unit and in the other in an enameled unit. The same degree of concentration in an enameled unit under vacuum has resulted in a much less marked change in color, as will be noted in curve



FIG. 6. FRUIT JUICE TRANSPORTATION CAR

3. The dotted line at 0 indicates the original color of grape juice in terms of the standard caramel solution.

When iron equipment is used for refining oils, the product first prepared turns out dark yellow. Gradually the iron is covered with a crust of oxidized oil which lessens the discoloring. With enameled equipment, a glass lining, instead of a burned-on crust, is used to protect the oil. Oils do not form crusts on enamel. Similar differences are noted in other processes.

The tendency for vegetable oils to discolor when being heated in contact with metal is evident in Fig. 3, which

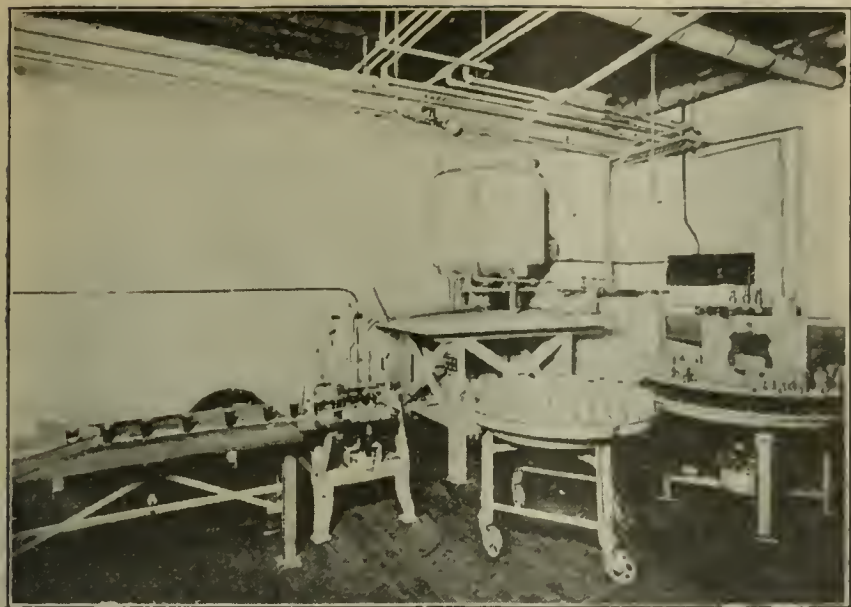


FIG. 7. JAM FILLING TANK

shows a series of tests on cottonseed oil under uniform conditions of heating, but in contact with enamel, copper and steel. The unmarked tube at the left indicates the intensity of color in the unheated oil. The oil in the tubes *E-1*, *C-1* and *S-1* were heated for a given time in contact with enamel, copper and steel. The oil in tubes *E-2*, *C-2* and *S-2* was heated for twice the period of time and that in tubes *E-3*, *C-3* and *S-3* for three times the period of time. It will be noted that in each case the change in color of the oil heated in contact with copper and steel is much more marked than that heated in contact with enamel. It should be noted that the differences in color intensity indicated in this figure are far from being as positive as in

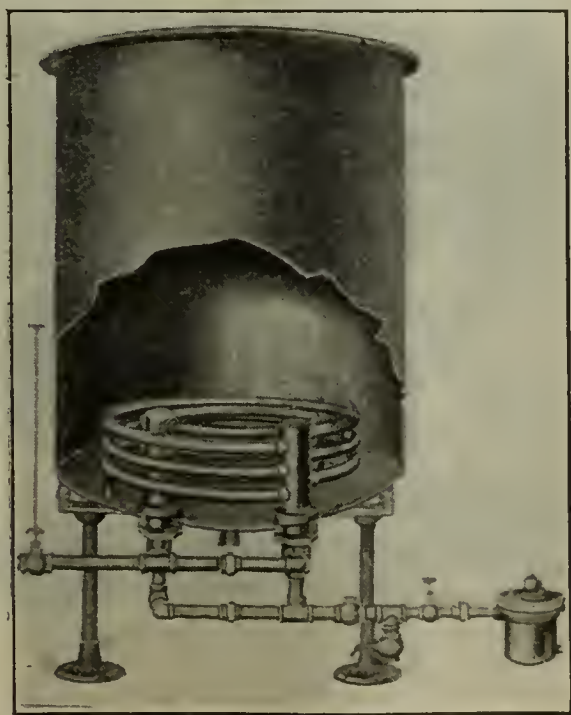


FIG. 8. TOMATO PULP COOKER

the actual samples observed by the eye, due to the extreme difficulty of registering differences in intensity of yellow by means of the photographic plate.

There are other reasons for using enameled equipment which are advantages that are inherent to the glass lining itself. Fats do not readily become rancid when heated in enameled containers, while they do turn rancid before long when heated in any metallic container. Caramelization of sugars is much slower in enamel than in metallic vessels and this considering the same amount of evaporation or other heating being accomplished when making the comparison. As can readily be seen, this permits obtaining lighter color

in many varieties of manufactured food products. With some of the more acid foods, on the other hand, metals have a considerable bleaching effect, tending to destroy the rich natural colors and producing uninviting caramel-like colors and tastes.

The relative effects of copper and enamel in promoting caramelization in hot cane sugar sirup is indicated in Fig. 4. Curve 1 indicates the discoloration produced by various periods of heating in contact with copper, whereas curve 2 indicates the color change when heated in contact with enamel. The heating conditions were such that the same amount of heat was being transferred per unit area in the two cases.

Still another field where enameled equipment presents its advantages is in the manufacture of pharmaceutical and chemical products. Here the acid-resistant types of enameled ware offer great advantages. In many cases

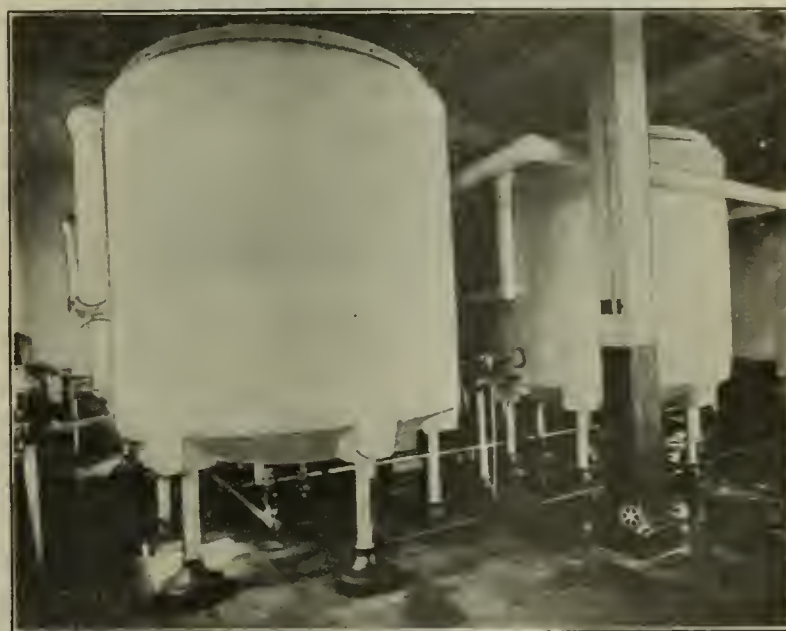


FIG. 9. WHOLE MILK STORAGE TANKS

the glass lining, in preventing metallic contamination, avoids the necessity of special purification of the products. For some operations metallic equipment can be used if certain strengths of acids are maintained, but rarely do these concentrations permit the largest yields. With acid-resistant glass-lined units, concentrations of acids to permit the largest output can always be employed. Many chemical processes involve strong acid reactions which can be carried out successfully only



FIG. 10. PASTEURIZING VATS

in glass or acid-resistant enamel, and in such cases the ruggedness and strength of enameled units make the latter far superior.

The variety of uses for enameled equipment is practically without limit. It may be worth while, however, to consider a few of the typical uses for enameled ware and why it is well adapted for such uses.

Glass-Lined Beverage Equipment.—Enameled equipment has become a standard material for the manufacture of beverage sirups. The flavors are extracted, compounded and colored in steam-heated kettles. Sugar sirups are prepared by dissolving sugar in water and the resulting sirups are then blended with the various flavoring materials. The finished product is frequently held in large enameled storage tanks which supply the bottling machines. The same units are used interchangeably for making many varieties of sirups.

Enameled Units for Flavoring Extracts.—The manufacture of some types of flavoring extracts involves



FIG. 11. CONDENSED MILK STANDARDIZERS

processes very similar to those used in the preparation of beverage sirups. Orange or lemon extracts and similar products are manufactured by dissolving the flavoring oils in alcohol and storing in airtight enameled tanks. Vanilla extracts are obtained by alcoholic extraction of vanilla beans. Enameled percolators are used in both the hot and cold processes. The finished product is bottled frequently with the aid of enameled filling tanks. When non-alcoholic extracts are made, the extract liquor is concentrated in glass-lined vacuum pans, the vanilla solids being held in solution by glycerine. Recently various non-alcoholic flavoring emulsions have been put on the market. These are usually essential oils emulsified with vegetable gums. Enameled mixing machines are frequently used, because they permit obtaining lighter colored emulsions.

Fruit Juice Equipment.—Glass-lined equipment has been found very adaptable in the manufacture of fruit juices. Fruits such as loganberries, grapes, etc., are preheated in jacketed enameled kettles. After pressing, the juice is held in horizontal storage tanks to permit particles of fruit pulp to settle out. Jacketed enameled kettles are then used for pasteurizing the product before bottling.

Enameled Jam and Jelly Kettles.—The preparation

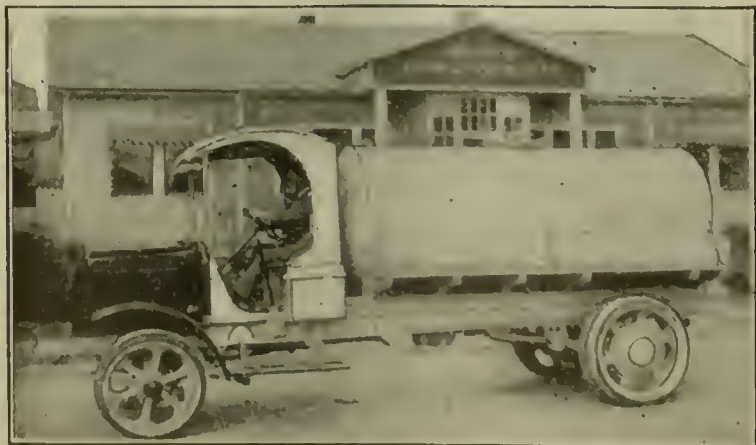


FIG. 12. MILK TRANSPORTATION TRUCK

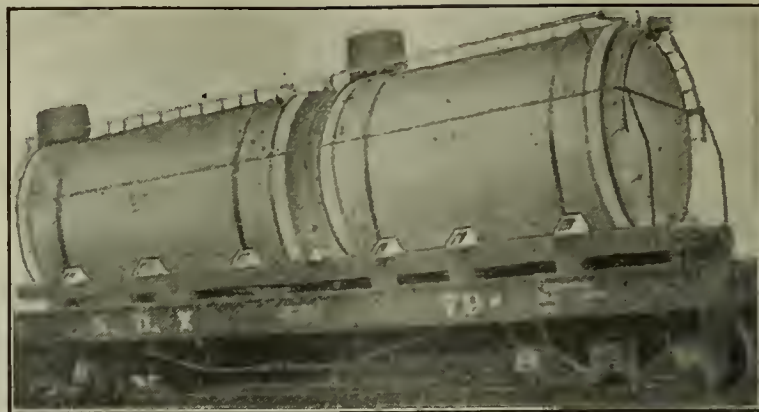


FIG. 13. MILK TRANSPORTATION CAR

of fruit juices for making jellies involves a very similar procedure. The juice, after being clarified by settling in a horizontal storage tank, is boiled up with an equal volume of sugar, and, when concentrated to the proper consistency, is run immediately into an enameled jam cooler, where it is cooled to stop any further loss of color before bottling. It has been found that a better flavored and richer colored product is obtained if jellies are concentrated under vacuum in enameled vacuum pans built for that purpose. The vacuum system also eliminates the necessity of having a jam cooler.

Enameled Equipment in the Tomato Industry.—A better color and flavor are the aim of manufacturers of food products. Many types of industrial equipment do not produce as good a finished article as that which the housewife can obtain using small utensils, and naturally she considers the value of the products by the comparison. The tomato industry illustrates very well the advantages which enameled equipment possesses, when the improvement in color and flavor, which it permits,

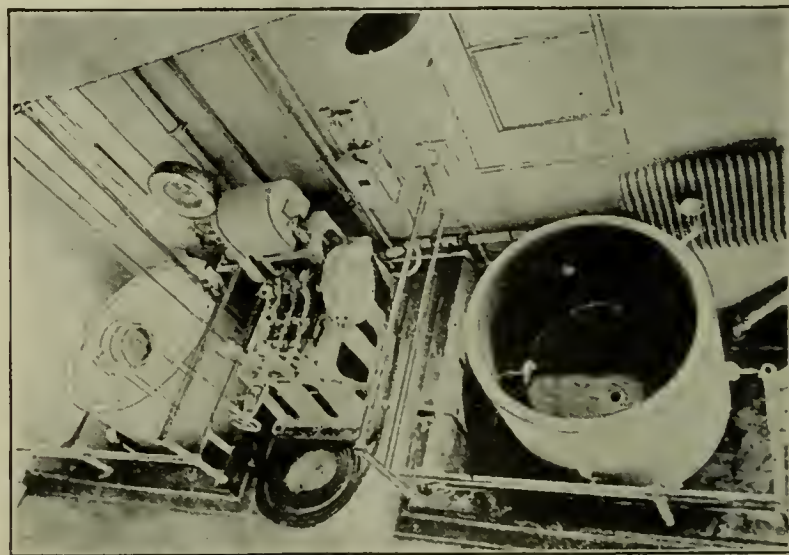


FIG. 14. ICE CREAM MIXER AND PASTEURIZER

is considered. Enameled tomato pulp cookers are in very common use for concentrating tomato pulp. The finished pulp is stored in large enameled storage tanks, being held until converted into tomato paste or various tomato products such as are used for making purée, catsups, etc. The problem of keeping the enameled units clean is very simple. Records, kept over long periods of time, show that the products manufactured have a much lower bacteria count than those made in other equipment.

Enameled Equipment in the Milk Products Industries.—In the milk and milk products industry sanitation and freedom from metallic flavors must receive greater consideration than in most other food industries. For such work enameled equipment has found great favor. Rectangular vats are used for receiving and weighing

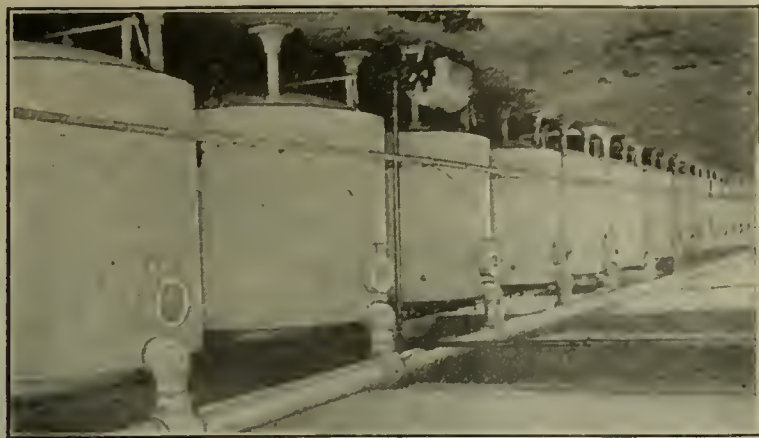


FIG. 15. CREAM AGING TANK

the milk as it comes from the farmer. From these vats the raw milk is pumped over tubular coolers and into closed enameled tanks equipped with brine-cooled jackets. The milk is pasteurized in steam-heated enameled vats and then cooled and bottled. In the condensed milk industry the milk is received and held in similar manner. It is preheated in enameled hot wells and after being concentrated in vacuum pans is run into large enameled standardizing and storing tanks, where the entire day's output is mixed to a uni-

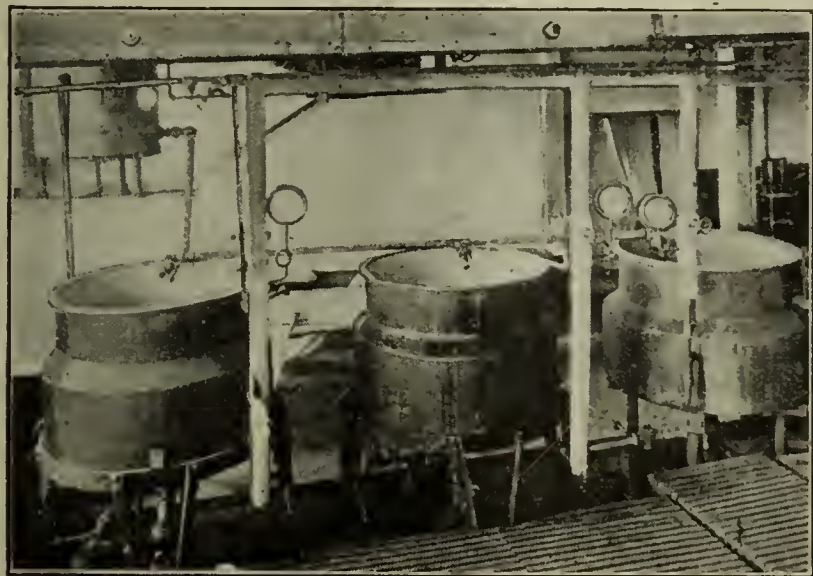


FIG. 16. MINCE MEAT COOKERS

form blend. Enameled motor trucks and tank cars are now replacing cans for collecting milk and bringing it to central receiving stations. Usually ice cream is made by mixing condensed or powdered milk, butter, sugar and other ingredients in steam-jacketed enameled tanks. The mixture is pasteurized in the same apparatus and is immediately homogenized. It is then aged several days in enameled aging tanks to improve its flavor and texture. Enameled units are also available for neutralizing and ripening cream for butter manu-

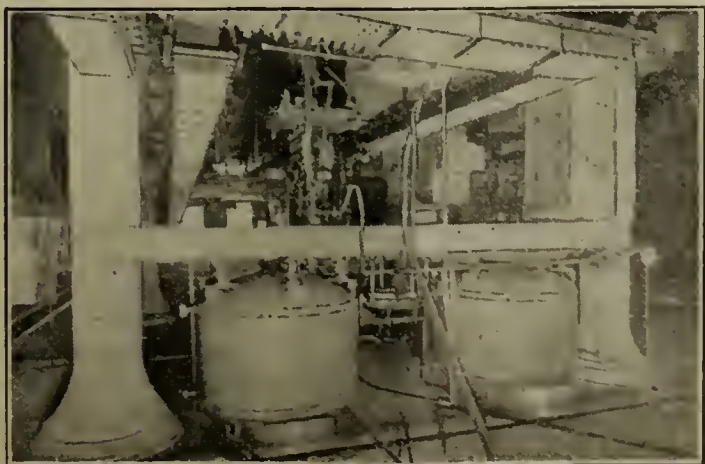


FIG. 19. PHARMACEUTICAL MIXING AND FILLING TANKS

facture and for preparing starters to produce proper flavors during this ripening. Enameled vats are used in preparing cheese, churning oleomargarines and nut butters with ripened milk, rendering lard for oleomargarines, and in many other like operations.

Applications in Other Food Industries.—The list of processes where enameled equipment is used, not only

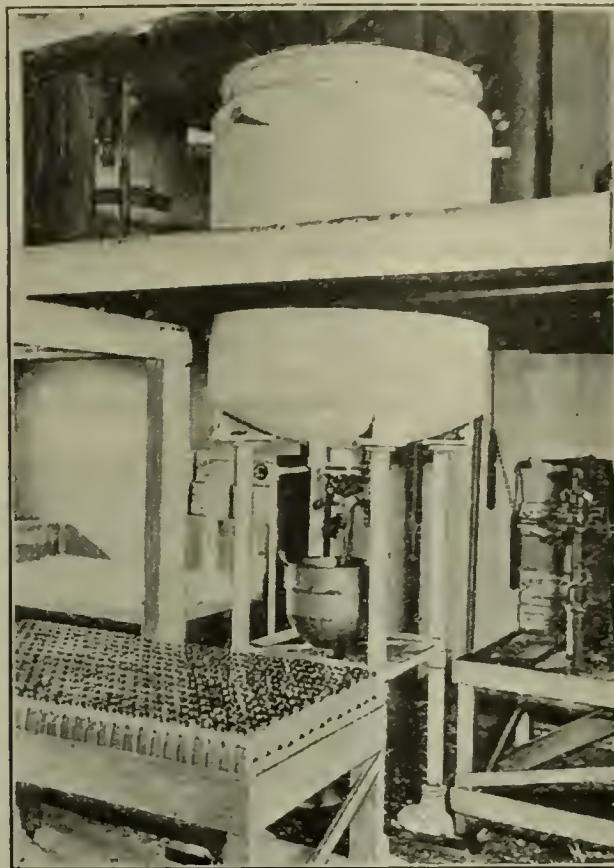


FIG. 17. SALAD DRESSING FILLER

because it is applicable but mainly because it has many advantages, is far from being exhausted. In many food industries such as the manufacture of gelatine, invert sugar, mince meat, the blending of honey, making prepared mustard, refining edible oils, mixing salad dressing, cooking tomato catsup and pasteurizing vinegar, enameled equipment is now used. Time is not



FIG. 18. PHARMACEUTICAL STORAGE TANK

available for describing many possible applications. There are still a few uses of different types which merit mention.

Enameled Equipment for Pharmaceutical Purposes.—One would naturally expect manufacturers of pharmaceutical products to equip their factories quite extensively with enameled apparatus, and such is the case. Enameled equipment has been successfully applied in the manufacture of cod liver oil emulsion, camphor ointment and similar emulsions. Alcoholic soap for

tooth pastes is prepared in closed enameled tanks and the various ingredients, such as glycerine, flavoring oils and chalk, are incorporated using the same apparatus. Numerous varieties of sirups, elixirs, antiseptics and medicines are mixed in enameled tanks and held in storage in other closed tanks until ready for use. The mixing of face creams, evaporation of metallic citrates, extraction of alkaloids, preparation of synthetics such as barbitol, veronal, dichloramine T and many other pharmaceutical preparations are carried out advantageously employing enameled equipment.

Chemical Uses for Glass-Lined Equipment.—The difference between pharmaceutical and chemical operations does not permit of a sharp division. On one hand we have the preparation of aspirin, and on the other the evaporation of thorium nitrates. Enameled equipment is applicable to both. In fact, in each case indicated it is practically essential. The field of chemical operations involves such problems as the preparation of pure

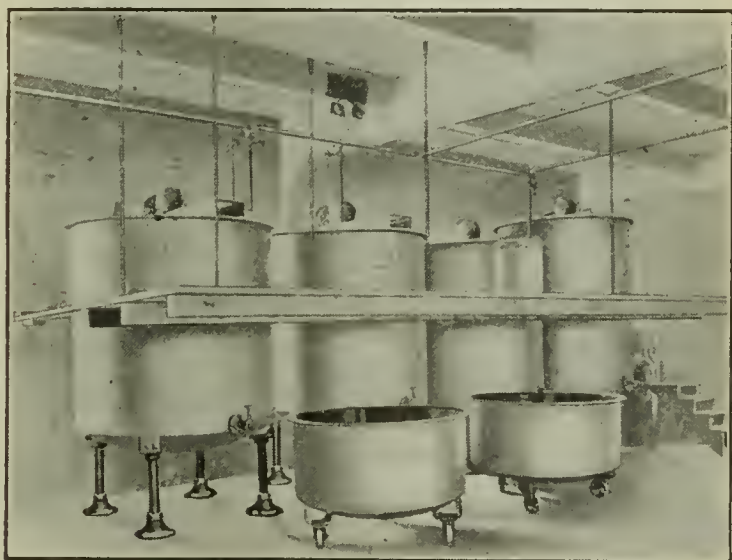


FIG. 20. TANKS USED IN PREPARING SYNTHETIC DRUGS

inorganic salts by evaporation, the distillation of compounds such as acetic anhydride or the chlorination of aromatic compounds. In each, enameled evaporating dishes, stills or reaction kettles are very applicable. In fact their use frequently eliminates purification processes which other types of equipment usually make necessary, and there are many other chemical processes eventually connecting with our everyday life which are carried out using glass-lined equipment. Rare earth bromides used for luminous paints are evaporated in enameled dishes. Platinum chloride solutions are similarly processed before refining. Tartaric acid and cream of tartar for use in baking powders are boiled up with charcoal and crystallized in enameled pans. Many dyestuffs and intermediates are prepared using enameled reaction kettles. And so the list goes on, but the above examples are perhaps more than sufficient.

A BROAD FUTURE

Enameled equipment has not been applied to all industrial processes with their varied demands. In some cases its use is rather recent. Often the manufacturer, searching for the best, has tried enameled equipment for his purpose with marked success. A great many possibilities still remain untried. The uses to which enameled equipment has been applied have pointed out that it has certain advantages which may be improvements in any process and have also pointed out an occasional drawback for its application. Being familiar with some of the various types of work wherein it is



FIG. 21. JACKETED EVAPORATING DISHES

successfully used, new uses may suggest themselves and their possibilities be considered by comparison. If the preceding notes have, in such a way, pointed out the nature of the field of enameled equipment, then their purpose has more than been accomplished.

Cement Specifications for Foreign Countries

The specifications that the various countries of the world use in buying portland cement have been summarized in a chart that has just been issued by the Bureau of Standards of the Department of Commerce.

Cement is an international building material and thirty-two countries of the world have specifications for portland cement, twenty of which differ in important details. Twenty-five others use the specifications of other countries in assuring the quality of the cement used in construction within the country, and many others accept the cement if it passes the tests of the country in which it is made.

Though the specifications differ in details and values, they include the same kind of tests in most cases. These are tests for chemical composition, specific gravity, fineness of grinding, setting time, soundness, and tensile and compressive strength.

In this country, there is one universal specification for portland cement, which has been adopted by the commercial interests and testing engineers as well as the Government.

Italian Olive Oil Industry

In 1918 583,600 hectares was cultivated exclusively with the olive tree, and 1,711,100 hectares with this tree and other plants, the total production of olives reaching 17,244,000 quintals, and that of olive oil 2,800,000 hectoliters. The greatest production of olive oil was in the Puglia region; then came Sicily, Calabria, Campania, Tuscany, Abruzzi, Lazio, Umbria, Sardinia, Basilicata, Liguria, Marche, Emilia, Lombardia and the Veneto.

At present the most important region in Italy for the production of the olive oil tree is Puglia, where 300,000 hectares is cultivated exclusively with it, and about 200,000 hectares with it and other plants. In other Italian regions the hectares devoted to olive tree culture are much below such figures. Piedmont is the only region that does not produce olive oil, owing to its colder climate. The exportations of olive oil (edible) increased during the first six months of this year, reaching 1,394 tons, against 798 tons during the same time last year.

Recent Chemical & Metallurgical Patents

British Patents

For complete specifications of any British patent apply to the Superintendent, British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Polymerizing Fatty Acids.—Unsaturated fatty acids to be polymerized are converted into alkali salts free from glycerine, and these salts are boiled with caustic lyes, such as caustic soda of 10-12 deg. Bé., to settle out albuminous and other impurities, precipitated out with common salt, heated in an autoclave at 180-214 deg. C. for at least 3 hours, afterward concentrated at constant pressure until the soap contains at least 75 per cent of fatty acids, and then heated in the closed autoclave at 180-214 deg. C. until the desired degree of polymerization is obtained. The purification of the alkali salts admits of lower temperatures being employed so that fish oils, refuse oils, and other impure oils can be treated satisfactorily. (Br. Pat. 166,236. De Nordiske Fabriker De-No-Fa Aktieselskap, Christiania. Sept. 7, 1921.)

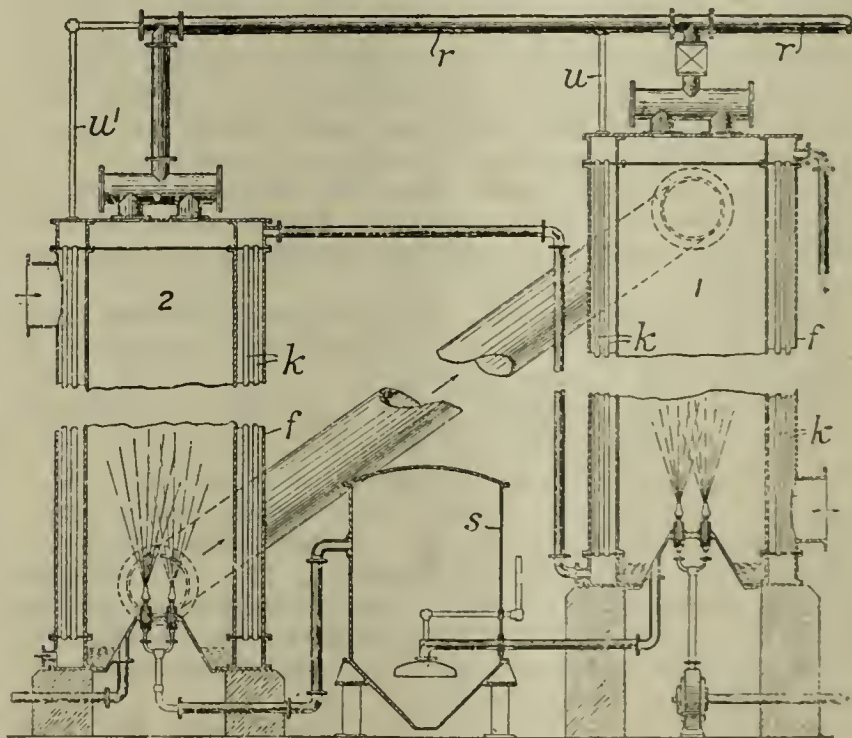
Amino Compounds.—Amino compounds are prepared by passing nitro compounds such as nitrobenzene and nitrotoluene, in the vapor phase and together with hydrogen, water gas, etc., over or in contact with a copper-containing catalyst. In place of hydrogen as such there may be employed a body such as secondary butyl alcohol, which is capable of being dehydrogenated under the conditions suitable for the reduction of the nitro compounds, in which case there is obtained in addition to the amino compound, methyl ethyl ketone, or, if methyl alcohol is employed, the reaction product of formaldehyde and aniline. The copper-containing catalyst in a dense porous condition is produced by fusing cupric oxide, cooling it and breaking it into pieces; if desired, the mass may be wholly or partly reduced in a current of hydrogen after the cooling stage. Instead of cupric oxide, a copper salt, such as the nitrate or carbonate, capable of producing cupric oxide on heating, may be used as starting material. The catalyst can be revived by heating in air to temperatures between 300 and 1,000 deg. C. (Br. Pat. 166,283. D. A. Legg and M. A. Adam, both of London. Sept. 7, 1921.)

Dyes Derived From Anthracene.—Vat dyes are obtained by heating 2-aminoanthraquinone with caustic potash in the presence of a non-hydroxylic diluent or solvent—for example aniline, naphthalene, liquid paraffine or toluene; temperatures of 180-250 deg. C. are suitable. According to examples: An impure 1:2:2':1'-N-dihydroanthraquinoneazine dyeing green shades is obtained by boiling 2-aminoanthraquinone with aniline and caustic potash; a pure 1:2:2':1'-N-dihydroanthraquinoneazine dyeing blue shades is obtained by boiling 2-aminoanthraquinone with naphthalene, caustic potash, and potassium nitrate. (Br. Pat. 166,297. F. W. Attack, Manchester, and J. Anderson, St. Andrews, Fifeshire. Sept. 7, 1921.)

Cellulose Ethers.—Cellulose derivatives, suitable for the same or similar applications to the known cellulose ethers and esters, are prepared by reacting on cellulose or its conversion products with halogen esters of glycols or of polyhydric alcohols, or of their ethers—for example, ethylene or propylene chloride or chlorhydrin, glyceryl chlorhydrins, epichlorhydrin and monochlorether; if the ester contains free hydroxyl groups, then such groups are retained in the resulting cellulose derivative. The reaction is carried out in the presence of basic substances, preferably caustic alkalis, and it is preferred to start with cellulose or a conversion product not soluble in alkali and as little depolymerized as possible; it is preferred to employ in the reaction limited quantities of water, say from no water up to four times the weight of the cellulose taken, but preferably between one-half to one and a half times such weight, and preferably a total amount of alkali as would correspond to a 50-75 per cent or even 95 per cent

solution in the water present or added; usually the reaction is carried out at about ordinary temperature, and preferably with cooling to about 0 deg. C. or lower; and the reaction may be carried out with the addition of diluents or solvents such as benzene and in the presence of contact substances such as copper powder, or copper salts or hydroxides. In examples, cellulose is impregnated with 50 per cent caustic soda solution, kneaded with ethylene chlorhydrin or glyceryl monochlorhydrin while cooling to 0 deg. C., with subsequent additions of powdered caustic soda and chlorhydrin; alternatively, the cellulose may be impregnated with water and the caustic soda added in powdered form. The whole of the caustic alkali may be added prior to the treatment with halogen ester, and the ester may be incorporated all at once or in portions or continuously during the process. Mixed cellulose derivatives may be obtained by the introduction of different groups or residues of the class referred to, or by the introduction of other ether groups such as alkyl, benzyl and homologous groups. (Br. Pat. 166,767. H. Dreyfuss, London. Sept. 14, 1921.)

Distilling Ammoniacal Liquor.—Heated ammoniacal liquor is sprayed in succession into two or more evaporating chambers 1, 2, the pressure in the first chamber being utilized to effect the spraying into the second. The liquor may be passed through an intermediate chamber *s* in which it is mixed with a reagent to liberate fixed ammonia. The chambers 1, 2 are heated by flue gases circulating in jackets *f*. The ammoniacal liquor is preheated by passage through tubes *k* in the jackets. Connecting-pipes *u*, *u'* serve to pass the gases generated during the heating of the liquor in the tubes *k* to the collecting main *r*, which leads to a saturator



for the formation of ammonium sulphate. If pure ammonia is to be separated, the first evaporating chamber is surmounted by a column up which the vapors pass and down which a portion of cold ammoniacal liquor flows and removes ammonia from the vapors. The liquor falls through the perforated top of the spraying chamber. The liquor from the base of the chamber is passed through a vessel *s* and then in succession through spraying chambers from which ammonia gas is withdrawn. (Br. Pat. 167,719. Holmes & Co., Ltd., W. C. and M. Boocock, and W. Wyld. Leeds. Oct. 5, 1921.)

Lubricants.—Lubricating oils are obtained by blowing air or oxygen through a mixture of hydrocarbon oil and a catalyst consisting of a manganese, lead or mercury compound, maintained below the cracking point of the oil and between 50 and 300 deg. C. until 0.2 to 1.0 per cent fatty acid is produced. Volatile products may be permitted to escape, or any desired portion may be retained as by flowing the oil and air or oxygen in the same direction and cooling sufficiently to condense the desired portion. The product may be blended with other hydrocarbon lubricating oils, vegetable or animal oils or fats, alkali, soap or graphite. (Br. Pat. 167,789. J. Harger, Liverpool. Oct. 5, 1921.)

Current Events

in the Chemical and Metallurgical Industries

More Plants Increasing Operations

Glass. The Libbey Glass Co. has arranged production on a full 24-hour working basis at its Sandusky, Ohio, plant.

Paper. The Young & Goodfeller Paper Co., Bently Springs, Md., has resumed operations at its local Eagle Mill, following a suspension of manufacture for several months. New machinery has been installed in certain departments of the plant during the idle period.

The Whalen Pulp & Paper Co., Toronto, Ont., is perfecting plans for the early resumption of production at its paper mill in the Swanson Bay section, near Prince Rupert, B.C. Other plants of the company at Port Alice and Howe Sound are now in operation.

The Hinde & Dauch Paper Co., Sandusky, Ohio, has placed its local mills on a normal operating basis. The No. 1, main plant, is running on full time, 5½ days a week; the No. 2, or West End mill, is operating on a 6-day week schedule.

Chemical. The Davison Chemical Co., Baltimore, Md., is now operating its local plant on a basis of about 80 per cent of normal. It is stated that there is a marked increase in demand for sulphuric acid, one of the principal products of the factory.

Leather. Practically all of the tanneries at Wilmington, Del., are taking on additional employees for increased production. It is said that the larger local plants will reach a pre-war basis of manufacture at an early date.

Metals. The New Jersey Zinc Co., Palmerton, Pa., is increasing manufacture at its local plant in the line of oxides and lithopone, and additions are being made to the working force.

The Rosario Mining Co., Tegucigalpa, Honduras, has resumed operations at its local silver mines, following a curtailment of a number of months.

Tin Plate. The American Sheet & Tin Plate Co. began operations at twenty additional mills at its New Castle, Pa., plant Nov. 20, bringing production up to a point of about 90 per cent of normal; a 5-day week schedule will be operative. Operations have also been resumed on full time, working three shifts, at the Monesson, Pa., mills of the company, effecting 100 per cent or normal production at this plant. It is announced that the Shenango, Pa., works will also be resumed under full capacity, where twenty out of thirty mills have been running.

Coke. The H. C. Frick Coke Co., Uniontown, Pa., has placed 850 additional ovens in blast at its works, bringing operations up to a total of about 2,000 ovens and giving employment to approximately the same number of men. The majority of the ovens have been idle since last March and April.

The W. J. Rainey Co., Inc., is operating 150 ovens at its Mount Braddock, Pa., plant, and 100 ovens at the Elm Grove, Pa., works.

Iron and Steel. The Interstate Iron & Steel Co., Chicago, Ill., has increased production to about 50 per cent of normal at its local plant.

The American Steel Foundries Co., East St. Louis, Ill., has resumed production at its local plant, following a shutdown since last February. Employment will be given to about 800 men. The company also reopened its plant at Alliance, Ohio, Nov. 14, with a working force of about 300 men, which will be increased gradually from week to week.

The Thomas Iron Co., Alburtis, Pa., is planning to blow in its Lockridge furnace early in December.

The National Tube Co., McKeesport, Pa., has placed another furnace in blast at its local works, making three out of four furnaces now in service.

The National Malleable Castings Co., Sharon, Pa., has increased operations from 5 to 6 days a week.

Dye Investigation Not Ordered

An unsuccessful effort was made by Senator King, of Utah, during the closing hours of the extra session of Congress to obtain action on the resolution proposing to investigate the dye industry and its efforts to influence legislation. Senator King objected to the action of the Judiciary Committee in limiting the investigation to the alleged dye lobby and to the alleged existence of a dye monopoly. He said that any investigation should include a probe of the efforts made to influence the federal dye control agency and various other activities of dye interests.

Had Senator King been willing to accept an amendment by Senator Frelinghuysen, of New Jersey, that the investigation be broadened so as to allow the committee to search into the activities of importers of dyes, the probe doubtless would have been ordered. Instead, he tried to override the Frelinghuysen suggestion by demanding a vote on the measure as reported by the Judiciary Committee. The absence of a quorum was developed and a motion that the Senate adjourn *sine die* put an end to the effort.

Senator Frelinghuysen expressed the opinion that the Senate should know whether or not the importers are controlling or influencing the dye market or the trade in dyes. He said that neither the dye nor the chemical industry fears any investigation, but that something might be revealed if the practices of importers were laid bare.

Senator McCumber, of North Dakota, expressed the opinion that an investigation of the character proposed by Senator King would be of doubtful value. He said that matter already has been the subject of extended inquiry and that enough testimony has been taken to enable anyone concerned to determine "whether or not there has been such a propaganda as is supposed to influence Senators, and whether or not the dye industry is a monopoly."

Senator Moses, of New Hampshire, declared that there is a vast amount of evidence on the subject that never has been presented to a congressional committee. He declared that he personally has evidence concerning the activities of dye interests in New Hampshire which never has been revealed. Senator King added that there should be an investigation "that will investigate—that will get all the facts relating to this monopoly, its activities, its sinister purposes, its reprehensible if not corrupt methods of operation, its persistent efforts to control Congress and to secure legislation that will enable it to destroy all competition and put millions in the pockets of a favored few."

Senator Brandegee, of Connecticut, not only expressed the opinion that the investigation would amount to nothing but stated that it is not the business of Congress to determine what is and what is not a monopoly. He held that it is a judicial question for the courts to decide. "It would amount to nothing," he said, "to resolve that in our opinion the dye industry is a monopoly."

Additional Papers for the Baltimore Meeting, A.I.C.E.

The final program for the meeting of the American Institute of Chemical Engineers, which will be held in Baltimore, Dec. 6 to 9, contains four papers which were not included in the program printed in our issue of Nov. 16. L. W. Wallace, executive secretary, F.A.E.S., will address the institute at 10 a.m., Dec. 6. During the morning of Dec. 8, Prof. J. H. James will present a paper on "Some New Products From Petroleum" and Dr. Robert M. Yerkes will discuss the research information service of the National Research Council. The fourth paper, which is scheduled for 10:15 a.m., Dec. 9, is "Regenerative Evaporation," by Prof. W. L. Badger.

Program, American Petroleum Institute Meeting

As announced in a preliminary bulletin, the program of the second annual meeting of the American Petroleum Institute at the Congress Hotel, Chicago, Dec. 6, 7 and 8, will include general sessions in the afternoons and evenings, and technical sessions Tuesday and Wednesday mornings.

Among the addresses at the general sessions will be:

"The Current Year in the Petroleum Industry," Walter C. Teagle, president Standard Oil Co. of New Jersey; "The Mid-Continent Refiner," D. W. Moffitt, vice-president, Cosden & Co.; "Looking Ahead," Harry F. Sinclair, chairman of board, Sinclair Consolidated Oil Corporation; "Some Things We Might Be Doing," Henry L. Doherty, president, Cities Service Co.; "As John Bull Views It," Sir John Cadman, formerly his Majesty's petroleum executive; "World Highways of Trade," A. C. Bedford, chairman of board, Standard Oil Co. of New Jersey.

The technical program is as follows:

TUESDAY, DEC. 6, 10 A. M.

General topic, "The Motor Fuel Problem."

Presiding, R. D. Benson, president, Tide Water Oil Co.

"Quantitative"

"Quantitative Survey of Petroleum Industry From the Standpoint of Production of Motor Fuel," Van H. Manning, director of research, American Petroleum Institute.

"Quantitative Survey of the Automotive Industry, Present and Prospective," Edward S. Jordan, president, Jordan Motor Car Co.

"Qualitative"

"Requirements of Motor Vehicle Fuel," H. M. Crane, engineer.

"Qualitative Limitations in Refining and Marketing," Frank A. Howard, manager, Development Department, Standard Oil Co. (New Jersey).

"Volatility of Motor Fuel as Marketed in the United States," N. A. C. Smith, petroleum chemist, U. S. Bureau of Mines.

"What Constitutes True Volatility," R. E. Wilson, director of research, Laboratory of Applied Chemistry, Massachusetts Institute of Technology.

"Present Variations in the Quality of Motor Fuel—Its Extent and Causes," C. K. Francis, chief chemist, Cosden & Co.

General discussion.

WEDNESDAY, DEC. 7, 10 A. M.

General topic, "The Motor Fuel Problem."

Presiding, Capt. J. F. Lucey, president, Lucey Manufacturing Corporation.

"Limitations Imposed on Economy by Volatility Changes," F. C. Mock, research engineer, Stromberg Motor Devices Co.

"Practical Effects of Too Low Volatility," O. C. Berry, chief engineer, Wheeler-Schebler Carburetor Co.

Thirty minutes of general discussion.

General topic, "Value of Research to the Petroleum Industry in General."

Discussion by:

David Beecroft, president, Society of Automotive Engineers; T. G. Delbridge, chief chemist, Atlantic Refining Co.; A. W. Ambrose, petroleum technologist, U. S. Bureau of Mines; K. G. Mackenzie, chief chemist, the Texas Co.; W. C. Platt, president, *National Petroleum News*; J. R. Stockton, vice-president, Producers & Refiners Corporation.

Executive Committee, Division of Chemistry and Chemical Technology, N.R.C., to Meet

The executive committee of the Division of Chemistry and Chemical Technology of the National Research Council will meet in Washington on Monday, Dec. 12, to consider the progress of investigations and the committee work which will be supported for the coming year. Any persons interested desiring to make suggestions regarding plans for the work of the division should send them before that date to Dr. F. G. Cottrell, chairman, 1701 Massachusetts Ave., Washington, D. C. Other members of the committee are: Julius Stieglitz, vice-chairman; Colin G. Fink, W. F. Hillebrand, R. B. Moore and W. D. Bancroft.

Federated American Engineering Societies to Review Progress at Annual Meeting

In a statement summarizing general conditions in the Federated American Engineering Societies, the executive secretary, L. W. Wallace, expresses the belief that the federation has made substantial progress. At the annual meeting of the American Engineering Council to be held in Washington Jan. 5 and 6, this progress will be shown by reports covering activities in many fields.

"Unquestionably," says Mr. Wallace, "the federation has made favorable and permanent contacts in Washington. Through the activities of Congress and of the new federal administration, we have had the opportunity of rendering some really constructive service. We feel, however, that the great body of engineers are not adequately informed of the organization of the federation, of its aims and purposes and of its activities.

"This lack of information is serious and until engineers in general are more fully informed, we shall not hope to function to the best advantage. The executive board should therefore give serious consideration to methods of informing engineers as to the aims, policies and activities of the federation. Some member societies have been and are now perhaps rather indifferent to a continuation of their affiliation. As far as we have been able to ascertain, this condition is due to the officials and the members of such organizations not being fully informed.

"While it may be true that during the first year the federation has not been able to accomplish all that was expected on the part of some and that it has not fully found itself, so to speak, yet the progress has been such as to justify optimism rather than pessimism as to the future usefulness of the federation. The federation has been fairly well established in the minds of the public and in Government circles. This is evidenced by the character and quantity of publicity that the federation has received.

"The report of the publicity committee to the executive board clearly shows that the activities of the federation have attracted attention and notice in all of the leading cities and many of the towns and villages of this country. Constant reference is being made to the federation in the technical, daily and periodical press of every description. It is also being referred to in the official proceedings and publications of many commercial and trade associations. This alone is one reason for encouragement."

Sectional Meetings of Steel Treathers

The American Society for Steel Treating is planning to hold sectional meetings at quarterly intervals in addition to its annual meeting and exhibit. By holding the directors' meetings at the same time, a double purpose may be served: The national officers may become acquainted with regional activities with the minimum travel, while many local members who cannot afford to attend the convention—which may be at some distance—will be able to get together for an afternoon and evening social and technical session. The first of these meetings will be held in New York City some time in March, 1921. It is hoped that it will attract the membership of chapters in Baltimore, Boston, Bridgeport, Hartford, Lehigh Valley, New Haven, Schenectady, Syracuse, Providence, Springfield, Washington and Worcester. Walter F. Graham, Truell Court, Plainfield, N. J., is in charge of the arrangements.

Muscle Shoals Deal Likely to Go Through

A definite recommendation by the Secretary of War favorable to Henry Ford's proposal to develop Muscle Shoals probably will be made to Congress shortly after the opening of the regular session. Certain details of the negotiations are not complete and have been delayed by the illness of Secretary Weeks. It is believed, however, that an agreement will be reached without difficulty, although alternative plans may be submitted to Congress.

Muscle Shoals was discussed at a meeting of the Military Affairs Committee of the House on Nov. 21. It was revealed that the committee is thoroughly in sympathy with the policy of having this water power developed by private interests.

Minerals Separation Claims 12 Millions

At the hearing before the Master in the accounting proceedings resulting from the infringement suit against the Butte & Superior Co., which was held in New York, Nov. 3 to 19, Minerals Separation presented a claim of \$11,904,913.95 as representing the profits, gains and advantages which the Butte & Superior Co. had realized from its use of the Minerals Separation patented processes.

The magnitude of this amount is due to the setting up of water gravity concentration as the standard of comparison. This standard, it was testified by Minerals Separation, was the only one which was available to the Butte & Superior Co. It was also testified by Minerals Separation witnesses that 65 per cent recovery of the zinc and a 48 per cent grade of concentrate was the best result which it would have been possible to have obtained upon Butte & Superior ores by water gravity concentration. Applying the difference between this result and the results which admittedly had been obtained through the operation of the Minerals Separation patented processes over the period of years from 1913 to 1919, during which period infringement had been adjudged, the above-mentioned claim as to amount of damages was arrived at.

It would therefore seem that the amount of resulting damages resolves itself largely into a question as to the standard of comparison which may be found to be applicable. Judge Bourquin, in the United States District Court of Montana, has rendered an opinion as to the law governing the available standard of comparison (see *CHEM. & MET. ENG.*, Sept. 7, 1921, page 484), and since this opinion is based upon a motion by Minerals Separation in this very case, the application of this opinion may have the effect of very considerably modifying the figure above given, since by this opinion the Butte & Superior would not seem to be restricted to water gravity concentration as a standard, nor if so, is it likely that the percentages given by the plaintiff will remain unchallenged in the defense which will be submitted when the hearings are resumed Feb. 14, 1922.

Meeting of Synthetic Organic Chemical Manufacturers Association

The adjourned organization meeting of the Synthetic Organic Chemical Manufacturers Association was held Nov. 18 in the Pennsylvania Hotel, New York City. A large and representative attendance was present. During the meeting there were added to the membership by election thirteen active members and one associate member.

W. S. Cashman of the Grasselli Chemical Co., Cleveland, Ohio, was elected a member of the board of governors of the association, having been recommended by the Intermediate Section.

The association is preparing the issuance of a pamphlet setting forth the address of Secretary Hoover which preceded the inaugural meeting in the city of Washington on Oct. 28, extracts from the constitution, and a statement covering fully the objects and purposes of the association.

The following resolution was unanimously passed:

Whereas it has been brought to the attention of this association that it has been reported that the dyestuff manufacturers of the United States are opposed in the tariff legislation to what is known as the American valuation plan, therefore be it

RESOLVED, That the president be instructed to advise the National Manufacturers Association of the United States that it is the sense of this meeting of the Synthetic Organic Chemical Manufacturers Association, manufacturers in the United States of synthetic organic chemicals, including dyestuffs, that the statement, reported in the *New York Times* of Nov. 18, as made by Wilbur F. Wakeman, secretary of the American Protective Tariff League, at a meeting of manufacturers held at the Hotel Pennsylvania, Nov. 17, under the auspices of the National Association of Manufacturers of the United States, to the effect that the administrative feature of the tariff bill now under consideration by the Finance Committee of the United States Senate, providing for American valuation in the determination of ad valorem duties, was opposed, among other influences, by "the domestic dye manufacturers' bloc" is

strongly resented, and the association desires that it be clearly understood that it is in entire sympathy with all measures necessary to encourage and adequately protect all American manufacturing industries, including the American valuation plan.

The meeting adjourned to Dec. 9 at 2 p.m., at the Hotel Pennsylvania, New York City.

International Labor Conference to Adopt Convention on Use of White Lead in Painting

Supplementing the item published on page 980 of the November 23 issue, the Washington office of the International Labor Office reports that the International Labor Conference at Geneva adopted, by a vote of 76 to 3, a resolution to draft a convention on the subject of the use of white lead in painting.

The resolution provides for the prohibition of the use of white lead in interior painting, except in factories and railway stations. However, this portion of the convention does not become effective for 6 years. The convention also provides certain regulations for the use of white lead in other forms of painting, such as measures for protection in dry scraping, in spraying with white lead pigments, providing adequate facilities for washing to those using white lead pigments, etc.

The subject has now gone to the drafting committee of the conference, which will draw up the convention in its final form. Owing to the character of the vote above mentioned, there is little doubt that the draft convention in its final form will receive the necessary two-thirds majority.

New Jersey Clay Workers to Hold Annual Meeting

The New Jersey Clay Workers' Association and Eastern Section of the American Ceramic Society is perfecting arrangements for its annual meeting to be held at Rutgers College, New Brunswick, N. J., Dec. 16. An interesting technical program is being developed by the committee in charge, which includes Prof. George H. Brown, secretary of the organization; Roy H. Minton and Fred A. Whitaker, both of the General Ceramics Co.; Leslie Brown, of Lenox, Inc.; and A. D. Forst, Jr., of the Robertson Art Tile Co. It is expected to have five or more papers on pertinent subjects, with sessions held both morning and afternoon. The annual election of officers will also take place at this time.

Chemical Warfare at the Arms Conference

The limited discussion of chemical warfare which has been had in connection with the Conference on the Limitation of Armament has revealed that it is very generally conceded that chemical warfare has come to stay. The probabilities are that the conference will not go into the details of the use of gas in warfare and that this weapon will be affected only as there may be agreement to make reductions in all military activities.

Gas-Free Ingots

Metallurgists have for years been searching for means to prevent the absorption of gas by the steel during the melting process and there have been several attempts to devise a method to melt in vacuo. Such a plan, emanating from Norway, is the subject of experiment at the present time at the University of Sheffield, England, along the lines of what is known as the "vacuum converter press." The charge to be converted is melted in a vessel; when the contents are thoroughly fluid the vessel is connected to a vacuum pump, which draws out all the gases that remain, and the vacuum is then sealed and the steel cools without being able to reabsorb. Hence the ingot is wholly sound. According to *The Ironmonger*, the experimenters are satisfied that the idea of a vacuum converter has been definitely proved to be of practical value and that it must be reckoned with in the future of the steel trade. Razor steel of unusually fine quality has been made by the process, and it is claimed that it will be equally successful for making all high-quality grades of cutlery steel at less cost than the present crucible process.

British Discuss Plan to Facilitate Production of Denatured Alcohol

At a London conference recently convened by the Empire Motor Fuels Committee of the Imperial Motor Transport Council of delegates from Empire Governments, at which representatives of British India, the Australian Commonwealth, the Union of South Africa, New South Wales, Tasmania, British Columbia, Quebec and the Crown Colonies were present, a resolution was passed for submission to the appropriate departments of the various governments concerned. The conference discussed the present customs and excise restrictions on alcohol and suitable methods for denaturation of alcohol, and the resolution urges that the various Empire Governments be requested to consider the necessary action to facilitate the production and distribution of industrial and power alcohol throughout the empire. It recommends that each Empire Government should consider the advisability of putting forward for consideration at a further conference proposals regarding the adoption of common methods of, and formulas for, the denaturation of alcohol within the empire so as to cheapen and facilitate operations.

Connecticut Valley Section, A.C.S., Elects Officers

At the November meeting, held at the University Club, Hartford, on Nov. 14, the Connecticut Valley Section of the American Chemical Society elected the following officers:

Chairman, Dr. J. S. Chamberlain of Massachusetts Agricultural College; vice-chairman, Dr. Hill of Wesleyan College; treasurer, G. B. Hogaboon; secretary, Paul Serx, jr., Massachusetts Agricultural College; executive committee, Messrs. Andrews of New Britain, Wolfendale of Springfield and Kriebel of Hartford; councilors, Dr. C. R. Hoover and Dr. J. A. Newlands.

Following the business meeting a dinner was served at the University Club. About forty were present. Later in the evening Dr. Chamberlain, of Amherst, gave a historical sketch of the work that led to the discovery of vitamins and a brief account of some of the more recent developments.

Citation by Federal Trade Commission

The Federal Trade Commission has issued a formal complaint against the Procter & Gamble Co., of Cincinnati, Ohio. Thirty days is given for answer, after which the case will be tried on its merits.

The respondent, the complaint alleges, manufactures a soap designated as "P. & G., the White Naphtha Soap," and a washing powder designated as "Star Naphtha Washing Powder," neither of which, it is charged, contains naphtha as a constituent ingredient, but contains instead a petroleum distillate other than naphtha to the extent of 2 per cent or less of the whole ingredients of the washing powder. It is further charged that the distillate used is substantially all lost by volatilization or evaporation by the time the commodity reaches the ultimate consumer. Such practice is alleged to be false and misleading and unfair to competitors of the respondent.

Effect of Impurities in Retarding Crystallization

Professor J. H. Walton, of the department of chemistry of the University of Wisconsin, lectured before the Milwaukee Section of the American Chemical Society on November 18 on the subject, "The Influence of Impurities on the Rate of Growth of Certain Crystals." Prof. Walton's talk had particularly to do with the effect of the presence of impurities upon the rate of crystallization, a subject which is both of theoretical and technical interest. His researches show that substances which are hydrated to the greatest extent show the greatest retarding effect. The retardation is best explained by the slowing down of the reaction by which large molecular aggregates are formed during the process of crystallization. Experiments with undercooled formamide solutions show that here also those substances which are solvated to the greatest extent are the ones that show greatest retardation of the velocity of crystallization.

"Tinkering With Scientific Bureaus"

Through the publication in the *Congressional Record* on Oct. 26 of a plan by Arthur McDonald of Washington, to consolidate all Government scientific bureaus in the Smithsonian Institution, wide circulation has been given to a scheme which is not taken seriously in Washington and which does not have the indorsement of the Smithsonian Institution. Dr. Charles D. Walcott, secretary of the Smithsonian Institution, states that the plan was drawn up and circulated without his knowledge or approval. Representative Melvin O. McLaughlin, who inserted the proposal in the *Congressional Record*, states that he is opposed to the scheme himself, but sees no reason why publicity should not be given to the suggestion so that those concerned could accept it for what it may be worth.

It may be recalled that in an editorial in its issue of Oct. 19, CHEMICAL & METALLURGICAL ENGINEERING pointed out the utter fallacy of the proposal and warned its readers against giving the scheme any serious consideration. As a result, however, of the publication in the *Congressional Record*, the various scientific bureaus and the Smithsonian Institution have received a flood of comment aroused by the suggestion.

To Revise Summary of Tariff Information

The Tariff Commission has been requested by the Senate Finance Committee to prepare for the use of that committee a volume similar in character and contents to the Summary of Tariff Information which was submitted to the Ways and Means Committee in January, 1920. The new volume is to contain much of the information which is in the present Summary and, in addition, later notes and statistics regarding changes which have occurred in the industries since the original volume was published.

It will be recalled that some time ago the proposal was made by Dr. Bernhard C. Hesse that trade associations and scientific societies interest themselves in correcting and bringing up to date this valuable source of industrial information. This opportunity is now offered and it is suggested that any of our readers who are interested in the products of Schedule 1—chemicals, oils and paints of the bill H.R. 7456, submit their comments and criticisms to the United States Tariff Commission not later than December 15.

New Oil Companies in October

During the month of October a total of 55 new companies was organized in the petroleum industry with capital of \$50,000 or over, the aggregate indicated investment being \$83,450,000. This is an increase of about \$30,000,000 in combined capitalization over the figures for September, but a decided decrease from the total of \$496,968,000, as was evidenced for similar new companies in the corresponding month of last year.

For the first 10 months of the present year the indicated investment of new companies in this line of industry aggregates \$1,129,913,600, divided among 807 companies. In the same period of 1920 a total of 2,327 new companies were formed, with a combined capitalization of \$2,410,944,700. Since the beginning of the present year, 27 companies have been organized with a capital of \$10,000,000 or greater.

Obituary

WILLIAM H. STENGEL, treasurer of the George Stengel Co., Inc., Newark, N. J., leather manufacturer and son of the late George Stengel, founder of the company, died at his home, 64 Johnson Ave., Newark, Oct. 28, from a complication of diseases. He was fifty-three years of age.

HOWARD THOMAS, vice-president and general manager of the Eastern Oil Co., Buffalo, N. Y., died on Nov. 12, aged fifty-eight years.

Personal

Dr. E. D. BALL, recently appointed director of scientific work for the Department of Agriculture, has been designated as the representative of that department on the research information service committee of the National Research Council. He fills the place made vacant by the resignation of Dr. Carl L. Alsberg. Dr. Alsberg's place on the Division of Federal Relations of the National Research Council has been filled by Dr. Frederick D. Power, for many years the director of the Wellcome Research Laboratory in London, and now in charge of the phytochemical laboratory of the Bureau of Chemistry.

Prof. EDWARD BARTOW, head of the department of chemistry at the State University of Iowa, has just returned from a trip to Tulsa, Okla., where he was engaged in an investigation of the water supply of that city.

ROBERT F. BROWN, formerly connected with the banking firm of Weil, Farrell & Co., Boston, Mass., has been elected treasurer of the Dayton Rubber Manufacturing Co., Dayton, Ohio, with offices in that city.

A. S. CARLTON has been elected president of the Union Chemical Co., Boston, Mass. For some time past he has been vice-president of the company.

BURGESS DARROW has been appointed development manager for the Goodyear Tire & Rubber Co., Akron, Ohio. He is a graduate of the Massachusetts Institute of Technology and has been connected with the company for the past ten years in tire development and compounding work.

W. MCA. JOHNSON has recovered control of his electrothermic zinc-lead process and expects to take steps to introduce it commercially.

Dr. J. A. LECLERC, who is a recognized expert on cereal products and has been associated with one of the large corn mills for a number of years, has been sent as a special trade commissioner to confer with European authorities upon the use of corn grits as a food.

T. A. PATTERSON has severed his connection with the Niagara Alkali Co., Niagara Falls, N. Y., to become technical director of the Belle Alkali Co., Belle, W. Va.

N. A. V. PAULSSON, who as consulting engineer for Corning & Co., Albany, N. Y., has designed an electric iron and steel plant for the Cia Electro Metallurgica Brasileira, has sailed for Brazil to supervise the installation of the furnaces and the early operation of the plant. His address will be Ribeirão Preto, São Paulo, Brazil, for several months.

Prof. J. H. WALTON, of the department of chemistry of the University of Wisconsin, lectured before the Milwaukee Section of the American Chemical Society on Nov. 18, on the subject "The Influence of Impurities on the Rate of Growth of Certain Crystals."

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, Nov. 28, 1921.

The chemical market during the past week has shown encouraging signs of increased buying power, although again interrupted by a holiday period. Business in most items has been of a satisfactory nature and producers are optimistic about future conditions. An outstanding feature of the market was the position of caustic soda in foreign fields. Large tonnage sales have been authoritatively recorded among leading manufacturers, with the bulk of shipments going to European and South American countries. It is a source of gratification to know that American producers are again successfully able to compete with European factors. The call for caustic and ash at home has also been renewed. There was some future business placed and

more interest is manifested in covering requirements over next year. Producers have announced a standard price for 1922, although there have been various rumors around the market of different contract prices. Yellow prussiate of soda commanded increased interest from the consuming trade and the market was a trifle firmer at the close of the week. Producers of oxalic acid have been much stronger in their views, and goods at the works were quoted considerably higher. Bichromate of soda is moving in slower fashion with actual sales being recorded at lower figures. Caustic potash has been somewhat overlooked during the week and spot prices were a shade weaker. Imported chlorate of potash was about the most unstable item on the market and holders of good-sized quantities were eager to sell regardless of standard quotations. Consumers of bleaching powder have shown an eagerness for full contract deliveries, and supplies appear to be relatively light on both the imported and domestic material. It can be stated, in general, that the outlook for the chemical market is noticeably improving. There is no doubt that the big shot for expansion depends upon the result of the armament conference. Should all the nations concerned agree to reductions of armament, there will be a prompt response in the foreign exchange market which will mean a big boom in our export trade. Domestic soap, paper, textile and tanning industries are showing more interest in the market and new orders are coming in for larger quantities than noted two or three months ago. Those close to the pulse of trading are of the opinion that the spring months will see trade conditions in a very healthy and normal condition.

CHEMICALS

Prices on *oxalic acid* have moved upward during the past week and at the close producers held prices firm at 14½c. per lb., f.o.b. works. Sales on spot were transacted during the week at prices ranging from 14½@16c. per lb., according to brand and quantity. Leading sellers were not inclined to part with stocks under 15c. at the close of the week. The market seems to have become steady again and higher prices are expected. Spot prices on *prussiate of soda* were a fraction firmer at the close and sales were made at 14½c. per lb., ex-store. Some dealers quoted up to 14¾c. Shipment prices remained unchanged at 14¼c. per lb. c.i.f. New York. Dealers of *bichromate of soda* were not desirous of quoting under 8c. per lb. for spot material, although some business was done down to 7½c. The general quotation ranged from 8@8½c. per lb. for prime goods. The demand has remained moderate with small orders attracting the most attention. Commercial *white arsenic* is quoted by leading producers at 6½@7c. per lb. for spot and shipment material. The demand has shown a slight improvement of late. Second hands still quote the market at 6@6½c. per lb. according to quantity. Recent importations of *chlorate of potash* have placed the market in a very unsettled condition and dealers have had to resort to price slashing in an effort to distribute supplies. The price ranges from 5½@6c. per lb. on imported material for spot. Domestic goods is unchanged at 12c. per lb. f.o.b. works. Sales of *caustic potash*, 88-92 per cent, during the week were reported at 5¼@5½c. per lb. The demand has not shown any signs of improvement and prices are barely steady. Large consumers seem to have well supplied themselves with shipment material. The big encouraging feature of the chemical market was the position of *caustic soda* both here and abroad. There has been a marked improvement in the export field since the beginning of the month with reports varying as to the actual amount of business that was placed. Italy was reported to have bought large tonnages at prices ranging from \$4.80@\$5 per 100 lb. c.i.f. Italian ports. South America is also an added buyer of caustic soda with Argentina doing the most purchasing. Producers stated that the demand for domestic material has shown a steady increase. Several carlots have been moved at \$3.90 per 100 lb., with lesser quantities selling around \$4.10. Manufacturers of *copper sulphate* have not advanced the price of this chemical, although the trade is looking for an upward revision on account of the strength in copper metal. The demand has not been at all encouraging of late and this, no doubt, has kept producers from

advancing prices. The carlot price is 5½c. per lb. for standard 99 per cent, large crystals. The market on soda ash in single bags has not shown much change from the previous quotation. The domestic demand has not been up to the standard and prices remained around \$2 per 100 lb. for carload quantities. Smaller lots commanded up to \$2.40 per 100 lb. Barrels were quoted at \$2.40@2.50 per 100 lb. The trade was somewhat surprised that ash was not included in the recent demand for export.

COAL-TAR PRODUCTS

The coal-tar products market during the past week has shown practically no improvement, with prices in most directions unchanged. Small-lot business seems to be attracting the most attention, with an increased amount of inquiries and orders recorded. Contract business is almost unheard of in the trade, as most consumers feel that the general tendency is toward lower rather than higher levels. Producers and buyers are operating in an extremely cautious manner, but are quite optimistic that business will materially improve with the turn of the year. Stocks in consumers' hands are noticeably light and any upturn in the market will, no doubt, tend to bring a considerable amount of orders. The demand for *benzene* still far exceeds the supply, but refiners are experiencing an improvement in stocks with the increased activity in the steel industry. First hands are quoting 27@33c. per gal. Resale material is extremely difficult to locate. The tone of the *cresol* market is somewhat easier, with prices about 1c. per lb. lower. Quotations range from 15@16c. per lb. The market on *phenol* is stronger and holders of prime material are somewhat firmer in their views. Sales under 10c. per lb. are quite rare and quotations range from 10@14c. per lb. according to quantity and seller. Sales on *metaphenylenediamine* were made down to \$1.05 per lb., but the general quotation was \$1.10@1.15 per lb. The demand continues fair in view of the adverse conditions in the garment trade. Resale quotations on *naphthalene flakes* are around 6½@7c. per lb. The market is a trifle firmer and there is some hope for higher prices. Makers ask 7½c. per lb. for the flake and 8@8½c. for the balls. Sales of *alpha-naphthylamine* were made at 30c. per lb., despite rumors of lower figures. This seemed to be the inside price, with holders asking up to 32c. for smaller quantities. Sales of *aniline oil* were made at 18c. per lb., with some sellers asking up to 20c. The market is reported a shade stronger, with most of the low-priced material either sold or withdrawn from the open market. Makers of *beta naphthol* ask 32c. per lb., with sales made by second hands down to 30c. The tone of the market seems to have noticeably improved, although there are still holders of large sized quantities. First hands on *dichlorobenzene* are holding prices at 6@8c. per lb. The demand is not exceptionally strong, but the general tone of the market is steady.

The St. Louis Market

ST. LOUIS, Nov. 25, 1921.

Since the last letter there has been practically no change in the drug and chemical markets as far as activities are concerned. However, a few minor price changes have taken place, principally upward. The second-hands are generally being eliminated but importers are still very active.

ALKALIS

The market continues firm on *caustic*, with the solid selling at \$4 per 100 lb., point of production in carlots, the flake in drums at \$4.25 per 100 lb. for the 76 per cent solid material. *Soda ash* is in light demand, with free movements, the price remaining at \$3 per 100 lb. in barrels ex-warehouse. The market on *bicarbonate* and *sal soda* remains very quiet, with few sales at \$2.90 and \$2.15 per 100 lb. in barrels respectively.

CHEMICALS, DRUGS AND PHARMACEUTICALS

The market on *acetphenetidin* has been strengthened by the elimination of the price-cutting competition. *Ammonia water* is moving through regular channels. *Ammonium sulphate, pure granular*, continues in good inquiry and demand. *Bismuth salts* are moving in a very lively manner,

especially the *subcarbonate*. Large sales of *bromides* have been reported. Orders for *carbon bisulphide* are dropping off. *Creosotes* and *guaiacols* are commanding a better position and should continue to do so, as these are seasonable products. *Ether* continues to move freely. *Glycerin* has advanced slightly and is now selling at 14½c. per lb. in drums. The demand is very strong and even higher prices may be expected. *Glycerophosphates* are moving in larger volume. There appears to be a better demand for *hypophosphites*. *Hypo* and other photographic chemicals are not so active. *Iodides* are very lively. Of the narcotics, *codeine* is the most active of the group. *Salicylates* are moving in good volume. The *sulphur* market is very sluggish. Prices have not declined, but are not firm by any means, being \$1.35 per 100 lb., carlots f.o.b. mines, for 88 per cent commercial. *Zinc oxide* is in fair demand and movement nominal. Future business looks promising. Price remains at 7½c. in barrels and 7¼c. in bags, f.o.b. works, for the standard brands.

ACIDS

Movement of the heavy mineral acids has been retarded this month owing to customers having anticipated their November requirements at the time of the threatened railroad strike. Factors reduced their price on *acid phosphoric sirupy*. *Acid tartaric* is very steady.

VEGETABLE OILS AND NAVAL STORES

Turpentine is somewhat weaker today than at the last report, having declined from 85c. to 83c. for single barrel orders, with a 4c. differential in 5-bbl. lots. The *castor oil* demand has fallen off slightly, but the price remains steady at 12½c. in barrels and 12c. in returnable drums. *Linseed oil* is slow and steady at the same price prevailing in the last report—namely, 70c., basis raw oil ex-warehouse.

The Iron and Steel Market

PITTSBURGH, Nov. 25, 1921.

Except in tubular goods and tin plate, the finished steel market continues to present an appearance of decided dullness, in contrast with the increasing activity observed up to about the middle of October. That is the appearance seen in market circles, but there is the inconsistent thing that production of steel does not seem to decrease at all. There are some cases of increases and in the aggregate there cannot have been much decrease. Steel ingot production may fairly be estimated at between 40 and 45 per cent of capacity, against the 44 per cent rate shown for October, the highest rate since February.

It is quite certain that mills are accumulating no stocks and it is equally certain that neither distributors nor manufacturing consumers are accumulating stocks. There is a fresh effort to liquidate stocks completely, from the double influence of the inventory date being approached and a general reduction in freight rates being expected.

There seems to be no flaw in the argument that the actual ultimate consumption of steel is maintained and is at what may be considered a fair rate by comparison with earlier months in the year. Yet one of the dull seasons of the year has arrived or is being approached. It seems quite reasonable to assume therefore that consumption is to continue at substantially the recent rate, subject to increases when conditions favorable to an increase develop. Four factors at least should make for eventual improvement, within the discernible future:

1. The approach of spring, which normally brings seasonal increase in consumption, this influence being likely to be felt in February.

2. Increasing easiness in money.

3. General reduction in freight rates, which all have been waiting for, in all probability to come between Jan. 1 and April 1.

4. Further liquidation in building costs, and in readjustment and harmonizing in prices and wage rates generally.

These points relate to the consumption of steel. As to demand upon the steel mills, another point can probably be counted upon. There has been drastic liquidation in stocks of steel in the hands of buyers. Steel prices, already low by comparison with commodities and values generally, continue to sag and are likely to reach a level from which

a slight upward reaction could reasonably be expected. With such a point reached and with stocks in buyers' hands at an altogether unnaturally low level, a stocking up process is extremely likely to be seen, and even if pursued very conservatively this would bring an added demand upon the steel mills. Then there would be present consumption plus an increase in consumption plus a partial restoration of stocks. Within the early months of the new year this may not unreasonably be expected to produce a mill operation of 75 per cent or more.

LINES OF DEMAND

Demand upon the pipe mills seems to have increased somewhat even up to date. It certainly has not noticeably decreased. In the past fortnight the National Tube Co. (Steel Corporation) has increased its active blast furnaces from four to six, partly because of exhaustion of stocks of pig iron, partly because of increased demand. There is an equally fair call for standard pipe and for oil country goods. The latter line does not show the usual seasonal decline in activity, partly on account of sharp increases in oil prices in recent months, partly because there is now more oil territory where winter interferes less. Prices on these lines are fairly well maintained. In line pipe there has been severe cutting, said to be well below the cost of production. Each of the three oil companies in the new Mexia field in Texas contemplates laying a 200-mile mine of 8-in. pipe.

Tin plate mill operations are increasing, being supported by current demand of seasonal character and by the entering of specifications against requirements for the first quarter of the new year, furnishing mills extra employment now, shipments to begin after Jan. 1. The \$4.75 price announced Nov. 3 appears to be well held.

Railroads continue to exhibit interest in rolling stock, first exhibited in practical way in the past two or three weeks.

Bars, shapes and plates appear to be in quite moderate demand in general. Sheets are distinctly duller than a month ago. Wire products appear to have been tapering off, some distributors evidently having accumulated stocks through specifying against contracts made in anticipation of the price advance of Sept. 12.

STEEL PRICES

Bars, shapes and plates are more frequently done at 1.50c. than a fortnight ago, but small orders, down to carloads, usually involve a slightly higher price. The continued sagging suggests that eventually there will be a turning point, which is likely to be at 1.50c. or a trifle less. Sheet prices are in a state of flux. After the failure of the recent attempt of some independents to advance the market from 3c. to 3.25c. prices began to sag, some recent quotations being at 2.75c. or possibly a trifle less. It being intimated that the Steel Corporation was about to announce prices for first quarter, independents have been disposed in the past week to withdraw prices under 3c. for black and 4c. for galvanized, and if this withdrawal proves complete the prices mentioned may be announced for the first quarter. The recent attempt to advance wire from 2.60c. to 2.70c. and nails from \$2.90 to \$3 appears to have been abandoned, not enough contract business being booked at existing prices to justify an advance, while it may be that present prices are being shaded, by extension of old contracts and by other methods.

Pig iron continues dull, with a softening tendency when competitive business is offered. The valley market remains quotable at \$20 for bessemer, \$19 for basic and \$20.50 for foundry, but these prices could possibly be shaded on a round tonnage.

Connellsville coke has continued to weaken, with a slight accumulation on track and with continued failure of additional consumption to develop. Prompt furnace coke is down to a range of \$3@3.10, while foundry is not particularly strong at \$4@4.50. The Trumbull-Cliffs Furnace Co. contemplates blowing in its furnace Jan. 1 and is out with an inquiry for 18,000 tons a month for first quarter or first half, apparently expecting to buy at \$3.25, a price not yet quoted for the period.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots		Less Carlots	
Acetic anhydride.....lb.	—	—	\$0 40	\$0 45
Acetone.....lb.	\$0 12½	\$0 12½	.13	.13½
Acid, acetic, 28 per cent.....100 lbs.	2 75	3 00	3 25	3 50
Acetic, 56 per cent.....100 lbs.	6 00	6 25	6 50	7 00
Acetic, glacial, 99½ per cent, carboys, 100 lbs.	10 00	10 50	10 75	11 00
Boric, crystals.....lb.	.12½	.12½	.13	.13½
Boric, powder.....lb.	.13	.13½	.14	.14½
Citric.....lb.	—	—	.45	.47
Hydrochloric.....100 lb.	1 25	1 50	1 60	1 75
Hydrofluoric, 52 per cent.....lb.	.12	.12½	.12½	.13
Lactic, 44 per cent tech.....lb.	.09½	.10	.10½	.12
Lactic, 22 per cent tech.....lb.	.04½	.05½	.06	.07
Molybdic, C.P.....lb.	3 25	3 50	3 60	4 00
Muriatic, 20 deg. (see hydrochloric).....lb.	—	—	—	—
Nitric, 40 deg.....lb.	.06½	.06½	.06½	.07
Nitric, 42 deg.....lb.	.06½	.07	.07½	.07½
Oxalic, crys tals.....lb.	.14½	.15	.15½	.16
Phosphoric, 50 per cent solution.....lb.	.13	.13½	.14	.18
Picric.....lb.	.20	.25	.27	.35
Pyrogallol, resublimed.....lb.	—	—	1 90	2 00
Sulphuric, 60 deg., tank cars.....ton	—	—	11 00	12 00
Sulphuric, 60 deg., drums.....ton	—	—	13 00	15 00
Sulphuric, 66 deg., tank cars.....ton	17 00	18 00	—	—
Sulphuric, 66 deg., drums.....ton	21 00	22 00	22 50	23 00
Sulphuric, 66 deg., carboys.....ton	—	—	—	—
Sulphuric, fuming, 20 per cent(oleum) tank cars.....ton	21 00	22 00	—	—
Sulphuric, fuming, 20 per cent(oleum) drums.....ton	23 00	23 50	24 00	24 50
Sulphuric, fuming, 20 per cent(oleum) carboys.....ton	31 00	32 00	33 00	34 00
Tannic, U. S. P.....lb.	—	—	.75	.85
Tannic (tech.).....lb.	.45	.48	.50	.55
Tartaric, imported crystals.....lb.	—	—	.26½	.27½
Tartaric acid, imported, powdered.....lb.	—	—	.27½	.28½
Tartaric acid, domestic.....lb.	—	—	—	.35
Tungstic, per lb. of WO.....lb.	—	—	1 10	1 20
Alcohol, Ethyl.....gal.	—	—	4 65	5 00
Alcohol, Methyl (see methanol).....gal.	—	—	—	—
Alcohol, denatured, 188 proof.....gal.	—	—	.37	.38
Alcohol, denatured, 190 proof.....gal.	—	—	.35	.36
Alum, ammonia, lump.....lb.	.03½	.03½	.04	.04½
Alum, potash, lump.....lb.	.03½	.04	.04½	.04½
Alum, chrome lump.....lb.	.08½	.08½	.08½	.09
Aluminum sulphate, commercial.....lb.	.01½	.02	.02½	.02½
Aluminum sulphate, iron free.....lb.	.02½	.03	.03½	.03½
Aqua ammonia, 26 deg., drums(750 lb.) lb.	.07½	.07½	.08	.08½
Ammonia, anhydrous, cyl.(100-150 lb.) lb.	.31	.32	.33	.35
Ammonium carbonate, powder.....lb.	.07	.07½	.08	.09
Ammonium chloride, granular (white sal ammoniac).....lb.	.07	.07½	.07½	.07½
Ammonium chloride, granular (gray sal ammoniac).....lb.	.07	.07½	.07½	.07½
Ammonium nitrate.....lb.	.07½	.07½	.07½	.08½
Amylacetate tech.....gal.	—	—	2 40	2 65
Arsenic oxide, (white arsenic) powdered lb.	.06½	.06½	.06½	.07
Arsenic, sulphide, powdered (red arsenic) lb.	.11½	.12	.12½	.13
Barium chloride.....ton	46 00	48 00	49 00	55 00
Barium dioxide (peroxide).....lb.	.20	.21	.22	.23
Barium nitrate.....lb.	.06½	.07	.07½	.08
Barium sulphate (precip.) (blanc fixe) lb.	.04	.04½	.04½	.05
Bleaching powder (see calc. hypochlorite).....lb.	—	—	—	—
Blue vitriol (see copper sulphate).....lb.	—	—	—	—
Borax (see sodium borate).....lb.	—	—	—	—
Brimstone (see sulphur, roll).....lb.	—	—	—	—
Bromine.....lb.	.27	.28	.28½	.30
Calcium acetate.....100 lbs.	1 75	2 00	—	—
Calcium carbide.....lb.	.04½	.04½	.05	.05½
Calcium chloride, fused, lump.....ton	23 50	24 00	24 50	25 50
Calcium chloride, granulated.....lb.	.01½	.02	.02½	.02½
Calcium hypochloride(bleach'g powder) 100 lb.	2 25	2 30	2 35	3 00
Calcium peroxide.....lb.	—	—	1 40	1 50
Calcium phosphate, tribasic.....lb.	—	—	.15	.16
Camphor.....lb.	—	—	.91	.95
Carbon bisulphide.....lb.	.06½	.06½	.07	.07½
Carbon tetrachloride, drums.....lb.	.10½	.10½	.11	.12
Carbonyl chloride, (phosgene).....lb.	—	—	.60	.75
Caustic potash (see potassium hydroxide).....lb.	—	—	—	—
Caustic soda (see sodium hydroxide).....lb.	—	—	—	—
Chlorine, gas, liquid-cylinders(100 lb.) lb.	.08	.09	.09½	.10
Chloroform.....lb.	—	—	.40	.43
Cobalt oxide.....lb.	—	—	2 00	2 10
Copperas (see iron sulphate).....lb.	—	—	—	—
Copper carbonate, green precipitate.....lb.	.19	.19½	.20	.21
Copper cyanide.....lb.	—	—	.50	.62
Copper sulphate, crystals.....lb.	.05½	.05½	.05½	.06
Cremon of tartar(see potassium bitartrate).....lb.	—	—	—	—
Epsom salt (see magnesium sulphate).....lb.	—	—	—	—
Ethyl Acetate Com. 85%.....gal.	—	—	.70	.80
Ethyl Acetate pure (acetic ether, 98% to 100%).....gal.	—	—	.95	—
Formaldehyde, 40 per cent.....lb.	.11	.11½	.11½	.12½
Fusel oil, ref.....gal.	—	—	2 50	3 00
Fusel oil, crude.....gal.	—	—	1 50	1 75
Glauber's salt (see sodium sulphate).....lb.	—	—	—	—
Glycerine, C. P. drums extra.....lb.	—	—	.14½	.15
Iodine, resublimed.....lb.	—	—	3 50	3 60
Iron oxide, red.....lb.	—	—	.12	.18
Iron sulphate (copperas).....ton	18 00	19 00	20 00	23 00
Lead acetate.....lb.	—	—	.10½	.12½
Lead arsenate, powd.....lb.	.15	.15½	.15½	.16½
Lead nitrate.....lb.	—	—	.15	.20
Litharge.....lb.	.08	.08½	.08½	.09
Lithium carbonate.....lb.	—	—	1 40	1 50
Magnesium carbonate, technical.....lb.	.08	.08½	.09	.10
Magnesium sulphate, U. S. P.....100 lb.	2 50	2 75	—	—
Magnesium sulphate, technical.....100 lb.	—	—	1 10	1 75
Methanol, 95%.....gal.	—	—	.66	.68
Methanol, 97%.....gal.	—	—	.70	.72
Nickel salt, double.....lb.	—	—	.12	.12½
Nickel salt, single.....lb.	—	—	.14	.14½
Phosgene (see carbonyl chloride).....lb.	—	—	—	—
Phosphorus, red.....lb.	.40	.41	.42	.45
Phosphorus, yellow.....lb.	—	—	.30	.35
Potassium bichromate.....lb.	.11	.11½	.11½	.12

	Carlots	Less Carlots
Potassium bitartrate (cream of tartar)..... lb.	\$. . . - \$. . .	\$0.28 - \$0.30
Potassium bromide, granular..... lb.		.15 - .20
Potassium carbonate, U. S. P..... lb.	.15 - .16	.17 - .20
Potassium carbonate, 80-85%..... lb.	.04 $\frac{1}{2}$ - .04 $\frac{1}{2}$	.05 - .06
Potassium chlorate, crystals..... lb.	.05 $\frac{1}{2}$ - .06	.06 $\frac{1}{2}$ - .12
Potassium cyanide..... lb.		.40 - .45
Potassium hydroxide (caustic potash)..... lb.	.05 $\frac{1}{2}$ - .06	.06 $\frac{1}{2}$ - .08
Potassium iodide..... lb.		2.60 - 2.75
Potassium nitrate..... lb.	.07 $\frac{1}{2}$ - .07 $\frac{1}{2}$	.08 - .09
Potassium permanganate..... lb.	.17 - .18	.18 $\frac{1}{2}$ - .21
Potassium prussiate, red..... lb.	.28 - .29	.29 $\frac{1}{2}$ - .30
Potassium prussiate, yellow..... lb.	.21 - .21 $\frac{1}{2}$	.21 $\frac{1}{2}$ - .22
Rochelle salts (see sodium potas. tartrate)		
Salammoniac (see ammonium chloride)		
Salsoda (see sodium carbonate)		
Salt cake (bulk)..... ton		20.00 - 22.00
Silver cyanide..... oz.		1.10 - 1.20
Silver nitrate..... oz.		.45 - .46
Soda ash, light..... 100 lb.	2.00 - 2.10	2.15 - 2.50
Soda ash, dense..... 100 lb.	2.35 - 2.40	2.45 - 2.70
Sodium acetate..... lb.	.04 - .04 $\frac{1}{2}$	.04 $\frac{1}{2}$ - .05
Sodium bicarbonate..... 100 lb.	2.00 - 2.25	2.50 - 2.75
Sodium bichromate..... lb.	.08 - .08 $\frac{1}{2}$	.08 $\frac{1}{2}$ - .08 $\frac{3}{4}$
Sodium bisulphate (nitre cake)..... ton	5.00 - 5.25	5.50 - 6.50
Sodium bisulphate powdered, U.S.P..... lb.	.04 $\frac{1}{2}$ - .05	.05 $\frac{1}{2}$ - .06
Sodium borate (borax)..... lb.	.05 $\frac{1}{2}$ - .06	.06 $\frac{1}{2}$ - .07
Sodium carbonate (sal soda)..... 100 lb.	1.80 - 1.90	2.00 - 2.20
Sodium chlorate..... lb.	.07 $\frac{1}{2}$ - .07 $\frac{3}{4}$	.08 - .08 $\frac{1}{2}$
Sodium cyanide..... lb.	.28 - .28 $\frac{1}{2}$	.29 - .30
Sodium fluoride..... lb.	.11 - .12	.12 $\frac{1}{2}$ - .14
Sodium hydroxide (caustic soda)..... 100 lb.	4.00 - 4.10	4.15 - 4.50
Sodium hyposulphite..... lb.		.03 $\frac{1}{2}$ - .03 $\frac{3}{4}$
Sodium nitrite..... lb.	.06 $\frac{1}{2}$ - .07	.07 $\frac{1}{2}$ - .07 $\frac{3}{4}$
Sodium peroxide, powdered..... lb.	.25 - .26	.27 - .30
Sodium phosphate, dibasic..... lb.	.04 $\frac{1}{2}$ - .04 $\frac{3}{4}$	.04 $\frac{3}{4}$ - .05 $\frac{1}{2}$
Sodium potassium tartrate (Rochelle salts) lb.		.21 - .24
Sodium prussiate, yellow..... lb.	.14 $\frac{1}{2}$ - .14 $\frac{3}{4}$	.15 - .15 $\frac{1}{2}$
Sodium silicate, solution (40 deg.)..... 100 lb.	.95 - 1.00	1.10 - 1.25
Sodium silicate, solution (60 deg.)..... 100 lb.	2.30 - 2.40	2.45 - 3.00
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	1.50 - 1.75	2.00 - 2.25
Sodium sulphide, fused, 60-62 per cent (conc.) lb.	.04 $\frac{1}{2}$ - .04 $\frac{3}{4}$	.05 - .05 $\frac{1}{2}$
Sodium sulphite, crystals..... lb.	.03 $\frac{1}{2}$ - .03 $\frac{3}{4}$	.04 - .04 $\frac{1}{2}$
Strontium nitrate, powdered..... lb.	.13 - .14	.14 $\frac{1}{2}$ - .20
Sulphur chloride, red..... lb.	.06 - .06 $\frac{1}{2}$	.06 $\frac{1}{2}$ - .07
Sulphur, crude..... ton	18.00 - 20.00	
Sulphur dioxide, liquid, cylinders extra..... lb.	.08 - .08 $\frac{1}{2}$	.09 - .10
Sulphur (sublimed), flour..... 100 lb.		2.25 - 3.10
Sulphur, roll (brimstone)..... 100 lb.		2.00 - 2.75
Tin bichloride..... lb.	.09 - .09 $\frac{1}{2}$	.09 $\frac{1}{2}$ - .10
Tin oxide..... lb.		.37 - .38 $\frac{1}{2}$
Zinc carbonate, precipitate..... lb.	.16 - .16 $\frac{1}{2}$	.17 - .17 $\frac{1}{2}$
Zinc chloride, gran..... lb.	.09 - .09 $\frac{1}{2}$	.09 $\frac{1}{2}$ - .10
Zinc cyanide..... lb.	.42 - .44	.45 - .47
Zinc dust..... lb.	.11 $\frac{1}{2}$ - .11 $\frac{3}{4}$	.11 $\frac{3}{4}$ - .12 $\frac{1}{2}$
Zinc oxide, XX..... lb.	.07 $\frac{1}{2}$ - .07 $\frac{3}{4}$	.08 - .09
Zinc sulphate..... 100 lb.	3.00 - 3.25	3.30 - 3.50

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude..... lb.	\$1.10 - \$1.15
Alpha-naphthol, refined..... lb.	1.25 - 1.30
Alpha-naphthylamine..... lb.	.30 - .32
Aniline oil, drums extra..... lb.	.18 - .20
Aniline salts..... lb.	.24 - .26
Anthracene, 80% in drums (100 lb.)..... lb.	.75 - 1.00
Benzaldehyde U.S.P..... lb.	1.35 - 1.45
Benzidine, base..... lb.	.90 - 1.00
Benzidine sulphate..... lb.	.75 - .85
Benzoic acid, U.S.P..... lb.	.62 - .65
Benzoate of soda, U.S.P..... lb.	.52 - .55
Benzene, pure, water-white, in drums (100 gal.)..... gal.	.27 - .32
Benzene, 90%, in drums (100 gal.)..... gal.	.25 - .28
Benzyl chloride, 95-97%, refined..... lb.	.25 - .27
Benzyl chloride, tech..... lb.	.20 - .23
Beta-naphthol benzoate..... lb.	3.75 - 4.00
Beta-naphthol, sublimed..... lb.	.70 - .75
Beta-naphthol, tech..... lb.	.30 - .34
Beta-naphthylamine, sublimed..... lb.	1.75 - 1.85
Cresol, U. S. P., in drums (100 lb.)..... lb.	.15 - .16
Ortho-cresol, in drums (100 lb.)..... lb.	.24 - .26
Cresylic acid, 97-99%, straw color, in drums..... gal.	.70 - .80
Cresylic acid, 95-97%, dark, in drums..... gal.	.65 - .70
Cresylic acid, 50%, first quality, drums..... gal.	.45 - .50
Dichlorobenzene..... lb.	.06 - .09
Diethylaniline..... lb.	1.00 - 1.10
Dimethylaniline..... lb.	.45 - .60
Dinitrobenzene..... lb.	.23 - .27
Dinitrochlorobenzene..... lb.	.20 - .25
Dinitronaphthalene..... lb.	.30 - .35
Dinitrophenol..... lb.	.35 - .40
Dinitrotoluene..... lb.	.25 - .30
Dip oil, 25%, car lots, in drums..... gal.	.30 - .35
Diphenylamine..... lb.	.60 - .70
H-acid..... lb.	1.00 - 1.10
Meta-phenylenediamine..... lb.	1.10 - 1.15
Monochlorobenzene..... lb.	.12 - .14
Monoethylaniline..... lb.	1.65 - 1.70
Naphthalene crushed, in bbls..... lb.	.06 $\frac{1}{2}$ - .08
Naphthalene, flake..... lb.	.06 $\frac{1}{2}$ - .08
Naphthalene, balls..... lb.	.08 - .09 $\frac{1}{2}$
Naphthionic acid, crude..... lb.	.70 - .75
Nitrobenzene..... lb.	.12 - .15
Nitro-naphthalene..... lb.	.30 - .35
Nitro-toluene..... lb.	.15 - .17
Ortho-amidophenol..... lb.	3.00 - 3.10
Ortho-dichlor-benzene..... lb.	.15 - .20
Ortho-nitro-phenol..... lb.	.75 - .80
Ortho-nitro-toluene..... lb.	.15 - .20
Ortho-toluidine..... lb.	.20 - .25
Para-amidophenol, base..... lb.	1.40 - 1.45
Para-amidophenol, HCl..... lb.	1.70 - 1.80
Para-dichlorobenzene..... lb.	.12 - .15
Paranitroaniline..... lb.	.75 - .80
Para-nitrotoluene..... lb.	.80 - .85
Para-phenylenediamine..... lb.	1.70 - 1.75
Para-toluidine..... lb.	1.25 - 1.40
Phthalic anhydride..... lb.	.40 - .50

Phenol, U. S. P., drums..... lb.	.10 - .12
Pyridine..... gal.	2.00 - 3.50
Resorcinol, technical..... lb.	1.50 - 1.60
Resorcinol, pure..... lb.	2.00 - 2.25
Salicylic acid, tech., in bbls..... lb.	.20 - .21
Salicylic acid, U. S. P..... lb.	.22 - .23
Salol..... lb.	.70 - .72
Solvent naphtha, water-white, in drums, 100 gal..... gal.	.25 - .28
Solvent naphtha, crude, heavy, in drums, 100 gal..... gal.	.14 - .16
Sulphanilic acid, crude..... lb.	.27 - .30
Tolidine..... lb.	1.30 - 1.35
Toluidine, mixed..... lb.	.43 - .45
Toluene, in tank cars..... gal.	.25 - .28
Toluene, in drums..... gal.	.28 - .31
Xylidines, drums, 100 gal..... lb.	.40 - .45
Xylene, pure, in drums..... gal.	.40 - .45
Xylene, pure, in tank cars..... gal.	.45 - .48
Xylene, commercial, in drums, 100 gal..... gal.	.33 - .35
Xylene, commercial, in tank cars..... gal.	.30 - .33

Waxes

Prices based on original packages in large quantities.

Bayberry Wax..... lb.	\$0.20 - \$0.21
Beeswax, refined, dark..... lb.	.24 - .25
Beeswax, refined, light..... lb.	.28 - .30
Beeswax, white pure..... lb.	.34 - .38
Candellilla wax..... lb.	.24 - .24 $\frac{1}{2}$
Carnauba, No. 1..... lb.	.45 - .46
Carnauba, No. 2, North Country..... lb.	.23 - .23 $\frac{1}{2}$
Carnauba, No. 3, North Country..... lb.	.14 - .14 $\frac{1}{2}$
Japan..... lb.	.21 - .21 $\frac{1}{2}$
Montan, crude..... lb.	.04 - .04 $\frac{1}{2}$
Paraffine waxes, crude match wax (white) 105-110 m.p..... lb.	.04 $\frac{1}{2}$ - .04 $\frac{3}{4}$
Paraffine waxes, crude, scale 124-126 m.p..... lb.	.03 $\frac{1}{2}$ - .03 $\frac{3}{4}$
Paraffine waxes, refined, 118-120 m.p..... lb.	.04 - .04 $\frac{1}{2}$
Paraffine waxes, refined, 125 m.p..... lb.	.04 $\frac{1}{2}$ - .04 $\frac{3}{4}$
Paraffine waxes, refined, 128-130 m.p..... lb.	.04 $\frac{1}{2}$ - .04 $\frac{3}{4}$
Paraffine waxes, refined, 133-135 m.p..... lb.	.05 $\frac{1}{2}$ - .05 $\frac{3}{4}$
Paraffine waxes, refined, 135-137 m.p..... lb.	.05 $\frac{1}{2}$ - .06
Stearic acid, single pressed..... lb.	.09 $\frac{1}{2}$ - .09 $\frac{3}{4}$
Stearic acid, double pressed..... lb.	.09 $\frac{1}{2}$ - .09 $\frac{3}{4}$
Stearic acid, triple pressed..... lb.	.10 $\frac{1}{2}$ - .10 $\frac{3}{4}$

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl..... 280 lb.	\$5.60 - 5.60
Rosin E-I..... 280 lb.	5.65 - 5.70
Rosin K-N..... 280 lb.	6.25 - 6.80
Rosin W. G.-W. W..... 280 lb.	7.00 - 7.25
Wood rosin, bbl..... 280 lb.	6.25 -
Spirits of turpentine..... gal.	.80 -
Wood turpentine, steam dist..... gal.	.78 -
Wood turpentine, dest. dist..... gal.	.76 -
Pine tar pitch, bbl..... 200 lb.	 - 6.00
Tar, kiln burned, bbl. (500 lb.)..... bbl.	 - 10.50
Retort tar, bbl..... 500 lb.	 - 10.50
Rosin oil, first run..... gal.	.36 -
Rosin oil, second run..... gal.	.39 -
Rosin oil, third run..... gal.	.46 -
Pine oil, steam dist., sp.gr. 0.930-0.940..... gal.	\$1.90 -
Pine oil, pure, dest. dist..... gal.	1.50 -
Pine tar oil, ref., sp.gr. 1.025-1.035..... gal.	.46 -
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla..... gal.	.35 -
Pine tar oil, double ref., sp.gr. 0.965-0.990..... gal.	.75 -
Pine tar, ref., thin, sp.gr. 1.080-1.960..... gal.	.35 -
Turpentine, crude, sp. gr., 0.900-0.970..... gal.	1.25 -
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990..... gal.	.35 -
Pinewood creosote, ref..... gal.	.52 -

Solvents

73-76 deg., steel bbls. (85 lb.)..... gal.	\$0.37 -
70-72 deg., steel bbls. (85 lb.)..... gal.	.35 -
68-70 deg., steel bbls. (85 lb.)..... gal.	.34 -
V. M. and P. naphtha, steel bbls. (85 lb.)..... gal.	.23 -

Fertilizers

Ammonium sulphate, bulk and d. bags..... 100 lb.	\$2.60 - 2.90
Blood, dried, f.o.b., N. Y..... unit	4.00 -
Bone, 3 and 50, ground, raw..... ton	30.00 - 32.00
Cyanamide, f.o.b. works..... unit	4.50 -
Fish scrap, dom., dried, f.o.b. works..... unit	2.90 - 3.00
Nitrate soda..... 100 lb.	2.40 - 2.45
Tankage, high grade, f.o.b. Chicago..... unit	2.75 - 3.00
Phosphate rock, f.o.b. mines, Florida pebble, 68-72 p.c..... ton	4.50 - 6.50
Tennessee, 78-80 p.c..... ton	8.50 - 9.00
Potassium muriate, 80 p.c..... ton	37.00 - 40.00
Potassium sulphate..... unit	1.00 - 1.10

Crude Rubber

Para-Upriver fine..... lb.	\$0.21 $\frac{1}{2}$ - .22 $\frac{1}{2}$
Upriver coarse..... lb.	.13 $\frac{1}{2}$ - .14
Upriver caucho ball..... lb.	.13 - .13 $\frac{1}{2}$
Plantation—First latex crepe..... lb.	.17 $\frac{1}{2}$ - .18
Ribbed smoked sheets..... lb.	.17 $\frac{1}{2}$ - .18
Brown crepe, thin, clean..... lb.	.15 -
Amber crepe No. 1..... lb.	.17 $\frac{1}{2}$ -

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls..... lb.	\$0.10 $\frac{1}{2}$ - \$0.10 $\frac{1}{2}$
Castor oil, AA, in bbls..... lb.	.11 $\frac{1}{2}$ - .12
China wood oil, in bbls. (f.o.b. Pac. coast)..... lb.	.13 - .13 $\frac{1}{2}$
Cocoonut oil, Ceylon grade, in bbls..... lb.	.09 - .09 $\frac{1}{2}$
Cocoonut oil, Cochinchina grade, in bbls..... lb.	.10 - .10 $\frac{1}{2}$
Corn oil, crude, in bbls..... lb.	.09 - .09 $\frac{1}{2}$
Cottonseed oil, crude (f. o. b. mill)..... lb.	.07 - .07 $\frac{1}{2}$
Cottonseed oil, summer yellow..... lb.	.08 $\frac{1}{2}$ - .09
Cottonseed oil, winter yellow..... lb.	.09 $\frac{1}{2}$ - .09 $\frac{3}{4}$

Linseed oil, raw, ear lots (domestic)..... gal.	.65	—	.66
Linseed oil, raw, tank cars (domestic)..... gal.	.60	—	.61
Linseed oil, in 5-bbl lots (domestic)..... gal.	.68	—	.69
Olive oil, Denatured..... gal.	\$1.15	—	\$1.20
Palm, Lagos..... lb.	.07 $\frac{1}{2}$	—	.08
Palm, Niger..... lb.	.06 $\frac{1}{2}$	—	.06 $\frac{1}{2}$
Peanut oil, crude, tank cars (f.o.b. mill)..... lb.	.08	—	.08 $\frac{1}{2}$
Peanut oil, refined, in bbls..... lb.	.11 $\frac{1}{2}$	—	.11 $\frac{1}{2}$
Rapeseed oil, refined in bbls..... gal.	.83	—	.84
Rapeseed oil, blown, in bbls..... gal.	.90	—	.92
Soya bean oil (Manchurian), in bbls. N. Y..... lb.	.08 $\frac{3}{4}$	—	....
Soya bean oil, tank cars, f.o.b., Pacific coast..... lb.	.07 $\frac{1}{2}$	—	....

FISH

Light pressed menhaden..... gal.	\$0.40	—	....
Yellow bleached menhaden..... gal.	.42	—	....
White bleached menhaden..... gal.	.45	—	....
Blown menhaden..... gal.	.48	—	....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C..... net ton	\$23.50	—	28.00
Barytes, ground, off color, f.o.b. Kings Creek..... net ton	20.00	—	24.00
Barytes, crude, 88% @ 94% ba., Kings Creek..... net ton	10.00	—	12.00
Barytes, floated, f.o.b. St. Louis..... net ton	23.00	—	24.00
Barytes, crude, first grade, Missouri..... net ton	7.00	—	....
Blanc fixe, dry..... lb.	.04	—	.04 $\frac{1}{2}$
Blanc fixe, pulp..... net ton	45.00	—	55.00
Casein..... lb.	.07	—	.10
Chalk, Precipitated, domestic, extra light..... lb.	.04 $\frac{1}{2}$	—	.05
Chalk, Precipitated, domestic, light..... lb.	.04	—	.04 $\frac{1}{2}$
Chalk, Precipitated, domestic, heavy..... lb.	.03 $\frac{1}{2}$	—	.04
Chalk, Precipitated, English, extra light..... lb.	.04 $\frac{1}{2}$	—	.05
Chalk, Precipitated, English, light..... lb.	.04 $\frac{1}{2}$	—	.05
Chalk, Precipitated, English, dense..... lb.	.04	—	.04 $\frac{1}{2}$
China clay (kaolin) crude, f.o.b. mines, Georgia..... net ton	6.50	—	8.50
China clay (kaolin) washed, f.o.b. Georgia..... net ton	9.00	—	10.00
China clay (kaolin) powdered, f.o.b. Georgia..... net ton	13.00	—	20.00
China clay (kaolin) crude f.o.b. Virginia points..... net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points..... net ton	13.00	—	20.00
China clay (kaolin), imported, lump..... net ton	12.00	—	20.00
China clay (kaolin), imported, powdered..... net ton	25.00	—	30.00
Feldspar, crude, f.o.b. Maryland and North Carolina points..... net ton	5.00	—	7.50
Feldspar, crude, f.o.b. Maine..... net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine..... net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina..... net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State..... net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore..... net ton	27.00	—	30.00
Fullers earth, f.o.b. Mines..... net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Pa..... net ton	15.00	—	18.00
Fullers earth, powdered, f.o.b. Fla..... net ton	18.00	—	....
Fullers earth, imported, powdered..... net ton	24.00	—	27.00
Graphite, Ceylon lump, first quality..... lb.	.06	—	.07
Graphite, Ceylon chip..... lb.	.04 $\frac{1}{2}$	—	.05
Graphite, high grade amorphous crude..... lb.	.00 $\frac{1}{2}$	—	.02 $\frac{1}{2}$
Kieselguhr, f.o.b. mines, Cal..... per ton	40.00	—	....
Kieselguhr, f.o.b. N.Y..... per ton	55.00	—	60.00
Magnesite, calcined..... per ton	50.00	—	65.00
Pumice stone, imported..... lb.	.03	—	.40
Pumice stone, domestic, lump..... lb.	.05	—	.05 $\frac{1}{2}$
Pumice stone, domestic, ground..... lb.	.06	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore..... net ton	....	—	10.00
Quartz (acid tower) 1 $\frac{1}{2}$ @ 2 in., f.o.b. Baltimore..... net ton	....	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore..... net ton	....	—	17.00
Quartz, lump, f.o.b. North Carolina..... net ton	5.00	—	7.50
Shellac, orange fine..... lb.	.68	—	.70
Shellac, orange superfine..... lb.	.78	—	.80
Shellac, A. C. garnet..... lb.	.58	—	.60
Shellac, T. N..... lb.	.68	—	.70
Soapstone..... ton	12.00	—	15.00
Sodium chloride..... long ton	12.50	—	13.00
Talc, paper-making grades, f.o.b. Vermont..... ton	11.00	—	18.00
Talc, roofing grades, f.o.b. Vermont..... ton	8.50	—	13.00
Talc, rubber grades, f.o.b. Vermont..... ton	11.00	—	18.00
Talc, powdered, Southern, f.o.b. cars..... ton	7.50	—	11.00
Talc, imported..... ton	30.00	—	40.00
Talc, California talcum powder grade..... ton	18.00	—	25.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh..... per ton	\$50.00	—	....
Carborundum refractory brick, 9-in. { less than earlot	1,000	—	1250.00
..... { earlot lots	1,000	—	1100.00
Chrome brick, f.o.b. Eastern shipping points..... net ton	52- 55	—	....
Chrome cement, 40-45% Cr ₂ O ₃ net ton	30- 32	—	....
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in ear lots, f.o.b. Eastern shipping points..... net ton	33- 35	—	....
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works..... 1,000	35- 40	—	....
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works..... 1,000	30- 35	—	....
Magnesite brick, 9-in. straight..... net ton	65- 70	—	....
Magnesite brick, 9-in. arches, wedges and keys..... net ton	77	—	....
Magnesite brick, soaps and splits..... net ton	98	—	....
Silica brick, 9-in. sizes, f.o.b. Chicago district..... 1,000	40- 42	—	....
Silica brick, 9-in. sizes, f.o.b. Birmingham district..... 1,000	42- 45	—	....
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa..... 1,000	35- 38	—	....

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18% C, f.o.b. Niagara Falls, N. Y..... net ton	\$200.00	—	225.00
Ferrochrome per lb. of Cr. contained, 6-8% carbon, earlots..... lb.	.11	—	....
Ferrochrome per lb. of Cr. contained, 4-6% carbon, earlots..... lb.	.11	—	.12
Ferromanganese, 76-80% Mn, domestic..... gross ton	58.00	—	60.00
Ferromanganese, 76-80% Mn, English & German..... gross ton	58.00	—	59.00
Spiegelisen, 18-22% Mn..... gross ton	25.00	—	27.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo..... lb.	2.25	—	....
Ferrosilicon, 10-15% Si..... gross ton	38.60	—	40.00
Ferrosilicon, 50% Si..... gross ton	57.00	—	59.00
Ferrosilicon, 75% Si..... gross ton	120.00	—	125.00
Ferrotungsten, 70-80% W, per lb. of contained W..... lb.	.40	—	.45
Ferrouanium, 35-50% U, per lb. of U content..... lb.	6.00	—	....
Ferrovandium, 30-40% V, per lb. of contained V..... lb.	4.25	—	4.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content..... net ton	\$8.00	—	\$10.00
Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃ ton	22.00	—	23.00
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard..... ton	22.00	—	23.00
Coke, foundry, f.o.b. ovens..... net ton	4.00	—	4.25
Coke, furnace, f.o.b. ovens..... net ton	3.00	—	3.25
Fluorspar, gravel, f.o.b. mines, New Mexico..... net ton	12.00	—	....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines..... net ton	20.00	—	22.00
Ilmenite, 52% TiO ₂ , per lb. ore..... lb.	.01 $\frac{1}{2}$	—	.01 $\frac{1}{2}$
Manganese ore, 50% Mn, c.i.f. Atlantic seaport..... unit	.23	—	.24
Manganese ore, chemical (MnO ₂)..... net ton	55.00	—	60.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y..... lb.	.45	—	.50
Monazite, per unit of ThO ₂ , c.i.f., Atlantic seaport..... unit	30.00	—	....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport..... unit	.12	—	.12
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport..... unit	.13	—	.13
Pyrites, domestic, fines, f.o.b. mines, Ga..... unit	.11	—	.12
Rutile, 95% TiO ₂ per lb. ore..... lb.	.15	—	....
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal)..... unit	2.50	—	2.75
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C..... unit	2.75	—	3.00
Uranium ore (carnotite) per lb. of U ₃ O ₈ lb.	1.25	—	1.75
Uranium oxide, 96% per lb. contained U ₃ O ₈ lb.	2.25	—	2.50
Vanadium pentoxide, 99%..... lb.	12.00	—	14.00
Vanadium ore, per lb. of V ₂ O ₅ contained..... lb.	1.00	—	....
Zircon, washed, iron free, f.o.b. Pablo, Florida..... lb.	.04 $\frac{1}{2}$	—	.13

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic.....	13.50
Aluminum, 98 to 99 per cent.....	24.50 @ 25.00
Antimony, wholesale lots, Chinese and Japanese.....	4.60
Nickel, ordinary (ingot).....	41.00
Nickel, electrolytic.....	44.00
Monel metal, shot and blocks.....	35.00
Monel metal ingots.....	38.00
Monel metal, sheet bars.....	40.00
Tin, 5-ton lots, Straits.....	29.625
Lead, New York, spot.....	4.65 @ 4.70
Lead, E. St. Louis, spot.....	4.35
Zinc, spot, New York.....	5.10
Zinc, spot, E. St. Louis.....	4.65

OTHER METALS

Silver (commercial)..... oz.	\$0.66 $\frac{1}{2}$
Cadmium..... lb.	1.00-1.25
Bismuth (500 lb. lots)..... lb.	1.50 @ 1.55
Cobalt..... lb.	3.00 @ 3.25
Magnesium (f.o.b. Philadelphia)..... lb.	1.25
Platinum..... oz.	80.00
Iridium..... oz.	150.00 @ 170.00
Palladium..... oz.	55.00-60.00
Mercury..... 75 lb.	44.00-45.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled.....	21.00
Copper bottoms.....	28.50
Copper rods.....	19.50 @ 20.25
High brass wire.....	16.75
High brass rods.....	14.25
Low brass wire.....	18.25
Low brass rods.....	18.75
Brazed brass tubing.....	25.00
Brazed bronze tubing.....	22.75
Seamless copper tubing.....	20.50
Seamless high brass tubing.....	18.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current	Cleveland	Chicago
Copper, heavy and crucible.....	9.75 @ 10.25	9.25	9.50
Copper, heavy and wire.....	9.25 @ 9.50	8.50	8.50
Copper, light and bottoms.....	7.50 @ 8.00	7.50	7.25
Lead, heavy.....	3.50 @ 3.75	3.25	3.25
Lead, tea.....	2.25 @ 2.35	2.25	2.25
Brass, heavy.....	4.25 @ 4.50	4.50	5.00
Brass, light.....	3.25 @ 3.50	3.25	3.50
No. 1 yellow brass turnings.....	4.00 @ 4.25	4.25	4.50
Zinc.....	2.00 @ 2.25	2.00	2.25

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by $\frac{1}{2}$ in. and larger, and plates $\frac{1}{2}$ in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes.....	\$2.88	\$2.88	\$2.78
Soft steel bars.....	2.78	2.78	2.68
Soft steel bar shapes.....	2.78	2.78	2.68
Soft steel bands.....	3.42	3.48	3.28
Plates, $\frac{1}{2}$ to 1 in. thick.....	2.88	2.88	2.78

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

MOBILE—The United States Turpentine & Rosin Co., organized with a capital of \$1,250,000, Frank W. Boynton, president, has preliminary plans under way for the establishment of a new plant at Crichton, Ala., for the manufacture of turpentine, rosin and affiliated products. The machinery installation will include crushing equipment, retorts, distilling apparatus, etc.

MOBILE—The International Cotton Protecting Co. has plans under way for the construction of a local plant for the manufacture of special raw cotton preservatives. Work will be commenced at an early date.

Georgia

ELBERTON—Fire, Nov. 9, destroyed a portion of the plant of the Elberton Cotton Oil Co., with loss estimated in excess of \$40,000, including equipment. The plant will be rebuilt.

ATLANTA—The Diamond Holfast Rubber Co. has awarded a contract to the Griffin Construction Co., for the erection of its proposed local plant, estimated to cost about \$25,000. A. Ten Eyck Brown, Forsyth Bldg., is architect.

Louisiana

CEDAR GROVE—The Shreveport Lamp Chimney Co., has preliminary plans under way for the erection of an addition to its local plant, to include the installation of new machinery. Thomas F. McBride, Salem, W. Va., is president of the company.

Maryland

BALTIMORE—The McHenry-Millhouse Mfg. Co., South Bend, Ind., is planning for early operations at the local plant of the Electrolytic Zinc Co., 1200 South 16th St., recently acquired, to be used for the manufacture of coating paints and compounds for roofing service, asphalt roofing specialties, etc. The building will be remodeled and enlarged, and necessary machinery installed. J. L. Kittinger is general manager.

BALTIMORE—The Spanish-American Cork Products Co. has acquired the plant and business of the Spanish-American Cork & Specialty Co., with works at Westport, near Baltimore, and in the future will operate at this location. The former factory of the company, recently destroyed by fire, will not be rebuilt at the present time. Plans are under way for expansion at the Westport plant to cost about \$150,000, with proposed machinery installation for the manufacture of cork automobile accessories to represent an investment of close to \$50,000. Oscar T. Harms is president, and Oscar L. Swope, treasurer.

Massachusetts

SPRINGFIELD—Flink & Olson, 518 Page Blvd., have had plans prepared for the erection of a 1-story foundry, 32 x 60 ft. Stuart & Tessler, 94 State St., are architects.

Michigan

PORT HURON—Contract for the new addition to be erected at the plant of the Port Huron Sulphite & Paper Co., has been awarded to Alfred J. O'Sullivan, Port Huron. It will be 2-story and basement, 70 x 100 ft., located on Black River St., with estimated cost of about \$150,000, including machinery. Walter Wythe, 509 Chestnut Ave., is architect.

THREE RIVERS—The Eddy Paper Co. is reported to be considering the construction of two new manufacturing units at its plant, estimated to cost in excess of \$5,000,000. H. L. Vanderherst is vice-president.

BLACK CREEK—The Outagamie Limestone Co., 75 Thirtieth St., Milwaukee, Wis., is perfecting plans for the erection of a new limestone plant in the vicinity of Black Creek, estimated to cost about \$200,000 with

machinery. H. O. Weldon, 10 South La Salle St., Chicago, Ill., is engineer.

KALAMAZOO—The King Paper Co. and the Monarch Paper Co., both of Kalamazoo, with the Bardeen Paper Co., Otsego, Mich., have been consolidated under the name of the Allied Paper Mills, capitalized at \$6,000,000. The different mills of the merged company include 10 paper machines and 3 coating mills, giving employment to over 1,400 operatives under normal production. It is proposed to acquire, by control or purchase, a pulp mill to insure a supply of bleached pulp for production. A general expansion in plant facilities is planned. A. L. Pratt, heretofore head of the King Paper Co., is president of the new corporation.

Minnesota

MINNEAPOLIS—The Minnesota Mfg. Co., 722 North Third St., manufacturer of chemical compounds, etc., has rejected bids received for the construction of its proposed 3-story plant on Eighth Ave., and will call for new bids early in the coming spring. The factory is estimated to cost about \$35,000. E. J. Miller is secretary.

Missouri

ST. LOUIS—The General Mfg. Co., Eighteenth and Pine Sts., has leased a 2-story building in the vicinity of its works, and will establish a plant for the manufacture of rubber specialties, leather belting, etc. The structure will be remodeled and improved to accommodate the industry.

CAPE GIRARDEAU—The National Mining Co. has acquired a local site and is said to have plans in preparation for the erection of a new silica refining plant, estimated to cost in excess of \$75,000.

Montana

GREAT FALLS—The American Refining Co., Okmulgee, Okla., is planning for the construction of a new oil refinery at Great Falls, to utilize crude oil production from the Cat Creek district.

New Jersey

WOODBIDGE—Fire, Nov. 14, destroyed the plant of the Sepoy Chemical Co., Edgar's Station, near Woodbridge, with loss estimated at about \$60,000. The factory was used for the manufacture of dyes, colors and kindred chemical products.

DOVER—The Thomas Iron Co. has commenced excavations for the construction of an addition to its concentrating mill at the Richard Mine, near Dover. The extension, with machinery, is expected to increase the present output of 4,000 tons of ore per month to more than 20,000 tons. A new crushing process will be adopted at the plant.

TRENTON—The Nottingham Rubber Co., 150 East State St., recently organized with a capital of \$500,000, has obtained options on a tract of land near Philadelphia, Pa., as a site for the erection of its proposed new plant for the manufacture of rubber products, including a patented puncture-proof inner tube for automobile tires. Preliminary plans for the factory are under way and it is said that erection will be commenced at an early date. The company is headed by C. Francis Fisk and Samuel H. Bell.

New York

HUDSON—The International Cement Co. has awarded a contract to the Turner Construction Co., 244 Madison Ave., New York, for the erection of a 1-story building at its local plant, 160 x 600 ft., estimated to cost about \$200,000. Excavation work will be placed under way at once.

LONG ISLAND CITY—The Grasselli Chemical Co., Independence Road, Cleveland, O., has filed plans for the erection of a 1-story building at its local plant, 80 x 250 ft., at Morgan St. and Montrose Ave. The Barney Ahlers Co., 110 West Fortieth St., New York, has the construction contract.

Ohio

ASHLAND—The Dragon Rubber Co., North Galloway St., is considering the erection of an addition to its plant.

SANDUSKY—The Farrell-Cheek Steel Foundry Co., has construction under way on a 1-story plant addition, 90 x 180 ft., and plans for early occupancy. Herbert Farrell is president.

MARBLEHEAD—The Kelly Island Lime & Transport Co., Leader-News Bldg., Cleveland, O., has commenced the erection of the steel work for its new local crushing plant, to be 60 x 60 ft., and 170 ft. high, and plans to have the structure ready for the machinery installation at an early date.

Oregon

PORTLAND—The Shope Brick Co., manufacturer of cement brick products, has received a contract for the erection of a plant for the Chinese Government at Canton, China, to be equipped for an initial production of about 125,000 bricks per day. Machinery will be constructed and transported to the site in the near future. D. F. Shope is president.

Pennsylvania

NEW CASTLE—F. A. Seiberling, former president of the Goodyear Tire & Rubber Co. and now operating a local plant under the name of the Lehigh Tire & Rubber Co., has organized a new company under Delaware laws, to be known as the Seiberling Rubber Co., capitalized at \$55,000,000, to manufacture tires and other rubber products. Arrangements have been perfected for the purchase of the plant and business of the Portage Tire & Rubber Co., operating under a receivership for a number of months past, for a consideration said to be close to \$1,000,000. This plant will be operated in conjunction with the New Castle works, representing two manufacturing units of the new Seiberling Co.

PITTSBURGH—The Aluminum Co. of America, Oliver Bldg., has tentative plans under way for the construction of a new hydro-electric power plant in the vicinity of Long Sault Rapids, N. Y., to be used for works operating service in this district. F. S. Fickes, company address, is engineer.

SHIPPENPORT—Fire, Nov. 16, destroyed a portion of the local oil works of the Southwest Pennsylvania Pipe Lines Co., a subsidiary of the Standard Oil Co., with loss estimated at about \$35,000.

PITTSBURGH—The Standard Envelope Mfg. Co. has leased space in the new Chatfield & Woods Bldg., Second Ave. and Short St., for expansion.

LANCASTER—The Armstrong Cork Co. has construction under way on a 1-story shop addition at its local plant, 25 x 35 ft., at Liberty and Mary Sts.

PHILADELPHIA—The Metzger Co., Fifth and Federal Sts., glass products, has filed plans for the erection of a 3-story plant addition, 35 x 68 ft., to cost about \$17,000.

Tennessee

CHATTANOOGA—The new works to be constructed by the Ocoee Copper Co., 1135 Volunteer Life Bldg., at Ducktown, Tenn., will include an extensive flotation plant for the treating of copper ores. The entire works will cost about \$200,000. J. I. Carter is president.

Texas

WACO—The Morris Oil Refining Co. has commenced preliminary production at its new refinery at South Bosque, near Waco, and proposes to develop a capacity of about 1,000 bbl. a day. R. E. Whitlock is manager.

CISCO—Homer Peeples, operating in the Callahan field, near Cisco, has plans under way for the construction of a new casing-head gasoline plant to serve the different properties in this district.

West Virginia

WESTON—The Interstate Window Glass Co. is planning for the rebuilding of its local plant, recently partly destroyed by fire, with loss estimated at about \$25,000.

Canada

BRITANNIA BEACH, B. C.—The Britannia Mining & Smelting Co. is planning for the early rebuilding of its smelting works, recently damaged by flood, and has awarded a contract to the Traylor Engineering & Mfg. Co., Allentown, Pa., for the construction of 18 large tube mills and 5 sets of crushing rolls, the largest to be 72 in. in diameter. The machinery is expected to be ready for shipment in about 90 days.

New Publications

Industrial India is the title of a new monthly magazine published for distribution among the industries of India by the Tata Publicity Corp., Ltd., London. This is the first attempt to produce a modern industrial magazine for India, and the publication should be of interest to those who are developing the Indian market.

THE IMPERIAL MINERAL RESOURCES BUREAU, London, England, has published the following bulletins, on Talc: Fluorspar; Coal, Coke and Byproducts; Tungsten and Manganese.

NEW U. S. GEOLOGICAL SURVEY PUBLICATIONS: Mineral Resources of the U. S. in 1920 (Preliminary Summary); I:1, Cadmium in 1920, by C. E. Siebenthal and A. Stoll (Mineral Resources of the U. S., 1920, Part I), published May 12, 1921; I:2, Gold, Silver, Copper, Lead and Zinc in the Eastern States in 1920, by J. P. Dunlop (Mineral Resources of the U. S., 1920, Part I), published Aug. 13, 1921; I:4, Chromite in 1920, by Edward Sampson (Mineral Resources of the U. S., 1920, Part I), published Aug. 17, 1921; I:5, Bauxite and Aluminum in 1920, by James M. Hill (Mineral Resources of the U. S., 1920, Part I), published Aug. 31, 1921; I:6, Platinum and Allied Metals in 1920, by James M. Hill (Mineral Resources of the U. S., 1920, Part I), published Sept. 9, 1921; I:7, Arsenic, Bismuth, Selenium and Tellurium in 1920, by Victor C. Heikes (Mineral Resources of the U. S., 1920, Part I), published Sept. 22, 1921; I:13, Silver, Copper, Lead and Zinc in the Central States in 1919, by J. P. Dunlop (Mineral Resources of the U. S., 1919, Part I), published May 25, 1921; I:16, Gold, Silver, Copper, Lead and Zinc in Arizona in 1919, by V. C. Heikes (Mineral Resources of the U. S., 1919, Part I), published Aug. 12, 1921; I:17, Gold, Silver, Copper, Lead and Zinc in Nevada in 1919, by V. C. Heikes (Mineral Resources of the U. S., 1919, Part I), published Aug. 16, 1921; I:18, Gold, Silver, Copper, Lead and Zinc in Utah in 1919, by V. C. Heikes (Mineral Resources of the U. S., 1919, Part I), published Aug. 9, 1921; I:19, Gold, Silver, Copper, Lead and Zinc and Idaho and Washington in 1919, by C. N. Gerry (Mineral Resources of the U. S., 1919, Part I), published Aug. 11, 1921; I:20, Gold, Silver, Copper, Lead and Zinc in Montana in 1919, by C. N. Gerry (Mineral Resources of the U. S., 1919, Part I), published Aug. 17, 1921; I:21, Copper in 1919, by H. A. C. Jenison (Mineral Resources of the U. S., 1919, Part I), published Sept. 8, 1921; I:31, Zinc in 1918, by C. E. Siebenthal (Mineral Resources of the U. S., 1918, Part I), published April 29, 1921; I:B, Mineral Resources of the United States in 1918, Introduction by Edson S. Bastin, summary by Martha B. Clark (Mineral Resources of the U. S., 1918, Part I), published Aug. 15, 1921; II:1, Magnesite in 1920 by Charles G. Yale and Ralph W. Stone (Mineral Resources of the U. S., 1920, Part II), published July 27, 1921; II:2, Salt, Bromine and Calcium Chloride in 1920 by Ralph W. Stone (Mineral Resources of the U. S., 1920, Part II), published Aug. 5, 1921; II:3, Phosphate Rock in 1920, by Ralph W. Stone (Mineral Resources of the U. S., 1920, Part II), published in Aug. 11, 1921; II:4, Sand-lime Brick in 1920, by Jefferson Middleton (Mineral Resources of the U. S., 1920, Part II), published Aug. 24, 1921; II:5, Fullers Earth in 1920, by Jefferson Middleton (Mineral Resources of the U. S., 1920, Part II), published Aug. 25, 1921; II:6, Peat in 1920, by K. W. Cottrell (Mineral Resources of the U. S., 1920, Part II), published Sept. 7, 1921; II:7, Asphalt and Related Bitumens in 1920, by K. W. Cottrell (Mineral Resources of the U. S., 1920, Part II), published Aug. 25, 1921; II:8, Gypsum in 1920, by Ralph W. Stone (Mineral Resources of the U. S., 1920, Part II), published Aug. 31, 1921; II:9, Fluorspar and Cryolite in 1920, by Hubert W. Davis (Mineral Resources of the U. S., 1920, Part II), published Sept. 20, 1921; II:10, Graphite in 1920, by L. M. Beach (Mineral Resources of the U. S., 1920, Part II), published Sept. 16, 1921; II:11, Fuel Briquets in 1920, by W. F. McKenny (Mineral Resources of the U. S., 1920, Part II), published Sept. 19, 1921; II:12, Strontium in 1920, by George W. Stose (Mineral Resources of the U. S., 1920, Part II), published Sept. 17, 1921; II:20, Asphalt and Related Bitumens in 1919, by K. W. Cottrell (Mineral Resources of the U. S., 1919, Part II), published July 18, 1921; II:21, Asbestos in 1919, by J. S. Diller (Mineral Resources of the U. S., 1919, Part II), published May 14, 1921; II:23, Concrete Stone and Concrete Blocks in 1919, by G.

F. Loughlin and M. E. McCaslin (Mineral Resources of the U. S., 1919, Part II), published July 27, 1921; II:28, Silica in 1919, by L. M. Beach (Mineral Resources of the U. S., 1919, Part II), published Aug. 27, 1921; II:24, Barytes and Barium Products in 1919, by George W. Stose (Mineral Resources of the U. S., 1919, Part II), published July 28, 1921; II:25, Fluorspar and Cryolite in 1919, by Hubert W. Davis (Mineral Resources of the U. S., 1919, Part II), published July 20, 1921; II:27, Feldspar in 1919, by L. M. Beach (Mineral Resources of the U. S., 1919, Part II), published Aug. 12, 1921; II:30, Cement in 1919, by Ernest F. Burchard (Mineral Resources of the U. S., 1919, Part II), published Sept. 21, 1921.

THE MOSSBACHER CO., New York, N. Y., has been incorporated with a nominal capital of \$5,000, to manufacture chemicals and chemical byproducts. The incorporators are R. and J. Kraus, and S. S. Mossbacher, New York. The company is represented by Max Silverstein, 309 Broadway.

New Companies

THE VERA CHEMICAL CO., Stoneham, Mass., has been incorporated with a capital of \$100,000, to manufacture chemicals and chemical byproducts. Wilfred H. Smart is president; and Peter F. McCarty, 8 Winter St., Boston, Mass., treasurer.

THE STRAITS RUBBER CO., Detroit, Mich., has been incorporated with a capital of \$20,000, to manufacture rubber products. The incorporators are A. E. Severance, K. H. and E. R. Glanton, 3765 Philadelphia St., West, Detroit.

THE ANALGOL CHEMICAL CO., New York, N. Y., has been incorporated with a capital of \$25,000, to manufacture chemicals and chemical byproducts. The incorporators are M. and A. Saracena, and Luigi Miscione, 291 Broadway, New York.

THE CELLULOSE CORP., Newark, N. J., has been incorporated with a capital of \$5,000, to manufacture cellulose specialties, celluloid products, etc. The incorporators are Eugene Berry, E. Moore and John C. Waserbach, 78 Park St., Newark.

THE TITAN ABRASIVES CO., Room 610, 139 North Clark St., Chicago, has been incorporated with a capital of \$10,000, to manufacture abrasive products. The incorporators are Roland R. Hurford, A. B. Singleman and Albert J. Doermann.

FRED STERN & CO., INC., New York, has been incorporated with a capital of \$1,000,000, to manufacture rubber products, gutta percha specialties, etc. The incorporators are Fred Stern, J. S. Kane and L. H. Heyworth. Offices of the company are at 277 Broadway.

THE KEYSTONE CARBONIC GAS CO., Pittsburgh, Pa., has been incorporated under Delaware laws with capital of \$2,000,000, to manufacture carbonic acid gas and kindred products. The incorporators are S. S. Bailey, Pittsburgh; J. H. Loller and T. B. Donnelly, Connellsville, Pa. The company is represented by the Capital Trust Co., Dover, Del.

THE TEMPLE COTTON OIL CO., Hope, Ark., has been incorporated with a capital of \$1,000,000, to manufacture cotton oil and affiliated products. H. A. Carpenter is president; F. O. Colleman, vice-president; and R. L. White, secretary and treasurer, all of Hope.

THE NORTH AMERICAN RUBBER CORP., 508 Union Bank Bldg., Chicago, Ill., has been incorporated with a capital of \$50,000, to manufacture rubber products. The incorporators are L. E. Kraft, C. W. Brelsford and John C. Brown.

THE ECLIPSE MFG. CO., Pawtucket, R. I., has been incorporated with a capital of \$25,000, to manufacture polishes, paste, and kindred specialties. The incorporators are William H. Gough, Arthur Mellor and John W. Hadfield, 191 East Ave., Pawtucket.

THE AMERICAN NATIONAL PETROLEUM CO., New York, N. Y., has been incorporated with a capital of \$4,000,000, to manufacture petroleum products. The company is represented by the United States Corporation Co., 65 Cedar St., New York.

THE CYRUS CHEMICAL CO., South River, N. J., has been incorporated with a capital of \$20,000, to manufacture chemicals and chemical byproducts. The incorporators are James R. McCoy, A. L. Giles and Cyrus Butler, South River.

THE SOUTH FLORIDA OIL CO., Tampa, Fla., has been incorporated with a capital of \$50,000, to manufacture oil products. Earl H. McRae is president; John A. Gallagher, vice-president; and Edward A. Kitchen, secretary and treasurer, all of Tampa.

THE SCRANTON COLOR & CHEMICAL CO., Scranton, Pa., has been incorporated under

Delaware laws with capital of \$100,000, to manufacture chemicals and affiliated products. The company is represented by the Corporation Service Co., Wilmington, Del.

THE PORCELIZED METAL CO., Buffalo, N. Y., has been incorporated with a capital of \$150,000, to manufacture special porcelain compounded metal products. The incorporators are J. B. Devine and A. B. Taylor. The company is represented by D. F. Strebel, Marine Bank Bldg., Buffalo.

THE LONG-WEAR TIRE & RUBBER CO., Anderson, Ind., has been incorporated with a capital of \$300,000, to manufacture tires and other rubber products. The incorporators are B. B. Benner, Albert Anderson, Ernest Bond, and Nathan Ridgway, all of Anderson.

THE PITTMAN CHEMICAL CO., Birmingham, Ala., has been organized under state laws to manufacture chemicals and chemical byproducts. F. M. Pittman is president and general manager; R. L. Lange, vice-president; and M. I. Pittman, secretary, all of Birmingham.

THE PARAFLEX RUBBER CORP., New York, N. Y., has been incorporated with a capital of \$30,000, to manufacture rubber products of various kinds. The incorporators are A. W. Palmer and V. A. Roberts. The company is represented by Merrell, Bates & Topping, 27 Cedar St., New York.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its seventy-fourth meeting at Toronto, Canada, Dec. 27 to 31, 1921.

AMERICAN CERAMIC SOCIETY will hold its twenty-fourth annual meeting at St. Louis, Feb. 27 to March 2, 1922.

AMERICAN CHEMICAL SOCIETY will hold its spring meeting at Birmingham, Ala., April 4 to 7, 1922.

AMERICAN ENGINEERING COUNCIL will hold its next meeting in Washington, Jan. 5-6.

AMERICAN FOUNDRYMEN'S ASSOCIATION will hold its next convention and exhibit at Cleveland, O., during the week of April 24, 1922. Meetings will be held in the spring instead of in the fall as heretofore.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its annual winter meeting at Baltimore, Md., Dec. 6 to 9. Headquarters will be at the Emerson Hotel.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its spring meeting in New York the week of Feb. 20, 1922.

AMERICAN PETROLEUM INSTITUTE will hold its second annual meeting at the Congress Hotel, Chicago, Dec. 6, 7 and 8.

COLLEGE OF THE CITY OF NEW YORK, department of chemistry, will give public lectures under the auspices of the City College Chemical Society in the Doremus Lecture Theater, at 4:30 p.m., as follows: Nov. 30, "Afterthoughts of the War," by Leland L. Summers, of the War Industries Board; Dec. 6, "America in Chemistry," by Dr. Edgar F. Smith, provost emeritus, University of Pennsylvania, and president, American Chemical Society.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stettens Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

The following meetings are scheduled to be held in Rumford Hall, the Chemists' Club, New York: Dec. 2—Society of Chemical Industry, regular meeting; Dec. 9—American Chemical Society, regular meeting; Jan. 6—American Chemical Society, regular meeting; Jan. 13—Society of Chemical Industry, Perkin Medal; Feb. 10—American Electrochemical Society (in charge), Society of Chemical Industry, Société de Chimie Industrielle, American Chemical Society, joint meeting; March 10—American Chemical Society, Nichols Medal; March 24—Society of Chemical Industry, regular meeting; April 21—Society of Chemical Industry (in charge), American Electrochemical Society, Société de Chimie Industrielle, American Chemical Society, joint meeting; May 5—American Chemical Society, regular meeting; May 12—Société de Chimie Industrielle (in charge), American Chemical Society, Society of Chemical Industry, American Electrochemical Society, joint meeting; May 19—Society of Chemical Industry, regular meeting; June 9—American Chemical Society, regular meeting.

CHEMICAL & METALLURGICAL ENGINEERING

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A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY and IRON & STEEL MAGAZINE

ALAN G. WIKOFF
R. S. McBRIDE
CHARLES N. HULBURT
Assistant Editors
CHESTER H. JONES
Industrial Editor
J. S. NEGRU
Managing Editor

Volume 25

New York, December 7, 1921

Number 23

Land Armaments

And Business Recovery

BRUSHING aside the academic and partisan contention that the United States should keep out of European affairs, we believe it is growing clear that we are no longer confronted with the problem of whether we should keep out or get in, but rather of how much deeper we must get in before we can fairly get out. Whether we like it or not and whether it conforms to sonorous platitudes glibly quoted, the fact remains that the economic welfare of the United States is inextricably bound up with that of Europe. Splendid isolation will avail us nothing in efforts to bring about the desired revival of business.

Let us see if we can clarify the situation in a few words. Admitting that foreign trade is not essential to some of our industries, nevertheless there are others of fundamental importance like mining and agriculture that will not revive until foreign trade in considerable volume is again possible. Certainly the restoration of international trade in something like pre-war volume is a prerequisite to world prosperity. But it is idle to talk of developing foreign trade when the financial systems of Europe are crashing about our heads and when there is no stable basis on which to frame tariffs for future business.

Obviously there must be some logical and basic place to begin the rehabilitation of the world's economic and financial systems. Europe is more stable socially and politically than at any time since the Armistice. It is only in finance that there has been continued degradation. Money has depreciated because of inflation through printed currency. Printing presses have been kept busy because national expenditures have exceeded national income. Fiscal budgets have been unbalanced. And the curious coincidence about the fiscal deficits of the countries of central Europe is that they correspond almost exactly with the cost of maintaining land armaments in those countries. Four or five million men are under arms, including the Rhine army of 350,000 men with its tremendous cost to Germany contributing to her recognized inability to meet the reparations.

Have we not here the crux of the situation? If European land armaments could be greatly reduced and limited, fiscal budgets would be more nearly balanced. Inflation could cease. Exchange could then be stabilized and commerce could be resumed on a basis that could be depended upon to last over night. If the cost of maintaining land armaments is breaking down the financial systems of Europe and if that breakdown is being reflected in decreased buying power and unstable business conditions throughout the world, wouldn't it be wise to take steps to reduce land armaments? And might not the United States call an international conference for the purpose of considering land disarmament in Europe in its relation to worldwide economic and financial conditions?

Taking our cue from the present conference on naval disarmament and problems of the Far East, which gives every reasonable expectation of a successful issue, we think that a second conference might profitably be called at an early date to deal specially with economic and financial matters and the limitation of land armaments. The two are intimately related. The hopeful influence of such a conference cannot be overestimated. The mere announcement of the Hughes plan at the opening of the present conference caused a rise in all European exchange that could have been produced otherwise only by the movement of large quantities of goods. It increased confidence in world recovery, which is so greatly needed now. The calling of a second conference on economic conditions would likewise react favorably on world business.

It has been suggested that the present conference might consider this problem, but we are inclined to believe that it should be differently constituted. In addition to political representatives, such a conference should comprise men representing the great business interests and activities of the respective countries. The problems before such a conference would be essentially business problems, and as such should receive the attention of the best business minds. Probably no decisive steps can or should be taken to convene a new conference until the present one has had a successful outcome. But the call should be made as early as possible so that its stimulating first-aid influence can help sustain business until permanent stabilizing measures can be adopted.

We feel that we are not wrong in advocating the appointment of representatives of business and industry, capital and labor to a conference on economics and finance. Recent history affords ample evidence to support the contention that business leaders have long seen what political leaders have been either unwilling or unable to see with regard to the trend of economic affairs. Certainly the best views of the situation in Europe that have been laid before business in this country have come from American business men and bankers who have studied conditions at first hand.

Prevention of Tuberculosis

A Means of Increasing Business

SINCE the prevention of waste has become one of the cardinal principles of increasing production, any known means of eliminating waste of man power is a matter of vital interest. Prevention of tuberculosis unquestionably means a conservation of the human element in production, when it is known that this disease is responsible for one-third of all the deaths which occur in this country among persons between the ages of fifteen and forty-five years. In other words, tuberculosis strikes down man and woman alike during the period of their productive years.

The nature of tuberculosis is well known today and

numerous carefully conducted studies have demonstrated that its existence depends to a great extent upon conditions in which men work. There are, naturally, some particularly bad features about certain trades. Chief among these are the so-called dusty occupations, for dust inflames the air passages of the lungs and makes these passages liable to the disease. Not all dusts are dangerous, however, for coal dust apparently has no bad effect. Coal miners are even less likely than others to have the disease, and only one-third as many cases of tuberculosis appear among the coal miners in Pennsylvania as among other persons.

Of the workers showing a high mortality for tuberculosis, there are, first, the grinders, then tool makers, printers, stone cutters, brass workers, garment workers and furriers and all classes who are exposed to mineral and metal dusts. On the other hand, boot and shoe makers and millers have a very low mortality rate for this disease. In mining and the related industries the death rate from tuberculosis, with the exception of coal miners, is higher than for other work. This is particularly true of certain mining industries, such as copper, silver and lead mining. The reason for this is apparent, for metal mining is attended in most cases by the inhalation of particularly hard, sharp, flinty particles that find their way into the lungs and set up an irritation which makes fertile soil for the growth of the tuberculosis germ. Significant in this connection is the fact that out of the 44,000,000 men and women workers in the United States nearly 4,000,000, or 9.06 per cent, are employed in dusty trade industries and occupations.

That it pays to prevent tuberculosis in industries is well demonstrated in the experience of such large concerns as the New York Telephone Co., Metropolitan Life Insurance Co., Sears Roebuck Co., the International Harvester Co. and many others. The actual dollars and cents saved to these concerns as a result of health work aimed against tuberculosis has demonstrated the value and soundness of their investments along this line. It not only pays to prevent tuberculosis directly in industries but it pays also to prevent tuberculosis in the general population, of which the workers and employers alike are a part.

There is abundant evidence that any community can purchase a reasonable degree of freedom from tuberculosis if it is willing to pay the price. This price is not excessive, probably not more than \$2 per capita per year, spread over a period of 10, 15 or 20 years. Proper community organization can control disease, the extent of the control depending upon the intensiveness of organization. The annual December sale of tuberculosis Christmas seals furnishes the funds. Hence every person who buys Christmas seals is helping in a fight to conserve human life and therefore to prevent a waste of man power in business.

It is obvious that every person whose life is prolonged by the prevention of tuberculosis means increased wealth to the manufacturer and merchant because of the added working capacity of the individual. Nor is prevention a far away and hazy mirage. The fact is that the National Tuberculosis Association and its 1,200 affiliated agencies are fighting a winning war against tuberculosis. In the 15 years since the association began its work the death rate from tuberculosis in this country has been reduced from 200 per 100,000 population to the present figure of 120 per 100,000 population. This has been estimated to mean a clear saving of 75,000 lives a year.

New Propaganda For Old

A SPECIAL session of Congress has adjourned. Many of the legislators are at home, mending fences, and perhaps thereby getting clearer impressions of what their constituents think about it all. But they will immediately reassemble in regular session, and be engulfed in the whirl of politicians, lobbyists, patriots and well-meaning folk who clutter up the Capitol and increase the difficulty of doing the nation's business.

One of the important things yet to be done is to provide adequate protection for the chemical industry. It is not our present purpose to recount recent experiences proving that it is quite necessary for our country to have a well-developed chemical industry. That point is doubtless pretty well established. Nor is it desired to discuss various schemes which have been proposed, and all but enacted into law, for the fostering care of this essential industry. That ground has been covered at length many times. What we should like to emphasize is this—that whereas it is possible to present a convincing argument before congressional committees, and thus obtain a favorable report, it is and will be extremely difficult to get Congress as a whole to accept and act upon these reports. It naturally follows that success depends upon the ability to educate the Congressman hailing from the corn belt, who doesn't know much about chemistry except that a big bunch of nitrogen blew up recently in Germany, and the Senator living in a textile center who has been told that the American dye trust is a band of robbers.

We venture to express the opinion that friends of the industry would do well to emphasize the importance of chemistry to human progress and comfort, and to talk less about killing. Let's admit that chemistry has been introduced into warfare and we know very well that where science enters there it stays. We know, too, that with industry developed in organic chemistry, these factories are themselves arsenals of defense which cost the government nothing and can be quickly transformed to the production of the instruments of death and destruction.

But aren't we fed up on war and sick and tired of it? The minds of the civilized people of the whole world are against war. They have had more than enough! The gasp of incredulous joy which burst from every nation upon hearing Mr. HUGHES' disarmament proposals should entirely convince any but the stubbornest militarist that blood-curdling accounts of horribly dangerous poisons are no longer correct propaganda in support of the chemical industry.

Fortunately, machinery which can synthesize organic chemicals—like dyes, explosives, drugs, perfume and fabrics—are good for much else than for war. Otherwise, the chemical science and industry would not be worth saving, and we should be glad to help it along the path the battleship is taking. So, in abandoning the old arguments, there are new and cogent ones ready at hand which, instead of exciting fear and mistrust, light contentment and hope. A good anæsthetic or a specific for so mild a disease as measles would eventually save the future part of the woe the Hohenzollerns loosed upon the past. Not one, but a hundred, such discoveries are to be made in the future. And where, pray, will these be found if not by most advanced chemical research? In fact, only through this and its sister science physics can the process of life and the causes of death be anything but mystery. Here is common ground to

approach the corn-planter and the cotton-spinner, the miner and the fisherman.

We believe in the chemical industry because it is founded on truth, and its intensive development will promote our nation's economic health as will no other. That industry must be preserved and fostered because it will help every American to *live*, to live with more ease, more comfort, more safety, more health and joy. We believe in chemistry, because chemistry is life.

Speeding the Business Revival

EVEN in the chemical industry there is a widely prevalent feeling that "business is on the mend." This attitude on the part of our manufacturers augurs well for the future of business; it gives us a psychological advantage of real value. A year ago when trade began to fall from its post-war peaks, we started talking about business depression and hard times, we quit buying and very naturally business began to slump. In contrast with this pessimistic background, most of us at the present time are thinking in terms of business revival and are eagerly watching for signs of improvement and encouragement.

Obviously these signs will differ for the different industries and they will not carry the same significance to each of us. The iron and steel industry, for instance, has long held to the view that large-scale buying by the railroads was certain to herald the return of prosperity. This industry has recently had ample reason to be encouraged, for since the last week in October the railroads have been buying rails, locomotives, cars and other supplies on an increasingly heavy scale.

Most engineers regard new construction and the letting of building contracts as the most reliable index of business activity. It is heartening, therefore, to know that a building boom is sweeping the country. Contracts during October exceeded those in October, 1920, by 25 per cent and were only 10 per cent less than in the record month of September, 1921. One authority has reported the contracts for October to have reached \$222,500,000 and has pointed out that November's total promises to show a more striking increase. That the chemical and metallurgical industries are keeping pace with the building boom is shown by the following figures compiled from the Industrial Notes which appear weekly in this magazine:

	Total Cost			
	Oct.	Nov.	Oct.	Nov.
Projects planned...	34	43	\$11,338,000	\$26,353,000
Contracts awarded.	26	27	3,940,000	12,199,000

Construction on such a large scale means increased production of chemicals and a broadening market for chemical equipment, but, what is even more significant, it proves that chemical manufacturers are looking forward to the upward trend in business and are willing to make active preparations for it.

There is still another sign of encouragement which we are inclined to regard as the real proof that the wheels of industry are again in motion. In our news pages each week since Oct. 11 has been published an imposing list of industrial plants which have resumed operations or have materially increased their production. These give us incontrovertible evidence that manufacture is again under way and that the shut-down factories are gradually awakening from their period of lethargy. May the good work continue and may our weekly lists grow until they have included every plant in the chemical and metallurgical industries!

College Degrees For the Credulous

OUR excellent French contemporary *Chimie et Industrie* of Paris contains the following advertisement in its issue No. 4, Vol. 6, October, 1921:

Promotion de doctorat (par correspondance).
Université étrangère (U.S.A.) offic. reconnue.
Ecrire avec curric. vitæ à Prof. Demole, Case
Rhône 3373 Genève (Suisse).

They know better than that in France and they know better in Geneva. The acceptance of such an advertisement casts unfortunate reflections on all American university degrees. It belittles the academic honors lately bestowed on Field Marshal FOCH. We venture to state that there is no officially recognized university in the United States in which "Professor" DEMOLE of Geneva can arrange for doctorates in science or philosophy or letters or law, or in anything else, by correspondence.

It's curious how willing Europeans are to believe absurd things about the United States. To explain to credulous foreigners the customs of the country, the killings and shootings that make things interesting on the streets and to expound the unconventional ways of Indians and buffaloes constitute one of the few joys in life left to Americans. That sort of thing has become a habit with many of us, like killing sheep among dogs, because it is so easy. It is, however, an ancient sport. Sir JOHN MANDEVILLE was addicted to it back in the fourteenth century, as witness his description of the inhabitants of certain islands in his "Voyages and Travels."

And in another yle are foule men that have the lippes about the mouth so greate, that when they sleepe in the soone they cover theyr face with the lippe. And in another yle lyttle men, as dwarfes, and have no mouth but a lyttle round hole & through that hole they eate their meate with a pype, & they have no tongue, & they speake not, but they blow and whistle, & so make signes to one another. In Ethiopie are such men as have but one foote, and they go so fast yt is a great marvaill, and that is a large foote, that the shadow thereof covereth ye body from son or rayne. when they lye upon theyr backes; and when theyr children first be borne they loke like russet and when they waxe olde then they be all black.

The habit, it will be observed, is not even original with us Americans. But when foreigners imagine degree factories in the United States and proceed to fleece one another by selling false diplomas, it ceases to be innocent merriment. Thousands and thousands of young men and women come to our institutions of learning from all over the world, and they work hard for their degrees. They prize them highly. They stand for merit, just as French and Swiss and Italian and German degrees do. Of course, no one here can stop the precious DEMOLE from his misuse of foreign mails. But scientific and technological journals should not encourage the practice. The situation is very much as though we should publish an advertisement from somebody in Quebec offering to procure the decoration of the Legion of Honor for those who apply—and comply with his terms. It would be easy enough for him to fake up a diploma in French and to send a little red ribbon to his dupes—but it would not be ethical for us to help him. And we do not think it ethical for *Chimie et Industrie*, which is, generally speaking, an excellent paper, and for which we have a high regard, to permit DEMOLE to make use of its columns for his nefarious operations.

Readers' Views and Comments

Nitrogen in Carburized Steels

To the Editor of Chemical & Metallurgical Engineering

SIR:—In connection with the article appearing under the above title in CHEMICAL AND METALLURGICAL ENGINEERING, Nov. 9, 1921, page 867, it has just been called to our attention that no mention has been made of Fay's work in the same line, referred to in a note published in your journal in the issue of Feb. 16, 1921. The note referred to contains valuable analytical data having a very direct bearing in the subject under discussion in our paper, and promises later a full discussion of the entire subject, in which Dr. Fay has evidently been interested for some time. It is a matter of regret to the authors that such an important contribution should have been overlooked in the preparation of our paper.

Schenectady, N. Y.

W. E. RUDER.

G. R. BROPHY.

What Causes Slip to Halt?

To the Editor of Chemical & Metallurgical Engineering

SIR:—In studying the Slip Interference Theory of the Hardening of Metals as first published in CHEMICAL & METALLURGICAL ENGINEERING, June 15, 1921, by Zay Jeffries and R. S. Archer, and in critically reviewing the older theories as well as discussions which have appeared relative to the new theory, this writer is unable to find a satisfactory explanation of the stopping of slip.

In a later paper entitled "The Amorphous Metal Hypothesis," published in CHEMICAL & METALLURGICAL ENGINEERING, Oct. 12, 1921, Jeffries and Archer ask the question, "What causes slip to halt?" There seems to be no better reason known at present than that originally offered by Beilby. Quoting from the paper by Jeffries and Archer on "The Slip Interference Theory of the Hardening of Metals," we find the following as an explanation for the stopping of slip:

The amorphous metal theory of Beilby offers what appears to the present authors to be the only completely satisfactory explanation of this phenomenon. The rubbing together of the crystal fragments on the plane of slip is supposed to tear some of the surface atoms loose from their regular crystalline arrangement, thus forming a layer of amorphous metal. The friction generates heat rapidly, so that a high temperature is reached locally. This high local temperature softens the amorphous metal, which is essentially merely an undercooled liquid. With the softening of the amorphous metal layer the resistance to slip diminishes and there is less frictional heat developed. The high local temperature is then quickly dissipated by conduction to the surrounding metal, whereupon the amorphous metal hardens and offers a resistance to further slip which is greater than that on planes on which slip has not yet occurred.

At this point let us look into the amorphous metal theory as proposed some years ago by Beilby. After reading carefully the last paragraph above quoted, it seems that there is not a satisfactory explanation given for the stopping of slip. The last sentence in the above paragraph appears to be the weak point. If amorphous metal is formed on the cleavage plane by friction and if friction generates heat enough to soften materially this amorphous metal so that slip occurs rather easily for a time, then as cooling begins the viscosity of this

amorphous metal increases, its resistance to slip increases, the heat of friction likewise increases and the tendency will be for a certain viscosity to be obtained such that its resistance to slip will create enough heat to equal the heat dissipated by conduction.

If conduction gets ahead for a time and the temperature momentarily drops, then the viscosity increases, the resistance to slip increases, the rate of generation of frictional heat will increase and at once build up the temperature to a point where the viscosity is lowered and a balance is obtained between heat generated and heat conducted away from the source of generation. If this proceeds, we should expect ultimate failure to occur along the cleavage plane of first slip. This, however, is not the case and the writer will presently endeavor to explain why. I certainly cannot conceive of the heat of friction being conducted away from the amorphous cement "instantly," as Beilby's theory indicates.

The time consumed from the beginning to the end of slip on any particular plane must indeed be quite small. It seems reasonable that the time required for conducting away the generated heat would be a large percentage of the total time of slip, even though it is only necessary for a portion of the total heat to be removed from the place where it is generated. There is no license to use the term "instantaneously," as Beilby says it, when speaking in relative terms, since this leads to the inference that the time required for conducting the heat away will be very short, or negligible, in comparison to the total time of slip. It seems that something else must take place to retard the rate of slip, which in turn will retard the rate of heat generation and by so doing give the amorphous metal opportunity to "set."

The following explanation is offered to account for the stopping of slip. Referring the strength of metals to the atomic bonds that oppose stresses working toward the deformation of the metal, it will be agreed that the elastic limit is determined by the maximum number of atomic bonds that simultaneously oppose the force that first tends to cause deformation. No other atomic bonds will ever come into full action in opposing tensile stresses until the elastic limit has been exceeded. As soon as the elastic limit has been exceeded slip occurs on some cleavage plane (or planes) containing the least number of active atomic bonds per unit area. Following Beilby, I assume amorphous cement to be formed on this plane and heat to be generated in amount sufficient to permit slip to take place freely. Slipping cannot go on very far, though, without additional atomic bonds being brought into action to oppose the slip in a manner similar to the way that after a few fibers in a rope under stress have given way, additional ones begin to be stressed so that their resistance must be overcome. In fact, this is in keeping with the statement of Jeffries and Archer that "The strengthening of metals by cold work can only be due to some mechanism by which the interatomic bonds are brought more effectively into play so that more of them have to be broken simultaneously." As soon as this new set of atomic bonds is stressed and

must be overcome it is to be expected that the rate of slip on the plane on which it is progressing will materially slow down. When this happens the amorphous metal will have its opportunity to cool down and to set.

Or again, if one wishes to reject the theory of Beilby as impossible (as Jeffries and Archer have done on page 703 of *CHEMICAL & METALLURGICAL ENGINEERING*, Oct. 12, 1921), he still may offer the following explanation to account for the stopping of slip on one plane and the beginning on another. Reasoning as before, the plane which has the fewest active atomic bonds will be the one upon which slip first occurs. After slipping to a slightly new position, a great many more atomic bonds may be brought into action. May not these new bonds, when brought into action, make this plane more resistant to further slip than it was in the beginning and more resistant than other planes upon which slip has not yet occurred? As slipping proceeds it may happen and perhaps does, that as stronger and stronger planes are slipped the one upon which slip first occurred may by the process of elimination again become the weakest plane. It therefore may slip again until an additional set of atomic bonds is brought into action. One plane, then, is not limited to slipping just once during rupture, but may slip a number of times depending on the atomic arrangement. O. A. KNIGHT,

School of Mines,
State College, Pa.

Associate Professor of Metallurgy.

Prof. Knight has made it clear that without some interference, slip once started should continue at a rate of speed determined by the frictional resistance of amorphous metal and the heat conductivity of the surroundings. Is it not reasonable to suppose that slip stops because the forces which started it are momentarily released?

Stresses in a test-piece are ordinarily distributed irregularly. But suppose uniform distribution across a test-piece of fine grained metal. Even then some crystals will be so oriented that the load will throw a shear of maximum intensity along the crystalline plane offering lowest resistance. As the loading increases, the shearing strength of this crystal is passed and slip starts. But any actual movement suddenly disarranges all the neighbors. The slip once started speedily becomes "jammed," the stresses once resisted by the yielding crystal are thrown into adjoining particles of metal which safely bear them. Immediately the outside forces are released, slip stops, and any amorphous material generated immediately freezes into a very rigid and strong substance.

It may be objected that a test-piece may be formed of a single crystal, and this crystal will show much ductility under load, finally breaking in a highly contracted area. There is no chance for transfer of load to neighboring crystals. But could not the release of stress be due to the fact that inertia of the testing machine or imposed load prevents the stress immediately following the very rapid movement of the broken crystal? If this is true, the load is released momentarily, movement stops, and the amorphous material generated at the slipping plane solidifies.

Immediately after this solidification there should be an added stress due to impact, when the load catches up with the lengthened specimen. A ductile material should withstand this impact; a brittle crystal, on the other hand, would fail. Perhaps this distinguishes between these qualities.

EDITOR.

Scientific Relief Suggested for Russian Chemists

To the Editor of Chemical & Metallurgical Engineering

SIR:—I read with great interest your editorial regarding the whereabouts of the famous Russian chemists and later your editorial on sending relief to them.

I have in hand the first issue of the Scientific-Technical Bulletin of the Supreme Council of National Economy, published by the Russian Government in Moscow in 1920. In this bulletin is given a review of many chemical publications, among which is one of Prof. Ipatieff's recent book, "A Course in Organic Chemistry," 416 pages, published in Petrograd in 1919. Furthermore, I have before me a recent Russian newspaper which gives the personnel and the work and achievements of the Russian Supreme Council of National Economy. This Council consists of eleven of Russia's foremost representative engineers and is the highest technical body engaged in working out the industrial program of Russia. Prof. Ipatieff is one of these eleven and the newspaper in question speaks very highly of his scientific contributions to the industrial reconstruction of Russia.

Your suggestion to send relief to the Russian chemists is indeed an excellent one and very practical. Perhaps the greatest contribution that American chemists and scientific men could at present make to stricken Russia is in the form of chemical and scientific literature, from which she has been shut off since the beginning of the great war.

May I suggest that you take the initiative and issue an appeal to American chemists and men of science, through the American Chemical Society, to send to Russia some scientific and chemical publications since the year 1914? No deed or act on the part of American chemists could be more noble or humanitarian than the execution of your suggestion. The Russians have expressed their appreciation and admiration for the American relief in the famine-stricken districts. Russia's scientific men will equally appreciate this scientific relief. History will, I have not the slightest doubt, prove this.

Such scientific contributions can be transmitted, for distribution among the higher institutions of learning, to the Scientific-Technical Department of the Commissariat for Education, Moscow; or it can be sent to the Society for Technical Aid to Russia, 110 West Fortieth St., New York City, for transmission to the above address in Russia.

I shall be glad to assist you in carrying out this plan. I have recently talked with Dr. Benjamin T. Brooks, who thought very highly of such relief to the Russian chemists.

JOSEPH R. MINEVITCH.

New York City.

EDITOR'S NOTE: We are glad to publish this letter emphasizing the importance of one phase of the relief program for Russian chemists outlined in an editorial in our Oct. 26 issue. The appeal should meet with a hearty response.

Correction

The title of the article by Wilbert J. Huff, published on page 865 of our issue for Nov. 9, 1921, was misstated. It should read "Corrosion Beneath Oil Films, and the Protective Action of Certain Colloidal Solutions."

British Chemical Industry

FROM OUR LONDON CORRESPONDENT

LONDON, Nov. 15, 1921.

AS FORESHADOWED in my previous notes, the violent fluctuations and great depreciation in the value of German currency have influenced markets to a considerable extent and the general uncertainty has retarded recovery. On the other hand, quotations from abroad are now generally given in sterling and this method of compensating for fluctuations has slightly stiffened quotations, though as regards fine chemicals there is not much prospect of alteration in prices at present.

ON THE EVE OF IMPORTANT DEVELOPMENTS

It is notorious that new epoch-making British inventions have in the past been mainly developed abroad, but at the present time many new processes, to which a wealth of time and effort have been devoted, appear to be on the point of fruition. The barium process for the manufacture of cyanide is an example of close co-operation among the fuel expert, the expert on refractories and the highly trained chemical engineer. Calvert's process for the production of alcohol, referred to in my notes published on July 13, has now made further progress and it has been stated that with water gas at 15c. per thousand cubic feet, a production cost for power alcohol of 16c. per American gallon is in sight, while the capital outlay is relatively very low. It is understood that Calvert's process is now being tried out on an industrial scale and that important developments may be expected early next year. The idea of making alcohols from water gas is not new, but previous investigators appear never to have got further than the production of methane or ethylene, whereas Calvert obtains his product in one operation and of 50 per cent strength.

In this connection it is interesting to learn that Bury and Ollander's process for making alcohol from the ethylene in coke-oven gas is to be installed at two other plants, but it is considered to be unlikely that the cost of production will be less than 30c. per American gallon.

PROGRESS IN SYNTHETIC AMMONIA

The progress foreshadowed in my last notes regarding the Claude process has been realized and it is understood that the first installation will be in Norway and that work is to commence immediately. The electrolytic method of hydrogen manufacture will be used, under which the cost of production of hydrogen is expected to work out at 30c. per thousand cubic feet. The Claude catalyst tubes are to be made of Vickers special nickel-chromium steel, which appears to be very similar in all its properties to the new Krupp steel "V2A," which was used successfully during the war for a variety of chemical plant, including centrifugal pumps for nitric acid. Claude's tubes are 7 ft. long and 4 in. internal diameter and it is understood that the French Government Commission's report will pronounce in Claude's favor and against the Haber process. It was thought that the Oppau works would not be rebuilt until the success or failure of Claude's process was known, but it is now known that the works are to be restored with all speed and production is to be expected at the beginning of next year. The cause of the explosion can almost certainly be ascribed to the blasting

of mixed fertilizer, and it seems indefensible, however often the use of explosives had failed to detonate the fertilizer mixture, to have invited disaster by the use of such methods. The function of an explosive has always been to explode and with a potential explosive mixture of this kind, the risk was great.

BRITISH CHEMICAL ENGINEERS DISCUSS FORMATION OF AN INSTITUTION

The feeling that a qualifying body similar to the American Institute was necessary has been gathering momentum and culminated in a largely attended meeting just held at the Engineers' Club, at which it was decided to form a provisional institute and committee to inquire into the best method of organizing qualified chemical engineers. The provisional committee includes Sir Arthur Duckham, Mr. Woolcock, M.P., William McNab, Mr. Reavell and Prof. Hinchley, who has done practically all the spade work. It was mentioned at the meeting that the American Institute might decide, in accordance with a suggestion made recently, to call itself "The Institute of Chemical Engineers," and it seems quite probable and possible to arrange ultimately for an institution which shall embrace affiliated branches in all English speaking countries, rather than to form separate bodies. The possibility of utilizing the Institute of Chemistry as a qualifying body has been mooted in the past, but the present feeling undoubtedly leans toward the institution idea, the Institute of Chemistry having shown little sympathy with the movement. On the other hand, chemical engineering education is notoriously behindhand and until and unless degrees on chemical engineering are provided, the qualification for membership must rest mainly on achievement and distinction.

GENERAL PERSONAL NOTES

The *Times* Trade Supplement of Nov. 12 published a thoughtful article by Mr. Woolcock, M.P., general manager of the Association of British Chemical Manufacturers, in which the operation of the safeguarding of industries act is discussed in the light of the experience of the past two months. The attention of American readers may be drawn to the definitions of fine chemicals and the present position of synthetic camphor and milk sugar.

Something of a sensation was caused by the sudden reappearance of Dr. Paul Dvorkovitz, the well-known petroleum expert, who, after carrying out valuable work in the Allied interests in Russia, was definitely reported to have been shot by the Bolsheviks. One of the oldest members of the Society of Chemical Industry, Dr. Dvorkovitz received a warm welcome and entertained his many friends with details of his pleasant and unpleasant experiences in Russia.

Increased Duties on Competitive German Products

Acting Commercial Attaché S. H. Cross of Brussels reports that an emergency tariff act was put into effect Nov. 7 which covers exclusively German manufactured products entering into direct competition with Belgian industries. It provides for increases of 100 to 300 per cent on articles assessed by weight, and advances many ad valorem duties to 20 or 40 per cent.

Textile, chemical and mechanical products are prominent among the German products which are to bear increased duties.

The Aging of Rubber

Problems Arising in Studies of the Life of Rubber Goods—Methods of Testing—Aging Hypothesis—Additional Vulcanization by Oxygen—Depolymerization—Additional Vulcanization by Sulphur—Still and Active Aging Compared—Aging Under Strain

BY ANDREW H. KING

THE life of rubber goods is a subject of vital importance not only to rubber technologists but to the general public as well. The natural life of soft rubber goods seldom exceeds 30 years, but the average is much lower. For example, an average grade of garden hose seldom lasts more than 5 years, when it fails not from being worn out but because of certain changes which go on within the rubber compound. The cover will become checked or cracked and the tube and friction so stiff that the hose cracks open when bent. Similar conditions are found on some tires and occasionally on those of the best grades. Side-wall checking is usually the first warning of poor aging. One does not expect soft rubber goods to last forever, but just as in human life, there is a great divergence in mortality. There is a wide variation from brand to brand of the same article and not infrequently a variation just as wide in the product of the same manufacturer. In fact, there are cases where the article fails by bad aging before it is placed in service.

Bad aging can usually be traced to faulty materials or conditions of manufacture, but in many instances the conditions of service are responsible. In other cases the manufacturer has failed properly to appreciate the type of service desired and has produced an article designed for something else.

Naturally the blame for faulty aging from the manufacturer's standpoint falls on the rubber chemist. It is therefore not remarkable that at the last meeting of the Rubber Division of the American Chemical Society in New York the discussion on this subject was both extended and animated. It was characterized, however, by the wide divergence of opinions, ranging from the value of all artificial aging tests to the conditions deemed most suitable for performing them.

METHODS OF TESTING

The adequate determination of the life and service of any soft rubber compound requires at least 1 year's exposure; it is better that the exposure be for 2 or 3 years. Of course this method is entirely unsuitable for development work. One wishes to know approximately how his product will stand up in service and he wishes this knowledge as quickly as possible. This is the reason for the large number of artificial age tests which as a rule are merely each investigator's own method of attack on the problem.

The greatest single contribution to our knowledge on this subject has recently been published under the caption "Ten Years' Experience With Age Tests," by Dr. W. C. Geer and W. W. Evans of the B. F. Goodrich Co. (*India Rubber World*, September, 1921, p. 887). Their method in brief consists of heating test-pieces of the various compounds in an oven at 160 deg. F. (71 deg. C.) with a constant supply of fresh air previously

heated to the same temperature. Up to 4 or 5 days, 1 day's heating appears to give the same deterioration in tensile strength as is met with in 6 months of natural life. The test is comparative and therefore must always be run in conjunction with the same type of compound whose aging in natural life is known.

Their ideas on the subject may be summarized as follows:

1. It is more reliable to plot deterioration in tensile strength against time of heating and to determine the aging characteristics from the curve than to make simply one or two determinations at definite time intervals. In other words, it is the trend of data that determines.
2. Samples are not hardened as in actual aging, but are definitely weakened.
3. Sulphur changes are noticeable, but were not considered important.
4. The artificial age test is considered more severe than natural life.
5. The test is of little value for compounds having a tensile strength less than 1,000 lb. per sq.in.
6. The authors are of the opinion that in the majority of cases of too rapid deterioration, this is due to overcure or undercure and in the majority of cases to overvulcanization.

This paper was originally presented in England before the International Rubber Conference. The discussion that followed was quite interesting. Stevens stated he found that the moisture content of the air has a great effect on natural aging. Samples aged in moist air and immersed in water showed much lower deterioration than when exposed to heated air. Schidrowitz called attention to the absence of light in the test described above. DeVries stated that deterioration is more rapid in the tropics than in London. This may be due to more intense light. Dr. Geer in the course of further remarks mentioned that the current of heated fresh air in his test was very important and that it makes for uniformity of results. He also stated that fine para aged best, after which come the better grades of smoked sheets, which in turn are superior to pale crêpe.

OBSERVATIONS ON AGING TESTS

From the discussion of the aging question in New York the following observations are in order:

1. The majority of the chemists present perform their accelerated age tests at 70 deg. C. or thereabout.
2. Other investigators employ a comparatively high temperature—e.g., 130 to 150 deg. C. Their theory is evidently to treat the samples more severely than will be met with in service.
3. An interesting and highly practical test was described by Dr. Somerville. Test-pieces were placed in

ordinary Mason jars and immersed in boiling water for various periods of time. At the beginning of the test the samples are exposed to oxidation as well as to the action of heat. Within a short time the oxygen disappears and further deterioration is due to heat alone.

4. Sanderson described a new type of oven in which dry air previously heated to the required temperature is supplied continuously. The oven is immersed in a thermostat for the accurate control of temperatures.

An outstanding feature of the remarks was that very few had any concrete ideas or theories as to what aging actually is or how it progresses. Naturally this is considerable to expect on a subject so little understood. However, it is true that more satisfactory progress is always obtained when a moderately simple hypothesis is adopted as a means of visualizing the problem in the beginning.

AGING HYPOTHESIS

It is with precisely this object in mind that the following is presented. Let us assume for the present that the deterioration of rubber with age is solely dependent on additional vulcanization subsequent to the normal "cure."

By vulcanization we mean the addition of a substance or substances to rubber which results in the production of a more elastic material—i.e., one with less plasticity. When the change becomes of sufficient magnitude that the product becomes of commercial value it is then known as "cure." It is well known that substances other than sulphur or sulphur chloride—for example, oxygen, chlorine, selenium, etc.—produce a change in plasticity—in other words, that they vulcanize—but the products obtained this way have not to date had any commercial value and therefore cannot be called "cured." In speaking of additional vulcanization it is to be understood that we are not limiting ourselves to sulphur or sulphur chloride.

In vulcanization by sulphur there are two ranges within which the products have commercial value. The first or soft rubber range contains compounds vulcanized so that they have from 1.5 to perhaps 4 per cent combined sulphur on the rubber. When reclaims are used, this figure goes up to 6 or 8 per cent combined sulphur. Above this point there is a long intermediate range where the products are without value. Then we come to the range of the ebonites, which will run from about 20 to as high as 47 per cent combined sulphur on the rubber.

For purpose of argument we may assume that we can have vulcanization—for example by oxygen—in addition to the sulphur cure which preceded it. We may even assume that under proper conditions it is possible for oxygen or other vulcanizing substances to saturate the remaining free bonds of the rubber and produce a material related to $C_{10}H_{16}S_2$ (ebonite) or $C_{10}H_{16}Br_2$. Under the ordinary conditions of aging additional vulcanization by oxygen or by sulphur or by both are probably all that will be encountered.

Surface aging which results in a hardening and checking of the surface is probably due largely to additional vulcanization by oxygen. On the other hand, internal aging which lowers the tensile strength and the ultimate elongation is likely to be a combination of additional vulcanization by both sulphur and oxygen which may be released from the compounding ingredient or merely from the air dissolved in the stock during the milling. Such rubber has a perished smell and feel.

Additional vulcanization is probably affected by the following factors:

By Oxygen

- (a) Concentration and activity of oxygen.
- (b) Accelerators of oxidation such as
 - (1) Actinic light.
 - (2) Certain compounding ingredients—e.g., red lead.
 - (3) Impurities such as copper and manganese oxides or salts.
- (c) Depolymerization.

By Sulphur

- (a) State of cure.
- (b) Depolymerization.
- (c) Concentration and activity of sulphur.
- (d) Accelerators.
- (e) Heat.

Direct evidence of the combination of oxygen with rubber was found by Herbst (*Ber.*, 1906, vol. 39, pp. 523-525), who purified rubber by Harries' method—by dissolving in chloroform and precipitating with alcohol—which was repeated several times. The purified rubber he then dissolved in benzene, which cement was boiled under a reflux condenser; meanwhile passing dry washed air through the solution for 140 hours. On distilling off the benzene he found an increase in weight of 12.2 per cent. From the sirupy mixture of resinous bodies he was able to isolate two compounds having the empirical formulas $C_{10}H_{16}O$ and $C_{10}H_{16}O_3$. The latter he found to correspond in its properties to Spiller's resin.

An indirect evidence of vulcanization by oxygen is found in the scorching or lumping with change in elasticity, etc., sometimes noticed when large amounts of carbon black are milled into rubber without proper care in handling.

The action of ozone on rubber is well known. One molecule of O_3 adds on at each double bond. Ozone is extremely active. Obviously additional vulcanization by oxygen depends in a great measure on the concentration of oxygen present. In fact all protective coatings which retard or prevent surface aging do so by excluding oxygen.

ACCELERATION OF OXIDATION

Actinic Light.—Light is perhaps the most powerful catalyst of oxidation known. C. O. Weber (*J. Soc. Chem. Ind.*, 1903, p. 875) described experiments in which thin films of para, both crude and milled, vulcanized and unvulcanized, were exposed to light for 50 days. The acetone extracts of the samples were determined at intervals. His conclusions were:

1. That unvulcanized rubber was more liable to oxidation than vulcanized due to lower saturation state.
2. The longer rubber is milled on hot rolls the higher the acetone extract. With very excessive working the extract becomes gummy and not resinous, as is the case with truly oxidized rubber. Weber considered the increase in extract as due to the decomposition of the rubber molecule.
3. Overworked rubber oxidizes very rapidly, yielding after 50 days' exposure 38.7 per cent extract against 5.7 per cent when properly milled.
4. The lower the degree of vulcanization (probably referring to undercure) the faster the oxidation.

Additional evidence is furnished by Gorter (*Gummi Zeit.*, vol. 30, p. 351, 1916), who exposed samples of rubber to light in sealed tubes containing air, oxygen, carbon dioxide and hydrogen. The rubber became tacky only in those tubes containing air or oxygen. Oxidation proceeded slowly during the first 6 days, then more rapidly, reaching a maximum in about 30 days.

The presence of aldehydes in the tacky rubber was established.

Since light has the property of accelerating oxidation, it is to be expected that increased oxidation would result with an increase in the ultraviolet. That this is so was shown by Henri (*Le Caout. et Gutt. Percha*, 1910, vol. 7, pp. 4371-4376), who exposed sheets of fine para, pale crêpe, hevea latex evaporated on glass, rubber cement evaporated on glass and sheets containing various minerals to the action of light rich in ultraviolet, secured from a mercury vapor lamp placed 20 cm. from the samples. He found:

1. Unvulcanized rubber suffers visible deterioration in 20 hours. It darkens and becomes shiny. The surface cracks when sample is stretched.
2. Action is superficial only, with brown cut sheets.
3. But with pale sheets it penetrates quickly.
4. Vulcanized rubber requires 48 to 72 hours' exposure for deterioration to become noticeable.
5. Minerals slow down the action in some cases. Thus litharge tends to restrict and antimony pentasulphide to increase the oxidation.
6. Rubber from solution in naphtha is more easily attacked than the undissolved.
7. He concluded that the change is due to oxidation, which is accelerated by ultraviolet rays.
8. The most active rays have a wave length of less than 3,600 Angstrom units and are not screened off by thin sheets of glass. Absorption of oxygen by a very pale sample was found to begin at a wave length of 3,650 units. As rubber darkens in color the absorption of ultraviolet rays increases.
9. Due to the fact that ultraviolet concentration is greater with higher altitudes, balloon fabrics should be coated with an ultraviolet screen containing pigments such as lead chromate or aniline yellow.

Certain Compounding Ingredients.—Red lead (Pb_3O_4) was at one time rather extensively employed. However, it was found that most stocks containing it failed from internal aging.

An example of oxygen vulcanization is found in Ostromuiski's mono- and di-nitrobenzene processes, in which litharge plays the part of a catalyst of oxidation. The oxygen comes from the di- or mono-nitrobenzene, the reduction products of which may be determined in the vulcanized compound.

Impurities.—Copper and manganese compounds and probably alkali are other catalysts of oxidation which are occasionally found as impurities in various compounding ingredients. Apparently not all compounds of manganese have this effect, for a certain zinc oxide which gives compounds of excellent life contains traces of manganese.

DEPOLYMERIZATION

The conception most generally held is that the colloid rubber is made up of colloidal aggregates of unknown but possibly varying size. These aggregates probably consist of a large number of $C_{10}H_{16}$ molecules linked up through the partial valences of the double bonds, of which there are two to each molecule. We may write rubber as $(C_{10}H_{16})_n$, where n represents the number of molecules in the aggregate.

The tying up of the rubber molecules into the colloidal aggregates renders them less reactive due to local saturation of the partial valences. A somewhat analogous case is found in the benzene ring, which contains three double bonds yet does not react very readily

until something happens to break in some way the local or self-saturation of the partial valences of these bonds.

By depolymerization we mean the splitting up of the aggregates into others of smaller size. In ordinary milling the "breaking down" or plasticizing of the rubber probably corresponds to a reduction in size proportional to a change from n of 3,000 to one of 2,500. There is doubtless some relation between increase in plasticity and decrease in size of the aggregate. Within small limits there is the property of partial recovery. Thus milled stocks harden on standing. The change is probably proportional to an increase of n to 2,800. Partial recovery decreases with the severity of treatment. There is evidently a limit below which rubber remains permanently soft and tacky.

Polymerization is without doubt the greatest unsolved mystery of rubber chemistry. We know how to reduce it, but no one to date has shown how it may be increased without introducing some material as for example sulphur, which polymerizes by tying up the loose ends, or as may be better described, the locking of one molecule to another through their double bonds. Unfortunately sulphur when once in place so far has refused all invitations to let go its grip.

FACTORS AFFECTING DEPOLYMERIZATION

The factors affecting depolymerization are temperature, time and solvents. It appears to be nothing more than a physical separation of the aggregates into smaller units. It ought therefore to be proportional to the time and temperature of heating. The higher the temperature or the longer the period of heating the greater should be the depolymerization.

In normal vulcanization by sulphur we have two reactions, that of heat, which produces depolymerization, and that of sulphur, which increases the polymerization as described above. Naturally the shorter the time or the lower the temperature the less the depolymerization and therefore the less sulphur required to combine with the rubber to produce a normally cured product.

The depolymerizing properties of certain solvents are probably due to similar causes. Perhaps the most likely theory is that the rubber absorbs the solvent and swells in much the same manner as gelatine swells when immersed in water. The volume of the gel increases, but the total volume of gel plus water decreases—i.e., the process is accompanied by compression. The force exerted is terrific and probably runs into the hundreds of atmospheres. There is an evolution of heat, which in the case of gelatine amounts to 5.7 gram-calories per gram of gel. Swelling of rubber in solvent brings about a separation or dissociation of the molecules in the aggregates.

As pointed out above, depolymerization is a separate and distinct reaction from vulcanization. No matter how carefully vulcanized a product may be, if it is exposed to excessive heat or to certain solvents it will become depolymerized. This within small limits is probably harmless. Its bad effect, however, is that it opens up double bonds and makes them available for addition. This will take place with sulphur if there is sulphur and a sulphur catalyst available. If not, oxidation will begin. It is for this reason that most compounders try always to have a small residuum of free sulphur in their compounds.

It will be noticed in the experiments described under the effect of light and also under accelerated age tests that the samples became soft, tacky or weakened. Ap-

parently in these cases the rate of depolymerization exceeded that of addition of oxygen. In natural life tests perished rubber is most always hard and practically brittle. It has a characteristic odor. It is reasonable to suppose that the difference is due merely to the period of exposure and that, given time enough, the soft, tacky samples would also have become hard.

ADDITIONAL VULCANIZATION BY SULPHUR

State of Cure.—Additional vulcanization by sulphur is the principal factor in internal aging. Dr. Geer's statement that the cause of most bad aging is due to an overcure or an undercure and usually to an overcure is only too true. The uninitiated sometimes prefer a stock cured so that it has a great deal of snap. This is wrong, because the point of maximum snap lies on the overcured side. The correlated opinion of men who have been a long time in the business is that the best cure from an aging standpoint is a little short of that cure giving maximum tensile strength. The cure giving from 10 to 15 per cent less tensile than the maximum is usually preferred.

A study of the bloom is also helpful. This term is given to the deposit of sulphur which condenses on the surface after the cure to a more or less extent, depending on the amount of free sulphur remaining in the stock. It is usually desirable to examine stocks for bloom about 6 weeks subsequent to vulcanization. Many experienced compounders can pick out the best cure of a stock by simple appearance of sheets cured at different times, after the bloom has had an opportunity to develop. In very few cases will the non-blooming stocks be chosen, because in many instances they will be found to be overcured. Nor will those having a pronounced bloom be selected, for the reason that their cure is probably under. In most cases the optimum cure will be taken as the one where a slight but not excessive bloom is in evidence. In compounds becoming non-blooming in about 2 hours and 30 minutes curing time at 141 deg. C., this point will be found about 15 minutes previous to the non-blooming cure.

The best types of antimony tubes are practically but not quite non-blooming. But antimony sulphide is a special compounding ingredient. It appears to act as a stabilizer. For example, the theory is that as the tube becomes depolymerized because of the heat and flexing, the pentasulphide decomposes slowly and the liberated sulphur adds on to the rubber, thus neutralizing the effect of depolymerization. This theory has been advanced as a solution of the problem why antimony tubes maintain about the same physical properties over a long period of time. Some tubes are known to have been in service for more than 10 years without any serious deterioration. There are other substances which are even better stabilizers than antimony sulphide, as for example certain organic accelerators.

Many rules have been given for the proper free sulphur content. In many if not in all cases they are positively worthless, because free sulphur content is not nearly the whole story. The nature and amount of accelerator remaining after the cure are of equal if not paramount importance. Nor is the coefficient of vulcanization in itself a reliable criterion. This coefficient—the name given by C. O. Weber to the per cent combined sulphur based on the rubber—is very low. A good commercial cure may be obtained with a coefficient of but 1.5. On the other hand, such a compound will be badly overcured when a coefficient of 2.5 is reached.

In Weber's day this value was the minimum coefficient with which a commercial product could be obtained.

Depolymerization.—This subject has been discussed at some length above. Practically all the remarks apply to addition of sulphur as well as of oxygen. Perhaps the only difference is that with sulphur alone there is a temperature coefficient that prevents the addition of sulphur until a definite temperature is reached. On the other hand, there are so many powerful accelerators which work well at low temperatures that in most cases depolymerization is a decided factor in internal aging. This is particularly the case for those compounds containing substances known to be violent depolymerizers such as certain grades of rosin oil.

Concentration of Sulphur. Accelerators.—These subjects are so interwoven that it is almost hopeless to separate them. For a time the tendency was to make practically non-blooming stocks by the aid of powerful organic accelerators. Older compounders have always insisted on a liberal supply of bloom. Today it is believed that an intermediate position is most desirable. The proper accelerator and sulphur ratios can be determined only by long experience. A compound should stand 100 to 200 per cent overcure without serious deterioration in physical properties.

Heat.—As is well known, heat speeds the reaction of sulphur with rubber during the cure. It also has a similar effect in speeding after vulcanization, but to a much less extent than at the normal curing temperatures. From an aging standpoint its worst effect is as a depolymerizer.

COMPARISON BETWEEN STILL AND ACTIVE AGING

A peculiar and apparently inexplicable phenomenon is the fact that rubber resists age better when in use than when idle. It is well known that a spare tire ages badly in comparison to its sister on the wheel in service.

Just why this is so is not yet known. The temperature of the exhaust is perhaps a small factor. But a more likely theory is that some internal rearrangement has taken place within the rubber itself. The stresses of a tire in service are greatly different from one held in reserve as a spare. In the latter case the entire carcass is under strain from the inside. This permits the tire to take a set along certain lines. When put in service the stresses are from an opposite direction and failure soon occurs. The exact cause of the trouble, as mentioned above, is not known. In the meantime it will be found desirable to keep spares covered and to put them in service at least every 3 months.

It has been observed that many otherwise good aging compounds when placed under strain, even so slight as when an 8-in. sheet is bent double, and exposed to the weather soon develop serious cracks and checks at the location of greatest tension—i.e., on the outside of the bend. Just why this is so is not yet known.

CONCLUSION

Several ideas as to the cause and mechanism of aging have been correlated. The hypotheses advanced are not considered as proved, but are merely tenable in the light of present knowledge.

There is no more serious problem facing rubber manufacturers and consumers today than the study of aging. It may be said without fear of contradiction that the average life of soft rubber goods as prepared at present could be greatly increased without much effort.

New York City.

On the Heat-Treatment of Aluminum Bronze

Exceptionally High Values Given in Handbooks for Strength of This Alloy Led to an Extensive Investigation of the Alloy for Use in Lifting Jacks—Hardness and Strength of These Bronzes Appear to Be Independent Variables

By A. A. BLUE
Metallurgist

MUCH valuable work has been done and published on the heat-treatment, with its attendant changes in structure and physical properties, of what is known as "aluminum bronze," an alloy of the general analysis: copper, 90 per cent; aluminum, 10 per cent, with occasionally 1 per cent iron substituted for a corresponding amount of copper. Under the necessity of producing lifting jacks of ever-increasing capacity with decreased weight, this alloy has been experimented with in various structural conditions. Since the large majority of the available data on this subject is made up from laboratory work done on small pieces, especially prepared, the results of the present investigation are offered, not with the idea of presenting considerations essentially new, but in the hope they may be of value to those who are interested primarily in the commercial application of this interesting material and in the results they may expect to obtain under actual conditions of everyday manufacture and treatment. Reference to the literature on heat-treatment of aluminum bronze reveals differences in opinion as to the nature of the changes involved and also as to the results obtainable from various treatments. After being unable to check some published results of treatments when applied in practice, a rather complete investigation was determined upon.

Cu:Al EQUILIBRIUM DIAGRAM

The theoretical considerations are embodied in the constitutional diagram shown in Fig. 1, taken, with a slight modification, from Greenwood¹. This arrangement was in turn prepared from the work of Curry², Carpenter and Edwards³, and Andrew⁴. The constitution of the alloys of copper and approximately 10 per cent aluminum consists of a series of solid solutions, the nature and designation of which have not been entirely agreed upon, but, as Fig. 1 is made up of what has been considered best in a number of the most carefully conducted works on the subject, it is probably very close to correct.

Alpha solid solution exists alone up to approximately 10 per cent aluminum, under conditions of equilibrium. An inclination in the boundary line exists above 1,050 deg. F. (566 deg. C.), thus permitting the appearance of the second phase, known as beta solid solution at higher temperatures. Curry² and Rosenhain⁵ show this boundary line at approximately 8.5 per cent Al,

but the work of Greenwood demonstrated the difficulty of obtaining the alloy in equilibrium, which accounts for the different locations of this line. The present work has been done with samples containing varying amounts of iron, which has also probably shifted the equilibrium. Increasing aluminum beyond 10 per cent produces a third solid solution known as delta, which forms a eutectic with alpha, the eutectic composition being approximately 12 per cent aluminum, as indicated in Fig. 1. Upon heating past the transformation temperature (1,050 deg. F., 566 deg. C.), the eutectic changes into the beta solution, which proceeds

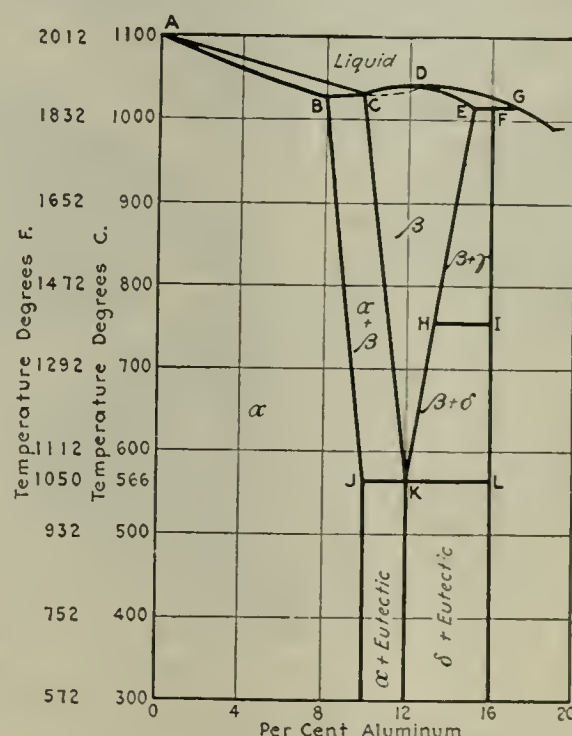


FIG. 1. PORTION OF THE Cu:Al
EQUILIBRIUM DIAGRAM,
AFTER GREENWOOD¹

to absorb increasing amounts of alpha or delta, whichever was the excess constituent, with increasing temperatures, as shown by the lines *CK* and *KE*. At 1,400 deg. F. (760 deg. C.) indicated by the line *HI*, the delta solution changes into a fourth form known as gamma. The melting point of the alloy is seen to be in the neighborhood of 1,900 deg. F. (1,040 deg. C.) along the line *ABCDEG*.

MICROSCOPIC APPEARANCE OF CONSTITUENTS

The structural appearance of bronzes containing varying amounts of aluminum on both sides of the value represented by J is shown in Figs. 2 to 5 inclusive. Fig. 2 is of a sample containing 7.54 per cent Al; practically all of one constituent, with here and there a slight appearance of the eutectic. The round black spots are of lead, which is insoluble in copper. A somewhat larger amount of eutectic is visible with 8.39 per cent Al, though it may be largely

¹Greenwood, "The Constitution of the Copper-Rich Aluminum Alloys," *J. Inst. Metals*, vol. 19, 1918, pp. 55-100.

²Curry, "The Constitution of the Aluminum Bronzes," *J. Phys. Chem.*, vol. 11, 1907, pp. 425-436; 461-491.

³Carpenter and Edwards, "On the Properties of the Alloys of Aluminum and Copper," Eighth Report to the Alloys Research Committee, *Proc. Inst. Mech. Engrs.*, vol. 72, 1907, pp. 57-269.

⁴Andrew, *J. Inst. Metals*, 1915, vol. 13.

⁵Rosenhain, "Introduction to Physical Metallurgy," p. 154.

FIGS. 2 TO 5. MICROSTRUCTURE OF COMMERCIAL ALUMINUM BRONZES. $\times 12$

Fig. 2. 7.54 per cent Al

Fig. 3. 9.48 per cent Al

Fig. 4. 0.76 per cent Fe

Fig. 5. 1.23 per cent Fe

masked by contrasty etching. Fig. 3 shows bronze containing 9.48 per cent Al; 10.4 per cent gives progressively increasing amounts of the black eutectic constituent. All of these samples contained approximately 0.5 per cent iron. Increasing the amount of iron appears to cause a bunching of the crystals around the large grain boundaries, as shown in Figs. 4 and 5, containing respectively 0.76 and 1.23 per cent iron.

All micrographs are after etching with FeCl_3 , acidified with HCl .

The effect of heating the same samples is shown in Figs. 6 to 8 inclusive, all samples being heated to 1,600 deg. F. (870 deg. C.) and quenched in a 5 per cent brine solution. The eutectic is seen to have changed into the fine needle-like beta solution, which has in turn absorbed some of the adjacent alpha, so that the area of the beta is in all cases greater than that of the eutectic from which it was produced. Fig. 8 is practically complete beta solution. Along the grain boundaries a small amount of alpha reappears no doubt due to the quenching not being sufficiently rapid.

The results obtained from various rates of cooling are illustrated in Figs. 9, 10 and 11, showing, respectively, the structures resulting from quenching samples of the same composition from 1,550 deg. F. (845 deg. C.) in oil, water and salt water. The effect of annealing is to produce a very much refined structure, as shown in Figs. 12, 13 and 14 of samples heated to 1,550 deg. F. (845 deg. C.), cooled in air; 1,600 deg. F. (870 deg. C.), cooled in lime, and 1,700 deg. F. (925 deg. C.), cooled in lime, respectively.

As indicated by the inclined line *BJ* in Fig. 1, increased temperatures above 1,050 deg. F. (566 deg. C.) produce increased amounts of beta solution, which is retained upon quenching. The actual progression of this absorption is shown in the series Figs. 15 to 20, inclusive, of samples heated respectively to 1,250, 1,300,

1,400, 1,500, 1,600 and 1,700 deg. F., in each case being quenched in 5 per cent brine. Progressive disappearance of the alpha solution is seen up to the temperature of 1,600 deg. F. (870 deg. C.), when complete solution is found. Further heating above this point appears to develop a formation along the grain boundaries. Greenwood states that this is a reappearance of alpha. It is apparent, as noted above, that some alpha is to be expected due to the impossibility of retaining all in solution during quenching, just as it is practically impossible to obtain pure austenite in quenching carbon steels, but it appears difficult to justify a larger amount of alpha at higher temperatures than at lower ones, when just the reverse is to be expected. It

TABLE I. ANALYSES OF SAMPLES USED

Mark	Copper	Aluminum	Iron	Lead	Tin	Brinell Hardness (500 Kg.)
1	89.09	7.54	0.61	1.05	1.32	57
2	90.66	8.39	0.29	.....	.....	70
3	90.82	8.75	0.33	.....	.....	70
4	90.09	9.42	0.50	.....	.....	100
5	89.56	9.45	0.67	.....	.....	100
6	89.66	9.48	0.54	.....	.....	100
7	89.31	9.61	1.23	.....	.....	93
8	89.05	9.73	0.57	.....	.....	100
9	89.70	9.90	0.37	.....	.....	100
10	89.05	10.06	0.76	.....	.....	119
11	89.12	10.13	0.45	.....	.....	119
12	88.54	10.39	1.26	.....	.....	93

appears more reasonable to assume that this formation is due to a coagulation of the beta crystals themselves, with probably less alpha present than before. A number of specimens examined after such treatment showed a marked increase in this formation along the grain boundaries with the higher temperatures, so that the phenomenon is not accidental.

EXPERIMENTAL PROCEDURE IN QUENCHING

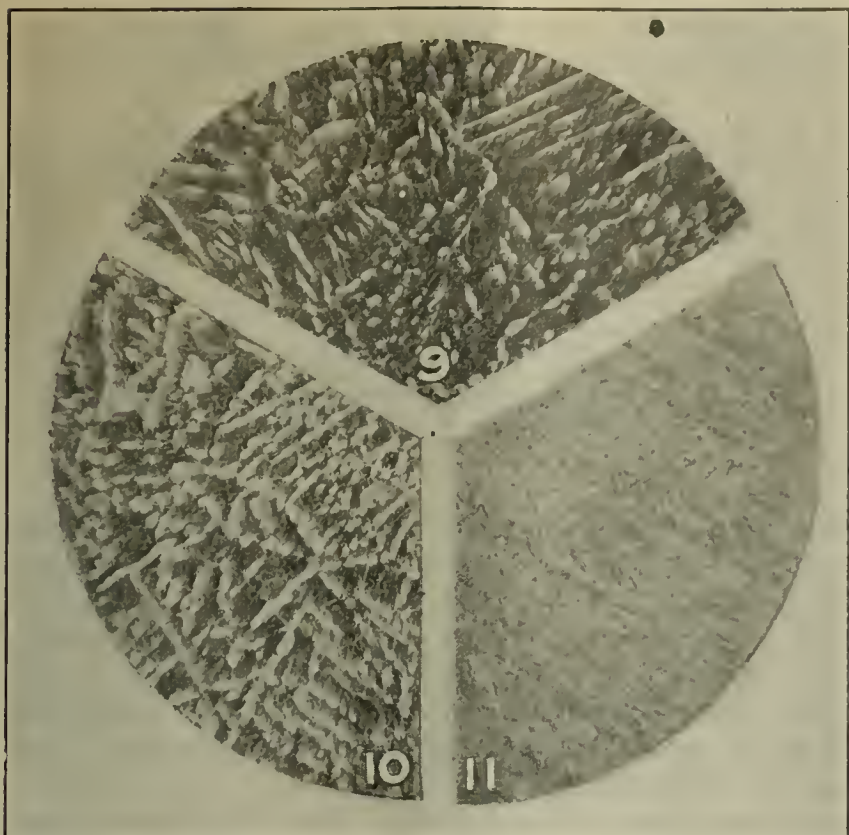
As noted above, samples of various analyses have been employed in the present discussion, coming from two foundries, one being an ordinary brass and bronze foundry and the other possessing an organization which has specialized on this alloy for a number of years. The analyses of the various samples used, together with the initial Brinell hardness figures, are shown in Table I. Greenwood found that samples 0.4 in. thick or larger

FIGS. 6, 7 AND 8. ALUMINUM BRONZES QUENCHED FROM 1,600 DEG. F. $\times 50$

Fig. 6. 7.54 per cent Al

Fig. 7. 8.39 per cent Al

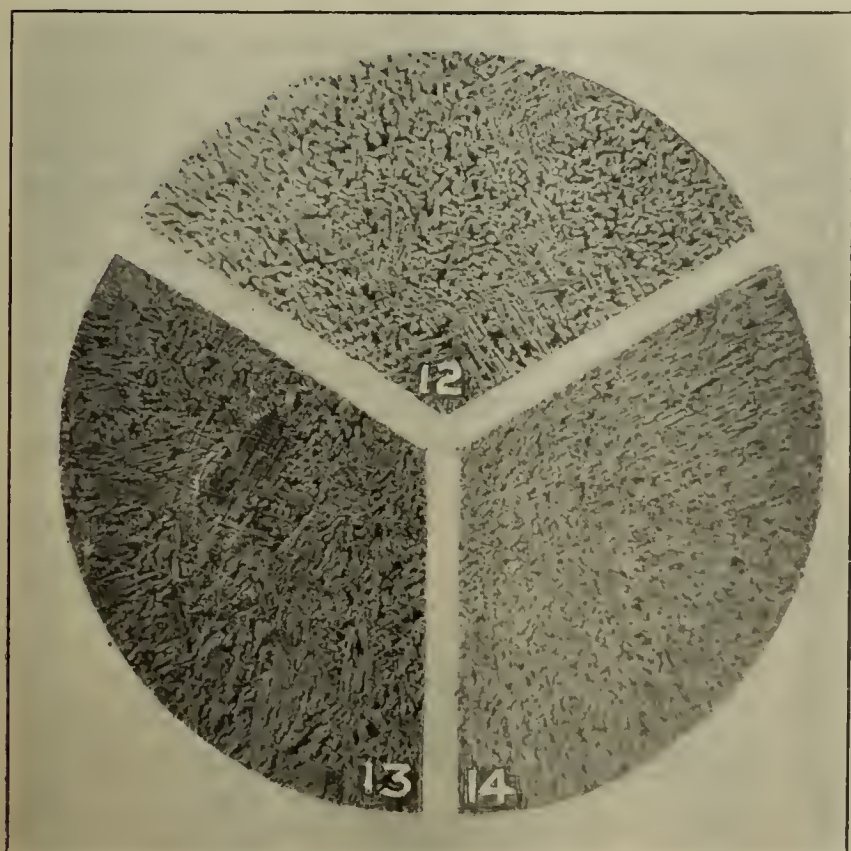
Fig. 8. 10.39 per cent Al



FIGS. 9, 10 AND 11. EFFECT OF COOLING RATE IN QUENCHING FROM 1,550 DEG. F. BRONZE CONTAINING 9.73 PER CENT AL. $\times 25$

Fig. 9. Cooled in oil. Fig. 10. Cooled in water. Fig. 11. Cooled in brine.

could be used without affecting the scleroscope values obtained. Accordingly, a number of samples from $\frac{1}{2}$ to $\frac{3}{4}$ in. square were made up from castings of the above analyses. These samples were mixed indiscriminately, heated to various temperatures, and cooled at various rates, two samples being run for each condition. The samples were heated in an electric muffle, ample time being allowed for the metal to soak at the desired temperature; they were then rapidly removed to the proper cooling medium. If liquids (at room temperature) were the coolant, the piece was kept in constant motion during the cooling period. Temperatures were accurately controlled by a Leeds & Northrup poten-

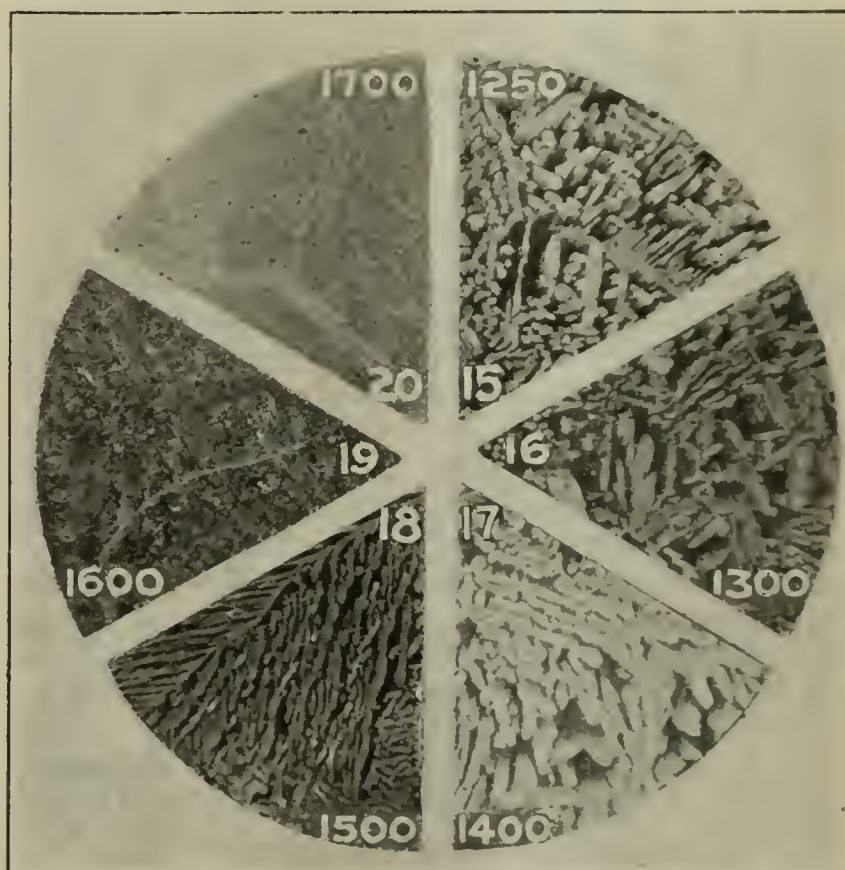


FIGS 12, 13 AND 14. EFFECT OF ANNEALING BRONZE CONTAINING 10.13 PER CENT AL. $\times 25$

Fig. 12. Cooled in air from 1,550 deg. F.
Fig. 13. Cooled in lime from 1,600 deg. F.
Fig. 14. Cooled in lime from 1,700 deg. F.

tiometer, the couple being in actual contact with the material in the furnace. The results of these tests, showing Brinell and scleroscope values before and after treatment, are shown in Table II. The magnifier hammer was used in all cases with the scleroscope, and the 500-kg. weight for the Brinell, except as noted when a corresponding correction was made, according to Fig. 21.

The results of the above series are plotted, Fig. 22 showing the increase in Brinell hardness and Fig. 23 in scleroscope. Due to the varying degree of hardness of the initial pieces, as a result of the increasing percentages of aluminum, the *percentage increase* in each case has been used, instead of the actual figures, as it was thought this would give a more accurate indication of the effects of the various conditions of treatment. Inasmuch as the samples lowest in aluminum showed no increase in hardness from treatments, these have been disregarded in plotting the curves. An examination of these curves shows a maximum harden-



FIGS. 15 TO 20. ABSORPTION OF ALPHA SOLUTION ON PROGRESSIVELY HIGHER QUENCHING. BRONZE CONTAINING 10.06 PER CENT AL. $\times 25$

ing effect at from 1,550 to 1,600 deg. F. (860 deg. C.) for all rapid coolings; 5 per cent brine, water and oil producing hardening effects in that order.

Annealing produces a slight softening of the bronze with apparently little to choose between air and lime cooling.

A close examination of the plotted points shows a drop in the Brinell hardness when quenched from 1,400 deg. F. (760 deg. C.) in oil, water or brine. Seidell and Horvitz⁸ show a similar drop, using straight aluminum bronze with no iron, at about 1,100 to 1,200 deg. F. (620 deg. C.) Greenwood's experiments showed that heating at 1,100 deg. F. (600 deg. C.) for 20 days was necessary to arrive at complete equilibrium. Heating to about 1,300 deg. F. (700 deg. C.) apparently permits this equalization to proceed more rapidly, resulting in the softening effect just mentioned.

A second series of tests was next made from the

⁸Seidell and Horvitz, "Relation of Microstructure to Phase Changes in Heat-Treated Aluminum Bronzes," CHEM. & MET. ENG., vol. 21, 1919, pp. 179-181.

TABLE II. HARDNESS OF ALUMINUM BRONZES BEFORE AND AFTER HEAT-TREATMENT

Hardness Before Treatment			Treatment	Hardness After Treatment	
Analysis No.	Sclero-scope	Brinell		Sclero-scope	Brinell
3	20	70	1,200°F., air cool.	20	65
4	20	100	1,200°F., air cool.	20	86
1	15	70	1,200°F., lime cool.	20	61
5	25	109	1,200°F., lime cool.	20	93
8	30	100	1,200°F., oil quench.	30	86
1	15	61	1,200°F., oil quench.	15	29.7
2	20	70	1,200°F., water quench.	20	74
6	30	93	1,200°F., water quench.	30	86
2	15	70	1,200°F., salt water quench.	20	61
11	30	130	1,200°F., salt water quench.	35	114
8	30	100	1,250°F., air cool.	30	74
6	25	100	1,250°F., air cool.	25	80
2	20	70	1,250°F., lime cool.	15	55
6	25	100	1,250°F., lime cool.	20	80
11	40	119	1,250°F., oil quench.	40	119
8	25	100	1,250°F., oil quench.	30	93
8	25	100	1,250°F., water quench.	30	100
2	20	70	1,250°F., water quench.	20	65
8	25	100	1,250°F., salt water quench.	30	100
10	30	119	1,250°F., salt water quench.	50	143
10	25	119	1,300°F., air cool.	30	119
3	20	70	1,300°F., air cool.	15	61
4	20	100	1,300°F., lime cool.	25	119
3	20	70	1,300°F., lime cool.	15	61
4	25	100	1,300°F., oil quench.	25	74
3	25	74	1,300°F., oil quench.	20	65
1	25	45	1,300°F., water quench.	20	31.2
8	35	100	1,300°F., water quench.	40	109
11	30	119	1,300°F., salt water quench.	40	119
3	20	70	1,300°F., salt water quench.	20	70
11	35	119	1,350°F., air cool.	32	109
11	30	119	1,350°F., air cool.	30	93
5	30	93	1,350°F., lime cool.	25	80
3	15	70	1,350°F., lime cool.	10	61
3	20	74	1,350°F., oil quench.	25	80
1	25	43	1,350°F., oil quench.	20	50
8	25	100	1,350°F., water quench.	40	130
5	30	119	1,350°F., water quench.	35	100
8	25	100	1,350°F., salt water quench.	40	119
6	30	100	1,350°F., salt water quench.	30	109
2	15	70	1,400°F., air cool.	10	50
8	20	86	1,400°F., air cool.	20	100
5	25	100	1,400°F., lime cool.	25	63
2	20	65	1,400°F., lime cool.	15	54
11	40	119	1,400°F., oil quench.	60	228 (3,000 kg.)
4	30	100	1,400°F., oil quench.	32	100
4	30	100	1,400°F., water quench.	35	109
5	35	119	1,400°F., water quench.	45	130
6	35	86	1,400°F., salt water quench.	35	93
6	30	93	1,400°F., salt water quench.	40	74
4	30	100	1,450°F., air cool.	30	93
10	30	119	1,450°F., air cool.	30	109
8	20	100	1,450°F., lime cool.	20	89
6	25	100	1,450°F., lime cool.	25	86
4	30	100	1,450°F., oil quench.	35	109
1	15	61	1,450°F., oil quench.	15	61
5	35	100	1,450°F., water quench.	45	158
11	25	119	1,450°F., water quench.	65	255 (3,000 kg.)
6	25	93	1,450°F., salt water quench.	35	130
1	20	43	1,450°F., salt water quench.	15	45
6	25	93	1,500°F., air cool.	20	93
2	18	70	1,500°F., air cool.	15	57
1	20	43	1,500°F., lime cool.	20	57
6	25	100	1,500°F., lime cool.	25	80
3	15	70	1,500°F., oil quench.	20	72
6	20	100	1,500°F., oil quench.	30	100
6	20	74	1,500°F., water quench.	25	93
5	30	100	1,500°F., water quench.	45	143
5	30	100	1,500°F., salt water quench.	50	150
4	25	86	1,500°F., salt water quench.	50	143
10	25	119	1,550°F., air cool.	20	109
11	35	119	1,550°F., air cool.	30	119
4	30	100	1,550°F., lime cool.	25	72
11	30	119	1,550°F., lime cool.	30	109
8	30	100	1,550°F., oil quench.	55	158
1	15	70	1,550°F., oil quench.	15	54
3	20	70	1,550°F., water quench.	25	86
5	25	100	1,550°F., water quench.	45	158
10	35	119	1,550°F., salt water quench.	60	207 (3,000 kg.)
10	35	119	1,550°F., salt water quench.	65	188
2	20	70	1,600°F., air cool.	15	54
11	25	119	1,600°F., air cool.	25	100
1	25	65	1,600°F., lime cool.	20	54
10	35	119	1,600°F., lime cool.	30	119
11	30	119	1,600°F., oil quench.	65	158
8	30	100	1,600°F., oil quench.	45	130
4	20	100	1,600°F., water quench.	50	158
4	25	100	1,600°F., water quench.	40	130
11	25	119	1,600°F., salt water quench.	85	192
10	25	119	1,600°F., salt water quench.	85	269 (3,000 kg.)
4	20	100	1,650°F., air cool.	20	80
8	30	100	1,650°F., air cool.	25	100
11	35	119	1,650°F., lime cool.	25	109
1	15	70	1,650°F., lime cool.	15	57
5	30	100	1,650°F., oil quench.	40	100
3	25	74	1,650°F., oil quench.	25	80
2	25	70	1,650°F., water quench.	20	80
3	25	70	1,650°F., water quench.	30	100
10	25	119	1,650°F., salt water quench.	70	202 (3,000 kg.)
11	35	119	1,650°F., salt water quench.	85	217 (3,000 kg.)

Hardness Before Treatment			Treatment	Hardness After Treatment	
Analysis No.	Sclero-scope	Brinell		Sclero-scope	Brinell
3	15	70	1,700°F., air cool.	15	70
5	20	119	1,700°F., air cool.	20	93
8	20	86	1,700°F., lime cool.	20	100
10	35	119	1,700°F., lime cool.	30	109
1	15	57	1,700°F., oil quench.	15	70
3	18	70	1,700°F., oil quench.	20	80
1	15	57	1,700°F., water quench.	20	61
6	30	100	1,700°F., water quench.	45	130
2	25	70	1,700°F., salt water quench.	30	80
5	35	119	1,700°F., salt water quench.	70	158
2	15	70	1,780°F., hold 12 hr., air cool.	15	61
10	28	119	1,780°F., hold 12 hr., air cool.	30	119
3	20	80	1,780°F., hold 12 hr., lime cool.	20	65
2	20	65	1,780°F., hold 12 hr., lime cool.	15	57
8	25	100	1,780°F., hold 12 hr., water quench.	30	109
6	20	100	1,780°F., hold 12 hr., water quench.	30	119

same lot of samples, all pieces being quenched at 1,600 deg. F. (870 deg. C.), in brine, and drawn at various temperatures, with various rates of cooling after the draw. The results of these experiments showed a progressive softening of the material as the drawing temperature was increased with no marked or consistent difference appearing with various cooling media. The data are included in Table II.

As noted above, the material used in the tests just

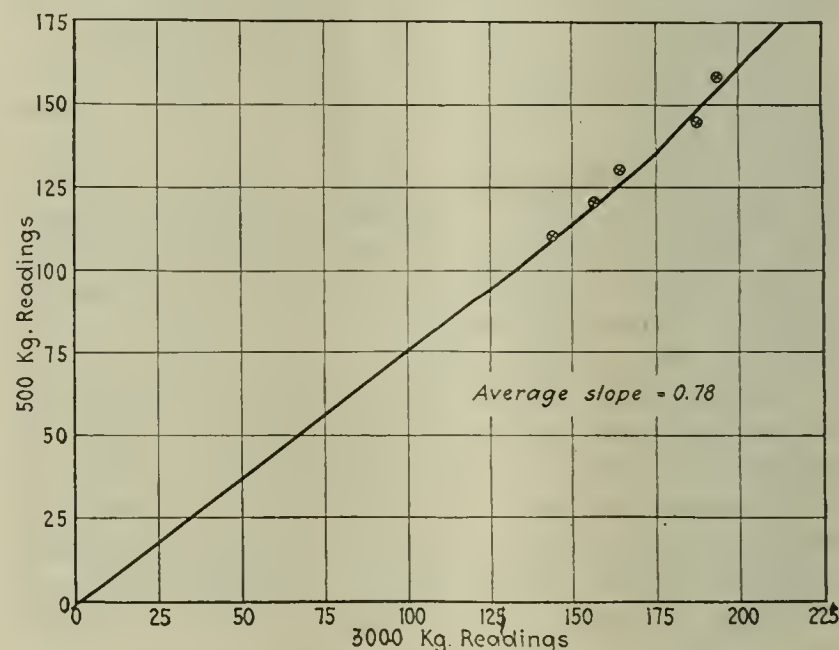


FIG. 21. RELATION BETWEEN BRINELL HARDNESS OF ALUMINUM BRONZES AS DETERMINED BY 500 KG. OR 3,000 KG. LOADS

described was obtained from two sources, one being an ordinary brass foundry and the other an organization which has specialized upon this material. As the samples from the latter were found to be more uniform in composition and to contain fewer casting defects, several bars for further tests were obtained from this source. The analysis of these bars was Cu, 88.54 per cent; Al, 10.39 per cent; Fe, 1.26 per cent.

These bars were cast 1 in. diameter by 10 in. long,

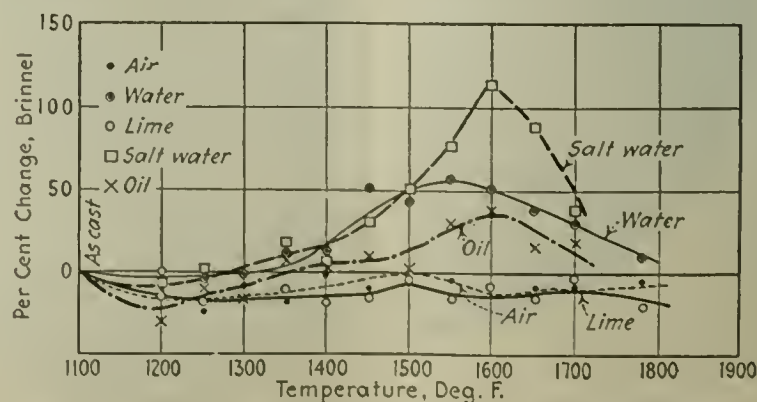


FIG. 22. CHANGE IN BRINELL HARDNESS OF ALUMINUM BRONZES AFTER COOLING AT DIFFERENT RATES

TABLE III. HARDNESS OF ALUMINUM BRONZES BEFORE AND AFTER QUENCHING 1,600 DEG. F. IN SALT WATER AND DRAWING AT VARIOUS TEMPERATURES

Analysis No.	Before Treatment		Draw	After Quench		After Draw
	Sclero-scope	Brinell		Sclero-scope	Sclero-scope	Brinell
1	20	45	800°, lime cool.	20	15	50
10	25	119	800°, lime cool.	60	55	228 (3 000 kg.)
6	25	100	800°, air cool.	40	40	130
2	20	70	800°, air cool.	20	20	72
2	15	70	800°, water cool.	20	15	70
10	25	86	800°, water cool.	60	55	158
5	35	100	900°, lime cool.	50	40	158
2	15	57	900°, lime cool.	10	15	40
5	25	93	900°, air cool.	50	40	119
1	15	70	900°, air cool.	15	15	57
10	25	109	900°, water cool.	70	45	158
4	25	100	900°, water cool.	45	35	119
11	30	119	1,000°, lime cool.	65	40	179 (3,000 kg.)
10	35	119	1,000°, lime cool.	70	40	150
1	15	70	1,000°, air cool.	15	15	65
8	20	100	1,000°, air cool.	45	32	130
3	20	74	1,000°, water cool.	25	20	86
10	32	119	1,000°, water cool.	80	50	158
5	25	100	1,100°, lime cool.	60	35	109
11	30	119	1,100°, lime cool.	60	35	109
5	30	100	1,100°, air cool.	60	40	130
4	25	100	1,100°, air cool.	45	30	109
4	30	100	1,100°, water cool.	50	35	109
3	20	70	1,100°, water cool.	25	20	74

and were quenched at varying rates from two temperatures, 1,600 deg. and 1,780 deg. F. (870 and 970 deg. C.) respectively; then drawn back to various temperatures, again with different rates of cooling after the draw. The bars were then cut into test bars as follows:

Tensile Tests. The central portion was turned down to the standard 0.505 in. diameter, allowing 2 in. for the determination of elongation.

Compression Tests. Test-pieces $\frac{1}{2}$ in. long by $\frac{1}{2}$ in. diameter were prepared.

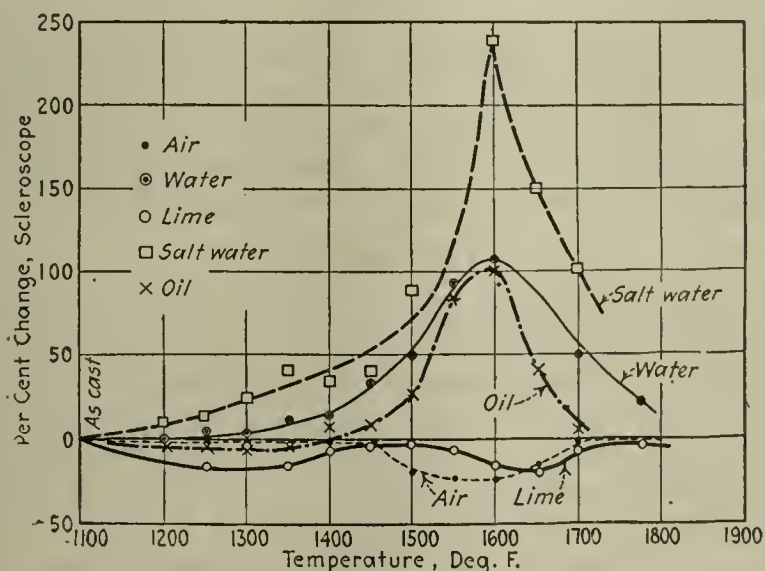


FIG. 23. CHANGE IN SCLEROSCOPE HARDNESS OF ALUMINUM BRONZES AFTER COOLING AT DIFFERENT RATES

Impact Tests. Charpy test-pieces were prepared, 10 mm. square with a standard notch, $1\frac{1}{2}$ mm. wide by 5 mm. deep.

All test-pieces were very carefully machined, being held accurately to the dimensions given, plus or minus 0.0005 in. Brinell tests were also made on these bars, using 3,000 kg. in all cases except the untreated bar. The results are plotted in Fig. 24. It is seen that a draw to 700 deg. F. (370 deg. C.) renders the material

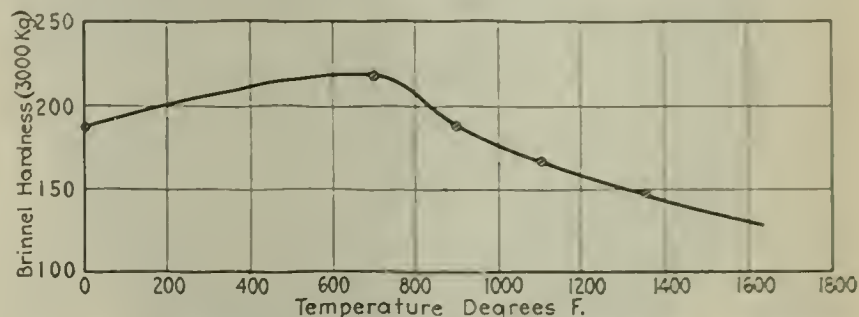


FIG. 24. EFFECT OF DRAWING ALUMINUM BRONZES AFTER QUENCHING IN WATER FROM 1,600 DEG. F.

harder than it was after the quench alone. A similar result is reported by Corse and Comstock¹ and by Portevin and Arnon², although Seidell and Horvitz³ found no such effect.

POOR CORRELATION OF PHYSICAL PROPERTIES

The tensile results, together with the other values obtained from this series of tests, are shown in Table IV. These figures present rather surprising results. In the first place, the large number of piped and defective pieces coming from a manufacturer with much experience indicates most forcibly the difficulty of handling this material in the foundry. However, the absence of all relation between Brinell hardness and tensile properties and between tensile properties and treatment is indeed unexpected. One feature especially peculiar (and apparently consistent) is the inverse ratio found between tensile strength and yield point. While the Brinell and scleroscope values respond very readily to treatment, they do not indicate any corresponding tensile strength and yield point, as they do with steel.

The above tensile tests were made on bars which had simply been turned down in the center. It was felt that possibly the low results were due to inequalities in the pull exerted by the testing machine. Therefore a number of threaded-end test-bars were prepared from addi-

¹Corse and Comstock, "Aluminum Bronzes: Some Recent Tests and Their Significance," *Proc., A.S.T.M.*, vol. 16, Part 2, 1916, pp. 118-144.

²Portevin and Arnon, *Comp. rend.*, vol. 154, 1912.

³See footnote 6.

TABLE IV. PHYSICAL PROPERTIES OF HEAT-TREATED ALUMINUM BRONZE

No.	Treatment	Brinell	Ultimate Strength	Yield Point	Elongation, per Cent	Reduction in Area, per Cent	Compressive Strength, Lb. per Sq. In.	Impact Strength, Ft.-Lb. per Sq. In.
158	As cast.	93	61,000	19,000	20.5	24.5	190,950	229
159	1,600° water.	187	53,000	23,000	Outside mark		150,550	130
160	1,600° oil.	156	64,100	16,000	Outside mark*		120,500*	190*
161	1,600° brine.	255	69,500	20,000	3.0	7.0	118,350*	117
162	1,600° water; 700° air.	217	41,600	27,500	Outside marks		145,800	149*
163	1,600° water; 900° air.	187	69,550	25,000	Outside marks*		169,675	43
164	1,600° water; 900° lime.	187	45,875	26,000	Outside marks*		161,225	55*
165	1,600° water; 1,100° air.	163	73,875	19,000	12.5	18.0	188,575	249
166	1,600° water; 1,100° lime.	170	51,500	30,000	3.5	10.0*	186,375	174*
167	1,600° water; 1,350° air.	149	54,650	21,000	13.0	22.0*	197,625	310*
168	1,600° water; 1,350° water.	187	66,500	22,500	15.5	18.0	143,900	192*
169	1,780° water.	187	77,400	21,000	9.0	16.0	164,000	174
170	1,780° brine.	174	53,000	28,000	Outside marks		93,475*	200*
171	1,780° water; 900° air.	179	59,250	31,500	2.5	3.0*	130,900*	51
172	1,780° water; 900° lime.	187	76,050	25,000	4.0	8.0	168,350	38
173	1,780° water; 1,100° air.	170	58,575	24,500	8.5	15.0	169,450*	
174	1,780° water; 1,100° lime.	149	65,500	27,500	13.0	19.0	167,875*	220*
175	1,780° water; 1,350° water.	166	56,500	23,500	3.0	7.0	159,125*	142

* Pipe or blow hole in specimen.

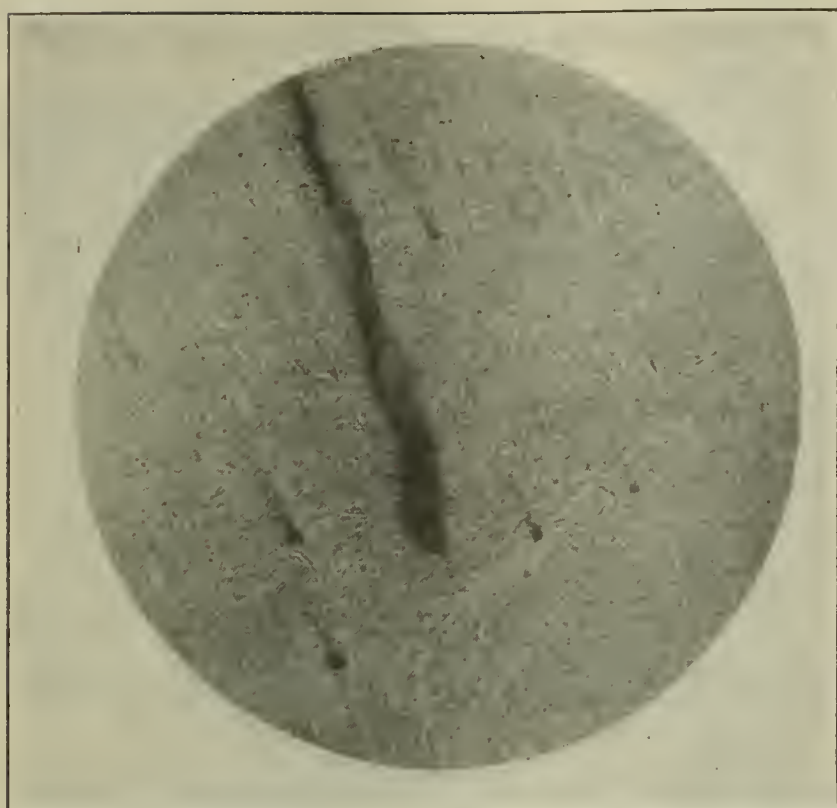


FIG. 25. TRANSGRANULAR FRACTURE IN ALUMINUM BRONZE. $\times 100$

tional bars, cast with especial care to avoid all foundry defects. These bars showed an improvement in the condition of the metal after heat-treatment, as shown by figures for elongation and reduction in area, but the tensile strength and yield point were practically unaffected. Typical results were as follows:

Heat to 1,700 deg. F., quench in brine; draw at 1,000 deg. F., cool in lime.

Brinell hardness 179 (3,000 kg.).

Tensile strength, 81,495 lb. per sq.in.; yield point, 32,500 lb. per sq.in.; elongation, 22.5 per cent; reduction in area, 23.7 per cent.

Tensile strength, 79,480 lb. per sq.in.; yield point, 20,000 lb. per sq.in.; elongation, 20 per cent; reduction in area, 22 per cent.

Such results do not warrant discarding the first results obtained with the plain end test-bars.

Compression and impact results listed in Table IV indicate a draw at approximately 1,100 deg. F. (595 deg. C.) to give the best results. The increased brittleness shown by the impact test with a draw at 900 deg. F. (480 deg. C.) is very marked. This is of the same nature as the increased Brinell hardness with low draws, shown in Fig. 24.

Results obtained from castings made for lifting jacks substantiated the above results. The castings in question carry the entire load on the jack, delivering the load to a screw turning in the bronze casting. These castings were treated under all reasonable quenching temperatures, drawing temperatures and cooling rates from both heats. Brinell hardness figures corresponding to those given above for the test-bars were consistently obtained on the castings, but they all failed in service tests at approximately the same load, untreated doing as well as treated.

FRACTURE IS TRANSCRYSTALLINE

The failure of treated castings demonstrated a point of interest and one in accord with theory. Examination of fractures, as shown in Fig. 25, show the break to pass through the grains and not along the boundaries. This is as would be expected from theoretical considerations, inasmuch as the hard brittle beta is in the interior of the grain, while the softer more ductile alpha solu-

tion commences its formation along the grain boundaries, thus increasing the toughness at these points.

One of the prominent engineering handbooks on the market gives 100,000 lb. per sq.in. tensile strength to be expected from *forged* aluminum bronze. Actually to test this, bars 1 in. in diameter were forged at a temperature of 1,600 to 1,700 deg. F. to $\frac{3}{4}$ in. in diameter, treated as indicated in Table V, and turned to standard 0.505-in. threaded-end test-bars. The forged structure had a marked grain refinement, and the results

TABLE V. PROPERTIES OF FORGED ALUMINUM BRONZE

Treatment	Tensile Strength, Lb. per Sq.In.	Elastic Limit, Lb. per Sq.In.	Elongation, per Cent	Contraction in Area, per Cent
Forged, untreated.....	79,750	34,360	32.5	34.8
Forged, untreated.....	81,245	34,240	31.0	30.8
Forged, reheated to 1,650 deg. F., quenched in brine, drawn to 1,000 deg. F., cooled in lime.....	92,190	44,820	Broke outside gage marks.	Broke outside gage marks.
Forged, reheated to 1,650 deg. F., quenched in brine, drawn to 1,000 deg. F., cooled in lime.....	81,345	43,820	Broke outside gage marks.	Broke outside gage marks.
Drawn to 1,000 deg. F., cooled in brine	86,490	47,760	12.0	14.9

show some improvement in tensile properties, but an increase in brittleness in the heat-treated specimens; compare cast and forged bars, quenched and drawn to 1,000 deg. F. (540 deg. C.) cooled in lime. A small increase in tensile strength is accompanied by a 40 per cent drop in elongation. Likewise the bar quenched and not drawn shows a considerable increase in strength, but was so brittle that it broke at the end, even though threaded-end test-bars were used and generous fillets provided.

The fact that mechanical working of the bronze produces little effect upon its tensile properties is brought out by Corse¹⁰; he states that rolling has been found to be of little value in this regard, describing the circumstance as a "remarkable metallurgical fact."

CONCLUSION

In conclusion it may be said that: (1) The theory of the copper-rich aluminum alloys is apparently well developed. (2) Heat-treatment produces marked and consistent changes in Brinell and scleroscope hardness. (3) Heat-treatment produces little or no effect on tensile strength and yield point. (4) Forging produces little effect on the tensile properties of the alloys. (5) Aluminum bronze is very difficult to handle in the foundry and at present yields uncertain results. (6) Figures have been published on the value of this alloy which cannot be readily duplicated in actual practice or tests.

World Reserves of Water Power

The Siemens Schuckert Co. has compiled data on the world reserves of water power. The following are some of the figures, condensed:

Of the estimated total 745 million hp.

65 millions are in Europe.

160 millions are in North America.

94 millions are in South America.

236 millions are in Asia.

160 millions are in Africa

30 millions are in Australia.

Compared to population South America leads with 5.25 hp. per inhabitant, followed by Australia, with 3.75 hp.; North America, 1.27 hp.; Africa, 1.14 hp.; Asia, 0.27 hp., and Europe, 0.13 hp. per inhabitant.

¹⁰Corse, *Trans.*, A.I.M.E., vol. 60, 1919, p. 174.

Importance of the Olefine Gases and Their Derivatives

IV—Isopropanol (Isopropyl Alcohol)*

Commercial Preparation of Isopropanol From Propylene—Properties Depend to Some Extent Upon Method of Manufacture—Non-Potable Character Makes It an Important Industrial Alcohol—No Serious Physiological Effects—Interesting Possibilities for Use in Chemical Synthesis

By GEORGE O. CURME, JR., AND E. W. REID

IT IS interesting to note that within the past twelve months still another of the lower aliphatic alcohols has been removed from the list of materials available for pure science only and has taken its place among the commercial products open for development to our chemical industries. This alcohol is that one commonly known to chemists as isopropyl alcohol, but which will be termed isopropanol by the writers, as a more suitable common name.¹ The commercial introduction of isopropanol was first announced in this country late in 1920 by Ellis² as a product derived from the waste hydrocarbon gases of the Burton refining process. According to trade reports, it was also introduced industrially in Germany at about the same time. Further, the writers' company has been producing it on a commercial scale since early in the present year. As in all of these cases this product is being derived from gaseous propylene, and, moreover, is still relatively unknown to many industrialists, it finds a place among the other products of the new olefine gas industry which deserve to be better known by the chemical public.

The first description of isopropanol was given by Berthelot³ in 1855, who prepared it by the absorption of propylene in sulphuric acid and the subsequent hydrolysis of the reaction product in water. Judging from his analyses, Berthelot was at first led to believe that this product was the *n*-propyl alcohol, and reported his discovery as such. At a later date Friedel⁴ prepared this same product from acetone by reduction with sodium amalgam, and noted the identity of his product with that which Berthelot had prepared. It was not until the work of Kolbe,⁵ however, that the identity of this material was cleared up and isopropanol was shown to be the first member of the series of secondary alcohols. Still another source of isopropanol has been reported—

namely, the fusel oil from the abnormal fermentation of grain,⁶ in which it is said to occur to a limited extent. This source has been a matter of dispute and is of little importance from a production standpoint. A limited amount of isopropanol has always been available for scientific purposes, and this was made almost exclusively by the process of reduction of acetone with sodium⁷ or with hydrogen.⁸ Naturally from this latter source it would be impossible to prepare the material cheaply by any process, since acetone itself has always been much more expensive than commercial alcohol. Accordingly, until the technical development of the cheaper propylene process was accomplished, isopropanol could not sustain itself in competition with the other alcohols.

PROPERTIES

The pure product, (C₃H₇OH) is a colorless liquid with a pleasant alcoholic odor. It boils at 82.44 deg. C.⁹ at 760 mm. and has¹⁰ a density $D_{15}^{15} = 0.7903$. As is characteristic of the lower aliphatic alcohols above methanol, it forms a constant boiling mixture with water. It is in this form that it is being produced chiefly and may expect to have the widest application, just as is the case with grain alcohol. This constant boiling mixture contains 90.1 per cent isopropanol by volume or 87.9 per cent⁹ by weight. It boils at 80.37 deg. C.⁹ and has a density $D_4 = 0.8336$.⁹ An excellent table of specific gravities of isopropanol:water mixtures has been prepared by Lebo.¹¹ Some of the commercial grades, when prepared from gaseous mixtures containing olefines other than propylene, may contain certain amounts of ethyl alcohol—from ethylene—and also of secondary butyl alcohol—from butylene. This latter impurity is objectionable in some uses in that it gives a strong odor to the resulting product. Furthermore, there is the possibility of commercial grades being contaminated with an insoluble oil, a polymerized product of propylene, if not properly rectified in the production process. This also gives a distinctive odor to the material and is recognized by the turbidity given on dilution with water.

In the process of manufacture described by Ellis,¹² the gaseous mixture, containing propylene along with other ethylene and other olefine vapors, is first treated with sulphuric acid under conditions that absorb the higher olefine material, permitting the propylene and

A contribution from the Mellon Institute of Industrial Research of the University of Pittsburgh.

*This article, the fourth of a series of five, treats of the most recent addition to the family of available industrial alcohols. It is now being produced in the development work carried out by the Carbide & Carbon Chemicals Corporation. Parts I, II and III were published Nov. 16, p. 907, Nov. 23, p. 957, and Nov. 30, p. 999, respectively.

¹For commercial reasons it seems preferable to avoid the use of the word "alcohol" in designating a non-beverage material, as has been agreed by manufacturers and users of methanol and butanol. Accordingly, the writers propose the descriptive name isopropanol as a suitable designation for this new industrial product. The trade-name "petrohol" has already been adopted by the Standard Oil Co. of New Jersey for the commercial isopropanol which it has already placed upon the market. Since many other alcohols can equally well be made from petroleum and since isopropanol was first made from another source, this name does not seem well adapted for general use. Our industrial nomenclature will be much simplified to avoid such ambiguous terms, and to hold to names with a sounder chemical derivation.

²Ellis, *Oil, Paint and Drug Rep.*, vol. 98, No. 28, p. 23 (1920). See also *CHEM. & MET. ENG.*, vol. 23, p. 1230, Dec. 22, 1920. U. S. Pats. 1,365,044; 1,365,046, and 1,365,048.

³Berthelot, *Ann. chim., phys.* (3), vol. 43, p. 399 (1855).

⁴Friedel, *Ann.*, vol. 124, p. 327 (1862).

⁵Kolbe, *Z. für chem.*, 1862, p. 687.

⁶Fringsheim, *Biochem. Z.*, vol. 10, p. 493; vol. 16, p. 243.

⁷Friedel, *loc. cit.*

⁸Sabatier and Senderens, *Compt. rend.*, vol. 137, p. 302 (1903).

⁹Young and Fortey, *J. Chem. Soc.*, vol. 81, p. 728 (1902).

¹⁰Thorpe, *J. Chem. Soc.*, vol. 71, p. 923 (1897).

¹¹Lebo, *J. Am. Chem. Soc.*, vol. 43, p. 1005 (1921).

¹²Ellis, *loc. cit.*

ethylene to pass unabsorbed. By a second treatment the propylene only is absorbed in strong sulphuric acid and a solution of isopropyl sulphates in sulphuric acid is thus built up. By a subsequent hydrolysis of the reaction mixture with water, the sulphates are changed to the alcohol and the pure isopropanol is rectified to the constant boiling mixture. In the process in use by the writers certain of the above steps are avoided. From the sources mentioned in an earlier paper,¹³ a gas containing none of the olefines but propylene is used for absorption in sulphuric acid, by a procedure that yields pure isopropanol directly on hydrolysis.

NON-POTABILITY AN IMPORTANT PROPERTY

In its general physical and solvent properties, isopropanol stands much closer to ethyl alcohol than does any other of the aliphatic alcohols, and consequently its applications may be expected to be in the nature of amplifying the supply of industrial alcohol available. It does possess the one great advantage that it is not a potable alcohol. Since this is true, it can be used in the pure form without need for any added denaturant, which is a material advantage in many applications. Indeed in most applications of isopropanol as a solvent or for other purely physical purposes it is so close to denatured alcohol in its properties that it may well be considered as a naturally denatured alcohol requiring no tax, no legal restrictions and no supervision.

By action of the Commissioner of Internal Revenue on June 15, 1921, isopropanol became a permissible substitute for acetone in the denaturing formulas 39, 39-A and 40. This is an official recognition of its non-potable character and at once offers a very considerable outlet for this new product in the production of denatured alcohol for uses where the strong odor of other denaturants is objectionable, such as in perfume manufacture, lotions for external application, etc.

PHYSIOLOGICAL EFFECTS

In the use of isopropanol there is not the poisonous effect noticeable that is so characteristic of methanol. It may be handled quite safely without any but the most common precautions against inhaling high concentrations of the vapor. The characteristic which renders it non-potable is quite similar to that of acetone, to which latter substance it is undoubtedly oxidized in the body on ingestion.¹⁴ On account of this very favorable lack of serious physiological effects from handling, it seems most probable that in making shellacs, varnishes and other solutions, where the spontaneous evaporation of the solvent is an important item, the use of isopropanol will replace that of methanol, which in the past has caused many unfortunate accidents.

GERMICIDAL ACTION

Furthermore, the germicidal action of the higher alcohols has been claimed to be greater than that of ethyl alcohol. Therefore, after proper experimentation has determined the safe limits of application, it would seem to offer a wide field of usefulness in hospitals in many forms of surgical work, and also in dental practice, to provide a safe and accessible sterilization agent. Ethyl alcohol has been used for this in the past,

but unfortunately the present stringent regulations make it inaccessible to many who would desire to use such a material for strictly legitimate purposes.

CHEMICAL APPLICATIONS OFFER INTERESTING POSSIBILITIES

In strictly chemical applications the isopropanol does not compete so directly with the other alcohols, but offers a new material to work with, which will undoubtedly be found to have its own peculiar advantages and characteristics. Through this substance the isopropyl radical will become available for all kinds of synthetic work. At this time there is a very incomplete knowledge of the characteristics of isopropyl derivatives in the dyestuff, pharmaceutical, perfumery and other fine chemical industries. That the isopropyl derivatives will have a somewhat different color, solubility, stability, odor or physiological effect is assured, and to employ this knowledge, which is mostly yet to be gained, will require much research and many years for its fullest development. One large class of naturally occurring substances—namely, the terpenes—contains an isopropyl or modified isopropyl group. The possibility of producing any of these commercially by synthesis is now surely advanced through having a reliable source of this characteristic radical available.

Among the largest uses of all the other commercial alcohols is the preparation of their immediate derivatives which possess even a greater value—e.g., formaldehyde from methanol, ether from ethyl alcohol, amyl acetate from amyl alcohol, etc. The commercial value of the direct derivatives of isopropanol are as yet largely unknown, although that of acetone, the simplest and most direct one, is already fully established through its production from other sources. The commercial possibilities of isopropyl acetate, isopropyl chloride, isopropyl ether and the many other similar products, whose chemistry is already worked out in the older literature, are attractive indeed, and these materials are now waiting for the opportunity to be of service.

(Part V, dealing with ethylene chlorhydrin and ethylene oxide, will be published in a subsequent issue.)

Radium Production in Czechoslovakia

There is a large radium content in the uranium ore found at Jachymov, in Bohemia, near the frontiers of Saxony, reports Trade Commissioner Breed in *Commerce Reports*. Although the radium production in the United States is greater as to quantity, the ores of Jachymov are richer in quality. The known supply of radium in the Jachymov district will last for 20 years at the present rate of production and there are three large mines which are not yet prospected as to depth and in which the veins of ore widen as they are followed deeper.

The Jachymov mines passed in 1912 into the possession of the Austro-Hungarian Government. They have now become the property of the Czechoslovak Republic. The annual quantity of radium produced amounts to about two grams. The net profits to the government expected for the current year is about 3,500,000 crowns, which, of course, has less foreign exchange value than the pre-war profits. As the earnings from the radium mines of the republic are looked upon as a possible source of much profit to the government, projects are under way for electrifying the shafts and millhouses as well as enlarging and modernizing the entire plant.

¹³"The Technical Importance of the Olefine Gases and Their Derivatives—1," CHEM. & MET. ENG., vol. 25, No. 20, Nov. 16, 1921.

¹⁴For a more precise description of the pharmacological action of alcohols see Francis and Fortescue-Brickdale, "The Chemical Basis of Pharmacology," 1908, pp. 91-92. Sollman, "A Manual of Pharmacology," 1918, also treats of this matter.

Physiological and Histological Studies on Flayed Skins*

Importance to Leather Manufacturer of a Knowledge of the Structure of Untanned Skins—Principal Divisions of the Corium—Elastic Fibers and Their Function—Experiments Showing the Value of These Observations in Studying the Mechanism of Bating

BY ALFRED SEYMOUR-JONES

THE leather industry and the veterinary profession are unfortunate in not possessing any literature dealing with the histology of animal skins. The published researches of Ranvier, Koelliker, Schaefer and others are devoted to the histology of the human skin, or part of it. Although their results are of material aid and value in enabling one to understand the physiology of animal skins, the variations in the physiological structure of these latter, according to the environment, breed, feed, habitat, etc., of the animal, are so great and marked that it is impossible to apply the work of Ranvier and others, except on general principles. This will at once be apparent if one compares the skins of such mammalia as the elephant, sheep, whale, seal, ox, rabbit, etc., or of reptiles, such as the alligator, lizard, etc.

While it is not proposed in this short paper to describe the histology of all, or even a modicum, of the skins entering into the art of leather manufacture, an endeavor will be made to cover some part of the ground by enunciating general principles which are the result of my researches, in the hope that by so doing it may be possible to throw some light on the causes for certain operations within the tannery.

The skin consists of two main divisions, the epidermis and the corium. The epidermis is entirely composed of keratins and their derivatives. The corium consists principally of collagen, keratins, elastin and fats.

The first act of the tanner is to remove the hair from the skin. In doing this the epidermis is removed as well, though it has not yet been practicable to remove entirely the epidermic products from within the corium, such as hair roots, hair follicles, sweat ducts and glands, etc.

The epidermis and hair being removed, there remains the corium, commonly called the "pelt." The tanner's next act is to remove the adhering flesh from the inner side, which is the *panniculus adiposus*, loose connective tissue joining the skin to the animal's body and which forms the flaying line.

The corium or pelt is now ready for examination. It is a most complex organization, possessing four distinctly different features, structural and chemical, of supreme interest to the producer of sound leather. The four divisions I shall term, pending the suggestion of more appropriate titles: (1) Grain membrane. (2) *Cutis minor*. (3) *Stratum adiposum*, or fatty layer. (4) *Cutis major*, or leather skin.

The grain membrane may be identified with the *membrana propria* observed by human skin physiologists, and is the same membrane which may be seen at the entrance to every opening into the body where the white

skin ends. Klein and Noble-Smith, in their "Atlas of Histology," refer to it as follows: "The boundary between the *stratum Malpighii* of the epidermis and the superficial part of the corium is represented by a fine but distinct membrane structure, basement membrane, which is very conspicuous in preparations stained with dyes. While in some instances it appears as a bright substance separating the deepest layer of epithelial cells from the corium, in others it takes the staining very readily, and, in fact, is made up of the individual cells which have undergone a chemical and morphological alteration. The basement membrane, then, is a direct product of the deepest layer of the epithelium, and its several constituent elements are comparable to the footplate of the deepest columnar cells of the stratified epithelium." That observation is a sound one.

The grain membrane varies in thickness and texture according to the breed of animal, varying, when dry, from 0.001 in. upward. It must be considered as much a part of the corium as it is of the epidermis, being partly keratinous and partly collagenous, and containing a comparatively large proportion of elastin. If a piece be boiled, very little gelatin is obtained; so little is it that the membrane undergoes very slight alteration. To the leather trade it is a valuable feature, and it is the aim of every manufacturer to maintain it intact and uninjured. It would appear to derive the bulk of its keratin from the roots of the basal epidermic cells. These cells are not cemented or glued to the grain membrane, but are attached by minute and innumerable fiber roots, to which the title "young keratin" may rightly be applied, to differentiate them from the harder keratin of the epidermis. When unhairing has been performed with milk of lime, only then these roots dissolve at the point of contact of the grain membrane and the epidermis, producing a glossy sheen called hyaline, or hyaline surface. Unfortunately it is seldom to be seen on the bellies of a skin, but is most marked on the back down the spinal area. Dyers of skins have been puzzled why the color is lighter on the back than on the bellies; this is due to the unequal distribution in thickness and density of the hyaline. Where and when the skin has been unhaired with pure sodium sulphide, or the limed skin has been treated to a bath of sulphide solution before bating, the keratinous hyaline is cleaned away. It is well known that sodium sulphide produces a coarser and rougher feel on the grain of the pelt compared with skins treated with lime alone. In this case the sulphide not only dissolves the hyaline but attacks the basal cell roots of young keratin penetrating the grain membrane.

The collagen content of the grain membrane would appear to be limited to the terminal white fibers of the *cutis minor* which tie themselves into the grain membrane. A large constituent appears to be elastin or its

*Paper presented before the Division of Leather Chemistry at the sixty-second meeting of the American Chemical Society, New York City, Sept. 6 to 10, 1921. Published by permission of the American Chemical Society.

equivalent, and it is because of this that it requires suitable treatment to prepare it to receive any tannage.

The grain membrane is soft and thin in the soft fur or wool-bearing animals, but increases in thickness and harshness as the hairs become coarser and thicker. This latter fact especially applies to certain classes of goat-skins. The epithelial pavement of the grain membrane is sometimes so thick as to form overlapping scales, giving a beard effect after unhairing. Beard is also caused by the coarse hairs either breaking off at their junction with the skin, or, when removed, they may have left behind, but broken off at their junction with the skin, the thick and horny hair follicle (epidermic). This and the broken off hair protrude sufficiently to cause the rough feel called "beard."

CUTIS MINOR

The *cutis minor* is the *cutis vera* of the human skin histologist. I suggest that the entire flayed skin or corium is the *cutis vera*, or true skin. The *cutis minor* is only from 5 to 20 per cent of the entire corium substance. But, small as it is, it is the most vital part of the whole, both pathologically and from the leather-making standpoint. The *cutis major* is radically different in every way and functions and forms a clearly separate layer. The *cutis minor* begins with the papillary layer and ends at the *stratum adiposum*, or fatty layer, in which the hair root bulbs repose and wherein are the sudoriferous glands with their ducts ascending through the *cutis minor* via the epidermis to the exterior. The *cutis minor* is composed of white collagenous fibers, yellow elastic fibers, *erector pili*, or hair-erecting muscles (which belong to the involuntary type), nerve fibers, sudoriferous ducts, blood capillaries and hairs with their accompanying epidermic follicles. It will be seen that it is a very complex organization.

STRATUM ADIPOSUM, OR FATTY LAYER

If the works of Koelliker and others are referred to and the drawings of vertical sections of skin examined, it will be seen that, perhaps inadvertently, the third layer has been called the *panniculus adiposus*. Obviously this is a mistake, as that layer is the loose connective tissue between the skin and the animal body, which enables the pelt to be flayed conveniently, and is commonly termed in the leather trade "the flesh," the substance which is removed from the inner side of the skin. Assuming that this is admitted, it becomes necessary to give a new title to this layer, and, as it is mainly composed of fat cells in groups, like bunches of grapes, it seems that *stratum adiposum* fits the case.

CUTIS MAJOR, OR LEATHER SKIN

The *cutis major* is to be identified with the *pars reticularis*, or leather skin. It is the major part of the whole, and is composed of large, thick white fibers, built up of numerous fibrils, traveling in every conceivable direction, crossing, criss-crossing, intertwining and sometimes splitting to become parts of other fibers. This apparently unreasonable arrangement appears to defy an explanation. It would seem that it is of set purpose. This layer is devoid of elastic fibers. It is collagenous, contains the usual blood vessels requisite for its nourishment and that of the regions beyond; likewise the nerve fibers pass through it. It is an almost inextensible layer, lying next to the body, growing as the beast grows; but it fails to reduce its area with the decline of the beast. Its functions would therefore appear to be

to act as a limiting and protecting coat for the body and a non-expansile base upon which the fatty layer and the *cutis minor* can rest.

Having rapidly reviewed the general structure of skin without going into minute details, the grain membrane and the *cutis minor* will be discussed in greater detail.

THE CAUSE OF GRAIN

Consider first the papillary layer lying immediately under and attached to the grain membrane. If a section be made of a raw skin in the hair, it will be seen that below the epidermis the skin shows a line of ridges and indentations. These represent depressions and elevations in the skin; they contain nerve endings and blood capillaries. If a section be made after unhairing, then they will probably have disappeared, or can be traced only with difficulty. This is due to the epidermis filling up the hollows or valleys; while appearing flat on the surface, the epidermis is thicker in the hollows and thinner on the apexes. The epidermis is a non-extensible quantity, holding the papillary layer intact, but, once the support has been removed, the grain membrane and papillary layer fall flat and expand in proportion. This layer calls for little comment from the leather standpoint, except to say that where the papillæ exist, as in the case of goatskins, they are the cause of the pretty morocco grain. Their almost entire absence in ox, sheep and various other skins is the reason for their not "graining."

ELASTIC FIBERS AND THEIR FUNCTIONS

The *cutis minor* is very largely composed of white fiber bundles composed of fibrils, whose arrangement differs from that of their colleagues of the *cutis major* inasmuch as they are erect or nearly so. Except in certain instances they do not anastomose like those in the *cutis major*. If a section be examined after treatment with weak acid, it will be seen that they are in minute bundles, each bundle being choked by bands. These bands are elastic fibers. Descending from the grain membrane, they permeate the entire white fiber structure of the *cutis minor*, encircling the bundles, gathering the fibrils into bundles, sometimes dividing neighboring bundles, and attaching fibrils to other bundles. They are seen massed, encircling each hair follicle, and alongside are white fiber bundles which do not stand erect, but encircle the hair follicle with the elastic fibers keeping company. They spread all through the *cutis minor* in a marvelous network, terminating their activities only around the bases of the hair roots. According to their character, thick or thin, and their quantity, so is the firmness of the pelt.

It is interesting to note that the elastic fibers appear to possess selective capacity because they are never to be seen bunching the masses of blood capillaries or interfering with the *erector pili*, or any other part of the *cutis minor* organization except the white fibers. What is then their function? It naturally suggests itself. As the white fibrils are disposed more or less erect and are very densely packed together, they require something to maintain them in their erect attitude. This appears to be the function of the elastic fibers. They are under tension, and keep the whole of the *cutis minor* under tension, thus forming a cushion, keeping the hairs and their follicles in their correct positions and the groundwork clear for the other organs to function, giving free movement for the life-giving lymph sub-

stances. They enable the *cutis minor* to become a cushion to the *cutis major* and the animal body. Press the skin gently in life and it promptly recovers on removal of the pressure, due to elastic fiber action.

These statements are easy of proof. It will have been noted by tanners that the grain membrane is slightly larger after unhairing. Now split a skin through the *cutis minor*; this cuts through the elastic fibers, releasing them from tension. The white fibers then more or less collapse, the grain split expands several inches in area, but the flesh split remains exactly the same area. J. T. Wood, of Nottingham, at my request very kindly measured a number of split grains and their flesh. He states: "The grains averaged 86 sq.ft. to the dozen, and the linings or flesh, fully stretched, 71 sq.ft. to the dozen." But that is not the full area of the grains; they are still more or less bonded by the elastic fibers. Again Mr. Wood says: "When the grains are puered, they come out considerably more, because they can be stretched without springing back." Why do they not spring back after puering? The answer is the answer to the question, "Why do we puer?"

EXPERIMENTS ON THE MECHANISM OF BATING

Over 2 years ago I set out to find the answer by making a series of practical experiments. In order that there should be no question as to the accuracy of the experiments and results and having no available means to carry them out personally, Mr. Wood was asked if he would carry out certain experiments without indicating the object, though he, being an expert, quickly realized their aim.

First a sheepskin pelt was split and the grain and flesh were divided down the spine to make two halves of each. Grain A was delimed and puered with trypsin, because this enzyme acts freely on elastin, while grain B was simply delimed. Similar treatment was meted out to flesh A and B. The deliming was carried out with weak acetic acid. The trypsin-treated grain, after tanning in sumac, was all such a leather should be—color, texture, etc., excellent. Its substance in the crust state was 0.008 in., CaO content 0.6 per cent.

The grain merely delimed, after sumac tanning, was of a brownish hue, with the grain tucked into fine nodules, texture harsh, lacking ideal qualities. In the dry crust condition its substance was 0.013 in., and CaO content 0.9 per cent.

The lime content is a negligible quantity and does not offer the true explanation for the great difference. The trypsined grain shows a loss in substance, the difference in the two grains being approximately 50 per cent. Something has been dissolved out. As trypsin attacks elastin vigorously, it may be assumed that the elastic fibers have undergone a change, especially as the grain membrane is so soft and flexible.

The trypsined flesh on casual examination does not appear to vary in any marked particulars from the acid delimed flesh, but on testing equivalent parts for substance, it was seen that the trypsined flesh was thicker and also weighed more. CaO contents were 0.72 and 0.82 per cent respectively. On analysis the following results were obtained:

	Flesh A Per Cent	Flesh B Per Cent
Moisture.....	14	14
Mineral ash.....	1.6	1.9
Hide substance.....	43.1	45.6
Tanning matter.....	41.3	38.5

Here lies the explanation. The trypsined flesh has lost some of its hide substance (probably mucin), which has been replaced with the heavier weighing tanning substance filling up the waste areas opened up. On washing out the free tan, the flesh fell in substance to lower than the delimed flesh. While trypsin attacks elastin preferentially, it is quite capable of attacking the young collagen substance or mucin, but does not digest collagen unless previously suitably treated.

The trypsined flesh is slightly coarser of fiber than the delimed. This is to be expected. What the experiment does prove is that it is not at all necessary to puer the flesh unless loss of hide substance is desired. As a chamois-making proposition, or for making imitation suèdes, the delimed flesh is far superior. As it appeared to be unwise to puer the flesh when it is desired to retain as much substance as possible, a further experiment was undertaken to prove whether it was possible and practicable in a whole skin to puer the grain membrane and *cutis minor* only. Mr. Wood, at my request, anointed a sheep pelt, after acid deliming, with a trypsin paste on the grain membrane side only. After laying out flat on the floor until it was considered "down," it was scudded and sent direct into sumac tan. The result was a perfect full-substanced tanned skin of beautiful color. There was no loss of *cutis major* substance. The skin was degreased with naphtha after tanning. It will be noted that no bran drench was employed.

The last experiment was repeated, this time on a light medium substance goatskin, subsequently chrome tanned and finished as glazed kid. Here the grain is silky and mellow without the least evidence of internal looseness, texture excellent, and substance has been maintained. The only loss of substance in either the sheepskin or the goatskin occurs in the collapse of the *cutis minor* structure due to the loss of its binding fibers.

ELASTIN REMOVED BY BATING WITH TRYPSIN

So far as these experiments go, they illustrate the fact that it is the grain membrane and the *cutis minor* alone which require puering or bating, and it is wise to confine the bating action to that part of the skin alone. But they are not conclusive as to what it is that has "collapsed" under the treatment. To test this it is necessary to make skin sections at different stages of the process of bating. It must be pointed out that the method of testing skin sections as to the presence of cells, collagenous fibers, yellow elastic fibers, etc., is by applying different staining materials. For example, collagen has a special affinity for acid fuchsin and water blue, while elastin has a strong affinity for acid orcein. Sections made before and after bating clearly showed that the elastin had disappeared; at least, if it was present, it had so altered its character as to be void of elastin proper and unresponsive to acid orcein tests.

Most interesting confirmatory evidence has come from the laboratory of R. F. Gallun & Sons of Milwaukee, in a paper by J. A. Wilson, entitled "The Mechanism of Bating." This paper was accompanied by excellent photomicrographs showing sections of calfskin untreated with trypsin, and after 6, 20 and 24 hours bating with trypsin. The unbated section exhibits the elastic fibers massed. The three successive sections, varying as to time of treatment by trypsin, show the gradual disappearance of the elastic fibers until finally none are to be

seen. This then furnishes practically conclusive evidence of the part played by trypsin on the elastic fibers.

ACTION OF OTHER BATING METHODS

But trypsin or its equivalent is not the only material employed in bating. Our forefathers employed what has been called the "river process," the skins being left in a soft water running stream until they were soft and flaccid. Exactly what happened is not at all clear. Then the bran drench alone is used as a bate with great success. Here there can be no question of the presence of trypsin, it being entirely composed of fermentative acids. This acid process is the same as the old ooze employed by tanners in bygone days, and the same as the sour suspenders of modern tannery practice and the process invented by Dr. MacBride of Dublin over a hundred years ago in using vitrol to hasten tanning. The pickled sheepskins from New Zealand and Australia cannot be said to receive any bate prior to pickling, and yet they tan soft grains, like all pickled skins will. The acid bate is an alternative to trypsin. Pfeuffer, Mall and others have pointed out that acids and alkalis break up the elastin into globules, and eventually dissolve it. This implies inverting the elastic tissues along the line of their growth. Ranvier has shown that the development of elastic tissue is by deposition of fine granules of elastin, forming themselves into monoliform rows of fibers; these are inclosed in a sheath, the whole containing the substance called "elastin." The granules or cells grow or are converted into what we know as elastic tissue. The acid or alkali process mentioned causes the process to invert, with the consequential release of the "elastin" and the grain membrane is capable of receiving tanning.

OPPORTUNITIES FOR FURTHER RESEARCH

This only touches on the fringe of one of the most perplexing yet important subjects of the leather industry. Yet enough has been said to make it worth while for the subject to become a valuable line of research. No process of leather making is more disgusting, or attended with more unpleasant consequences, or causes more unsound leather to be made and money lost, than the bating process. No money is spared to tan a skin soundly, but such is wasted when the very foundation is wrong, and I submit that a case has been made out for more extended research into the foundation processes of the leather industry.

It has been impossible to describe the structure of all the varied skins entering into the art of leather manufacture, or to speak of its chemical side.² But sufficient has been said to illustrate the assistance which a proper use and appreciation of the microscope can be in elucidating the problems, amounting to mysteries until they are solved, which surround leather production. The field for research is larger in this than in any other industry, and the rewards from patient successful research cannot be estimated in cash values. The golden key to the mysteries lies hidden, waiting the advent of the finder, and he who will devote himself patiently to research, however long it may take, will discover that key fitted with suitable wards ready to open unto him his inheritance. Successful research is the highest rewarded effort in this life.

Wrexham, North Wales.

²The chemical metabolism within the skin organization, differing as each successive layer does from its neighbor, yet called under the one term, collagen (glue producing), is an almost untrodden field for research.

Legal Notes

BY WELLINGTON GUSTIN

The Gaulin Patent, Claim 7, Held Valid, but Not Infringed

In the recent case of Marston-Gaulin Manufacturing Co. vs. Wright-Ziegler Co. and others, the Federal Circuit Court of Appeals, First Circuit, held that the Gaulin patent No. 756,953, claim 7, for an apparatus for intimately mixing liquids, was valid but not infringed. (271 Fed., 391.)

The patent was issued to August Gaulin for an "improved apparatus for intimately mixing milk and other liquids more or less resembling it by means of the action produced by the passage of liquids more or less heterogeneous under considerable pressure through very small orifices." The claim in issue was No. 7 and follows: "In a machine of the class described, an element having a re-entrant conical surface, a complementary conical element to fit the same, and means to force milk between them, substantially as described."

Defendant contended that the patent was invalid and non-infringed. In two previous suits on the patent it had been held valid on another claim, hence the court assumed that the approved apparatus disclosed inventive thought and was patentable.

The plaintiff contended that although a re-entrant conical valve is old, the combination is new and the claim valid, even though it does not state whether the surfaces of the conical valve, when in operation, yield one to the other, rendering the orifice of the valve variable, or whether the surfaces are rigidly fixed, rendering the orifice invariable, and that the plaintiff is at liberty, for the purpose of making the combination workable, to employ such means as may be disclosed in the specification for holding and adjusting the surfaces, or any suitable means that is common.

CLAIM OF THE DEFENSE

The defense was that if the claim be valid its language must be interpreted to mean that the conical surfaces are yielding and thus afford a variable orifice; that if the surfaces are non-yielding so that the orifice, when the device is in operation, is fixed or invariable, as the plaintiff said the claim should be interpreted, the claim would not be based upon the invention which Gaulin conceived, but upon a device the principle of which he disclaimed in his specification.

DECISION OF THE COURT

However, the majority opinion of the court held that the claim was valid; that read in the light of the specification, the language of the claim, where the conical surfaces are spoken of and are required to fit one with another, and between which the liquid is to be "forced, substantially as described," means that the liquid is to be forced between surfaces which fit closely one to the other and permit the liquid to be forced through because of their yielding quality.

As thus construed, the defendants do not infringe the claim, for the conical surfaces of the defendants' device are not yielding, but fixed, and the orifice is invariable, said the court.

Note on Mushet Steel

By A. H. D'ARCAMBAL

Metallurgist; Pratt & Whitney Co., Hartford, Conn.

WE RECENTLY conducted some tests on a 1 3/4 x 3/4-in. bar of Mushet steel received by the Pratt & Whitney Co. about 30 years ago. The analysis of this material was as follows:

	Per Cent		Per Cent
Carbon.....	2.38	Chromium.....	1.12
Manganese.....	1.73	Tungsten.....	4.80
Silicon.....	1.15		

The chromium content is considerably higher and the tungsten content slightly lower than the Mushet steel¹ used by Taylor in his classical experiments. Brinell hardness on this material as received was 512, somewhat high according to present ideas, but as tools were always forged from this material, this hardness was not detrimental. Referring to Fig. 1, the micrograph of the material as received shows large plates of carbide imbedded in the martensitic-troostitic matrix.

Three small pieces were cut from the bar, one quenched from 1,500 deg. F. (816 deg. C.) into oil (the temperature usually given Mushet steel), the second piece quenched from 1,900 deg. F. (1,038 deg. C.) into oil, and the third piece from 2,200 deg. F. (1,204 deg. C.) into oil. After hardness tests and micrographs were made of each of these pieces, they were drawn to 1,000 deg. F. (538 deg. C.), air-cooled, again tested for hardness, and photographed. Hardness results were:

Quenching, Deg. F.	Temperature, Deg. C.	Medium	Drawing Temp., Deg. F.	Drawing Temp., Deg. C.	Sclero-scope	Brinell	Micro-structure
1,500	816	Oil			95	652	Fig. 2
1,500	816	Oil	1,000	538	80	512	Fig. 3
1,900	1,038	Oil			53	364	Fig. 4
1,900	1,038	Oil	1,000	538	87	600	Fig. 5
2,200	1,204	Oil			50	364	Fig. 6
*2,200	1,204	Oil	1,000	538	95	652	Fig. 7

* The first piece given this treatment broke into several small pieces while being tested for hardness and a new piece had to be given the same treatment.

Figs. 2 to 7, containing these micrographs, show that the 1,500 deg. F. (816 deg. C.) quench gave a martensitic structure, most of the carbides being in the free state. Drawing at 1,000 deg. F. (538 deg. C.) produced a martensitic-troostitic structure with a corresponding decrease in hardness.

The 1,900 deg. F. (1,038 deg. C.) treatment produced an austenitic structure, containing a little martensite. This higher temperature also dissolved more carbides. Drawing to 1,000 deg. F. (538 deg. C.) gave a martensitic structure, greatly increasing the hardness.

¹C, 2.40; Mn, 1.90; Si, 0.71; Cr, 0.49; W, 5.62.

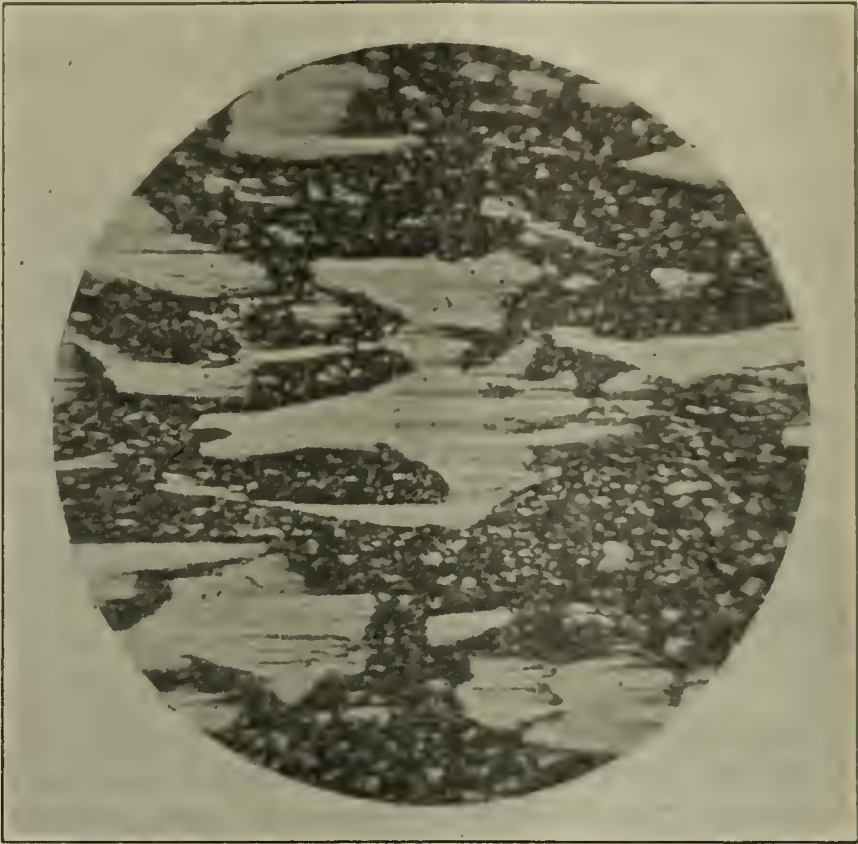
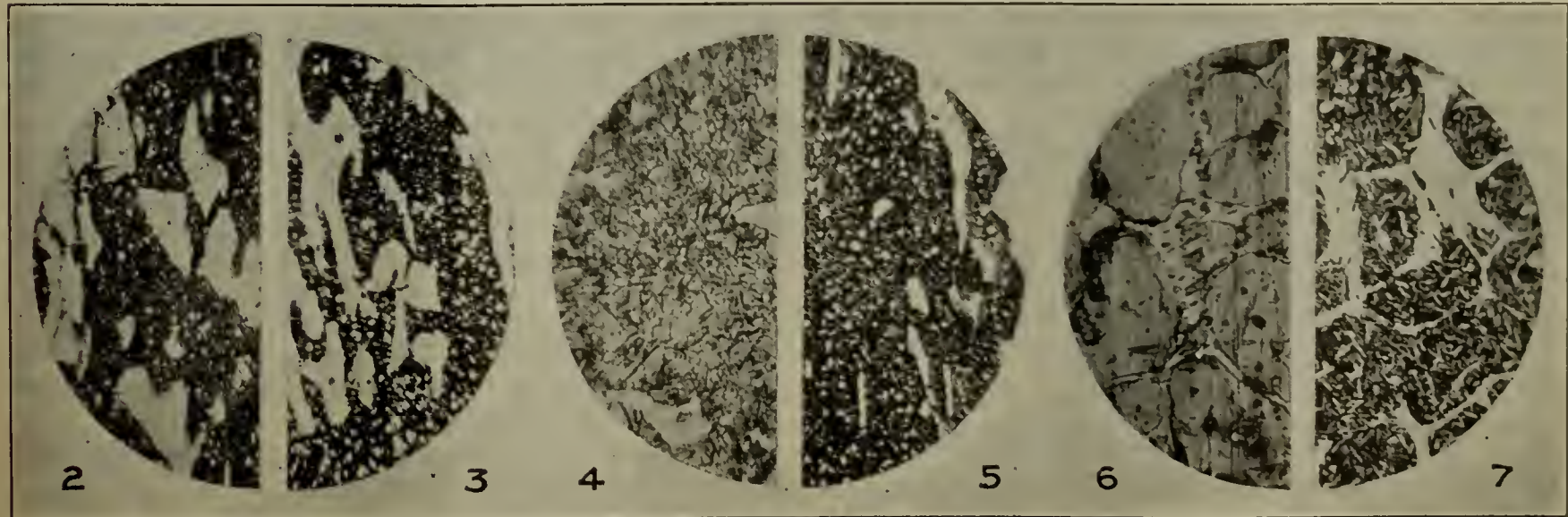


FIG. 1. BAR AS RECEIVED. X 500. ETCHED 3 MIN. WITH NITAL

We attempted to quench the remaining piece from 2,300 deg. F. (1,260 deg. C.), but due to the analysis of this material, principally the high percentage of carbon present, the material began to soften at 2,200 deg. F. (1,204 deg. C.) and was therefore quenched at this temperature. The micrograph shows the material to be overheated, liquefaction and resolidification of the carbides at the grain boundaries taking place. The structure is austenitic and entirely non-magnetic. Drawing to 1,000 deg. F. (538 deg. C.) gives a martensitic structure, the large grain boundaries remaining unchanged, but this high drawing temperature made the steel so brittle it broke into several pieces under the Brinell ball. The scleroscope and Brinell readings nearly doubled after this high draw.

It would appear from the results obtained in these experiments that the best treatment for this steel would be to quench from 1,900 to 2,000 deg. F. (1,038 to 1,093 deg. C.) and draw back to from 1,000 to 1,050 deg. F. (538 to 566 deg. C.). Taylor in his experiments showed that Mushet steel did not respond to the Taylor-White treatment in as high a degree as some of the other self-hardening steels, due to the low chromium content of the Mushet material.



FIGS. 2 TO 7. MUSHET STEEL AFTER VARIOUS HEAT TREATMENTS NOTED IN THE TABLE. X 350. ETCHED 3 MIN. WITH NITAL

Greensand as a Source of Fertilizer Potash*

By R. NORRIS SHREVE

GREENSAND occurs very extensively in the states of New Jersey, Delaware, Maryland and Virginia. The commercial beds carrying from 5 to 7.5 per cent potash, however, are chiefly within the state of New Jersey. When it is realized that "a 20-ft. bed (of 7 per cent K_2O material) that covers a square mile should yield 1,500,000 tons of potash; a 20-ft. bed of 5 per cent greensand should yield 1,000,000 tons to the square mile;" and when it is further remembered that "there are many square miles of greensand containing 7 per cent of potash and perhaps hundreds of square miles containing 4 or 5 per cent," it is easy to see the commercial possibility of greensand as a large potential source of potash for fertilizer or other use.

LOCATION AND CHARACTER OF GREENSAND DEPOSITS

The greensand deposits are accessibly located near the potash-using localities; the beds are cut by railroads in a number of places, and they are also accessible to water transportation. Furthermore, the greensand is near the surface, so that cheap methods of mining by steam shovel or dredging can be employed. Mineralogically greensand is a mixture of the potash-carrying glauconite with more or less sand, shells, etc. The separation can be made magnetically, and this scheme is practical on a large scale to concentrate the beds with lower potash percentages up to 6.5 to 7 per cent potash.

Commercial beds of greensand contain around 7 per cent of potash, 50 per cent of silica, 18 to 23 per cent of iron oxides (as Fe_2O_3), 7.5 to 10 per cent of alumina, 3 to 7.5 per cent of magnesia and small amounts of lime, soda, sulphuric acid and phosphoric acid. Often the soda is practically absent, and chlorine is always very low.

Forty and more years ago the greensand was mined very extensively by the local farmers of New Jersey and spread on their fields with very satisfactory results for that time. However, the potash and phosphoric acid in the greensand are so slowly available that this practice was not economical in competition with the more concentrated and more readily available fertilizers later introduced.

A number of potassium compounds suitable for fertilizer use can be made from greensand, and among these potassium nitrate offers the most advantages.

The process that the Eastern Potash Corporation has used for 2 years at its small manufacturing plant at Jones Point, N. Y., and which will be used at the large plant now under construction on the Raritan River, near New Brunswick, N. J., involves the initial manufacture of caustic potash by treating the greensand with lime in the presence of water and at a temperature of about 470 deg. F. for 1 hour.

Caustic potash is a very reactive compound and can be easily changed into various potassium salts and in such a way as to preserve also the very valuable hydroxyl part of the caustic potash—in the form of caustic soda for example.²

The reaction was initially carried out as follows: 1302 g. of a commercial caustic potash from greensand, analyzing 42.6 per cent KOH, was placed in an iron kettle and 912 g. of commercial nitrate of soda, analyzing 1.65 per cent KNO_3 and 94.2 per cent $NaNO_3$, was introduced. This was sufficient to produce theoretically 1,000 g. of potassium nitrate.

The reaction was carried out by heating at 105 to 110 deg. C. for 30 minutes, and then allowing to cool. The potassium nitrate was separated and washed with alcohol, weighed and analyzed:

Dry weight of potassium nitrate recovered, grams.....	957
Weight of mother liquor, caustic soda (37.5 deg. Bé.), grams..	90
Weight of alcoholic wash, grams.....	242
Analysis of Potassium Nitrate	
KNO_3 , per cent.....	97.3
NaOH, per cent.....	0.8
Na_2CO_3 , per cent.....	2.0
NaCl, per cent.....	0.1

The recovery of potassium nitrate was 91.6 per cent on this first crop, when the 15 g. of potassium nitrate contained in the original nitrate of soda is subtracted from the weight obtained.

A few more per cent of potassium nitrate is recovered from the mother liquors by subsequent concentration and crystallization. The final mother liquor is 50 deg. Bé. caustic soda carrying about $1\frac{1}{2}$ to 2 per cent K_2O and about twice this per cent of N_2O_5 . During the process of solidification of this caustic soda the N_2O_5 can be largely removed, resulting in a caustic soda of commercial quality.

On a large scale, using centrifuges and water washing, a potassium nitrate of from 95 to 97 per cent purity is easily obtained without recrystallization, and this potash salt will be offered to the fertilizer trade.

POTASSIUM NITRATE DIRECT FROM GREENSAND

As the process will actually be carried out, the sodium nitrate will be added to the digestion mixture of greensand, lime and water, because of the very valuable accelerating action of the nitrate upon the decomposing action of lime on the greensand,⁴ wherein the yield of converted potash is increased from 60 to about 80 per cent.

Upon concentration of the caustic liquors, the potassium nitrate crystallizes out, leaving the caustic soda. For every 100 tons of potassium nitrate manufactured there will be obtained about 40 tons of caustic soda of commercial grade. Consequently the importance of the caustic soda production in cheapening the cost of the potash compound is very apparent.

The plant under construction will produce about 20,000 tons of K_2O per year, and approximately three-quarters of this will be marketed as potassium nitrate, thus furnishing about 34,000 tons of 95 per cent quality.

Opinion of competent fertilizer experts is that the only reason that potassium nitrate has not come into more extensive use in the fertilizer trade is on account of its price. As the intention is to sell the potassium nitrate on the basis of the current market prices for the potash and the nitrate contents, the past objection will no longer prevail.

Furthermore, because of the concentration of two fertilizer ingredients in the same chemical, there will be a large saving in transportation charges, which is an important item these days.

To be sure, the ratio of nitrogen to potash will need to be varied as occasion demands.

New York City.

*Read before the Fertilizer Division at the New York meeting, Sept. 7, 1921, and published by permission of the American Chemical Society.

¹Ashley, Greensand Deposits of Eastern United States, U. S. Geol. Sur. Bull. 660, p. 28.

²Ibid., p. 28.

³J. Ind. Eng. Chem., vol. 13, p. 695 (1921).

⁴J. Ind. Eng. Chem., vol. 13, p. 693 (1921).

Electric Iron and Steel Plant for Brazil

This Unique Installation, the First of Its Kind, Includes Two Swedish Type Pig-Iron Furnaces, Two Bessemer Converters, a Ludlum Steel Furnace and Two Merchant Mills, All Driven by Electric Power and Heated by Electric Energy

By N. A. V. PAULSSON
Consulting Engineer, Corning & Co.

WHAT is thought to be the first all-electrical plant making steel from iron ore has been designed by Corning & Co., Inc., of Albany, N. Y., and is now under construction in Brazil. It also bears the distinction of being the first complete steel plant in Brazil—a country which has been credited with having the greatest reserves of iron ore in the world. At present there are a few very small, primitive blast furnaces making charcoal iron, but their combined output is not more than 40 tons of pig iron per day. The State of São Paulo also has a steel foundry, with two small electric furnaces melting scrap, and a small rolling mill where faggoted scrap is rolled into bar iron. Consequently the new plant is the first step toward supplying a domestic market which in 1919 imported 40,000 tons of merchant bar and sheets and 135,000 tons of wire, tin plate, rails and pipe.

TO ABSORB SURPLUS POWER BETWEEN SEASONS

Electric steel making in Brazil will be the result of an attempt to utilize electrical generating capacity during the "off-peak" season. A power company called the *Empresa Força e Luz de Ribeirão Preto* had built some hydro-electric plants and gradually spread out a network of transmission lines serving a large number of coffee plantations. Each of these required in the neighborhood of 100 hp. to drive its machinery for cleaning the hulls from the coffee bean, but a large part of this demand existed only during June, July and August, and unfortunately these months are the dry season, when there is a minimum stream flow. During the remainder of the year a considerable amount of developed and an enormous amount of undeveloped horsepower was available for use, but no user appeared. Consequently the power company set about a search for some industry—any industry—which would have a large consumptive demand for electricity, which could run at a low rate, or be entirely shut down for two or three months each year, which would increase the population of the locality and which would turn out a product readily salable in domestic or foreign markets. Steel manufacture seemed best to meet these requirements, so an affiliated company, the *Cia Electro Metallurgica Brasileira*, was organized to construct and operate such a works at Ribeirão Preto, a small town near the center of the power network.

Ribeirão Preto, as can be seen from the map, Fig. 1, is in the northern part of the State of São Paulo, about 250 miles inland from Santos. Entering the latter port, one boards the English-owned São Paulo Railway Co., of broad-gage and excellent equipment, which climbs up the steep border of the inland plateau through São Paulo to the rail-center at Campinas. From here inland extends the *Cia Mogyana de Estrado*

do Ferro, of 1-meter gage, through rolling country, well developed, with good communications and almost exclusively given over to coffee plantations. Ribeirão Preto is in the midst of such a region, at 1,500 ft. elevation. Ore will come about 75 miles from an iron mountain called Morro do Ferro, just over the line in the State of Minas Geraes. Eventually the steel company will own a direct road between mine and smelter, but at present the ore will be brought to the plant over narrow-gage (60 cm.) English-owned road connecting with the main line at São Simão.

Morro do Ferro is a huge deposit of hematite, covered with broken ore—canga, so called—which analyzes 65 to 67 per cent iron, the equivalent of 93 to 96 per cent Fe_2O_3 . It is therefore of unusually high tenor. One sample analyzed in this country showed Fe_2O_3 , 90.9; FeO, 2.9; MnO, 0.54; SiO_2 , 5.4; S, 0.00; P, 0.022. Pig iron reduced from a sample shipment to the United States, using a pit furnace and charcoal, analyzed Fe, 95.3; Si, 0.06; P, 0.02, and C, 4.5. A considerable tonnage of this loose ore may be had for the trouble



FIG. 1. MAP OF TERRITORY SURROUNDING SANTOS

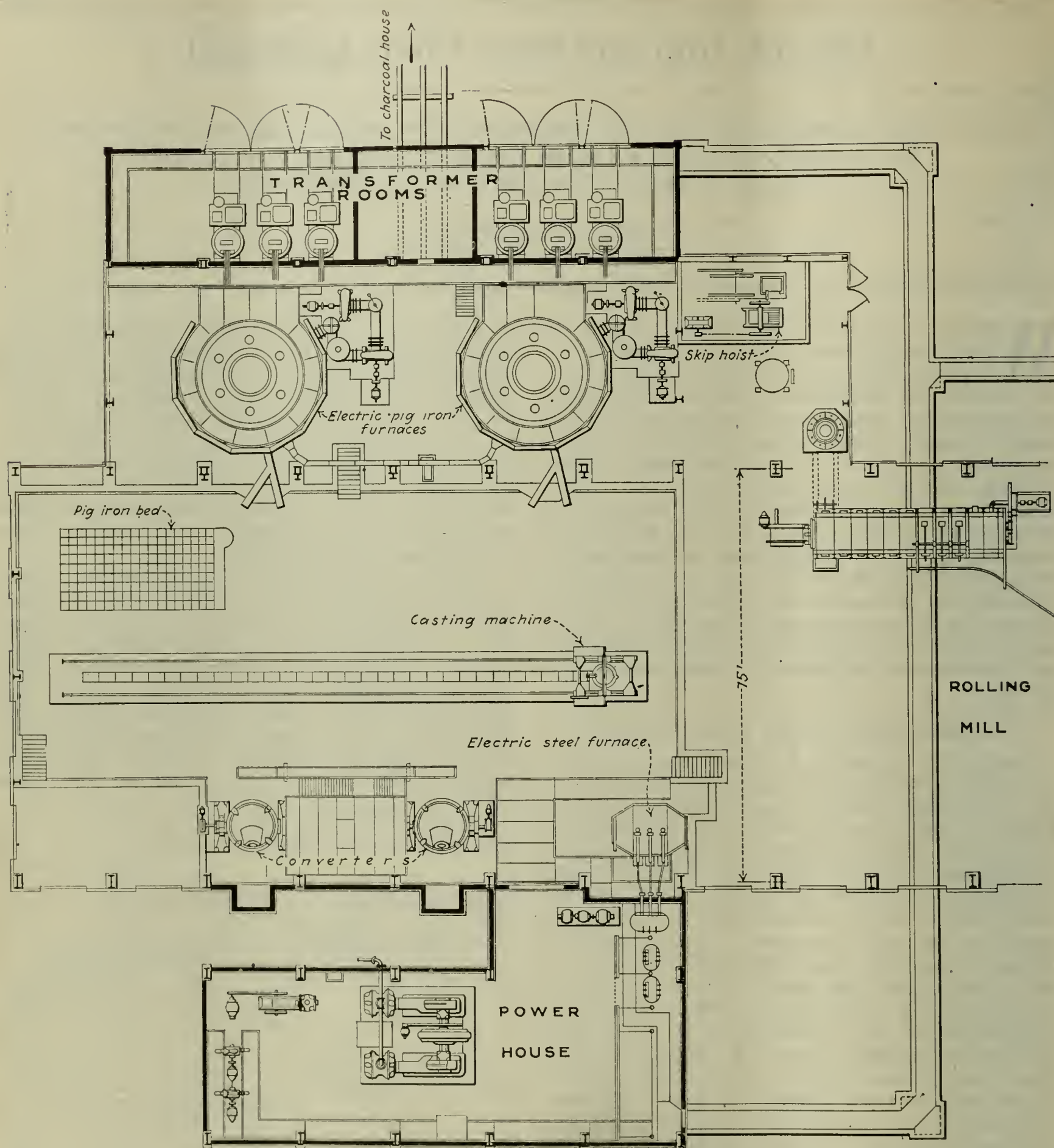


FIG. 2. GROUND PLAN OF IRON AND STEEL PLANT

of loading it on cars; quarrying operations will begin later.

At present 5,000 kva. is available for use in the iron and steel plant, and it has been designed for this limiting condition, as will be detailed later. The power company has started construction of a new power house, developing 12,000 kva., which will be for the exclusive use of the smelter; the plans (Figs. 2 to 4) permit of any extension demanded. Machinery to be installed is:

Two Swedish type furnaces, 1 standby, kva.....	3,000
Two 6-ton bessemer converters (blowing engine for one), kva.....	700
One 6-ton Ludlum steel furnace, max., kva.....	1,500
One 16-in. rolling mill, kva.....	500
One 10-in. rolling mill, kva.....	500
Miscellaneous 220-volt power for motors, cranes, shops and lighting, kva.....	400
	6,600

This tabulation shows that it will not be possible to operate all units simultaneously—indeed, the plant is designed having balanced operation not so much in mind as to be the nucleus of a larger plant, and therefore it contains a series of units large enough to operate with undoubted success and economy. Thus, experience has shown that the pig-iron furnaces may be tapped advantageously four or five times a day, each tap yielding about 6 tons of iron. This is transferred immediately to the bessemer converter and blown to steel, an operation requiring not more than 15 to 20 minutes on the iron smelted in 5 hours. Normally the steel will be cast direct into ingots, but if it needs “doctoring” in any way, it will be transferred molten to the Ludlum steel furnace, an appropriate slag made up, deoxidizers and carburizers added, and then it will be cast into

ingots. Cold, low-silicon pig will also be reheated in the Ludlum furnace, and necessary ferrosilicon added before the blow. Such duty on the steel furnace might require 2 hours at most, and would occur but infrequently. Consequently there remains an ample period of time, even during the day shift, when the mills can dispose of the 30 tons of steel produced in the preceding 24 hours without drawing any power when the steel-making department is also making its demands.

ELECTRIC PIG-IRON FURNACE

Exclusive South American rights for the Swedish type of electric pig-iron furnaces have been bought by the Cia Electro Metallurgica Brasileira. Two of them are now being installed (Figs. 2 and 3), each with electrical transformers and complete in all respects. As noted above, only one can be operated, however, until the new power house is completed.

This furnace has been discussed from many viewpoints in the technical press and especially in America by CHEMICAL & METALLURGICAL ENGINEERING, so there is no need of describing the details further, except noting such changes as it has been thought desirable to make to conform to the conditions existing in Brazil. An excellent drawing of the furnace was published in this journal, March 9, 1921, vol. 24, p. 431, by Baron de Geer, which may be referred to.

It has been thought desirable to decrease the diameter and height of the shaft (which, by the way, is hung from the building), because the charcoal avail-

in the open market—in the almost total absence of coal, it is a staple commodity. As circumstances warrant, the company will plant its own eucalyptus forests for a source of fuel. Such is a common practice of the Brazilian railways; eucalyptus culture is quite well understood. The tree matures in 5 to 6 years, having a trunk at least 6 in. in diameter.

ELECTRICAL FEATURES

Current is received at 30,000 volts, 50 cycles, three phase, and will be transformed outdoors to 6,000 volts, whence it is taken by lead-covered underground cables

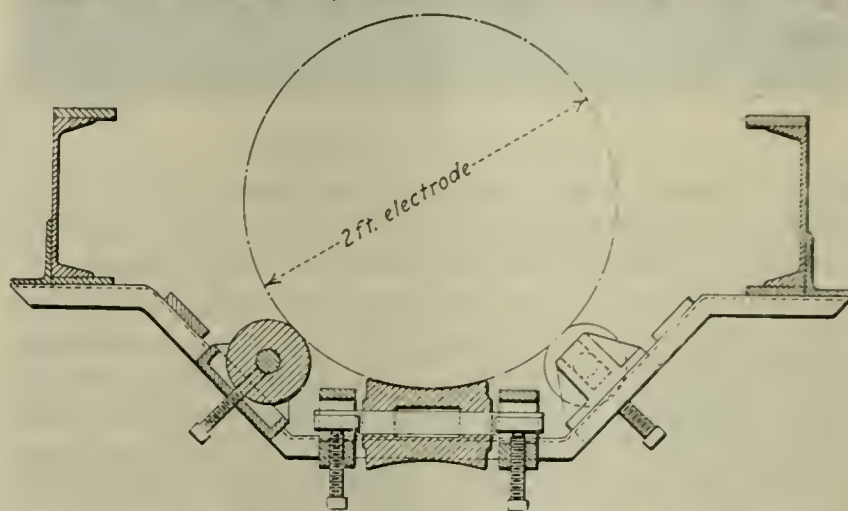


FIG. 4. CROSS-SECTION OF ELECTRODE CRADLE

to the substation adjacent to the mill building. Each pig-iron furnace has three 1,500-kva. water-cooled General Electric transformers, especially built for this service, whose secondary will deliver any voltage from 60 to 120 volts—smooth curve regulation. Each furnace has six 24-in. carbon electrodes. Adjacent electrodes are connected with the same phase; or, expressed in another way, denoting phases by A, B and C and reading around the circle, the electrodes are connected thus: A, A, B, B, C, C. Such a layout makes for very

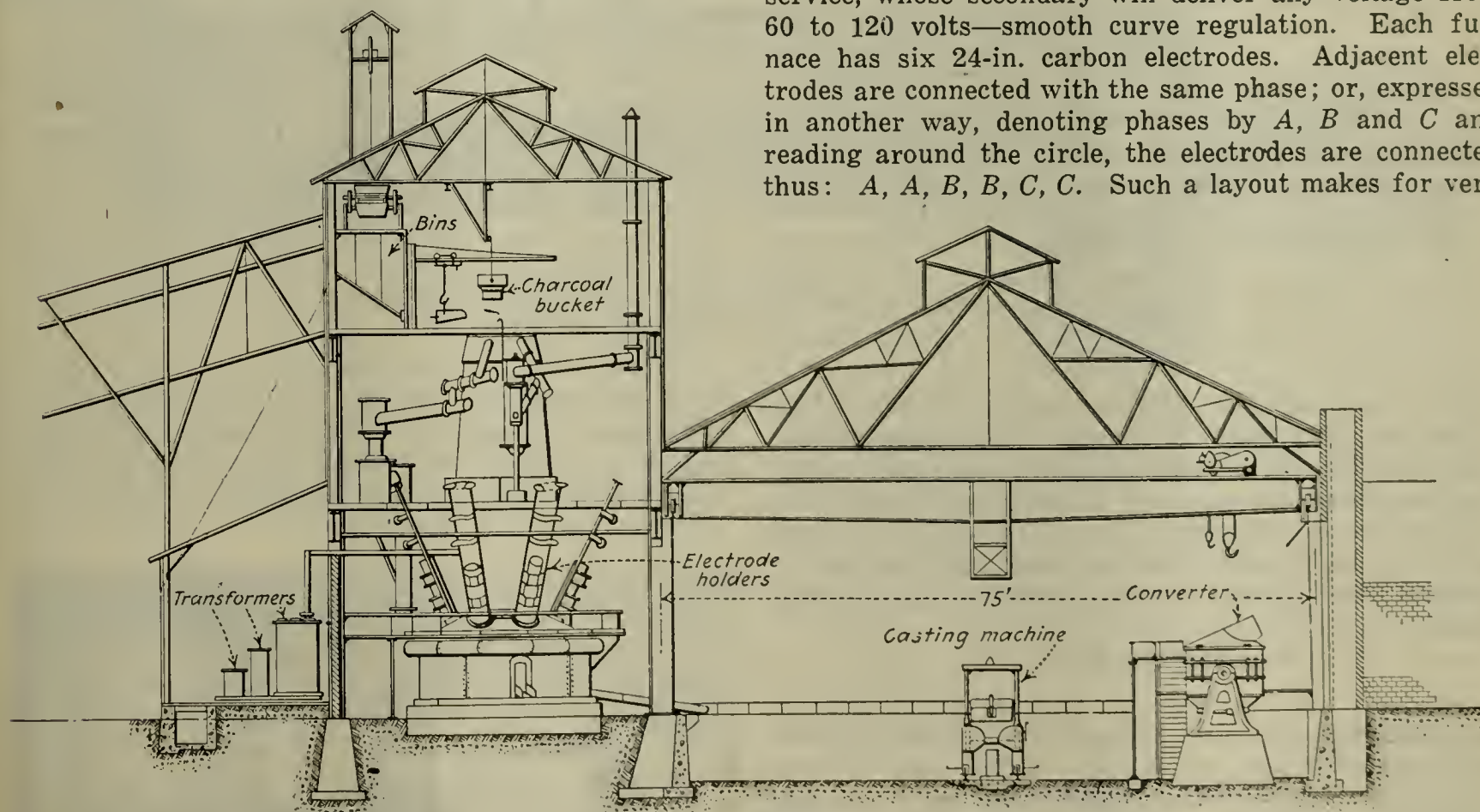


FIG. 3. ELEVATION OF STEEL-MAKING DEPARTMENT

able in Brazil is very much denser than that made from the northern conifers, and the charge is consequently less bulky. Brazilian charcoal weighs 15 lb. per cu.ft., while that name in Sweden weighs but 9 lb. Its electrical resistance and other physical characteristics are not so much different as to cause the designers to expect a repetition of the troubles experienced when coke was first used in place of charcoal.¹ Charcoal will be bought

easy busbar connections, offering ample opportunity for interlacing between transformer and electrode, and produces a good power factor.²

An ample equipment in electrical meters is provided for each electrode. Since the electrodes are immersed in the hot granular charge and are fed into the furnace only at intervals as they are consumed at the lower end, control is had by adjusting the voltage impressed on

¹"Electric Smelting of Iron Ore With Coke," by Georg Stig, CHEM. & MET. ENG., vol. 23, p. 29, July 7, 1920.

²"Manufacture of Electric Pig Iron in Sweden," by J. A. Leffler, Teknisk Tidskrift, April 27, 1921.



FIG. 5. CONVERTER SHELLS

any one phase. One operator is assigned to this duty, and if the current becomes unbalanced, the input is adjusted by appropriate changes at the transformer.

Electrodes enter the bosh roof through close-fitting water-cooled copper sleeves, set in the brickwork. Directly above is clamped a solid copper ring, leading in the current. Some distance further back is a ring which not only supports the weight of the electrode, but has ears on each side which fit into channel-iron guides, 16 ft. long and supported by the building. Hung

Charcoal is transported from the charcoal house to the furnace top in 250-lb. buckets, carried on an aerial tramway.

About sixty charges per day of approximately 1 ton each will be made. A single bell is sufficient for such infrequent operation. A small quantity of powdered ore is thrown into the hopper previous to the regular charge, thereby forming a seal which prevents gas escaping and guards against gas poisoning.

Since the steel is to be made in bessemer, it is necessary that it contain at least 0.75 to 1.00 per cent silicon to furnish the requisite heat during conversion. It is also desirable to blow iron containing 1.5 to 2.0 per cent manganese, so there may be some residual manganese. To provide the latter an appropriate amount of manganese ore from some Brazilian source will be a portion of the charge. It is well known that furnace irregularities make it impossible to tap hot high-silicon iron at all times; consequently the Ludlum furnace is expected to prove most useful in increasing the temperature and adjusting the chemical composition of off-runs of iron before conversion.

STEEL MAKING

Two 6-ton bessemer converters shown in Fig. 5, built by the M. H. Treadwell Co., will be installed, one of

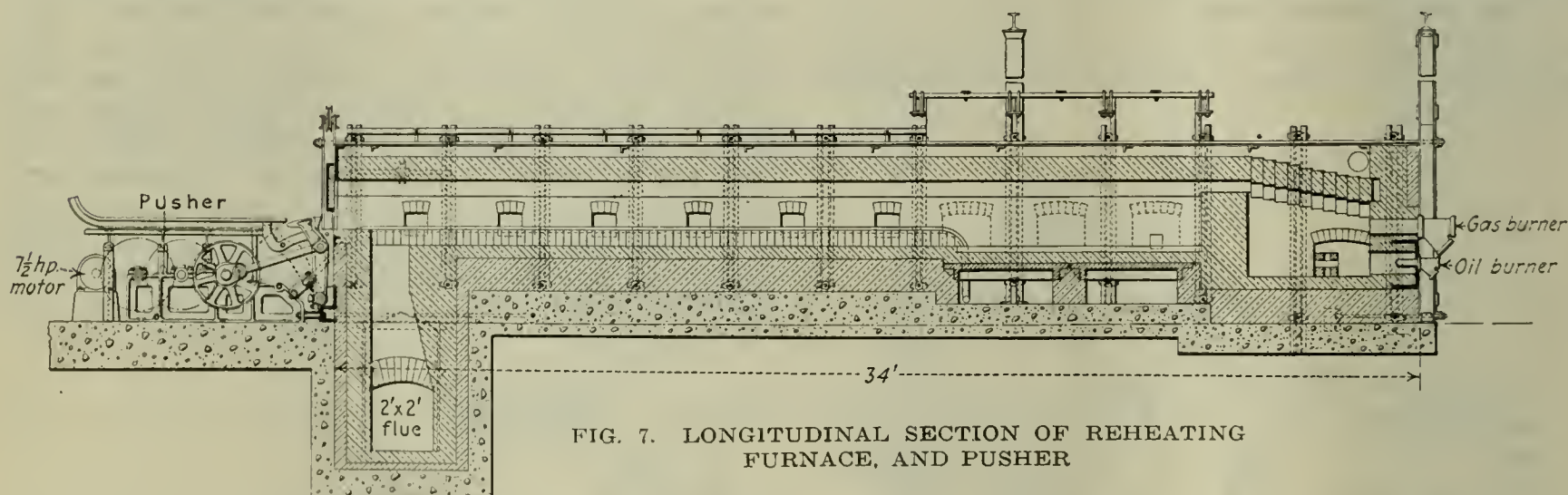


FIG. 7. LONGITUDINAL SECTION OF REHEATING FURNACE, AND PUSHER

under these guides at 3-ft. spacings are rollers which cradle the electrode; two pairs of side rollers also help maintain the alignment. Its up-and-down movement is effected by a pair of long screws threaded into the ring mentioned above, the screws being geared together by link chain at the top and hand-operated by ratchet. Fig. 4 shows a cross-section of this electrode cradle.

IRON SMELTING

Ore is brought in from the mine in 14-ton narrow-gage steel gondolas, with swinging side doors, very similar to the familiar ballast car. (These were favored over hopper-bottom cars, since they are a general-purpose car and can easily handle charcoal by merely adding to the height of the sides.) It is discharged from the stockpile into a jaw crusher, reduced to 2 in., and elevated by a counterweighted skip carrying 3,000 lb. to a hopper in the roof of the furnace building. Thence it is drawn into a car on an automatic railway, discharging 3,000 lb. each trip to a chosen storage bin. All these operations are remote controlled.

These ore and limestone bins above the charging floor have a combined capacity of 250 tons. From bin to charging bell, the ore and stone are carried by a jib crane, bearing suspension scales and a large scoop.

which will be kept in standby condition, ready to take metal when the sides of the other require relining or in case of accident. It will be noticed that the mouth is much smaller and somewhat hooded, as compared with



FIG. 6. LUDLUM FURNACE

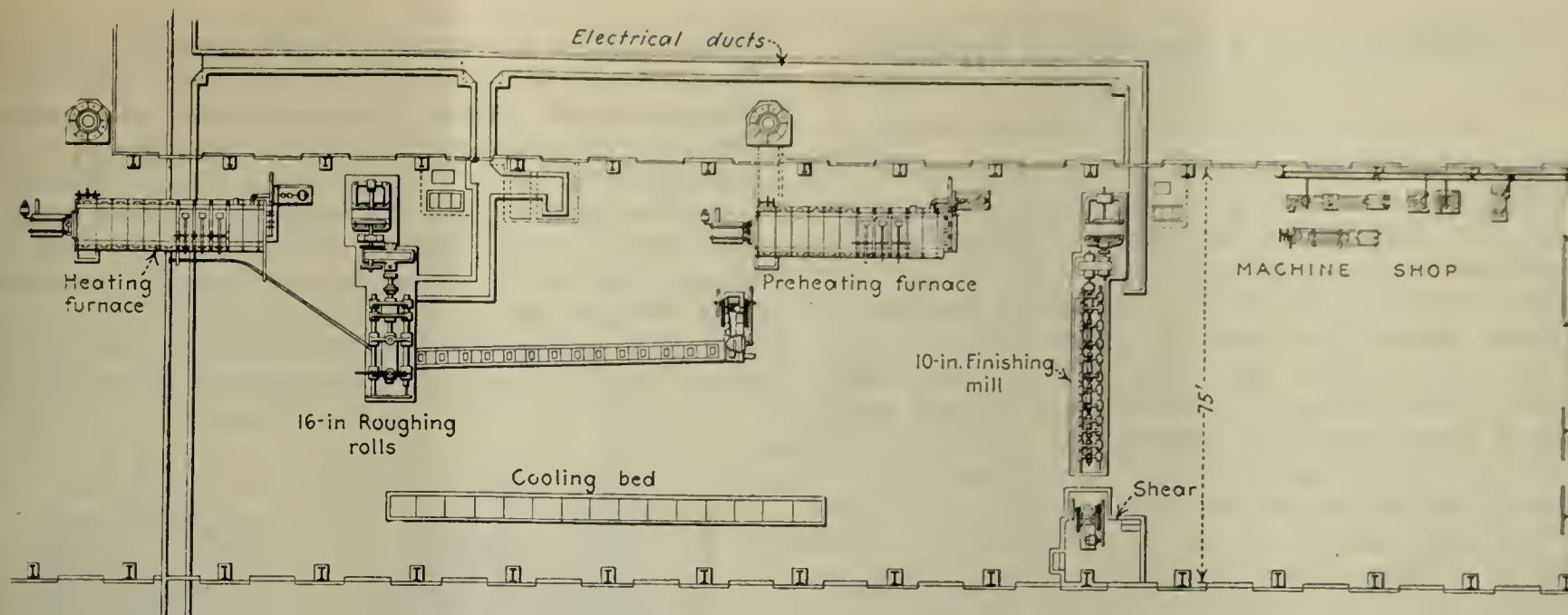


FIG. 8. PLAN OF ROLLING MILL

the vertical converter common to American plants, a feature necessary to conserve the heat during the long intervals between blows. Transfer of hot pig iron will be made by ladles and overhead cranes. One blowing engine only will be installed, and it will be in use not more than 2 hours out of the 24. It will be driven by a 6,000-volt, 700-kva. synchronous three-phase motor.

Blown steel will be recarburized in the vessel—residual manganese is expected to cut down the needed deoxidizer to a minimum. It is then discharged into a 6-ton ladle, and teemed into solid or split ingot molds, 7 in. square by 4 ft. high, big end up. No stripper will be needed.

A 6-ton Ludlum electric steel furnace (Fig. 6) will be provided as an essential piece of emergency equipment. As noted, it will be in readiness to reheat cold pig, to quiet wild bessemer metal and, in addition, to reclaim mill scrap and on occasion make alloy steel or castings. This furnace, as is perhaps well known, is the original three-phase furnace having its three electrodes set in a row, an oval-shaped, accessible hearth, with doors at each end and a removable roof. The plan, Fig. 2, shows its location alongside the converters; it is commanded by a 6-ton crane. Its electrical equipment is located in the substation immediately adjacent and consists of one 1,500-kva. General Electric transformer, with all necessary instruments and automatic electrode control.

ROLLING MILLS

Ingots are reheated in a long furnace shown in Fig. 7, utilizing excess gas from the blast furnace in three burners, or oil, in case both furnaces are shut down. A rather unique feature is the fact that the roof is air cooled and the air is thus preheated for combustion. A simple pusher is installed to feed the furnace.

Two merchant mills of the conventional type are being installed; the plan is given in Fig. 8. They deserve no special description. The roughing stand is a three-high 16-in. mill, reducing the ingot to a 2-in. square. Finishing is done in a 10-in. mill, stands three-high, and the finishing stand two-high. Rolls for making rounds, flats, squares and various types of merchant bar and concrete reinforcement, as well as light angle iron, will be provided. Each mill will be driven by a 6,000-volt, 500-kva., three-phase induction motor.

The government is naturally interested in the beginnings of this industry, financed as it is exclusively by

Brazilian capital, and has permitted the entry of all the construction material duty free. All of the material has been shipped; construction of the plant is actively under way, and it is hoped that the furnaces may be blown in not later than March, 1922.

A technical staff and sufficient expert steel workers will be brought from Europe or America to act as executives and foremen, relying upon the country to supply unskilled labor. In course of time doubtless many of the more skilled posts will be filled by Brazilians.

Albany, N. Y.

Portland Cement Output Increases in October

There were appreciable increases in both production and shipments of portland cement in October, 1921, notwithstanding the seasonal trend. The production exceeded that of October, 1920, and according to available statistics was the largest ever recorded for a single month. The production for the first 10 months of 1921 was greater than the production during the corresponding period of 1920 and about 10.5 per cent in excess of the average for the same period during the 5 years 1917-1921.

The production of clinker, or unground cement, in October was approximately 9,891,000 bbl. Clinker production for the 10 months amounted to approximately 82,419,000 bbl.

The statistics shown in the following table, prepared under the direction of Ernest F. Burchard, of the United States Geological Survey, are based mainly on reports from producers of portland cement and in part on estimates.

PORTLAND CEMENT STATISTICS FOR FIRST 10 MONTHS, 1921

Month	Production, Bbl.	Shipments, Bbl.	Stocks at End of Month, Bbl.
January.....	4,098,000	2,539,000	10,300,000
February.....	4,379,000	3,331,000	11,400,000
March.....	6,763,000	6,221,000	12,000,000
First quarter.....	15,240,000	12,091,000	.....
April.....	8,651,000	7,919,000	12,600,000
May.....	9,281,000	9,488,000	12,450,000
June.....	9,296,000	10,577,000	11,150,000
Second quarter.....	27,228,000	27,984,000	.....
July.....	9,568,000	10,301,000	10,414,000
August.....	10,244,000	12,340,000	8,280,000
September.....	10,027,000	11,329,000	6,953,000
Third quarter.....	29,839,000	33,970,000	.....
October.....	10,506,000	12,114,000	5,348,000
First 10 months.....	82,813,000	86,150,000	.....

Meters for Ammonia Liquors

BY A. THAU

Superintendent of the Oxelösund Coke Works, Sweden

IN CONNECTION with an earlier article describing the operation of column stills for ammonia and benzene,¹ the metering of the liquors before entering the stills was urged. It was also pointed out that the usual water meters of the wheel or propeller type are not always adapted for measuring ammonia liquor or oil. The positive acting piston-type meter was therefore recommended, and since the author has received a number of inquiries as to the principle of these meters and the details of their construction, it is believed that their description may be received with a measure of interest.

The metering of clean and neutral liquids to a high degree of accuracy does not present any difficulties, but when it comes to measuring liquids fed into stills, such as ammonia liquor or benzolized oil, special precautions must be taken to insure a continuous feed and at the same time an accurate record of the volumes which have passed through the meter and still. Both the ammonia liquor and benzolized oil react alkaline, and furthermore they are seldom free from solid substances. The alkaline reaction makes it impossible to use copper, brass, bronze, nickel or aluminum for the internal parts of the meters coming in contact with the liquid, and in the presence of benzene, vulcanite is also attacked and is therefore objectionable. For these reasons the usual water meters are impracticable for this purpose and they possess the additional disadvantage that they are easily obstructed by pieces of naphthalene or anthracene carried forward or held in suspension by the liquids. Filtering vessels to retain the solids before entering the meter soon become obstructed and check the flow.

Other means of measuring the liquids are resorted to in most cases. Weir meters which record the volume of the liquor or oil in accordance with the height of the

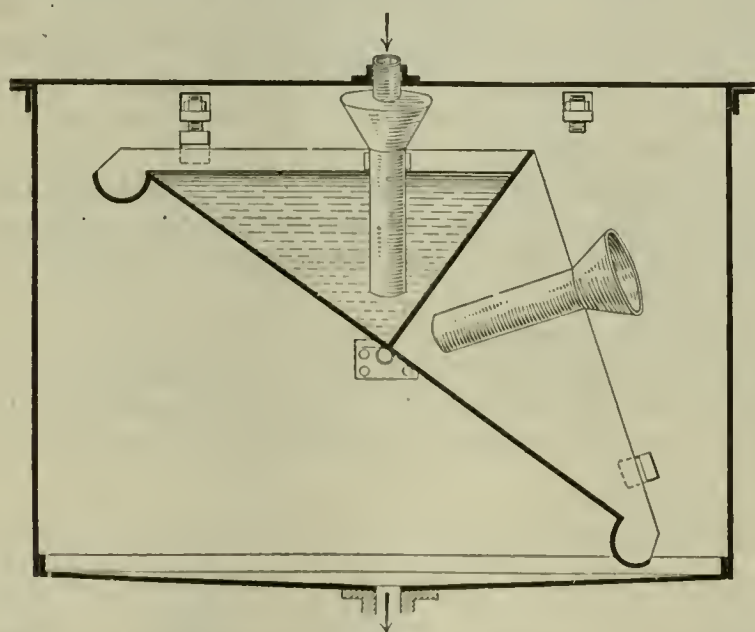


FIG. 1. A TILTING DEVICE FOR METERING LIQUIDS

liquid passing over the weir are often used. As reliable as they may be for clean water or oil, any solid substances obstructing even a small area of the weir temporarily affect the accuracy of the measurements.

Another type of flow meter consists of two vessels which are filled and emptied alternately and by recording the number of fillings give an indication of the volume passed. For example, tilting vessels, such as are shown in Fig. 1, are frequently applied. This

tilting vessel is divided by a central partition directly above the pivoted shaft on which the device is supported. When one half is filled, it overbalances and empties itself, and the other half comes into the filling position under the feed pipe. One end of the shaft is connected to a counting mechanism indicating or, by a supplementary electrical arrangement, recording the number of fillings over a given time. As simple as this arrangement looks, its degree of accuracy is not very great and there is no immediate indication in case the device gets out of order. If the pivots become worn or unhooked,

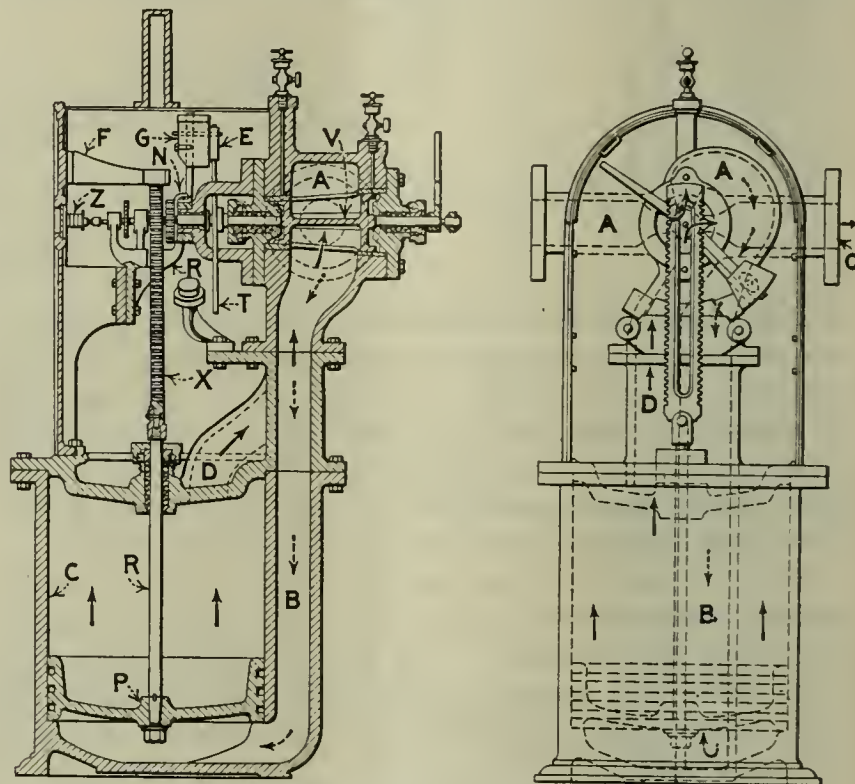


FIG. 2. VERTICAL SECTION AND ELEVATION OF PISTON-TYPE METER

the liquor will simply pass forward without the vessel tilting and the volume is then not indicated on the index. Even when the device is working properly a certain spill during tilting must be taken into consideration. This is naturally omitted on the records and is difficult to estimate, as its proportion varies with the amount of feed. All these measuring devices have also the great disadvantage that they must be placed at such a height that their outlet provides sufficient head for feeding the stills; consequently they are usually erected in the most inaccessible and unobservable places.

One type of meter which can be placed into the feed pipe of the still near the floor level is the flow meter previously described in these columns,² and while it is quite reliable, it only gives indications of the volume passing through the feed pipe at the time of observation. It does not add, as is expected of a meter from which a continuous record is obtained.

The disadvantages of these measuring devices are largely overcome by the use of the positive acting piston-type meter. This is a very reliable apparatus, of simple design, and its indications are very accurate. The meter is shown in vertical section and in elevation in Fig. 2. In its principle it resembles very much that of a steam engine, where the cylinder serves as a measure and the piston rod acts upon a valve causing the piston to reciprocate, at the same time acting upon the mechanism of a dial index to record the amount of liquid which has passed through the meter.

In Fig. 2 C represents a vertical cylinder which holds

¹Thau, A., "Ammonia and Benzene Column Stills," CHEM. & MET. ENG., vol. 23, No. 25, pp. 1203-7, Dec. 22, 1920.

²CHEM. & MET. ENG., vol. 23, No. 25, p. 1206, Dec. 22, 1920.

the piston *P* with rod *R*. The cylinder *C* is machined inside and the piston is provided with three cast-iron piston rings to give it an absolutely tight fit. The bottom and the top of the cylinder are each provided with port holes, the former being connected by the passage *B* and the latter by *D* to a common four-way valve *V* on top. This valve separates the inlet branch *A* and outlet branch *O*. The top of the piston rod *R* carries a double rack *X* which is slotted through in its center to enable the shaft of the valve *V* to pass through it without hindering the vertical movement of the rack. On its upper end the rack engages with gear wheels, by means of which it turns the toothed wheel *N*. In revolving, the wheel raises the balance weight *G* fixed to a lever and lifts it up so high that it overbalances and drops down to its opposite side, its fall being terminated by a soft buffer arranged on each side. A projecting edge *E* on the weight *G* comes in contact with lever *T*, which operates valve cone *V*.

The liquor enters at *A* and is conducted by the corresponding position of the valve *V* to the passage *B*, thus entering the cylinder *C* from the bottom and lifting the piston *P* to its highest position. At the same time the liquor filling the cylinder space above the piston is forced by the raising of the latter through the passage *D* and the corresponding ports of the valve *V* to the outlet branch *O*. When the piston has reached its highest position, the rod *R* and rack *X* cause the balance weight *G* to overturn, thereby giving the valve cone *V* half a turn, so that the flow of the liquid through the cylinder is reversed. The liquor enters now through the passage *D* and presses the piston downward, forcing the liquor underneath the piston to be expelled through the passage *B* and to be conducted through the valve *V* to the outlet *O*. The overturning of the weight *G* and the reversing of the valve, when the piston reaches its highest or lowest position respectively, is effected so rapidly that the continuous flow of the liquid is in no way interrupted. The strokes of the piston are transmitted to the meter-index *Z* by means of gear wheels which are held by the bracket *R* indicated in liters or gallons. The meter is provided either with the ordinary gas meter index with five dials and pointers or with a row of jumping figures like those on meters for measuring electric current.

ADVANTAGES OF THIS METER

The indications of the meter are accurate to 1 per cent and are guaranteed not to vary more than $1\frac{1}{2}$ per cent, a margin which must be considered very close for the purpose they serve. For use in connection with ammonia or benzene plants, the interior parts of these meters coming in contact with the liquids are made entirely of iron, while in the case of measuring fresh water some parts, such as the piston, piston rod, top gland and valve cone, can be made of brass or bronze.

A number of these meters are in use in England and on the European Continent for varying purposes, in the majority of cases as feed-water meters for boilers, and offer the advantage that they can be placed into the pressure feed pipe between feed pump and boiler. For this purpose the meters are tested to withstand a pressure of 300 to 375 lb. per sq.in.

The meters used in connection with boilers are connected into the feed pipe at a convenient place on the pressure side of the pump. In the case of ammonia or benzene stills, they are connected to the feed pipe between the high level tank and the still and are placed

at a convenient and easily accessible position on the ground floor. They require very little pressure for acting, 70-in. water gage being sufficient to use them. Much higher pressures are required for feeding the stills.

It may be further mentioned that with the exception of the piston all movable parts are open, can be observed during working and are readily accessible. No gears are exposed to the liquid to be metered and the pressure resistance of the meter is scarcely noticeable. The temperature of the liquid passing the meter does not affect its working and the four-way valve is so constructed that it can be tightened while the meter is in operation. The speed of the liquid passing through the meter is comparatively slow and the piston makes two to ten double strokes per minute. By these means the wear and tear of such meters is very small and their upkeep very slight. Obstructions do not generally interfere and therefore filtering arrangements are not required.

"Squaring a Circle"

BY C. T. PATTERSON

The accompanying photograph gives one way to solve the classical problem, "How to square a circle."

It is a sulphur print of a shaft which failed after a very short life. The section was polished and laid on a film saturated with 4 per cent H_2SO_4 . The film was then fixed, washed and dried in the usual way, and it now



"A SQUARED CIRCLE"

serves to make any number of exact duplicates of a single sulphur print.

Sulphur contents of the center and outside are respectively 0.11 and 0.05 per cent.

The shape of the segregate may be explained by the idea that the steel, cast in a square mold, built up a segregate forming a roughly cylindrical or conical volume in the center. When the square ingot was rolled to a $3\frac{1}{2}$ -in. round bar, the circular segregate was squared. Part of the bar was then turned down to $2\frac{1}{2}$ -in. for a piece of shafting, and the result was as shown in the illustration.

Solvay, N. Y.

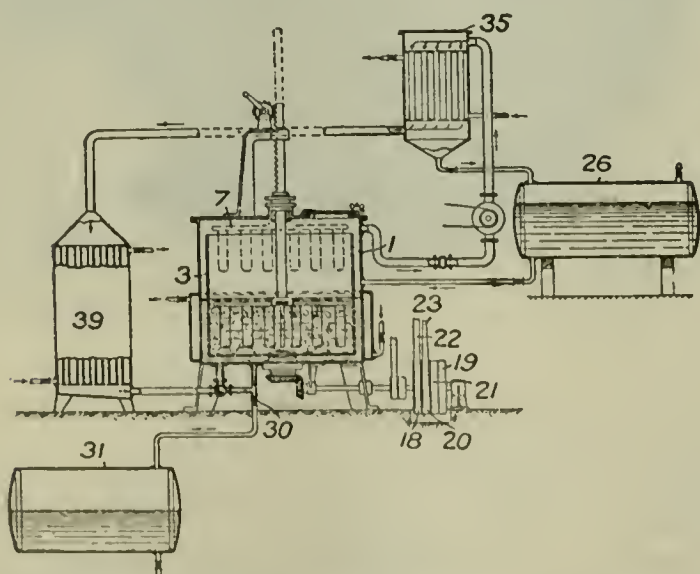
Recent Chemical & Metallurgical Patents

British Patents

For complete specifications of any British patent apply to the Superintendent, British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Alum and Aluminum Sulphate From Alunite.—The invention consists in the preparation of alum and aluminum sulphate from alunite without the use of sulphuric acid. The coarsely crushed ore is roasted, preferably in the absence of material quantities of air and in a furnace in which the ore is passed down a series of hearths, the bottom one or more of which are heated to 700-900-deg. C. The sulphur dioxide, sulphur trioxide and oxygen which are evolved thus come in contact with the descending alunite and the iron oxide contained therein, acting as a catalyst, causes the sulphur dioxide and oxygen to recombine. The gaseous products from the furnace pass over some ground previously calcined alunite in a drum or chamber into which sufficient water is sprayed to convert the sulphur trioxide into sulphuric acid, whereupon a substance is produced from which alum and aluminum sulphate are obtained by lixiviation. The alum and aluminum sulphate may be separated by fractional crystallization or sufficient potassium sulphate, which may be obtained by extracting another portion of calcined ore with water, is added to combine with the free aluminum sulphate to form alum. The residue of calcined alunite that cannot be employed as above described may be used as a potash fertilizer or as a source of alumina and potash. (Br. Pat. 167,555. A. Matheson, London. Oct. 5, 1921.)

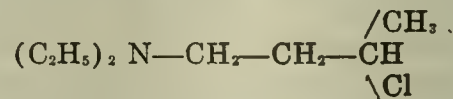
Utilizing Waste Rubber.—Rubber and textile material are recovered from waste rubber fabric by treating it, without reducing it to a state of fine division, with a solvent, the material and solvent being heated and kneaded or agitated under pressure, the temperature not rising above 120 deg. C. For this purpose the fabric is introduced with solvent into a rotary perforated cage 3 in an airtight steam-jacketed chamber 1. Stirring blades 7 are provided which do not rotate with the cage, but can be raised out of the liquid as shown. Ribs, etc., on the interior of the cage may assist in the agitation. The cage 3 is rotated in opposite



directions alternately by gearing comprising fast and loose pulleys 18, 19, 20, 21 and straight and crossed belts 22, 23. When the operation is completed, the solution is run off through a cock 30 into a vessel 31, and the cage rotated rapidly to expel the remainder of the solution. The fabric is then washed with a fresh charge of solvent which is similarly expelled. Air or an inert gas is then circulated through a heater 39, the chamber 1 and a condenser 35 to

remove the last traces of solvent, which are collected in a vessel 26. The solution and the solvent which has been used for washing may be collected separately. (Br. Pat. 167,667. F. Waitz, Bremen, Germany. Oct. 5, 1921.)

Dialkylaminoalkyl Compounds.—Dialkylaminoalkyl compounds are prepared by interaction of halogenalkyldialkylamines and the alkali salts of compounds of the type $R.CO.CHR_1X$, where R, R_1 are hydrogen or any radicals and X is an electro-negative group such as $-COOC_2H_5$, $-CO.CH_3$, $-CO.C_6H_5$, $-CN$; for example acetoacetic ester, cyanacetic ester, malonic ester, acetonedicarboxylic acid ester, camphorcarboxylic acid ester, succinyl-succinic acid ester, acetylacetone; alternatively, the compounds may be prepared from halogenalkyl derivatives of bodies of the above type, such as bromethylacetate or bromethylacetoacetic ester and dialkylamines. According to examples the following compounds are prepared: α -diethylaminoethylacetoacetic ester from sodioacetoacetic ester and chlor- or bromethyldiethylamine, or from α -bromethylacetoacetic ester and diethylamine; α -diethylaminoethylacetoacetic methyl ester; α -dimethylaminoethylacetoacetic ethyl ester; diethylaminobutylacetoacetic ethyl ester; diethylaminoethylmalonic diethyl ester; diethylaminoethylcyanacetic ester; bis-diethylaminoethyl-diketohexamethylenedicarboxylic acid diethyl ester from sodio-succinylsuccinic acid ethyl ester and chlorethyldiethylamine; diethylaminoethylacetonedicarboxylic acid diethyl ester; diethylaminoethylcamphorcarboxylic acid methyl ester; diethylaminoethylacetylacetone. Chlorethyldiethylamine is made by adding diethylaminoethanol to thionyl chloride in chloroform solution and decomposing the hydrochloride with potassium carbonate. Bromethyldiethylamine is made by boiling diethylaminoethanol hydrobromide with hydrobromic acid of 48 per cent strength. Chlorbutyldiethylamine

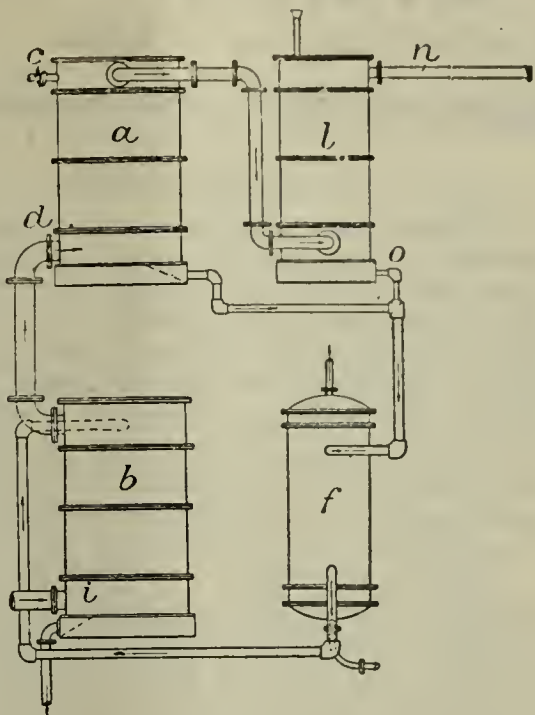


is made by reducing the corresponding diethylaminobutanone to the alcohol and treating the latter with thionyl chloride. The dichlorethylate of diethylpiperazine is obtained as a byproduct in the preparation of α -diethylaminoethylacetoacetic ester. (Br. Pat. 167,781; not yet accepted. Farbwerke vorm. Meister Lucius and Brüning Höchst-on-Main, Germany. Oct. 5, 1921.)

Tanning.—Hides, preferably after being subjected to a high vacuum, are tanned under pressure by liquor from which all air has been removed. Treatment with thin glue or gelatine may follow. The depilated and preferably dried hides are suspended in an autoclave and subjected for 30 to 60 minutes to a high vacuum, a strong tanning liquor from which all air has been removed by passage through a vacuum machine, etc., being then pumped in, preferably under a pressure of from 20 to 40 lb. per sq.in. After the tanning liquor has been run off, the hides are washed, and a solution of thin glue or gelatine is forced into the pores by alternate high vacuum and high pressure. The hides may be again washed and are dried in vacuo, small quantities of hot air being admitted, preferably through a red-hot-pipe. (Br. Pat. 167,785. A. Mauvers, London. Oct. 5, 1921.)

Separating Organic Substances by Distillation. The separation of the constituents of mixtures such as crude resorcinol, crude anthracene cake, crude anthraquinone, etc., is effected by distilling the substance with a mineral oil, such as kerosene, fuel oil, etc., containing fractions which boil within wide limits. The constituents of the mixture distill over with the oil at different stages and are collected separately. Alternatively, a mineral oil fraction having a boiling point above that of any of the constituents of the mixture to be separated is used. The mixture is heated and at various stages in the rise of temperature steam is passed through the mixture to carry off the constituents separately in the order of their volatility. In treating crude anthracene cake carbazol passes over first, then anthracene, and finally phenanthrene. (Br. Pat. 168,108. Berk & Co., Ltd., and J. J. Hood, London. Oct. 12, 1921.)

Ammonium Sulphides.—In preparing ammonium sulphide or polysulphide, ammoniacal liquor is heated under such conditions of temperature and pressure as to expel carbon dioxide but not sulphuretted hydrogen. The liquor is then distilled to obtain ammonia solution containing ammonium sulphide, which is treated with sulphuretted hydrogen prepared, for example, from iron sulphide and sulphuric acid, to yield ammonium sulphide or, if sulphur be added, ammonium polysulphide. The ammonium liquor is treated in an apparatus comprising two columns *a*, *b*. The liquor enters the column *a* by inlet *c* and is treated by the vapors from the column *b* entering by pipe *d*. The liquor passes from column *a* through a cooler *f* and then to the top of the column *b*, in which it is treated with steam from a pipe *i*. The liquor passes from the base of the column to an ammonia still. The vapors from the column *a* pass to a column *l*, in which they are washed with water. The unabsorbed gases escape by a pipe *n* and the wash water passes by a pipe *o* into the liquor leaving the column *a*. The temperature at the steam inlet *i* may be kept at 98 deg. C., and the pressure at 16 lb. per sq.in. absolute. Higher temperatures and higher pressures or lower temperatures and lower pressures may be used. (Br. Pat. 167,540. South Metropolitan Gas Co. and P. Parish, London. Oct. 5, 1921.)



of descriptions of sintering machines and the production of liquid SO_2 .

The latter criticism—that is, space used on unimportant points—might also be applied to the description of the supplying of niter to chambers by the oxidation of ammonia, especially since, by the authors' own statement, only one such installation exists in this country.

In the description of the contact method, the effort to cover the whole subject in a very limited space is particularly noticeable and has resulted in a series of more or less unrelated statements rather than a connected discussion. Some of these statements are very good; others are of little importance.

It is assumed by the reviewer that a misprint is responsible in Fig. 80, page 241, for the word "converters" under a picture showing coke boxes and mineral wool filters.

The tables in the back of the book are good.

While this book has an undoubted value in the literature of acid making in that it is the first effort of independent authors to cover the American field, one finishes reading it with a feeling that the subject might have been better handled by the expenditure of a little more effort and by more attention to literary style.

THOMAS R. HARNEY.

* * *

CHEMICAL REACTIONS AND THEIR EQUATIONS.

A Guide and Reference Book for Students of Chemistry.

By I. W. D. Hackh, professor of biochemistry, College of Physicians and Surgeons of San Francisco. Philadelphia: P. Blakiston, Son & Co. Price, \$1.25.

This is one of the most convenient and helpful little books we have come across in a long time. It is small enough to carry in a side pocket, contains only 138 pages, and does not profess to cover any more ground than its title indicates. The author found so many graduate students who were unable to balance an incomplete ionic equation that involved oxidation or reduction that he wrote the book for them. It confines itself merely to a consideration of purely chemical equations from a technical and arithmetical standpoint. There are six chapters, treating respectively of: Symbols, Formulas, Equations Involving No Oxidation or Reduction, Equations Involving Oxidation and Reduction, Reactions and Their Control, and Types of Chemical Reactions and Equations. After each chapter a group of carefully chosen questions reviews the subject comprehensively. It concludes with an appendix which adds a Key to Nomenclature, With a List of Radicals, Ions and Valence Numbers, Displacement Series of the Elements, Periodic System and Classification of Elements, Solubility Table of Compounds, Preparation of Salts, Key to Equations, and an Index and Glossary of Chemical Terms.

A vast amount of useful information is condensed into a small space, and a large number of facts are conveniently arranged. It is bound to be not only a very present help in the study of chemistry, but also a handy book for the forgetful chemist.

ELLWOOD HENDRICK.

* * *

TECHNICAL METHODS OF ANALYSIS, as employed in the Laboratories of Arthur D. Little, Inc. Edited by Roger Castle Griffin, Director of Analytical Department, Arthur D. Little, Inc. International Chemical Series. 666 pp., 5½ x 8, 29 illustrations. Price, \$6.

The author is to be commended for the comprehensive and concise manner in which he has covered a very wide range of quantitative analytical methods. This book should be very helpful to those interested in general analytical work. The main body of the text is supplemented by a bibliography which refers to many standard treatises on special subjects. A chapter on "The Analysis of Textile Fibers" contains much valuable information not commonly found in other standard works on quantitative analysis. There are few noticeable omissions to be pointed out, except possibly the failure to mention an additional method for the determination of cotton in asbestos-cotton twine. Cotton is readily and fairly accurately determined by combustion in a stream of oxygen, weighing the resultant carbon dioxide and calculating to cellulose. On the whole the book possesses great utilitarian value in the hands of the analytical chemist.

A. F. SHUPP.

Book Reviews

AMERICAN SULPHURIC ACID PRACTICE. By Philip De Wolf and E. L. Larison. Pp. 270; 85 illustrations, New York: McGraw-Hill Book Co., Inc., 1921. Price, \$3.50.

One feels that the authors of this little book have perhaps attempted too much in an effort to cover so general a subject as "American Sulphuric Acid Practice" in such limited space, and this is, perhaps, the cause of the somewhat disconnected and more or less unrelated style employed. To lack of space may be due also the authors' failure to give supporting evidence for statements which are sometimes at variance with opinions generally held among acid men.

Most noticeable of these unsupported statements is the remark on page 6, where, in a discussion of the relative merits of "contact" and "chamber" processes, the authors state: "Supervision, regulation and yield are all better on a contact plant, while depreciation and maintenance are less." This is so entirely contrary to the reviewer's experience that he feels that perhaps an error has been made in printing and that for "contact" one should read "chamber."

The part of the book devoted to the chamber process is, on the whole, more complete and better written than that devoted to the contact method. It is somewhat surprising, however, to find that in a book on American sulphuric acid practice no mention is made of Pratt chambers, as it is probable that more chamber acid is made in the United States in Pratt sets than in any other special type of chamber.

While the descriptions of various apparatus and methods for the production of SO_2 are interesting, it would seem that a little more detailed information on actual acid manufacture might well have been incorporated at the expense

Current Events

in the Chemical and Metallurgical Industries

More Plants Increasing Operations

Glass. The Thatcher Glass Co., Dunkirk, N. Y., has resumed operations at its local bottle-manufacturing plant under a 24-hour working schedule, following a two months' shut down. About 150 men will be employed. The company has made improvements at the works to an amount of about \$100,000.

The Lippincott Glass Co. will soon place a 10-pot furnace in operation at its Alexandria, Ind., works, giving employment to about 200 men. Repairs and improvements preparatory to resumption are now being made. The local plant will commence the manufacture of glass tumblers in the near future.

Ceramic. The Hall China Co., East Liverpool, Ohio, has resumed operations at its No. 2 plant, following a period of curtailment. There is now only one semi-porcelain manufacturing plant idle in this district.

The Crouse Clay Products Co., Akron, Ohio, manufacturer of brick, has increased operations to normal at its plant.

The Cincinnati Clay Products Co., Cincinnati, Ohio, manufacturer of brick, has increased production at its plant, giving employment to a considerably increased working force as compared with this time last year.

The Atlantic Terra Cotta Co. and the Federal Terra Cotta Co., with plants at Perth Amboy, N. J., are increasing the working forces in the different departments of their factories.

Paper. The Universal Paper Bag Mill and the Union Paper Mills, both of New Hope, Pa., have adopted a full-time operating schedule at their plants.

Chemical. The du Pont Chemical Co., Pennsgrove, N. J., has added about 1,000 employees at its Deepwater Point plant, bringing the working force up to a total of 2,500 operatives. Further increase in the number employed is expected at an early date.

Rubber. The Rubber Products Co., Barberton, Ohio, has adopted a night working schedule at its plant.

Oil. The Tidewater Oil Co., Bayonne, N. J., has resumed operations at its refineries, following a strike of operatives. A settlement with the men was arranged on a basis of 12 per cent wage reduction.

The New York Petroleum Corporation, El Dorado, Ark., has commenced production at its new local refinery under full capacity, totaling about 2,000 bbl. of oil per day.

Glue. The Perkins Glue Co., Lansdale, Pa., has placed an overtime working schedule in force, including night and Sunday operations.

Soap. The Procter & Gamble Co., Cincinnati, Ohio, is maintaining capacity production at its local plant.

Leather. The American Hide & Leather Co., Sheboygan, Wis., has increased operations at its local tannery to close to normal production.

The Badger State Tannery, Sheboygan, Wis., is giving employment to about 225 operatives, who are turning out the same ratio of leather as did 400 employees prior to the fire at this tannery in January, 1920, due to improved machinery and better working conditions, with modern buildings. Production is near to normal.

Iron and Steel. The Carnegie Steel Co., Youngstown, Ohio, has blown in its fifth blast furnace at its Ohio works, bringing production up to over one-third of normal.

The Trumbull Steel Co., Youngstown, Ohio, has placed eight of twelve mills in operation at its Liberty plant, which has been idle for eight months past.

The Portage Foundry Co., Barberton, Ohio, has increased production to more than 60 per cent of normal.

The Berks Foundry & Manufacturing Co., Hamburg, Pa., has adopted a full-time operating schedule at its plant, with increased force of molders.

War Minerals Relief Act Modified

Without the necessity of a roll call, the House of Representatives on Nov. 22 agreed to a Senate amendment to the war minerals relief bill which removed the necessity of re-appropriating the remainder of the war minerals fund for the payment of additional awards. The bill was signed by the President on the following day, thus becoming a law. This measure amends the original act as follows:

Add to the first paragraph of Section 5 the following proviso: "Provided, That all claimants who in response to any personal, written or published request, demand, solicitation or appeal from any of the government agencies mentioned in said act, in good faith expended money in producing or preparing to produce any of the ores or minerals named therein and have heretofore mailed or filed their claims or notice in writing thereof within the time and in the manner prescribed by said act, if the proof in support of said claim clearly shows them to be based upon action taken in response to such request, demand, solicitation or appeal, shall be reimbursed such net losses as they may have incurred and are in justice and equity entitled to from the appropriation in said act.

"If, in claims passed upon under said act, awards have been denied or made on rulings contrary to the provision of this amendment, or through miscalculation, the Secretary of the Interior may award proper amounts or additional amounts."

The measure includes an amendment proposed by Representative Anderson, of Minnesota, which broadens the language so as to allow claims when a written notice of their existence was filed prior to the expiration of the time limit. This amendment is understood to have been intended to admit two Minnesota claims totaling about \$750,000.

Asbestos Industry Shows Marked Improvement

Reports from leading companies in the asbestos products industry show a marked improvement in the business in this line, and increasing volume of orders. The Johns-Manville Co. reports record sales in October as compared with other months of this year, and more asbestos shingles were sold during that month than at any other time in 1921. The Keasbey & Mattison Co. reports a 100 per cent increase in business during this same month, with marked prospect for further advancement. The Keystone Asbestos Co. states that there has been considerable improvement in the orders placed for building and insulation asbestos, while the Ehret Magnesia Mfg. Co. reports 35 per cent increase in October sales as compared with the preceding month.

Increased Appropriation for C.W.S. Approved

The President and the director of the budget have approved a request for an appropriation of \$1,500,000 for the Chemical Warfare Service during the next fiscal year. This is an increase of \$150,000 over the amount appropriated for the current fiscal year. Among the items making up the total asked for next year's work are: Salaries and wages, \$1,007,444; materials and equipment for research and experimentation, \$143,023; chemical supplies, \$65,000; offense appliances and supplies, \$40,000; gas mask materials, \$21,000. These estimates of expenditure were submitted to Congress by the President on Dec. 5.

Employment Increases in Chemical Industry

There was an increase of 1.3 per cent in employment in chemical industries during November, according to a report issued Dec. 5 by the United States Employment Service. There was an increase of 0.46 per cent in employment throughout the country during November.

A Tribute to Canadian Business Papers

Ontario's Lieutenant-Governor, Colonel Henry Cockshutt, president of the Cockshutt Plough Co., Director of the Bank of Montreal, etc., himself an outstanding success as a business man and financier, paid an understanding tribute to the business papers of Canada when, speaking at a luncheon in connection with the annual meeting of the Canadian National Newspapers and Periodicals Association at the King Edward Hotel, Toronto, on Thursday, Nov. 10, he said:

"I am especially glad to be with you today because I believe that the influence of the business press will be one of the most important factors in re-establishing business conditions in Canada on a safe and sane basis. I make a distinction between the business newspapers and the daily press, because I believe that your papers—the business newspapers of Canada—exert a greater influence than the daily press because of the greater confidence your readers have in them. People read the daily newspapers to satisfy their desire for excitement or interest or entertainment. But this is not the case with the business newspaper. Business men need the service of these papers in the conduct of their everyday business life.

"You should be very careful that everything that appears in your columns bears the imprint of the truth. You must be sure that the news you give is correct beyond question, because there are thousands of your readers ready to set their business course by the news and advice you give them.

"In these days when there is disorganization, dissention, disruption in all walks—business, politics and religion, there is a great place for the business paper to bring out more complete information, to assist in making us all realize we must work for a common cause—the upbuilding of our country. The business men of this country need your assistance. They are looking to you for information and advice, and are expecting it. On your shoulders therefore, perhaps more than on the shoulders of any other single agency, rests the obligation to meet the needs of these trying days, with a sane and sound presentation of the case as it exists at the present time, a presentation free from private bias or the desire to serve a popular demand."

Fundamental Research Program for Cotton Seed and Cottonseed Products

Pursuant to the memorials adopted at the last meeting of the American Oil Chemists' Society and the Interstate Cottonseed Crushers' Association in Chicago in May of this year, a joint committee of the two organizations met with the officials of the U.S. Department of Agriculture of Washington for the purpose of acquainting them with the needs of the industry in certain lines of research, endeavoring to obtain their aid in having studies along these lines actively prosecuted and establish more intimate relations between the Agricultural Department and the cottonseed oil industry. To this end the committee recommended research along well defined lines incorporated in the following brief:

In the interest of the farmer producer, the converter of cotton seed into marketable food and the consumer of those products, we the basic research committee of the Interstate Cottonseed Crushers' Association and of the American Oil Chemists' Society, appointed at the suggestion of Secretary Wallace to advise and co-operate with the interbureau committee on oils and fats in the Department of Agriculture, respectfully submit to the department the following tentative program of research to be conducted in co-ordination by the various bureaus of the department having facilities and authority for such work.

(1) To develop varieties of cotton seed that will yield fiber of the maximum value and seed containing the maximum percentage of oil and also to determine the effects of cultural conditions.

(2) Isolation and identification of all constituents of crude cottonseed oil with special reference to effect on refining loss and quality. This would serve as a foundation for improvement in refining methods which will result in a larger yield of refined oil from the raw material and will also serve as the basis for a correct valuation of the crude oil.

(3) Continuance of work on rancidity with special reference to the nature and constitution of the products formed and their physiological effects. This will serve as the basis for determining why rancid fats are objectionable or harmful. It will also lead to a knowledge of methods for the prevention and removal of rancidity from oils and fats.

(4) Isolation and identification of constituents of cottonseed meal with special reference to feeding values. This will lead to the investigation of the so-called toxicity of cottonseed meal and establish definite information which will clear up any existing uncertainty regarding its use as feedstuff for all classes of farm animals. It will also furnish facts bearing upon the use of cottonseed meal for human use.

(5) The prompt publication from time to time by the department of results of its research in oils, fats and other products of the oil milling industry, and the revision or re-editing of all present bulletins, in cases of re-publication, with a view to correcting inaccurate data and conclusions based thereon. (Note. Reference is made here to Farmers Bulletin 36 and to Farmers Bulletin 1,179 and all other literature issued by the department in which the conclusions have been reached and data published that are not justified by present day information.)

(6) We ask that data of researches regardless of conclusions be made freely accessible to interested parties upon request.

This committee tenders its services in carrying out the above program and asks an opportunity to discuss with the department, from time to time, these research problems, their progress and contemplated publication. The committee offers to obtain and place at the disposal of the Agricultural Department all possible available data from the industry pertaining to its work.

On Oct. 4 the committee met with the officials in Washington and considered the matter from the standpoints of the various bureaus affected, with the result that plans are now under way for actively prosecuting these studies. In conjunction with this governmental research the committee on co-operation in research of the American Oil Chemists' Society has obtained from representatives of the industry, comprising chemists, technologists, engineers and producers, a list of problems which it is transmitting to the universities and experiment stations as a guide to them in planning such research along these lines as they may be in a position to prosecute.

A.A.A.S. to Meet in Toronto

The seventy-fourth meeting of the American Association for the Advancement of Science will be held at Toronto, Canada, Dec. 26 to 31, by invitation of the University of Toronto and of the Royal Canadian Institute. Meetings of interest to chemists are, besides the meetings of Section C (Chemistry) itself, a joint meeting with the Canadian Institute of Chemistry and the Toronto Section of the Society of Chemical Industry, at which Prof. S. W. Parr, retiring vice-president for Section C, will give his address on "The Carbonization of Coal"; a joint meeting with the Plant Physiology Section of the Botanical Society of America, devoted to biochemistry and chemical aspects of plant and animal physiology; and a symposium on the quantum theory, jointly with the American Mathematical Society and the American Physical Society.

Two Pottery Expositions Being Arranged

East Liverpool, Ohio, pottery manufacturers are arranging plans for two expositions early in 1922. The first will be held at Pittsburgh, Pa., in January, and upon the closing of the display it will be removed to Chicago, to be on exhibition there in February.

Brunner Mond Dividend

The directors of Brunner Mond & Co., Ltd., chemical manufacturers, announce an interim dividend of 2½ per cent, less tax. For the corresponding period of the previous year the distribution was at the rate of 10 per cent, less tax.

Successful Flight With Helium

The first practical demonstration of the use of helium for aircraft was made at Hampton Roads, Va., on Dec. 1, when the navy non-rigid airship C-7, filled with the gas, made two successful flights.

Philadelphia Chemical Club Celebrates Anniversary

The Philadelphia (Pa.) Chemical Club, composed of chemical manufacturers and others in the local trade, celebrated the first anniversary of its organization with a dinner at the City Club on Nov. 19. Reports made at the meeting showed a large and growing increase in the membership. Major Maurice Mercadier, of France, gave an interesting talk on the subject of "Exchange," and A. J. Morse spoke on the topic of the "American Melting Pot."

Merger Proposed to Establish Steel Industry in West

A plan has been proposed for the utilization of the enormous deposits of coking-coal and iron ore in Utah in establishing a steel industry to supply the Pacific Coast trade which now has to depend upon the Eastern manufacturers for finished products. The plan takes the form of a \$20,000,000 merger comprising a number of companies that control coal mines and iron ore deposits in Utah and two others that own and operate steel plants in California. Under the combination, iron ore from the deposits in the Iron Springs district of Iron County, Utah, limestone from the extensive quarries near Salt Lake City, and coke from a proposed byproduct coke plant would be smelted in a 500-ton blast furnace to be located near Utah Lake, 25 miles south of Salt Lake City. The pig iron would be shipped to the plants of the Columbia Iron & Steel Co., at Pittsburg, Cal., and at Portland, Ore., and the Southern California Steel Co.'s plant near Los Angeles. These plants would be expanded.

Patent Office Continues to Degenerate

When Commissioner Newton was in charge of the Patent Office, in July, 1919, he testified before a committee of Congress to the effect that the situation in his bureau was deplorable and that it was in a worse condition at that time than at any other time since he had been in the service. His service began in 1891. The present Commissioner of Patents, in his report to Congress, points out that the degeneration has continued steadily since the testimony of Commissioner Newton. Between July, 1919, and June 30, 1921, the Patent Office lost 163 of its examiners. "These men," says the Commissioner in his report, "were scientifically trained and also members of the bar. They have been replaced by inexperienced men, fresh from college, without any knowledge of patent law and without legal training." Continuing, the report says:

"During the time the Patent Office has been losing the 163 men aforesaid, the number of applications received in this office has increased by leaps and bounds. The number of applications for patents has increased 34 per cent during the period under discussion, while the trade-mark applications increased 85½ per cent. In July, 1919, when Commissioner Newton testified, there were 18,000 patent applications awaiting action. There are now about 50,000 applications awaiting examination. It is further shown that a number of divisions are over 11 months behind in their work, and to illustrate the large turnover in the personnel, there is cited one of the chemical divisions where five out of the nine examiners have been appointed in the last few months. At the close of the fiscal year, one of these had been in the office only 1 week, another 3 weeks, another 7 weeks and another 2 months. One out of every four examiners has resigned in 16 months and more than one-half have resigned in 32 months. Relief is, therefore, imperative.

"It is shown that there are many industries which can not enter into development work on account of the doubtful status of their applications for patents. A bill is now pending in the House H.R. 7077, which is designed as an emergency measure to help relieve the situation.

"Reference is made to the entrance salaries of the assistant examiners, who are a highly educated and picked corps of scientific men, who receive the same initial salary as clerks who perform routine duties in other branches of the government service. Note is made of the inadequacy of the salaries paid to these technical men as compared to their qualifications and the requirements of their position, showing the necessity of correcting the disparity of conditions.

"The receipts of money for the fiscal year just closed increased from \$2,615,697.33 of the previous fiscal year to \$2,712,119.69, or almost \$100,000. A net surplus of \$284,342.93 was earned, and if the bonus be subtracted therefrom, the surplus amounted to \$71,745.73, making the total net surplus to date—that is, the excess of receipts over expenditures during the history of the Patent Office—\$8,376,769.29.

"Emphasis is laid upon the figures given and the conditions cited to show that the volume of business presented to the Patent Office is altogether too large for the present personnel to perform properly."

Alcohol Export Situation

So as to be able to take advantage of a demand for American alcohol in Europe, the producers of industrial alcohol in the United States are urging that this traffic be permitted to move without undue interference from the Bureau of Internal Revenue. Captain James P. McGovern, representing all the alcohol producers in the United States, has submitted the following statement to the Commissioner of Internal Revenue and to the Federal Prohibition Commissioner:

"A condition has arisen in Europe whereby, because of lack of raw material necessary for the manufacture of alcohol, there is a demand for the purchase of alcohol manufactured in this country to be exported to sundry European countries for legitimate industrial uses there.

"The disturbed conditions in Europe have curtailed the raw material, such as molasses, the result of the beet sugar crops in various European countries, and of grains and potatoes, which are used in other countries as raw material for alcohol. The great and almost universal drought in Europe during the last summer will further tend to a restriction of raw material for the manufacture of alcohol in those countries. The result is that there is and will be a real necessity for alcohol in Europe for the arts and industries and a demand for the exportation of alcohol produced in the United States. This foreign trade, which is legitimate, should not have an embargo placed thereon simply because there have been isolated cases of attempts by bootleggers and irresponsible parties to feign the exportation for the purpose of surreptitiously bringing it back into illegal consumption in the United States. The mere fact that our governmental authorities are aware of this and have been able in some cases to prevent it shows that under proper regulation and vigilance and honest administration of existing laws such shipments can easily be controlled. Under no circumstances should the producers of alcohol in this country be deprived of their legitimate and lawful right of exporting their commodity to foreign countries, particularly in the case of alcohol, where the foreign market for American alcohol will cease to exist just as soon as European raw material is available for the production of alcohol there. This is an opportunity for American producers to sell in the foreign market and they should not be deprived thereof, particularly as this is an opportunity which will only come once in a lifetime.

"A proper co-operation of the various departments of the Treasury—namely, the Internal Revenue and Customs Service—even under present existing laws and regulations, will certainly safeguard the enforcement of the prohibition laws in this country. The producers of alcohol in the United States are desirous of co-operating with the government along these lines and under any reasonable and practical regulations, but the attempt to establish regulations which are now unreasonable and unnecessary will prevent the foreign trade now with these producers and any such action would not only be unwarranted and unreasonable but actually in violation of the constitutional rights of American producers."

Tax Bill Finally Approved

While the tax bill is admitted by its authors to be an imperfect measure, it does provide for a substantial reduction in the tax burden and greatly simplifies the administration of the law. The bill in its final form will require during the first fiscal year that it is in full operation the payment of about \$725,000,000 less than would have been raised had the law it supersedes remained in effect. The reduction will be greater when collections from the excess profits tax cease altogether.

The repeal of the transportation and so-called nuisance taxes means a reduction of \$326,630,266 during the fiscal year being July 1, 1921. That feature of the bill alone is held by many to justify its enactment. It was stated officially at the White House and by the chairman of the Finance Committee that the bill is intended as a temporary measure only. The great disappointment to business is that the recommendations of the Secretary of the Treasury were not carried into effect in the matter of transferring some of the higher brackets of the income tax to the estate tax title.

In its final form the bill is expected to yield \$3,216,100,000 in the fiscal year beginning July 1, 1922, and \$2,611,100,000 in the fiscal year beginning July 1, 1923. For the fiscal year of 1922 the bill is expected to raise about \$16,000,000 in excess of the government's requirements.

The Senate accepted the House rate of 12½ per cent applicable to the corporation income tax. This reduction of 2½ per cent from the rate proposed by the Senate will reduce by \$110,000,000 the annual tax burden on business. The lower rate is particularly advantageous to public utility companies and other corporations now earning small returns on their invested capital.

Exports and Imports of Chemicals in October

There was a slight upturn in chemical exports in October. Chemicals sent abroad in October were valued at \$262,214 more than the exports of September. The October exports, however, were scarcely more than one-third the value of those in October of 1920. The slump was heaviest in dyes and dyestuffs. In October, 1921, the value of all American dyes and dyestuffs shipped out of the country was \$481,927. In October of 1920 the value of these exports was \$2,251,659. The comparative figures covering the principal groups are as follows:

	1920	1921
Acids	\$479,060	\$144,860
Dyes and dyestuffs.....	2,251,659	481,927
Extracts for tanning.....	201,358	136,295
Total soda	2,430,497	514,176

The value of all chemicals exported in October was \$4,671,310. This compares with \$13,701,882 in October of 1920.

While there was a decrease in imports of chemicals on the free list, there was a decided upturn in the imports of those on the dutiable list. In the latter class the value of the exports was nearly \$700,000 greater than in September. The total imports for October, 1921, were valued at \$7,127,853, of which \$4,342,505 represent chemicals on the free list and \$2,785,348 represent those on the dutiable list. In October of 1920 the value of free-list chemicals was \$13,393,424 and dutiable-list chemicals \$5,798,615. Imports of coal-tar products during October, 1921, were valued at \$992,014. This compares with \$2,492,174 in October of 1920. The imports of gums in October of 1921 were valued at \$1,455,915. In October, 1920, the imports of gums were valued at \$4,460,316.

Independent Steel Merger Contemplated

Several independent steel companies have been considering a plan for arriving at a possible basis for consolidation. While the matter is still in a formative stage and very little definite information is obtainable, the following companies have been referred to in connection with the proposed merger: Republic Iron & Steel Co., Midvale Steel & Ordnance Co., Lackawanna Steel Co., Youngstown Sheet & Tube Co., Steel & Tube Company of America, Inland Steel Co., Brier Hill Steel Co.

Chicago Ceramists Hold Meeting

The Chicago Section of the American Ceramic Society met at the Morrison Hotel on Nov. 26 for the election of officers and semi-annual program. E. M. Bunting, of the School of Ceramics, Illinois University, presented papers prepared by himself and Dr. Washburn, on a new method of porosity measurements.

The porosity of clay specimens has previously been measured by immersion in water; the new method involves the placing of a test specimen about 1 x 1 x 4 in. in a small special glassware container, filling the complete apparatus with mercury, and permitting the mercury to run out of the bottom of the chamber into a barometer tube graduated in millimeters. Measurements of the two quantities of pressure and volumes thus procured give a measurement of porosity which is 5 to 20 per cent higher than measurement obtained by the water vacuum method. This is easily accounted for in the fact that air is more fluid than water. Accuracy of reading is greater than 0.1 per cent. The apparatus will be described in full in the November issue of the *Journal of American Ceramic Society*.

J. A. Dedouch, of the Imperishable Minature Co., gave an impromptu talk on photographic colors worked into enamels. Every whiteware plant may make a ceramic photograph as easily as the ordinary method of decorating white ware.

R. M. Onan, of the Carborundum Co., spoke on refractories as used in enameling furnaces, describing the production of a new non-oxidizable carborundum refractory, and the making of large shapes up to 12 ft. in diameter and 6 ft. high for use in a Chicago water gas plant.

The following officers were elected for the coming year: F. L. Steinhoff, of the *Brick and Clay Record*, chairman; B. T. Sweeley, of the Coomley Manufacturing Co., vice-chairman; W. Wilkinson, of the Lewis Institute, secretary-treasurer. H. E. Davis will serve as chairman of the program committee, and E. A. Brockman as chairman of the membership committee.

Drive on War Gases Expected

While the general subject of the use of gas in warfare has been taken up only in a preliminary way in the connection with the Conference on Limitation of Armament, there is reason to believe that formidable opposition to the use of gas in warfare will develop. No one has shown his hand in the open as yet, but the opponents of chemical warfare, both at home and abroad, very evidently will make a desperate effort to unseat chemical warfare from what they declare to be an undeserved position of respectability, made so by the official recognition it has received by the governments of the principal countries.

The committee which will consider chemical warfare in connection with the studies being made for the delegates to the conference is as follows: Dr. Edgar F. Smith, chairman; General Amos A. Fries, U. S. A.; Colonel W. H. Bartholomew, Great Britain; Charles Moureu and Prof. A. Mayer, France; Lieutenant-Colonel N. Pentimalli, Italy; Major-General H. Haraguchi, Japan.

Ford and Edison Inspect Muscle Shoals

Mr. Ford and his engineers, accompanied by Thomas A. Edison, are making a thorough inspection of the nitrate and water-power projects at Muscle Shoals. One particular object of the investigation is to estimate as exactly as possible the hydro-electric power capacity of the project. Mr. Ford believes 1,000,000 hp. can be developed there and expects to show by data to be collected that his offer to the government of \$28,000,000 for the completion of the Wilson Dam is a liberal one.

Denver to Hold Industrial Exposition

The Colorado Industrial Exposition is to be held at Denver from Feb. 20 to 25 inclusive, under the auspices of the Colorado Manufacturers and Merchants Association. At least twenty Chambers of Commerce throughout the state will have exhibits together with individual manufacturers from every community. These exhibits will be representative of every character of product manufactured in Colorado.

Civil Service Examinations

Open competitive examinations for the following positions are announced by the Civil Service Commission. Vacancies exist in the Bureau of Standards.

Technologist; associate technologist; assistant technologist; junior technologist.

Engineer; associate engineer; assistant engineer; junior engineer.

Physicist; associate physicist; assistant physicist; junior physicist.

For technologist, engineer and physicist the salary range is \$2,800 to \$4,000 a year; for associates, \$2,000 to \$2,800; assistants, \$1,500 to \$2,000; juniors, \$1,200 to \$1,500. Applicants for the junior grades will be required to assemble for a written test on Jan. 11, 1922.

It is also stated that the Bureau of Standards is in need of junior aids and laboratory apprentices. The basic pay offered is \$540 a year for apprentices and \$720 to \$840 a year for aids, to which salaries there is added the increase of \$20 a month granted by Congress.

The Bureau of Standards covers a wide field of work in physics, chemistry, engineering and industrial technology, and offers valuable experience to those preparing for those professions. Junior assistants at the Bureau of Standards are given opportunity to continue their college work at the universities in Washington, the courses of which are largely arranged to suit the conveniences of persons in the government service.

Personal

CURTIS R. BURNETT, an official of the American Oil & Supply Co., Newark, N. J., was re-elected president of the Ironbound Manufacturers' Association at its recent annual meeting, for the third consecutive year.

R. E. EDSALL has resumed his work at the byproduct coke plant of the McKinney Steel Co., after a leave of absence on account of illness.

Dr. MORIN FISHBEIN, editor of the *American Medical Association Journal*, spoke before the Chicago Chemists Club recently on "Chemical Book Plates."

NELSON B. GASKILL, of New Jersey, a Republican member of the Federal Trade Commission, succeeded to the chairmanship of the Commission Dec. 1 for a term of one year. Mr. Gaskill, who was vice-chairman during the past year, succeeds to the chairmanship under the rule of the Commission which provides for rotation in the office of chairman among the several commissioners. Mr. Gaskill was appointed to the Commission in December, 1919, to fill an unexpired term caused by the death of John Franklin Fort.

ARTHUR L. HALVORSEN, chemical engineer, of Perth Amboy, N. J., has just returned from a 5 weeks' visit to chemical plants in Germany and Norway.

A. E. HAY, Canadian sales manager for the Pratt & Lambert Co., Buffalo, N. Y., gave an interesting address before the members of the Buffalo Paint, Oil and Varnish Club, Nov. 25.

Prof. J. H. MATHEWS, director of the course in chemistry at the University of Wisconsin, lectured before the department of chemistry at Oberlin College, on Nov. 30, on the subjects "A General Survey of Photochemistry" and "Color Photography." The following evening he spoke before the Cleveland Section of the American Chemical Society on the subject "Photochemistry and Some of Its Research Problems."

A. V. H. MORY, formerly associated with Sears, Roebuck & Co. and with Procter & Gamble Co., is now engaged in private practice in Chicago, specializing in chemical organization.

F. W. NORTHRIDGE, JR., assistant manager of the export department of the National Aniline & Chemical Co., has resigned.

E. D. TWEEDELL, assistant librarian of the John Crerar Library, spoke before the Chicago Chemists Club recently on the operation and usefulness of a modern scientific library.

HENRY WIGGLESWORTH, director of development for the General Chemical Co. and the Allied Dye & Chemical Corporation, has resigned. He will take an extended vacation in Europe.

Dr. R. W. WOODWARD has resigned as physicist and chief of the section of mechanical metallurgy of the Bureau of Standards, Washington, D. C., to become chief metallurgist for the Whitney Manufacturing Co., Hartford, Conn.

The United States Potters' Association, East Liverpool, Ohio, has announced that FRANK P. JUDGE of the National China Co., Salineville, Ohio, will be elected president of the association at its meeting in Washington, D. C., during the present week, succeeding B. I. Salisbury of the Onondaga Pottery Co., Syracuse, N. Y. Charles F. Goodwin, East Liverpool, Ohio, will be re-elected secretary-treasurer.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, Dec. 5, 1921.

The demand for general chemicals during the past week was somewhat irregular, although producers reported a good volume of business from producing channels. Manufacturers of caustic soda and soda ash have not experienced the inquiry they were expecting because of keen competition among first hands. The consuming element had a desire to show more interest in the more important chemicals at prevailing quotations, but producers have shown their desire for new business to a marked extent and buyers in the majority of cases are holding back for new figures. This condition, however, does not hold true for every item, and indications in general point to a gradual increase in the volume of business after the turn of the year. The time is fast approaching for inventory taking, and with this out of the way, all will be ready for a resumption of regular trading. The export business continued to show encouraging developments and additional inquiries were received from various parts of South America and Mexico. Leading factors in the trade are of the opinion that a successful termination of the armament conference will mean a tremendous improvement in our export trade. Importers continued to receive fair-sized shipments of foreign material, but these have had little effect on the spot market, as the big portion has been sent directly into consuming channels on standing contracts. Yellow prussiate of potash, cyanide of soda and bleaching powder have been the most active commodities during the past week. Stocks of these producers appear to be quite scarce, with the demand greatly increased. Chlorate of potash and caustic potash have shown the most weakness in the entire list, with large portions of imported material available at reduced figures.

Producers of 28 per cent *acetic acid* reported sales at 2½c. per lb. The 56 per cent is held at 5½c., while the glacial material varied from 9½@11c. per lb., according to quantity and seller. The market has not shown any new developments during the past month on this product and producers have found their main outlet among consumers holding regular contracts. Most sellers of *formaldehyde* were not eager to quote under 11c. per lb. for spot material in barrels. It is quite possible that several odd lots could be picked up around a fraction below prevailing quotations. The demand has not been very heavy during the interval and dealers were eager to dispose of some of their spot supplies. *Oxalic acid* closed firm at 14½@15c. per lb., according to seller. Holders stated that the inquiry had materially improved since the advance in producers' figures at the works. Market conditions in *tartaric acid* appear easier, and sellers were offering crystals down to 26½c. per lb., with the powdered variety offered at 27c. Goods coming in from abroad were quoted at 25c. per lb. c.i.f. New York. Manufacturers'

prices remained unchanged. Leading producers of *Glaubers salt* quote \$1.25 per 100 lb. for single bags in carload quantities and up to \$1.40 in smaller lots. Barrels were quoted at \$1.40 per 100 lb. in carload lots. Second hands offered occasional lots of imported goods a trifle below producers' quotations. The conditions in the *bleaching powder* market remained quite steady and prominent sellers reported a good inquiry from the consuming trade. Sales were reported at \$2.25 per 100 lb. for large containers and 2½c. per lb. for small drums, f.o.b. works, in carload quantities. Spot material is rather scarce and dealers were firm in their quotations at 2½c. per lb. for large drums. Imported bleach was held around \$2.10 per 100 lb. ex-dock New York. First-hand sales of *sodium sulphite* were reported at \$3.65 @ \$3.75 per 100 lb. in carload lots f.o.b. works. Sales of smaller quantities were made up to 4c. per lb. Prices for light *soda ash* in single bags were quoted around \$1.98 @ \$2.10 per 100 lb., according to seller. Imported material was quoted at \$1.75 @ \$1.80 for 100 lb. Ash in barrels sold down to \$2.35 per 100 lb. The spot market was somewhat dull during the week, as purchasers have shown an inclination toward works material. Manufacturers quote \$1.45 per 100 lb., basis 48 per cent, f.o.b. works, in carload quantities for the single bags. *Prussiate of potash* has improved to a considerable extent and the market is decidedly firmer, with spot offerings very scarce. Sales early in the week were reported at 22 @ 22½c. per lb., with 22½c. reported on inside figure at the close. The demand for spot *caustic soda* was quite irregular and the market closed easy. Occasional offerings were heard around the trade at \$3.90 @ \$4 per 100 lb. Buyers in general were not anxious to pay over \$3.90 for larger quantities. Producers, on the other hand, reported a steady inquiry for material, with frequent sales at prevailing levels. A fair export demand has featured the market during the week. Spot *bichromate of soda* was quoted at 8c. per lb. for small lots. It was intimated that a few odd lots might be purchased a fraction below the regular quotation, although indications were very encouraging for firm prices. Quiet trading in *nitrite of soda* was reported among leading sellers. The market in most directions was quoted at 6½ @ 7c. per lb., while firm business at 6½c. would in all probability be accepted.

COAL-TAR PRODUCTS

The export inquiry in the coal-tar products market during the past week was surprisingly encouraging. Japan has come into the market again as a large purchaser of phenol and orders have been around the market for large-sized quantities. The demand from fur dyers has been quite active in the past few days and with an early settlement in garment trade entanglements, this branch of the market should show material strength in prices and demand. Aniline salt showed considerable improvement, as did paranitraniline and naphthalene. There was much surprise expressed at the new prices named by manufacturers of *naphthalene*. The contract quotations for 1922 are given at 6½c. per lb. for the flakes and 7½c. for the balls. This announcement has had a stimulating effect on spot prices and holders were not anxious to quote under 7c. per lb. for spot material. *Benzene* production is gradually coming around and with the increase in steel production the market on this commodity will again become normal. First hands still quote 27 @ 33c. per gal. for future delivery. Spot stocks are exceedingly light and most buyers have been unable to locate any supplies. The *phenol* market has been the leading feature of the coal-tar products division. Exporters with large orders have experienced extreme difficulty in finding prime material at the prices demanded by foreign interests. It seems that spot stocks are the remains of left-over war goods which have been in containers for several years and in the majority of cases have turned into a solid mass of off-colored brown. First hands quote the market at 15c. per lb., with resale material held around 10c. per lb. Government surplus stocks are quoted at 12c. per lb. Supplies of *paranitraniline* in second hands are becoming scarce. Inquiries have materially increased and the market has again become steady at 77 @ 80c. per lb. **Producers of H acid** are offering this product as low as \$1 per lb. but resale lots have sold considerably below this

level. Competition is very keen and some producers have found it impossible to keep up with the present low quotations. The demand is not heavy and orders are mostly for small quantities. Conditions in the *aniline oil* market are somewhat firmer since the scarcity of benzene. The general quotation is 18c. per lb., with 19 @ 20c. asked for smaller lots. Sellers of *diethylaniline* ask \$1 per lb. with several orders recorded down to 95c. per lb. The demand is not very active. The market on *diphenylamine* is steady at 60 @ 65c. per lb., depending upon seller and quantity. Inquiries were decidedly better during the past week.

The Chicago Market

CHICAGO, Dec. 1, 1921.

The condition of the chemical market in this district is about the same as has been noted for several weeks. All factors continue to report a good volume of business and are apparently satisfied. It is noticeable that buyers are confining their purchases to parcels that will be consumed by the first of the year and large business can scarcely be expected to materialize until after that time. All indications show that chemical inventories in consumers' hands will be very small this year, which makes the outlook for after the first of the year very bright. Prices for the past two weeks have as a rule held quite firm and there was a noticeable stiffening of quotations in some directions. This is particularly noticeable on imported material, as the situation abroad makes it very difficult to estimate the cost of replacement stocks.

GENERAL CHEMICALS

Caustic soda is not so firm on spot, although quotations are unchanged at \$4.75 per 100 lb. for the ground 76 per cent and \$4.25 for the solid. These figures could very likely be shaded somewhat for a quantity order. *Soda ash* continues to move in a routine way at \$2.60 per 100 lb. for material in cooperage. *Sal ammoniac* is firm, with supplies none too plentiful. The white granular is held at 8 @ 8½c. for spot stock, and it is doubtful if this could be bettered for ordinary quantities. *Carbon bisulphide* continues firm at 7 @ 7½c. per lb. *Carbon tetrachloride* is also in a firm position, with only moderate supplies available at 10½ @ 11c. per lb. *Glycerine* is very firm at the new advance recently announced by refiners, and 15c. per lb. for c.p. material in drums is the prevailing quotation. *Formaldehyde* is quiet, with supplies offered as low at 11c. per lb. for single barrels. *Mercury* is one of the firmest items on the list and only a few small lots were available at \$47 per flask.

Bichromates are moving in a routine way and are unchanged at 14c. for the *potash* and 8½ @ 9c. for the *soda*. *Carbonate of potash* is rather dull and one lot of 80-85 per cent calcined was offered at 6c. per lb. *Caustic potash* is moving fairly well at 6½c. per lb. for 88-92 per cent material. *Chlorate of potash* is rather scarce and 8½c. per lb. for the crystals was the best offer noted. The powdered was available in small quantities at 7½c. *Sodium bicarbonate* is plentiful and unchanged at \$2.60 per 100 lb. There was a fair demand for *borax* and supplies were available at 6c. per lb.

The acids are enjoying a fair demand and supplies are plentiful but could scarcely be called large. *Acetic acid* is unchanged at 2½c. for the 28 per cent commercial in barrels and 10 @ 10½c. for the glacial. *Oxalic acid* is moving well at 15½ @ 16½c. per lb. The heavy acids are firm, with *muratic*, 18 deg., at \$1.50 per 100 lb. in carboys and *nitric* at 6c. *Sulphuric acid* is offered at \$18 @ \$20 per ton in tank cars f.o.b. works.

VEGETABLE OILS

Linseed oil has failed to show any marked improvement during the past few days. There is only a fair movement and today's quotations were 77c. per gal. for the boiled and 75c. for the raw, lots of 1 to 3 drums.

NAVAL STORES

Naval stores remained in a firm position for the past few days and business was reported as good. *Spirits of turpentine* are enjoying a good demand, and small lots are quoted at 86c. per gal., drum basis. *Rosins* are unchanged as to price and appear to be moving in a fair way.

The Iron and Steel Market

PITTSBURGH, Dec. 2, 1921.

The finished steel markets continue to exhibit decided dullness, except that in tubular goods there is fully as heavy demand as formerly, while in tin plate there are fairly heavy engagements for first quarter deliveries. What has been suspected in the past few weeks is now made clear, that the usual year-end dullness of the steel market has this year come ahead of time. There is, however, an extenuating circumstance, for it has become evident now that in the past couple of months, when common report was that sales and purchases were only for current shipment, there was a fair volume of contract business done to the end of the year, and this contract business is helping to sustain mill operations at rates far above what would be required to execute the new business being booked from day to day.

In the case of a few commodities a key to the situation mentioned, as to the existence of contracts, is furnished by the yielding of the quoted market price, not to a new low level, but to a price which it is explained was done some time ago. An instance of this is furnished by hoops, bands and hot-rolled strips, which for a while were quoted at 2.25c., base, but are again obtainable at 2c., possibly at a trifle less.

Mill operations have begun to decrease, though the decrease to date is small. Measured in steel ingot output, the decrease is only a few points, as ingot production is estimated at between 40 and 45 per cent of capacity, against an average of 44 per cent in October and a slightly higher rate on Nov. 1. Production of finished steel has probably decreased in greater ratio, since during September and October very considerable tonnages of ingots and semi-finished steel, stocked earlier in the year, were rolled into finished products. Stocks of raw material and intermediate products are now quite thoroughly liquidated, except for large piles of iron ore and perhaps some moderate sized stocks of pig iron.

Of the various branches of the finished steel industry the pipe mills easily lead in point of activity, showing operations of from 60 to 80 per cent. Sheet and tin plate mills come next in point of activity, while wire mills show a moderate rate of operation. Bar, shape, plate and rail mills are relatively inactive.

STEEL PRICES

The steel market is strongly competitive in practically all branches, though for the time being at least prices are stabilized in tin plate and sheets, at \$4.75 for 100-lb. coke tin plate, 2.25c. for blue annealed sheets, 3c. for black sheets and 4c. for galvanized sheets. The American Sheet & Tin Plate Co. named these sheet prices a week ago, for deliveries through the first quarter, after independents had withdrawn various cut prices below the level indicated. In tubular goods the shading that has been in evidence almost since the reduced lists were issued Sept. 16 is more widespread, but has not gone deeper, an exception being line pipe which apparently has been selling at less than the cost of production. Bars, shapes and plates are quotable in general at a range of 1.50@1.60c.

PIG IRON AND COKE

The pig-iron market continues very dull, with no material changes in quotable prices. Unfortunately for the market, the failure of prices to exhibit change is ascribed chiefly to the absence of inquiry that would produce competition and an effort on the part of sellers to obtain business. For instance, while the valley market remains quotable at \$20 for bessemer, \$19 for basic and \$20.50 for foundry iron, some furnaces make no secret of the fact that they would welcome an opportunity to shade these prices to get a good-sized order, say one for 5,000 tons.

The Connellsville coke market has grown weaker still, spot furnace having become practically nominal at \$3, while foundry coke rarely sells at above \$4 and draws that price only with difficulty. Production by the merchant ovens in the Connellsville region has decreased fully 25 per cent in the past 5 weeks, while there is no evidence that the rate of consumption has decreased or that production is below consumption now, from which it seems clearly to follow that in the past few weeks a very considerable surplus has been produced.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots	Less Carlots
Acetic anhydride.....lb.	\$0.12½ - \$0.12½	\$0.40 - \$0.45
Acetone.....lb.	2.75 - 3.00	13 - 13½
Acid, acetic, 28 per cent.....100 lbs.	5.50 - 5.75	3.25 - 3.50
Acetic, 56 per cent.....100 lbs.		6.00 - 6.50
Acetic, glacial, 99½ per cent, carboys, 100 lbs.	10.00 - 10.50	10.75 - 11.00
Boric, crystals.....lb.	.12½ - .12½	.13 - .13½
Boric, powder.....lb.	.13 - .13½	.14 - .14½
Citric.....lb.		.45 - .47
Hydrochloric.....100 lb.	1.25 - 1.50	1.60 - 1.75
Hydrofluoric, 52 per cent.....lb.	.12 - .12½	.12½ - .13
Lactic, 44 per cent tech.....lb.	.09½ - .10	.10½ - .12
Lactic, 22 per cent tech.....lb.	.04½ - .05½	.06 - .07
Molybdic, C.P.....lb.	3.25 - 3.50	3.60 - 4.00
Muriatic, 20 deg. (see hydrochloric).....		
Nitric, 40 deg.....lb.	.06½ - .06½	.06½ - .07
Nitric, 42 deg.....lb.	.06½ - .07	.07½ - .07½
Oxalic, crys tals.....lb.	.14½ - .15	.15½ - .16
Phosphoric, 50 per cent solution.....lb.	.13 - .13½	.14 - .18
Picric.....lb.	.20 - .25	.27 - .35
Pyrogallol, resublimed.....lb.		1.90 - 2.00
Sulphuric, 60 deg., tank cars.....ton		11.00 - 12.00
Sulphuric, 60 deg., drums.....ton		13.00 - 15.00
Sulphuric, 66 deg., tank cars.....ton	17.00 - 18.00	
Sulphuric, 66 deg., drums.....ton	21.00 - 22.00	22.50 - 23.00
Sulphuric, 66 deg., carboys.....ton		
Sulphuric, fuming, 20 per cent(oleum) tank cars.....ton	21.00 - 22.00	
Sulphuric, fuming, 20 per cent(oleum) drums.....ton	23.00 - 23.50	24.00 - 24.50
Sulphuric, fuming, 20 per cent(oleum) carboys.....ton	31.00 - 32.00	33.00 - 34.00
Tannic, U. S. P.....lb.		.75 - .85
Tannic (tech.).....lb.	.45 - .48	.50 - .55
Tartaric, imported crystals.....lb.		.26 - .26½
Tartaric acid, imported, powdered.....lb.		.27 - .28
Tartaric acid, domestic.....lb.		.35
Tungstic, per lb. of WO.....lb.		1.10 - 1.20
Alcohol, Ethyl.....gal.		4.65 - 5.00
Alcohol, Methyl (see methanol).....		
Alcohol, denatured, 188 proof.....gal.		.37 - .38
Alcohol, denatured, 190 proof.....gal.		.35 - .36
Alum, ammonia, lump.....lb.	.03½ - .03½	.04 - .04½
Alum, potash, lump.....lb.	.03½ - .04	.04½ - .04½
Alum, chrome lump.....lb.	.08 - .08½	.08½ - .09
Aluminum sulphate, commercial.....lb.	.01½ - .02	.02½ - .02½
Aluminum sulphate, iron free.....lb.	.02½ - .02½	.03 - .03½
Aqua ammonia, 26 deg., drums(750 lb.) lb.	.07½ - .07½	.08 - .08½
Ammonia, anhydrous, cyl.(100-150 lb.) lb.	.31 - .32	.33 - .35
Ammonium carbonate, powder.....lb.	.07 - .07½	.08 - .09
Ammonium chloride, granular (white salammoniac).....lb.	.07 - .07½	.07½ - .07½
Ammonium chloride, granular (gray salammoniac).....lb.	.07 - .07½	.07½ - .07½
Ammonium nitrate.....lb.	.07½ - .07½	.07½ - .08½
Amylacetate tech.....gal.		2.40 - 2.65
Arsenic oxide, (white arsenic) powdered lb.	.06½ - .06½	.07 - .07½
Arsenic, sulphide, powdered (red arsenic) lb.	.12 - .12½	.12½ - .13
Barium chloride.....ton	48.00 - 49.00	50.00 - 55.00
Barium dioxide (peroxide).....lb.	.20 - .21	.22 - .23
Barium nitrate.....lb.	.06½ - .07	.07½ - .08
Barium sulphate (precip.) (blanc fixe) lb.	.04 - .04½	.04½ - .05
Bleaching powder (see calc. hypochlorite)		
Blue vitriol (see copper sulphate).....		
Borax (see sodium borate).....		
Brimstone (see sulphur, roll).....		
Bromine.....lb.	.27 - .28	.28½ - .30
Calcium acetate.....100 lbs.	1.75 - 2.00	
Calcium carbide.....lb.	.04½ - .04½	.05 - .05½
Calcium chloride, fused, lump.....ton	23.50 - 24.00	24.50 - 25.50
Calcium chloride, granulated.....lb.	.01½ - .02	.02½ - .02½
Calcium hypochloride(bleach'g powder) 100 lb.	2.75 - 2.85	2.90 - 3.50
Calcium peroxide.....lb.		1.40 - 1.50
Calcium phosphate, tribasic.....lb.		.15 - .16
Camphor.....lb.		.91 - .95
Carbon bisulphide.....lb.	.06½ - .06½	.07 - .07½
Carbon tetrachloride, drums.....lb.	.10½ - .10½	.11 - .12
Carbonyl chloride, (phosgene).....lb.		.60 - .75
Caustic potash (see potassium hydroxide)		
Caustic soda (see sodium hydroxide).....		
Chlorine, gas, liquid-cylinders(100 lb.) lb.	.08 - .09	.09½ - .10
Chloroform.....lb.		.40 - .43
Cobalt oxide.....lb.		2.00 - 2.10
Copperas (see iron sulphate).....		
Copper carbonate, green precipitate.....lb.	.19 - .19½	.20 - .21
Copper cyanide.....lb.		.50 - .62
Copper sulphate, crystals.....lb.	.05½ - .05½	.05½ - .06
Cream of tartar(see potassium bitartrate)		
Epsom salt (see magnesium sulphate).....		
Ethyl Acetate Com. 85%.....gal.		70 - 80
Ethyl Acetate pure (acetic ether, 98% to 100%).....gal.		95 - 112
Formaldehyde, 40 per cent.....lb.	.10½ - .11	.11½ - .12
Fusel oil, ref.....gal.		2.50 - 3.00
Fusel oil, crude.....gal.		1.50 - 1.75
Glauber's salt (see sodium sulphate).....		
Glycerine, C. P. drums extra.....lb.		.14½ - .15
Iodine, resublimed.....lb.		3.50 - 3.60
Iron oxide, red.....lb.		.12 - .18
Iron sulphate (copperas).....ton	18.00 - 19.00	20.00 - 23.00
Lead acetate.....lb.	.15 - .15½	.15½ - .16½
Lead arsenate, powd.....lb.		.15 - .20
Lead nitrate.....lb.	.08 - .08½	.08½ - .09
Litharge.....lb.		1.40 - 1.50
Lithium carbonate.....lb.	.08 - .08½	.09 - .10
Magnesium carbonate, technical.....lb.	2.50 - 2.75	
Magnesium sulphate, U. S. P. 100 lb.		1.10 - 1.75
Magnesium sulphate, technical.....100 lb.		.66 - .68
Methanol, 95%.....gal.		.70 - .72
Methanol, 97%.....gal.		.12 - .12½
Nickel Salt, double.....lb.		.14 - .14½
Nickel salt, single.....lb.		
Phosgene (see carbonyl chloride).....		
Phosphorus, red.....lb.	.45 - .46	.47 - .50
Phosphorus, yellow.....lb.		.32 - .35
Potassium bichromate.....lb.	.11 - .11½	.11½ - .12

	Carlots	Less Carlots
Potassium bitartrate (cream of tartar)..... lb.	\$0.28 — \$0.30	
Potassium bromide, granular..... lb.	.15 — .20	
Potassium carbonate, U. S. P..... lb.	.15 — .16	
Potassium carbonate, 80-85%..... lb.	.04 — .06	
Potassium chlorate, crystals..... lb.	.05 — .06	
Potassium cyanide..... lb.	.40 — .45	
Potassium hydroxide (caustic potash)..... lb.	.05 — .06	
Potassium iodide..... lb.	2.60 — 2.75	
Potassium nitrate..... lb.	.07 — .07	
Potassium permanganate..... lb.	.17 — .18	
Potassium prussiate, red..... lb.	.28 — .29	
Potassium prussiate, yellow..... lb.	.22 — .22	
Rochelle salts (see sodium potas tartrate).....		
Salammoniac (see ammonium chloride).....		
Salt soda (see sodium carbonate).....		
Salt cake (bulk)..... ton	19.00 — 21.00	
Silver cyanide..... oz.	1.10 — 1.20	
Silver nitrate..... oz.	.45 — .46	
Soda ash, light..... 100 lb.	1.90 — 2.00	
Soda ash, dense..... 100 lb.	2.25 — 2.30	
Sodium acetate..... lb.	.04 — .04	
Sodium bicarbonate..... 100 lb.	2.00 — 2.25	
Sodium bichromate..... lb.	.08 — .08	
Sodium bisulphate (nitre cake)..... ton	5.00 — 5.25	
Sodium bisulphite powdered, U.S.P..... lb.	.04 — .05	
Sodium borate (borax)..... lb.	.05 — .06	
Sodium carbonate (salt soda)..... 100 lb.	1.80 — 1.90	
Sodium chlorate..... lb.	.07 — .07	
Sodium cyanide..... lb.	.28 — .28	
Sodium fluoride..... lb.	.11 — .12	
Sodium hydroxide (caustic soda)..... 100 lb.	3.90 — 4.00	
Sodium hyposulphite..... lb.	.03 — .03	
Sodium nitrite..... lb.	.06 — .07	
Sodium peroxide, powdered..... lb.	.25 — .26	
Sodium phosphate, dibasic..... lb.	.04 — .04	
Sodium potassium tartrate (Rochelle salts)..... lb.	.14 — .14	
Sodium prussiate, yellow..... lb.	.14 — .14	
Sodium silicate, solution (40 deg.)..... 100 lb.	1.00 — 1.05	
Sodium silicate, solution (60 deg.)..... 100 lb.	2.30 — 2.40	
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	1.30 — 1.50	
Sodium sulphide, fused, 60-62 per cent (cone.) lb.	.04 — .04	
Sodium sulphite, crystals..... lb.	.03 — .03	
Strontium nitrate, powdered..... lb.	.13 — .14	
Sulphur chloride, red..... lb.	.06 — .06	
Sulphur, crude..... ton	18.00 — 20.00	
Sulphur dioxide, liquid, cylinders extra..... lb.	.08 — .08	
Sulphur (sublimed), flour..... 100 lb.	2.25 — 3.10	
Sulphur, roll (brimstone)..... 100 lb.	2.00 — 2.75	
Tin bichloride..... lb.	.09 — .09	
Tin oxide..... lb.	.37 — .38	
Zinc carbonate, precipitate..... lb.	.16 — .16	
Zinc chloride, gran..... lb.	.09 — .09	
Zinc cyanide..... lb.	.42 — .44	
Zinc dust..... lb.	.11 — .11	
Zinc oxide, XX..... lb.	.07 — .07	
Zinc sulphate..... 100 lb.	3.00 — 3.25	

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude..... lb.	\$1.10 — \$1.15
Alpha-naphthol, refined..... lb.	1.25 — 1.30
Alpha-naphthylamine..... lb.	.30 — .32
Aniline oil, drums extra..... lb.	.18 — .20
Aniline salts..... lb.	.24 — .26
Anthracene, 80% in drums (100 lb.)..... lb.	.75 — 1.00
Benzaldehyde U.S.P..... lb.	1.35 — 1.45
Benzidine, base..... lb.	.90 — 1.00
Benzidine sulphate..... lb.	.75 — .85
Benzoic acid, U.S.P..... lb.	.62 — .65
Benzoate of soda, U.S.P..... lb.	.52 — .55
Benzene, pure, water-white, in drums (100 gal.)..... gal.	.27 — .32
Benzene, 90%, in drums (100 gal.)..... gal.	.25 — .28
Benzyl chloride, 95-97%, refined..... lb.	.25 — .27
Benzyl chloride, tech..... lb.	.20 — .23
Beta-naphthol benzoate..... lb.	3.75 — 4.00
Beta-naphthol, sublimed..... lb.	.70 — .75
Beta-naphthol, tech..... lb.	.30 — .34
Beta-naphthylamine, sublimed..... lb.	1.75 — 1.85
Cresol, U. S. P., in drums (100 lb.)..... lb.	.15 — .16
Ortho-cresol, in drums (100 lb.)..... lb.	.24 — .26
Cresylic acid, 97-99%, straw color, in drums..... gal.	.70 — .80
Cresylic acid, 95-97%, dark, in drums..... gal.	.65 — .70
Cresylic acid, 50%, first quality, drums..... gal.	.45 — .50
Dichlorobenzene..... lb.	.06 — .09
Diethylaniline..... lb.	.95 — 1.10
Dimethylaniline..... lb.	.45 — .60
Dinitrobenzene..... lb.	.23 — .27
Dinitrochlorobenzene..... lb.	.20 — .25
Dinitronaphthalene..... lb.	.30 — .35
Dinitrophenol..... lb.	.35 — .40
Dinitrotoluene..... lb.	.25 — .30
Dip oil, 25%, car lots, in drums..... gal.	.30 — .35
Diphenylamine..... lb.	.60 — .70
H-acid..... lb.	1.00 — 1.10
Meta-phenylenediamine..... lb.	1.10 — 1.15
Mono-chlorobenzene..... lb.	.12 — .14
Monoethylaniline..... lb.	1.65 — 1.70
Naphthalene crushed, in bbls..... lb.	.07 — .08
Naphthalene, flake..... lb.	.07 — .08
Naphthalene, balls..... lb.	.08 — .09
Naphthionic acid, crude..... lb.	.70 — .75
Nitrobenzene..... lb.	.12 — .15
Nitro-naphthalene..... lb.	.30 — .35
Nitro-toluene..... lb.	.15 — .17
Ortho-amidophenol..... lb.	3.00 — 3.10
Ortho-dichlor-benzene..... lb.	.15 — .20
Ortho-nitro-phenol..... lb.	.77 — .80
Ortho-nitro-toluene..... lb.	.15 — .20
Ortho-toluidine..... lb.	.20 — .25
Para-amidophenol, base..... lb.	1.40 — 1.45
Para-amidophenol, HCl..... lb.	1.70 — 1.80
Para-dichlorobenzene..... lb.	.12 — .15
Paranitroaniline..... lb.	.75 — .80
Para-nitrotoluene..... lb.	.80 — .85
Para-phenylenediamine..... lb.	1.70 — 1.75
Para-toluidine..... lb.	1.25 — 1.40
Phthalic anhydride..... lb.	.40 — .50

Phenol, U. S. P., drums..... lb.	.10 — .15
Pyridine..... gal.	2.00 — 3.50
Resorcinol, technical..... lb.	1.50 — 1.60
Resorcinol, pure..... lb.	2.00 — 2.25
Salicylic acid, tech., in bbls..... lb.	.20 — .21
Salicylic acid, U. S. P..... lb.	.22 — .23
Salol..... lb.	.70 — .72
Solvent naphtha, water-white, in drums, 100 gal..... gal.	.25 — .28
Solvent naphtha, crude, heavy, in drums, 100 gal..... gal.	.14 — .16
Sulphanilic acid, crude..... lb.	.27 — .30
Tolidine..... lb.	1.30 — 1.35
Toluidine, mixed..... lb.	.43 — .45
Toluene, in tank cars..... gal.	.25 — .28
Toluene, in drums..... gal.	.28 — .31
Xylidines, drums, 100 gal..... lb.	.40 — .45
Xylene, pure, in drums..... gal.	.40 — .45
Xylene, pure, in tank cars..... gal.	.45 — .45
Xylene, commercial, in drums, 100 gal..... gal.	.33 — .35
Xylene, commercial, in tank cars..... gal.	.30 — .30

Waxes

Prices based on original packages in large quantities.

Bayberry Wax..... lb.	\$0.20 — \$0.21
Beeswax, refined, dark..... lb.	.24 — .25
Beeswax, refined, light..... lb.	.28 — .30
Beeswax, white pure..... lb.	.34 — .38
Candellilla wax..... lb.	.24 — .24
Carnauba, No. 1..... lb.	.45 — .46
Carnauba, No. 2, North Country..... lb.	.23 — .23
Carnauba, No. 3, North Country..... lb.	.14 — .14
Japan..... lb.	.21 — .21
Montan, crude..... lb.	.04 — .04
Paraffine waxes, crude match wax (white) 105-110 m.p..... lb.	.04 — .04
Paraffine waxes, crude, scale 124-126 m.p..... lb.	.03 — .03
Paraffine waxes, refined, 118-120 m.p..... lb.	.04 — .04
Paraffine waxes, refined, 125 m.p..... lb.	.04 — .04
Paraffine waxes, refined, 128-130 m.p..... lb.	.04 — .04
Paraffine waxes, refined, 133-135 m.p..... lb.	.05 — .05
Paraffine waxes, refined, 135-137 m.p..... lb.	.05 — .06
Stearic acid, single pressed..... lb.	.09 — .09
Stearic acid, double pressed..... lb.	.09 — .09
Stearic acid, triple pressed..... lb.	.10 — .10

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl..... 280 lb.	\$5.55 — 5.60
Rosin E-I..... 280 lb.	5.60 — 5.65
Rosin K-N..... 280 lb.	6.20 — 6.75
Rosin W. G.-W. W..... 280 lb.	7.00 — 7.25
Wood rosin, bbl..... 280 lb.	6.25 — .
Spirits of turpentine..... gal.	.80 — .
Wood turpentine, steam dist..... gal.	.78 — .
Wood turpentine, dest. dist..... gal.	.76 — .
Pine tar pitch, bbl..... 200 lb.	6.00 — .
Tar, kiln burned, bbl. (500 lb.)..... bbl.	10.50 — .
Retort tar, bbl..... 500 lb.	10.50 — .
Rosin oil, first run..... gal.	.36 — .
Rosin oil, second run..... gal.	.39 — .
Rosin oil, third run..... gal.	.46 — .
Pine oil, steam dist., sp.gr., 0.930-0.940..... gal.	\$1.90 — .
Pine oil, pure, dest. dist..... gal.	1.50 — .
Pine tar oil, ref., sp.gr. 1.025-1.035..... gal.	.46 — .
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla..... gal.	.35 — .
Pine tar oil, double ref., sp.gr. 0.965-0.990..... gal.	.75 — .
Pine tar, ref., thin, sp.gr., 1.080-1.060..... gal.	.35 — .
Turpentine, crude, sp.gr., 0.900-0.970..... gal.	1.25 — .
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990..... gal.	.35 — .
Pinewood creosote, ref..... gal.	.52 — .

Solvents

73-76 deg., steel bbls. (85 lb.)..... gal.	\$0.37 — .
70-72 deg., steel bbls. (85 lb.)..... gal.	.35 — .
68-70 deg., steel bbls. (85 lb.)..... gal.	.34 — .
V. M. and P. naphtha, steel bbls. (85 lb.)..... gal.	.23 — .

Fertilizers

Ammonium sulphate, bulk and d. bags..... 100 lb.	\$2.30 — 2.90
Blood, dried, f.o.b., N. Y..... unit	4.00 — .
Bone, 3 and 50, ground, raw..... ton	30.00 — 32.00
Fish scrap, dom., dried, f.o.b. works..... unit	2.90 — 3.00
Nitrate soda..... 100 lb.	2.30 — 2.35
Tankage, high grade, f.o.b. Chicago..... unit	2.75 — 3.00
Phosphate rock, f.o.b. mines, Florida pebble, 68-72 p.e..... ton	4.50 — 6.50
Tennessee, 78-80 p.e..... ton	8.50 — 9.00
Potassium muriate, 80 p.e..... ton	37.00 — 40.00
Potassium sulphate..... unit	.90 — 1.00

Crude Rubber

Para-Upriver fine..... lb.	\$0.21 — .22
Upriver coarse..... lb.	.13 — .14
Upriver cauchoball..... lb.	.13 — .13
Plantation—First latex crepe..... lb.	.17 — .18
Ribbed smoked sheets..... lb.	.17 — .18
Brown crepe, thin, clean..... lb.	.15 — .
Amber crepe No. 1..... lb.	.17 — .

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls..... lb.	\$0.10 — \$0.10
Castor oil, AA, in bbls..... lb.	.11 — .12
China wood oil, in bbls. (f.o.b. Pac. coast)..... lb.	.13 — .13
Cocoanut oil, Ceylon grade, in bbls..... lb.	.09 — .09
Cocoanut oil, Cochin grade, in bbls..... lb.	.10 — .10
Corn oil, crude, in bbls..... lb.	.08 — .08
Cottonseed oil, crude (f. o. b. mill)..... lb.	.07 — .07
Cottonseed oil, summer yellow..... lb.	.08 — .09
Cottonseed oil, winter yellow..... lb.	.09 — .09

Linseed oil, raw, car lots (domestic).....	gal.	.65	—	.66
Linseed oil, raw, tank cars (domestic).....	gal.	.60	—	.61
Linseed oil, in 5-bbl lots (domestic).....	gal.	.68	—	.69
Olive oil, Denatured.....	gal.	\$1.15	—	\$1.20
Palin, Lagos.....	lb.	.07 $\frac{1}{2}$	—	.07 $\frac{3}{4}$
Palm, Niger.....	lb.	.06 $\frac{1}{2}$	—	.06 $\frac{3}{4}$
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.08	—	.08 $\frac{1}{2}$
Peanut oil, refined, in bbls.....	lb.	.11 $\frac{1}{2}$	—	.11 $\frac{3}{4}$
Rapeseed oil, refined in bbls.....	gal.	.83	—	.84
Rapeseed oil, blown, in bbls.....	gal.	.88	—	.90
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.08 $\frac{3}{4}$	—	.....
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.07 $\frac{1}{2}$	—	.....

FISH

Light pressed menhaden.....	gal.	\$0.40	—	.....
Yellow bleached menhaden.....	gal.	.42	—	.....
White bleached menhaden.....	gal.	.45	—	.....
Blown menhaden.....	gal.	.48	—	.....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$23.50	—	28.00
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	15.00	—	17.00
Barytes, crude, 88% @ 94% ba., Kings Creek.....	net ton	10.00	—	12.00
Barytes, floated, f.o.b. St. Louis.....	net ton	23.00	—	24.00
Barytes, crude, first grade, Missouri.....	net ton	7.00	—	.....
Blanc fixe, dry.....	lb.	.04	—	.04 $\frac{1}{2}$
Blanc fixe, pulp.....	net ton	45.00	—	55.00
Casein.....	lb.	.15	—	.16
Chalk, Precipitated, domestic, extra light.....	lb.	.04 $\frac{1}{2}$	—	.05
Chalk, Precipitated, domestic, light.....	lb.	.04	—	.04 $\frac{1}{2}$
Chalk, Precipitated, domestic, heavy.....	lb.	.03 $\frac{3}{4}$	—	.04
Chalk, Precipitated, English, extra light.....	lb.	.04 $\frac{1}{2}$	—	.05
Chalk, Precipitated, English, light.....	lb.	.04 $\frac{1}{2}$	—	.05
Chalk, Precipitated, English, dense.....	lb.	.04	—	.04 $\frac{1}{2}$
China clay (kaolin) crude, f.o.b. mines, Georgia.....	net ton	6.50	—	8.50
China clay (kaolin) washed, f.o.b. Georgia.....	net ton	9.00	—	10.00
China clay (kaolin) powdered, f.o.b. Georgia.....	net ton	13.00	—	20.00
China clay (kaolin) crude, f.o.b. Virginia points.....	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points.....	net ton	13.00	—	20.00
China clay (kaolin), imported, lump.....	net ton	12.00	—	20.00
China clay (kaolin), imported, powdered.....	net ton	25.00	—	30.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	net ton	5.00	—	7.50
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27.00	—	30.00
Fullers earth, f.o.b. Mines.....	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Pa.....	net ton	15.00	—	18.00
Fullers earth, powdered, f.o.b. Fla.....	net ton	18.00	—	.....
Fullers earth, imported, powdered.....	net ton	24.00	—	27.00
Graphite, Ceylon lump, first quality.....	lb.	.06	—	.07
Graphite, Ceylon chip.....	lb.	.04 $\frac{1}{2}$	—	.05
Graphite, high grade amorphous crude.....	lb.	.00 $\frac{3}{4}$	—	.02 $\frac{1}{2}$
Kieselguhr, f.o.b. mines, Cal.....	per ton	40.00	—	.....
Kieselguhr, f.o.b. N.Y.....	per ton	55.00	—	60.00
Magnesite, calcined.....	per ton	50.00	—	65.00
Pumice stone, imported.....	lb.	.03	—	.40
Pumice stone, domestic, lump.....	lb.	.05	—	.05 $\frac{1}{2}$
Pumice stone, domestic, ground.....	lb.	.06	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore.....	net ton	.....	—	10.00
Quartz (acid tower) 1 $\frac{1}{2}$ @ 2 in., f.o.b. Baltimore.....	net ton	.....	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	.....	—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange fine.....	lb.	.68	—	.70
Shellac, orange superfine.....	lb.	.78	—	.80
Shellac, A. C. garnet.....	lb.	.58	—	.60
Shellac, T. N.....	lb.	.68	—	.70
Soapstone.....	ton	12.00	—	15.00
Sodium chloride.....	long ton	12.50	—	13.00
Talc, paper-making grades, f.o.b. Vermont.....	ton	11.00	—	18.00
Talc, roofing grades, f.o.b. Vermont.....	ton	8.50	—	13.00
Talc, rubber grades, f.o.b. Vermont.....	ton	11.00	—	18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	7.50	—	11.00
Talc, imported.....	ton	30.00	—	40.00
Talc, California talcum powder grade.....	ton	18.00	—	25.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	per ton	\$50.00		
Carborundum refractory brick, 9-in. { less than earlot	1,000	1250.00		
Chrome brick, f.o.b. Eastern shipping points.....	net ton	52- 55		
Chrome cement, 40-45% Cr ₂ O ₃	net ton	30- 32		
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in car lots, f.o.b. Eastern shipping points.....	net ton	33- 35		
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	35- 40		
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	30- 35		
Magnesite brick, 9-in. straight.....	net ton	65- 70		
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	77		
Magnesite brick, soaps and splits.....	net ton	98		
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	40- 42		
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	42- 45		
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	35- 38		

Ferro-Alloys

All f.o.b. Works

Ferrocobalt-titanium, 15-18% C, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00	—	225.00
Ferrochrome per lb. of Cr. contained, 6-8% carbon, earlots.....	lb.	11	—	..
Ferrochrome, per lb. of Cr. contained, 4-6% carbon, earlots.....	lb.	.11	—	.12
Ferromanganese, 76-80% Mn, domestic.....	gross ton	58.00	—	60.00
Ferromanganese, 76-80% Mn, English & German.....	gross ton	58.00	—	59.00
Spiegeleisen, 18-22% Mn.....	gross ton	25.00	—	27.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.25	—	.....
Ferrosilicon, 10-15%.....	gross ton	38.00	—	40.00
Ferrosilicon, 50%.....	gross ton	57.00	—	59.00
Ferrosilicon, 75%.....	gross ton	120.00	—	125.00
Ferrotungsten, 70-80% C, per lb. of contained W.....	lb.	40	—	.45
Ferrotungsten, 35-50% C, per lb. of U. content.....	lb.	6.00	—	.....
Ferrovandium, 30-40% C, per lb. of contained V.....	lb.	4.25	—	4.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content.....	net ton	\$8.00	—	\$10.00
Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃	ton	22.00	—	23.00
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard.....	ton	22.00	—	23.00
Coke, foundry, f.o.b. ovens.....	net ton	4.25	—	4.50
Coke, furnace, f.o.b. ovens.....	net ton	3.25	—	3.50
Fluorspar, gravel, f.o.b. mines, New Mexico.....	net ton	12.00	—	.....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	20.00	—	22.00
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01 $\frac{1}{2}$	—	.01 $\frac{3}{4}$
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	.23	—	.24
Manganese ore, chemical (MnO ₂).....	net ton	55.00	—	60.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.45	—	.50
Monazite, per unit of ThO ₂ , c.i.f., Atlantic seaport.....	unit	30.00	—	.....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport.....	unit	.12	—	.12
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.13	—	.13
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.11	—	.12
Rutile, 95% TiO ₂ per lb. ore.....	lb.	.15	—	.....
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	2.50	—	2.75
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	2.75	—	3.00
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	1.25	—	1.75
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.25	—	2.50
Vanadium pentoxide, 99%.....	lb.	12.00	—	14.00
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1.00	—	.....
Zircon, washed, iron free, f.o.b. Pablo, Florida.....	lb.	.04 $\frac{1}{2}$	—	.13

Non-Ferrous Metals

New York Markets

		Cents per Lb.
Copper, electrolytic.....		13.625
Aluminum, 98 to 99 per cent.....		24.50@25.00
Antimony, wholesale lots, Chinese and Japanese.....		4.60
Nickel, ordinary (ingot).....		41.00
Nickel, electrolytic.....		44.00
Monel metal, shot and blocks.....		35.00
Monel metal ingots.....		38.00
Monel metal, sheet bars.....		40.00
Tin, 5-ton lots, Straits.....		29.75
Lead, New York, spot.....		4.70
Lead, E. St. Louis, spot.....		4.35
Zinc, spot, New York.....		5.10@5.15
Zinc, spot, E. St. Louis.....		4.65@4.70

OTHER METALS

Silver (commercial).....	oz.	\$0.66 $\frac{1}{2}$
Cadmium.....	lb.	1.00-1.25
Bismuth (500 lb. lots).....	lb.	1.50@1.55
Cobalt.....	lb.	3.00@3.25
Magnesium (f.o.b. Philadelphia).....	lb.	1.25
Platinum.....	oz.	80.00
Iridium.....	oz.	150.00@170.00
Palladium.....	oz.	55.00-60.00
Mercury.....	.75 lb.	43.00-44.00

FINISHED METAL PRODUCTS

		Warehouse Price Cents per Lb.
Copper sheets, hot rolled.....		21.00
Copper bottoms.....		28.50
Copper rods.....		19.50@20.25
High brass wire.....		16.75
High brass rods.....		14.25
Low brass wire.....		18.25
Low brass rods.....		18.75
Brazed brass tubing.....		25.00
Brazed bronze tubing.....		29.75
Seamless copper tubing.....		20.50
Seamless high brass tubing.....		18.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current	Cleveland	Chicago
Copper, heavy and crucible.....	9.75@10.25	9.25	9.50
Copper, heavy and wire.....	9.25@9.50	8.50	8.50
Copper, light and bottoms.....	7.50@8.00	7.50	7.25
Lead, heavy.....	3.50@3.75	3.25	3.25
Lead, tea.....	2.25@2.35	2.25	2.25
Brass, heavy.....	4.25@4.50	4.50	5.00
Brass, light.....	3.25@3.50	3.25	3.50
No. 1 yellow brass turnings.....	4.00@4.25	4.25	4.50
Zinc.....	2.00@2.25	2.00	2.25

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by $\frac{1}{2}$ in. and larger, and plates $\frac{1}{2}$ in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes.....	\$2.88	\$2.88	\$2.78
8 ft steel bars.....	2.78	2.78	2.68
Soft steel bar shapes.....	2.78	2.78	2.68
Soft steel bands.....	3.42	3.48	3.28
Plates, $\frac{1}{2}$ to 1 in. thick.....	2.88	2.88	2.78

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

BIRMINGHAM—The Birmingham Paper Co. has awarded a contract to C. M. Allen & Son, Birmingham, for the construction of a 1-story plant, 100 x 190 ft., for the manufacture of corrugated paper boxes and kindred products, estimated to cost about \$75,000. Of this amount, approximately \$40,000 will be used for the machinery installation. T. M. McClellan is president.

GADSDEN—The Gadsden Clay Products Co. has commenced work on its extension and improvement program, to include the installation of three down-draft kilns, with capacity of about 150,000 bricks; drying plant of waste-heat type, and other department extensions. It is proposed to develop an output of about 40,000 bricks per day. Gordon Hood is treasurer and general manager.

Connecticut

WINDSOR LOCKS—The J. N. L. Smythe Co., 32-34 South Sixth St., Philadelphia, Pa., manufacturer of paper products, has acquired the plant and business of the Windsor Locks Paper Mills, Windsor Locks. The new owner plans for extensions in the mill to double the present capacity.

Florida

EUSTIS—Adam J. Walz, Fort Mason, near Eustis, is organizing a company to establish a local plant for the manufacture of pressed bricks. Steam-operated presses, drying apparatus and other equipment will be installed.

Illinois

CICERO—M. L. Barrett & Co., 233 West Lake St., Chicago, manufacturer of essential oils, will soon commence the erection of a new plant at Cicero, contract for which recently has been awarded to the Kniskern Co., 149 South Dearborn St., Chicago. It will consist of two 1-story buildings, and is estimated to cost about \$100,000, including equipment. H. N. Mulder, Room 1702, 140 South Dearborn St., Chicago, is architect.

Indiana

INDIANAPOLIS—The Beveridge Paper Co. has tentative plans under consideration for the erection of a new building at its plant. It is proposed to begin work next spring. H. L. Beveridge is president.

Kentucky

SOMERSET—The Kentucky Coal & Electro Chemical Co. has preliminary plans under way for the erection of a local chemical manufacturing plant, comprising a group of buildings, estimated to cost about \$500,000, including machinery. The Associated Engineering Co., Somerset, is engineer.

LOUISVILLE—The Dosch Chemical Co. has acquired a local plant totaling over 15 acres of floor space, for the establishment of a new works for the manufacture of lime sulphur, rubber sulphur, sulphite solutions and other chemical products. A large department will be operated for the manufacture of insecticides, as well as for the production of machinery for spraying, dusting, etc., with chemical solutions. The machinery and equipment installation at the plant is estimated to cost in excess of \$200,000. Theodore Dosch is president of the company.

Louisiana

BOGALUSA—The Bogalusa Paper Co. is planning for the construction of a large addition to its local paper mills, erected several years ago and representing an investment of about \$2,000,000. The proposed extension will duplicate, in part, the present mill and is estimated to cost close to \$1,000,000, with machinery. W. H. Sullivan is president.

Maryland

BALTIMORE—The Adamentex Brick Co., recently organized with a capital of \$1,000,000, has acquired property on the Sulphur

Springs Road, Towson, totaling about 25 acres of land, as a site for the erection of its proposed plant for the manufacture of sand-cement bricks. It is proposed to provide buildings and equipment for an initial daily production of about 200,000 bricks. The company is represented by Blum & Makover, Equitable Bldg. L. F. Ducker is president.

Massachusetts

FITCHBURG—The Crocker-Burbank Co., manufacturer of paper products, has perfected plans for extensions and improvements in its mill, estimated to cost in the neighborhood of \$100,000, including machinery which will be installed.

PEABODY—Buddell & Harrigan, manufacturers of leather products, have acquired the local plant of the Formal Leather Co., for the establishment of a works for the production of chrome white leather, with daily output to approximate 200 dozen skins. The company will also continue operations at its plant in the Ingraham Bldg., and plans to increase the facilities of this factory.

Michigan

PLAINWELL—The Otsego Angle Steel Co. has construction under way on a 1-story plant, 40 x 200 ft., and plans for the early occupancy of the structure.

RIVERROUGE—The American Brick & Tile Co., recently organized, has acquired a tract of land totaling about 16 acres, adjoining the plant of the Ewing Bolt & Screw Co., with about 600 ft. of frontage on the Rouge River. It will be used as a site for the erection of a brick- and tile-manufacturing plant, with facilities to provide for the employment of about 500 operatives at the start. Preliminary plans are under way.

Missouri

FERGUSON—The Republic Photographic Co., Kansas City, Mo., is perfecting plans for the early erection of its proposed plant at Ferguson, and will soon break ground for different buildings. It will be equipped for the manufacture of sensitized paper specialties. The main building will be 78 x 160 ft., with chemical laboratory, 54 x 250 ft., adjoining; a complete paper drying department will be installed, as well as power plant for factory operation. The complete plant is estimated to cost in excess of \$200,000. Albert F. H. Seelig, 2194 Railway Exchange Bldg., St. Louis, is engineer. E. B. Fish is president.

New Jersey

MATAWAN—The Mosaic Tile Co. has awarded a contract to Walter V. Patton, 273 Main St., for the erection of two 1-story additions to its plant, 60 x 138 ft. and 27 x 182 ft., respectively, for increased production. Work will be commenced at once, and it is proposed to have the buildings ready for machinery at an early date. Headquarters of the company are at Zanesville, O., and Walter Miller, regularly located there, will supervise the construction and equipment installation.

LAMBERTVILLE—The Lambertville Pottery Co., manufacturer of sanitary ware, has commenced the construction of a new kiln at its plant.

LAMBERTVILLE—The Perseverance Paper Mill Co. will make a number of improvements in its local mill, prior to a resumption of production during the coming months. New equipment will be installed in different departments, and present machinery repaired and overhauled. It is planned to remodel certain portions of the mill.

New York

NEW YORK—The Robinson Stoneware Co., 226-36 Newell St., has filed plans for the rebuilding of the portion of its plant recently destroyed by fire. The work is estimated to cost about \$20,000.

ALBANY—The Hires Turner Glass Co., Philadelphia, has completed the erection of its branch plant on Tivoli St., near Broadway, and operations have been commenced. A manufacturing department will be maintained for the production of mirrors, beveled window glass, etc.

Ohio

EAST PALESTINE—The National Fireproofing Co., Fulton Bldg., Pittsburgh, Pa., will rebuild by day labor its plant at East Palestine, recently destroyed by fire, and excavations for the main building, 160 x 100 ft., are under way. The work will cost about \$60,000. Sidney F. Heckert, Bessemer Bldg., Pittsburgh, is architect.

CLEVELAND—The Carbo-Oxygen Co. has construction under way on an addition to its local plant, devoted to the manufacture of carbo-hydrogen gas, for the manufacture of oxygen gas. Similar additions will be erected, also, at the company plants at Columbus, O.; Bayonne, N. J.; Corapolls, Pa.; and Chicago, Ill., and initial work has been commenced. At Buffalo, N. Y., work is proceeding on a new plant for the manufacture of carbo-hydrogen gas and oxygen gas. To carry out the details of the expansion, the company has arranged for a preferred stock issue of \$2,000,000. J. C. Trees, Pittsburgh, Pa., is president.

Oklahoma

DEWEY—The Dewey Portland Cement Co., Mutual Bldg., Kansas City, Mo., has awarded a contract to the MacDonald Engineering Co., 53 West Jackson Boulevard, Chicago, Ill., for the erection of an addition to its plant at Dewey, estimated to cost about \$60,000. Work will be commenced at an early date.

TULSA—The Producers & Refiners Corp. is perfecting plans for the erection of a wax lubricating and grease plant at its oil refinery at West Tulsa.

Pennsylvania

PHILADELPHIA—Fire, Nov. 18, destroyed a portion of the lamp black and carbon manufacturing plant of the L. Martin Co., Raleigh St., with loss estimated at about \$100,000, including equipment. It is said that the plant will be rebuilt.

PITTSBURGH—The Birmingham Mirror Co., 2014 Josephine St., manufacturer of mirrors and other glass specialties, has tentative plans under consideration for enlargements in its plant.

PHILADELPHIA—The United Oxygen & Mfg. Co., Bath and Westmoreland Sts., has filed plans for the erection of a 1-story plant.

Tennessee

KNOXVILLE—The Knoxville Glass Co. has arranged for the construction of a 1-story plant, 90 x 100 ft., for the manufacture of mirrors and other glass products.

Texas

BEAUMONT—The Humphreys-Pure Oil Co., Dallas, is planning for the construction of a new refinery at Beaumont. The local Chamber of Commerce is interested in the project. Paul Gage will be in charge of erection. A. E. Humphreys is president.

MCGREGOR—The Koury Calcium Co., recently organized with a capital of \$400,000, has acquired property near McGregor, totaling about 150 acres of land, as a site for the erection of a plant for the manufacture of lime products. The proposed works will have a capacity of about 1,000 bbl. of finished material a day, and are estimated to cost close to \$100,000, including machinery. Michael Koury is president of the company, and W. V. Hanover secretary.

CAMERON—The Owens Refinery Co., Ardmore, Okla., is perfecting plans for the immediate erection of a local oil-refining plant, with initial output of about 1,500 bbl. a day. Local offices will be established in the First National Bank Bldg.

Utah

SALT LAKE CITY—The Industrial Potash Corp. is perfecting plans for the erection of a new mill, estimated to cost close to \$1,500,000, including machinery. A bond issue for this amount has been arranged to carry out the details of the project.

Washington

SEATTLE—The Commonwealth Finance Co., Securities Bldg., is arranging details for the formation of a new company, which will build a local plant for the manufacture of soap products. The company will be capitalized at \$250,000 and headed by C. H. Colson. Negotiations are under way for a lease of property on Westlake Ave., as a site for the new factory.

Wisconsin

MILWAUKEE—The Wadhams Oil Co., 359 Clinton St., has construction under way on a new oil refinery at Thirty-third and Burnham Sts., estimated to cost about \$100,000, with equipment. S. S. Cramer is president.

New Companies

THE SCANLON LEATHER CO., Boston, Mass., has been incorporated with a capital of \$25,000, to manufacture leather products. J. Frank Scanlon, 233 Purchase St., is president; and George Strangman, Swampscott, Mass., treasurer.

E. F. DREW & CO., INC., New York, has been incorporated with a capital of \$50,000, to manufacture chemicals and chemical by-products. The incorporators are T. P. Durrell, R. Dadd and C. S. Soule. The company is represented by Hun, Parker & Reilly, Albany.

THE GREENBERG BOTTLE CO., Newark, N. J., has been incorporated with a capital of \$100,000, to manufacture bottles and other glass products. The incorporators are Samuel B. Ferster, Wesley B. King and Herman W. Brams, 800 Broad St., Newark.

THE PLANT, THEIS & GOULD PAPER CO., 30 North La Salle St., Chicago, Ill., has been incorporated with a capital of \$50,000, to manufacture paper products. The incorporators are William M. Plant, Robert S. Theis and George W. Gould.

THE SILVER LEAF PETROLEUM CO., Fort Worth, Tex., has been incorporated with a capital of \$250,000, under Delaware laws, to manufacture petroleum products. The incorporators are J. P. Haley and C. I. Barfield, Fort Worth; and G. E. Wilson, Mineral Wells, Tex. The company is represented by the United States Corporation Co., 65 Cedar St., New York.

THE GOLDEN STATE COLOR & CHEMICAL WORKS, INC., Long Beach, Cal., has been incorporated with a capital of \$25,000, to manufacture chemicals, colors and affiliated products. The incorporators are J. S. Reardon, R. L. Buffum and J. V. Nevin, Long Beach.

THE LAGLER PAPER PRODUCTS CO., INC., New York, has been incorporated with a capital of \$40,000, to manufacture paper goods. The incorporators are D. R. Daly, O. Wuest and H. G. Smith. The company is represented by York & York, 7 Dey St.

THE HOLLAND GLASS WORKS, INC., 615 West Monroe St., Chicago, Ill., has been incorporated with a capital of \$40,000, to manufacture brass and bronze products. The incorporators are Frank J. and F. B. Liska.

THE LINCOLN OIL CO., Wilmington, Del., has been incorporated under state laws with capital of \$2,000,000, to manufacture refined oil products. The company is represented by the Delaware Registration Trust Co., 900 Market St.

THE CHARLES F. MARTIN LUBRICATING CO., Tulsa, Okla., has been incorporated with a capital of \$10,000, to manufacture lubricating oils, greases, etc. The incorporators are D. D. and Charles F. Martin, and A. F. Hoffman, Jr., all of Tulsa.

THE TWIN CITY LEATHER CO., Gloversville, N. Y., has been incorporated with a capital of \$40,000, to manufacture leather products. The incorporators are F. W. and M. Shire, and B. W. Draums, Gloversville. The company is represented by T. Haviland, Gloversville.

THE TITAN STEEL TUBE CO., 4851 North Springfield Ave., Chicago, Ill., has been incorporated with a capital of 2,500 shares of stock, no par value, to manufacture steel tubing. The incorporators are William Smith and Martin Swanson.

THE PORCELAIN APPLIANCE CORP., Parkersburg, W. Va., has been incorporated with a capital of \$25,000, to manufacture porcelain specialties, including electrical porcelain products. The incorporators are J. H. Parker, Parkersburg; H. R. Holmes, East Liverpool, O.; and R. G. Spencer, Carey, O. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington, Del.

THE PEARL OIL CO., Jamestown, N. Y., has been incorporated with a capital of \$100,000, to manufacture refined oil products. The incorporators are P. W. Goodwin, E. W. Olson and C. O. Johnson. The company is represented by J. R. Rogerson, 136 Bartlett Ave., Jamestown.

THE SOLIDONE MFG. CO., Newark, N. J., has been incorporated with a capital of \$125,000, to manufacture chemicals and chemical byproducts. The incorporators are I. S. Fleitell, Charles Schaezle and Simon W. Gordon, 183 Lillie St., Newark.

THE TARX CHEMICAL CO., 348 East Illinois St., Chicago, Ill., has been incorporated with a capital of \$25,000, to manufacture chemicals and chemical byproducts. The incorporators are L. E. Harding, W. C. Waggoner and W. S. Carson.

THE BULLION CHEMICAL CO., Memphis, Tenn., has been incorporated with a capital of \$50,000, to manufacture chemicals and chemical byproducts. The incorporators are Howard Brode and Isadore Bullion, both of Memphis.

THE W. E. FRANKS OIL CO., New York, has been incorporated with a capital of \$105,000, to manufacture refined oil products. The incorporators are F. Anderson, I. Randall and W. E. Franks, New York. The company is represented by W. J. Kenny, New Brighton, S. I.

CHENY & CO., INC., New York, has been incorporated under Delaware laws with capital of \$500,000, to manufacture magnesium cements and other plastic materials. The company is represented by the United States Corporation Co., 65 Cedar St., New York.

THE OWENS & TRAEGER CARTON CO., Hoboken, N. Y., has been incorporated with a capital of \$200,000, to manufacture folding paper boxes and cartons, and other paper specialties. The incorporators are Frank E. Kolb, Christopher W. Traeger and Clarence M. Owens, 1100 Adams St., Hoboken.

THE FRANCE-UTAH OIL CO., Salt Lake City, Utah, has been incorporated under Delaware laws with capital of \$5,000,000, to manufacture refined petroleum products. The incorporators are J. W. Musser and D. H. Gustavsen, Salt Lake City. The company is represented by the Corporation Service Co., Wilmington, Del.

Industrial Notes

THE ESSENTIAL OIL SPECIALTIES CO., Philadelphia, Pa., has changed its name to the Essential Oil Co., and moved its offices to Mulberry and New York Ave., Trenton, N. J.

THE AETNA EXPLOSIVES CO. has been succeeded by the Hercules Powder Co. The advertising, purchasing and traffic departments are at Wilmington, Del., and the branch sales office is at 120 Broadway, New York City.

THE RAYMOND BROS. IMPACT PULVERIZER CO., Chicago, Ill., has located a permanent Eastern office at 50 Church St., New York City. S. B. Kanowitz will be in charge.

THE POWDERED COAL ENGINEERING & EQUIPMENT CO. moved its offices and manufacturing plant from Chicago to Buffalo, N. Y., on Nov. 1. The personnel of the organization has been somewhat changed and H. B. Pruden has been elected as chairman of the board and J. W. Lansing of Buffalo has been elected president. The new board of directors of the company is as follows: J. W. Lansing, Fenton M. Parke, J. E. Finley, Harry R. Wait, J. C. Trefts, H. B. Pruden, B. W. Wistar, W. M. Faber and Stephen T. Lockwood.

THE POWDERED COAL DEVELOPMENT CORP. has been organized, with headquarters at Omaha, Neb. This company controls the Pruden patents for the burning of pulverized coal in the western half of the United States. The company is actively engaged in financing and erecting central pulverizing plants and installation of equipment for burning pulverized coal. Byron B. Oberst, formerly with the Interstate Oil & Refining Co., is president of the new corporation. The board of directors includes R. M. Robertson, construction engineer, American Smelting & Refining Co.; A. E. Hall, manager Omaha plant, American Smelting & Refining Co.; Joseph C. Weeth, president of the Harmon Weeth Coal Co.; J. J. Dodds, president of the Dodds Lumber Co.; Bert Phillips, formerly chief engineer, Collis Products Co., Omaha plant, and Irving H. Arey, with the Republic Metal Ware Co.

THE HARDINGE CO., New York, announces that H. A. Kimber, formerly of the Quigley Furnace Specialties Co., is now in charge of the sales of the Quigley pulverized fuel department of the Hardinge Co., in New York, N. Y. L. W. Marso, who is in charge of the branch office of the Quigley Furnace Specialties Co., located at 427 Oliver Bldg., Pittsburgh, Pa., will continue in the Pittsburgh office under the name of the Hardinge Co., but will specialize in the handling of the Quigley pulverized fuel systems, which department has been acquired by the Hardinge Co. from the Quigley Furnace Specialties Co.; O. M. Rau, formerly consulting engineer to the Philadelphia Rapid Transit Co., has become associated with the Hardinge Co., and will specialize in the handling of Quigley pulverized fuel systems as applied to boilers. W. O. Renkin has become associated with the Hardinge Co., New York, N. Y., in the capacity of managing engineer of the Quigley pulverized fuel department.

THE UNITED STATES CAST IRON PIPE & FOUNDRY CO., Burlington, N. J., announces the opening of a new office at 811 Dixie Terminal Bldg., Cincinnati, O. P. T. Laws, assistant works manager, will make this point his headquarters. Sales from this office will be in charge of Harold G. Henderson.

Capital Increases, Etc.

THE SUPREME PAPER BOX CO., 10 Forest St., Brooklyn, N. Y., has filed notice of increase in capital from \$25,000 to \$50,000.

THE POWERS-WEIGHTMAN-ROSENGARTEN CO., 916 Parrish St., Philadelphia, Pa., manufacturer of chemicals, has filed notice of decrease in capital stock from \$3,390,000 to \$1,700,000.

Reorganization plans are being perfected by officials of the **REPUBLIC RUBBER CO.**, Youngstown, O. A change in capitalization and stock issues will be made.

THE R. L. GREENE PAPER CO., Providence, R. I., has filed notice of increase in capital from \$50,000 to \$500,000.

THE OIL PRODUCTION CO., Houston, Tex., has filed notice of increase in capital from \$55,000 to \$75,000.

THE GOODYEAR TIRE & RUBBER CO., Akron, O., has disposed of a bond issue of \$27,500,000, the proceeds to be used for general operations, expansion, etc. E. G. Wilmer is president.

THE W. R. HOLLINGSHEAD CHEMICAL CO., a Delaware corporation, has filed notice of intention to operate in New York, with capital of \$1,000,000, for the manufacture of chemical products, with headquarters at Binghamton. W. R. Hollingshead and C. M. Reynolds, Binghamton, represent the company.

THE TOWNS PAINT CO., 222 Pearl St., Buffalo, N. Y., has filed notice of increase in capital from \$100,000 to \$200,000.

Officials of the **NATIONAL LEATHER CO.**, 161 South St., Boston, Mass., are arranging reorganization plans for the company, to include a preferred stock issue of \$15,000,000. The common stock will be reduced from 3,000,000 to 750,000 shares.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its seventy-fourth meeting at Toronto, Canada, Dec. 26 to 31, 1921.

AMERICAN CERAMIC SOCIETY will hold its twenty-fourth annual meeting at St. Louis, Feb. 27 to March 2, 1922.

AMERICAN CHEMICAL SOCIETY will hold its spring meeting at Birmingham, Ala., April 4 to 7, 1922.

AMERICAN ENGINEERING COUNCIL will hold its next meeting in Washington, Jan. 5-6.

AMERICAN FOUNDRYMEN'S ASSOCIATION will hold its next convention and exhibit at Cleveland, O., during the week of April 24, 1922. Meetings will be held in the spring instead of in the fall as heretofore.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS is holding its annual winter meeting at Baltimore, Md., Dec. 6 to 9. Headquarters are at the Emerson Hotel.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its spring meeting in New York the week of Feb. 20, 1922.

AMERICAN PETROLEUM INSTITUTE is holding its second annual meeting at the Congress Hotel, Chicago, Dec. 6, 7 and 8.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stettens Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

The following meetings are scheduled to be held in Rumford Hall, the Chemists' Club, New York: Dec. 9—American Chemical Society, regular meeting; Jan. 6—American Chemical Society, regular meeting; Jan. 13—Society of Chemical Industry, Perkin Medal; Feb. 10—American Electrochemical Society (in charge), Society of Chemical Industry, Société de Chimie Industrielle, American Chemical Society, joint meeting; March 10—American Chemical Society, Nichols Medal; March 24—Society of Chemical Industry, regular meeting; April 21—Society of Chemical Industry (in charge), American Electrochemical Society, Société de Chimie Industrielle, American Chemical Society, joint meeting; May 5—American Chemical Society, regular meeting; May 12—Société de Chimie Industrielle (in charge), American Chemical Society, Society of Chemical Industry, American Electrochemical Society, joint meeting; May 19—Society of Chemical Industry, regular meeting; June 9—American Chemical Society, regular meeting.

CHEMICAL & METALLURGICAL ENGINEERING

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Industrial Editor
J. S. NEGRU
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Number 24

Administrative and Business

Opinions on Tariff Policy

TARIFF, always much in the public eye, is just now directly in the spotlight of legislative, administrative and business interest. With the resumption of Congressional sessions, the Senate resumes its hearings on the tariff bill; the President in his message to Congress comments at length upon the tariff situation; and the Chamber of Commerce of the United States begins to take the vote of its member organizations on a referendum regarding seven important recommendations as to tariff policy. Surely no one can say that the subject is being neglected.

In one important particular the message of the President and the recommendations of the tariff policy committee of the national Chamber of Commerce agree—namely, that there should be a flexibility for administrative regulation of tariff rates. Speaking to this point, the President recommends obtaining flexibility through “the extension of the powers of the Tariff Commission so that it can adapt itself to a scientific and wholly just administration of the law.” The committee recommendation is: “Legislation should permit, in the event of changes of economic factors, adjustment of tariff rates by administrative authorities within limits prescribed by Congress for the purpose of maintaining a consistent tariff policy,” and the committee also recommends “creation of a tariff adjustment board to administer adjustable rates.”

Although not identical in phrasing or in implication of the agency which should administer an adjustable or flexible tariff rate, both of these recommendations recognize what is now clearly established as a fact, that we cannot arbitrarily today fix a tariff rate for many commodities without almost certainly encountering great disadvantage therefrom within the next few years, if indeed not within the next few months. There clearly is now established in the minds of many the belief that the principal economic facts and laws must sooner or later govern tariff adjustments and that the system of political tariff revision to suit the constituencies of the most influential legislators is in the long run, even for these particular constituencies, a bad policy.

In another particular the comment of the President and the recommendations of the Chamber of Commerce committee agree in part at least—namely, with respect to the proposal of “American valuation” of imports. The President points out that an arbitrary adoption of this basis of duties would be hazardous. But the Chamber of Commerce committee, with only one dissenting vote out of the twelve committeemen, recommends that “the present system of valuation for levy of ad valorem duties should be maintained and the so-called American valuation should not be adopted.”

It is more and more coming to be realized that tariff protection is not an unmixed blessing even to those industries which are “protected.” The opportunities

existing for interruption of foreign trade by protective tariff rates fixed on anything like a rigid or permanent basis is too great to be risked at the present time. All agree that anti-dumping legislation of some type is essential, and that reasonable protection for American industries subject to destructive competition will be of general benefit to the country whenever those industries are on a sound economic footing; but even the most ardent advocates of protection are now apparently beginning to waver in their advocacy of general high protective rates. Industries that have been counting upon such rates must, therefore, begin to put their house in order for living on a different basis.

Senate to Investigate

The Dye Industry

WE ARE to be regaled with a Senate investigation of the dye industry in the United States in an effort to discover monopoly on the part of American manufacturers and alleged lobbying and other nefarious activities on the part of importers of German dyes and their agents. Senator KING of Utah introduced the original resolution, which provided only for ferreting out the domestic monopoly, but Senator FRELINGHUYSEN of New Jersey shrewdly brought sufficient pressure to bear on the Senator from Utah to make him accept an amendment to extend the investigation to the so-called German dye lobby. Of course, Senator MOSES of New Hampshire supported the original King resolution and demonstrated by means of a large map suspended from the public gallery the extent of the control exercised by the alleged American monopoly in this country. Curiously enough, the center of this control was a large red spot marking the location of Wilmington, Del., with the word “du Pont” printed in the center of the red circle. It has become habit with Senator MOSES to see red whenever the dye business is mentioned, and he could readily be counted upon to join in the chase.

Thus the whole dye business in this country is to be laid bare to public gaze and we have Senator FRELINGHUYSEN to thank for making the investigation comprehensive. Like most investigations, it will probably engage in needless excursions into unrelated subjects, but we express the hope that even though the Senatorial committee may get off the track, American dye manufacturers will insist on keeping the two purposes clearly in mind so that we may know beyond a doubt whether there is a domestic dye monopoly and a perniciously active lobby of agents of German dye manufacturers.

It is not improbable that the dye embargo will come in for its share of the discussion, and we urge upon American manufacturers the merit of considering ways and means for placating the opponents of the embargo by suggesting the appointment of a board of review with an impartial chairman whose duty it shall be to determine when the embargo should be enforced. There is no doubt that it will be impossible to get a tariff law

high enough to keep out German dyes. It is equally certain the embargo will be the only effective measure, but its opponents must be given assurance that it can and will be administered fairly and efficiently. For our part we welcome the investigation and doubt not that American dye manufacturers will welcome it also if it is sincerely conducted.

Ceramic Engineers

Develop Clay Industries

DISCUSSIONS of an industry by those who have a broad view of the field are apt to contain statements far more sweeping than actual facts justify. For instance, it is often said that while the art of burning clay has been practiced for many centuries the application of science in ceramic industries is woefully lacking. Now this is true in measure, particularly if the research phase in pure science is considered. We do have much to learn about colloids, plasticity, electrochemical effects and the eutectics of clay mixes in the burning. But so are other industries in the adolescence of youth as regards scientific fundamentals.

Ceramic engineers, though only recently so named, are the true technologists. They have never failed to come forward when needed on plant problems. They were the first to use regeneration and recuperation in burning processes. During the French Revolution they developed continuous firing. The American chemist developed architectural terra cotta to a stage where the Wrigley and Woolworth type of building is an accomplished fact. Optical glass production, originally centered at Jena, has been surpassed in quantity and quality in America. Further examples might be given of recent work done by the Bureau of Standards, the Bureau of Mines, the teaching staffs and graduates of our ceramic schools. Movements under way to develop engineers from plant operators in the pottery industries selecting for intensive education many of the fine young chaps who have generations of clay-working experience in the blood and who must otherwise remain mere mechanics is a laudable and logical procedure.

Ceramics must be thought of as one of the fields where engineering deeds are making for worth-while progress.

Helium Demonstrates

Commercial Utility

IN THE demonstration of the navigability of an airship filled with helium, the C-7 of the Navy flew successfully on several short test flights around Hampton Roads and then made a trip to Washington and return as a complete answer to the feasibility of floating an airship with helium, which has approximately 92 per cent of the lifting power of hydrogen. The event will give an impetus to aviation with lighter-than-air craft and may be expected to stimulate the government's activities in the production of helium from certain of our natural gases. We believe that the Helium Board is in possession of information pointing to the existence of comparatively large percentages of helium in some natural gases not yet exploited, and with the determination of a policy as to the best method of production we may look for a renewed and more successful campaign. Incidentally it is worth recording that advocates of lighter-than-air craft foresee a large development in commercial aviation with gas-filled ships, despite the fact that this phase of the industry has apparently lagged behind airplane development.

National Income

and Its Distribution

THE National Bureau of Economic Research, a non-partisan body and one apparently without material bias, numbering among its directors WALTER R. INGALLS and GEORGE E. ROBERTS, has made a study of "Income in the United States," the report being now in press. Undoubtedly many men have wished they could see a presentation of what our collective income is and who gets it. At intervals, in non-census years, the Bureau of the Census estimates the total "wealth" of the United States, and in connection with the census it ascertains the number of persons engaged in gainful occupations, although it does not attempt to ascertain how gainful the occupations are.

The presentation now available states for each of the years 1910 to 1911 inclusive: (1) The total national income, in dollars; (2) the same, per capita; (3) the total, reduced to "1913 dollars" and thus representing in substance the quantity of goods or services involved, and (4) the same, per capita.

According to the figures, the total income increased falteringly from 31.4 billion dollars in 1910 to 36.0 billions in 1915, then sharply and continuously to 65.9 billions in 1919. On account of increasing population, the per capita income of \$340 in 1910 increased scarcely at all to 1915, but rose to \$629 in 1919.

Reducing the dollars to the 1913 basis, and thus representing the quantity of business done rather than the money return, the curve takes a different shape. Instead of ascending continuously, it reaches a maximum in 1916 and 1917, then descends. On account of the increase in population, the per capita ascends more gradually and descends more rapidly. It was \$349 for 1910, increasing to \$400 in 1916 and then descending to \$358 in 1919.

The presentation undertakes to show the division of income between investors and management on the one hand and those receiving wages and salaries on the other. The division shifts from 31-69 in 1910 to 26-74 in 1914, then swings the other way to 33-67 in 1916 and then reacts to 23-77 in 1918. The bureau intends eventually to furnish figures for 1919 and later years.

These figures may not be precisely accurate, but they cannot be far out. They may be said to supply a long-felt want. For instance, there has been the oft-repeated statement which many thinking men have been disposed to question, that in the last analysis labor gets 85 per cent of the money turnover. The normal seems to range between a 30 to 70 and a 25 to 75 division.

One of the interesting uses we can make of the figures presented is to make comparison between income and wealth. The Bureau of the Census reported the "wealth" of the United States at \$107,104,212,000 for 1904 and at \$187,739,071,000 for 1912. By interpolation we get \$163,000,000,000 for 1910. The national income as reported is 19 per cent of this amount. Our wealth at the time represented the equivalent of income for a trifle more than 5 years.

The United States Chamber of Commerce reported the "wealth" of the United States in 1920 at \$290,464,000,000. Interpolating between this and the census report for 1912, we get \$275,000,000,000 for 1919. The income in actual dollars was 24 per cent of this, while the income reduced to 1913 dollars was 14 per cent. As the figures of wealth cannot have been swelled by the depreciation of the dollar nearly as much as the income was swelled, the ratio between quantity of product and

quantity of things representing wealth was probably about the same as in 1910, approximately 1 to 5.

A still more important use can be made of the figures. Reduced to the standard of the 1913 dollar, the per capita income was \$349 in 1910 and \$358 in 1919. That means, if it means anything, that in 9 years we came to work harder or more efficiently by only 2.6 per cent. We made practically no progress. With better methods, improved equipment and greater personal efficiency, we should have come in 9 years to produce a great deal more per capita. We have a great and expensive war to pay for and we have to work hard and efficiently to accomplish the task.

Haber, Nernst

And the Amenities of Life

IT MADE us wince last year when the Nobel prize for 1919 was awarded to Professor HABER. Now we learn that the 1920 award goes to Professor NERNST. We comforted ourselves in regard to the Haber award with the belief that, after all, it was NERNST who was really the chief offender against his nation's solemn vow and against the faith of mankind by the introduction of the art of poisoning into warfare. As for HABER, we thought that he had merely trailed along behind NERNST. Of course after the miserable business was begun everybody had to engage in it, and no onus attaches to those who participated in it later.

But there wasn't any invention or merit in the use of poison to kill enemies. If this were an honorable thing to do, we might all be carrying wreaths to the tomb of the late LUCREZIA BORGIA. The selection of chlorine or phosgene or mustard gas or any of the other poisons was in no case a masterstroke. When the German leaders in military and physical science resolved upon it they were bound by their nation's plighted word not to do so. It was when they broke it that they offended against national honor and proved themselves to lack those inhibitions which, throughout the ages, men of good will have been trying to establish and conserve. This lack is the true criminal quality. The killing of soldiers by poison when all the world had agreed not to do it ranks along with the invasion of Belgium as a contributing cause to the present degeneration of faith.

We knew NERNST to be a leader in this crime, but we resolved for lack of certainty in regard to HABER to be lenient with him. HABER quit the service with the rank of Captain, whereas NERNST was made a Count of the German Empire by the Kaiser. Our later information is to the effect that NERNST and HABER were active rivals in this sorry business. Both men are great chemists. Both, for services rendered before their days of crime, were abundantly entitled to the great honor of the Nobel prize. We do not question the merit of these two awards on the ground of achievement in chemistry before the war. The point that we make is that their later participation in the great offense against humanity may be construed as the very reason for the awards of merit that now accrue to them from Sweden. This is not our belief. But public opinion is a curious thing, and it does not listen to explanations. It connects the names of NERNST and HABER with the preparation of the German gas attacks, and now it connects the same names with the Nobel prizes. The whole proceeding seems to us unfortunate and contrary to the intent of ALFRED NOBEL, who established the Foundation. It seems also unfair to the eminent men who received the great prize before, by putting them into such company.

Ford and Edison

Inspect Muscle Shoals

MESSRS. FORD and EDISON have recently made an inspection trip to Muscle Shoals in connection with Mr. FORD's offer for the nitrate plants and water-power development. Doubtless they found the plants in good standby condition, for they were so left by the Army officers and engineers at the time that the termination of hostilities in Europe spoiled a lot of good business in America. Likewise they must have found a good piece of work well started at the site of the Wilson Dam. So much any laymen could well undersand in "inspecting" these overinspected properties, as the politicians who reported to Mr. FORD well knew.

Just there, however, we suspect, ends the value of an inspection trip by these gentlemen. When asked what he thought of Mr. FORD some time ago, one of our beloved statesmen replied that he was a successful manufacturer of low-priced automobiles. Likewise, all are aware of the fact that THOMAS A. EDISON is a successful organizer of scientific research. It is doubtful, however, if any conservative business concern would seriously retain either gentleman as an expert in engineering or economics relating to water-power or nitrate plants. Probably, then, this junket was a bouquet-throwing affair arranged by the politicians local to Florence and Sheffield, Ala., who may be behind the Ford offer.

Equally unbusinesslike have been all conditions surrounding the Ford offer for Muscle Shoals. After the manner of the State St. or East Side trader, a snap offer asking special privileges on the water power and a \$5,000,000 bid for a plant layout costing \$100,000,000, the farce of inspection is entered into with Mr. EDISON acting as Mr. FORD's engineer. The old clothes man will give a dollar for the scarcely used dress suit, and the housewife may accept in the husband's absence. A pittance for Muscle Shoals is "good business" for Mr. FORD, but poor stewardship on the part of government officials if they accept.

It is not necessary or desirable that Muscle Shoals be sold on a single bid.

Water Power Development

Shows Impetus Under New Law

IN THE first report of the Federal Power Commission we get an insight into the degree to which the country was ready for the federal water-power act of 1920. Although it had been in existence only 16 months at the time the report was made, the commission had received 270 applications covering the possible development of over 16 million horsepower. The capital expenditure required to complete these projects would exceed in the aggregate two billion dollars. But the report is not concerned alone with prospects. Construction under license is now under way on seven projects for the development of 557,800 primary and 1,276,400 installed horsepower. In addition to this, the commission has authorized twenty-seven preliminary permits and thirty-one licenses, involving 1,415,600 primary and 2,627,000 installed horsepower. These are impressive figures, particularly for the period of industrial depression through which we have passed. Under the circumstances the Federal Power Commission may be pardoned for feeling that hydro-electric power development will be the outstanding industrial fact of the next quarter of a century.

Readers' Views and Comments

Sound Ingots and Rails as a Matter of Course

To the Editor of Chemical & Metallurgical Engineering

SIR:—I have read with great interest the communication of Sir Robert Hadfield, appearing in *CHEMICAL & METALLURGICAL ENGINEERING* of Oct. 26, 1921, and although I am in entire accord with Sir Robert that "sound ingots will result in sounder rails," I cannot agree with him that production of sound ingots has not had a full and proper chance of being investigated and tested on a large scale in America. I also must take exception to his intimation that the American practice of producing sound steel ingots has been attempts to follow or copy his system. At the present time, though steel production is very light, there is being produced in large or so-called tonnage mills approximately 100,000 tons of sound steel ingots per month by a distinctly American method, which, I am certain, does not use any of the features patented by Sir Robert Hadfield.

Our methods for producing sound steel do, however, employ the fundamentals which are essential to the production of sound homogeneous ingots, namely:

First. That the bath of metal be thoroughly deoxidized before teeming, so that no marked chemical reaction takes place during solidification.

Second. That the metal be cast in an ingot mold whose inside dimensions are enough greater at the top to prevent internal bridging of the shrinkage cavity.

Third. That the ingot be kept in substantially a vertical position until solidification is complete.

Fourth. That a suitable refractory sink-head be used.

Sir Robert Hadfield's method, as I understand it, specified a fifth—namely, to place a solid fuel or heating material on top of the sink-head portion of the ingot and to keep this fuel at a high temperature by means of a blow-pipe or forced draft. This latter provision I do not consider fundamentally essential, as we are daily making many heats of 3- to 4-ton ingots in which the sound product in bloom or billet averages over 90 per cent of the total weight of the ingot.

My work during the past 10 years for the betterment of steel ingots may not be strictly classified as original research work, as many of the results obtained by me were previously predicted by Henry M. Howe and Bradley Stoughton in their pioneer work with wax ingots in 1906-07 and were indicated by DeLavell in a Swedish patent of 1881. Such work as I have contributed to the art and science of the production of sound steel ingots has primarily been that of carrying out in a feasible mechanical manner, with new apparatus, the methods and theories advanced in a broad manner by Messrs. Howe and Stoughton, so that sound ingots can be commercially produced without interference with production.

The rounded concavo-convex bottom of an ingot I have found absolutely essential in the prevention of cleavage planes, which are the potential cause of most butt-cracks and internal flaws in the lower portion of ingots cast on flat stools, as used, I believe, by Sir Robert Hadfield and as has usually been the practice with all large ingots in tonnage production. The metal of the bottom of such ingots, which theoretically should be the soundest, is frequently full of internal flaws.

The manifest advantages of the big-end-up mold type are now so well known and generally understood, both as to benefits obtained in the reduction of shrinkage cavity or pipe and in the reduction and lifting of axial segregation, that it is not necessary to specify them.

It may be well to state specifically the important patented features of the Gathmann ingot mold, and these are indicated as follows:

A. Heavy, heat-absorbing walls at the lower and lighter mold walls at the upper portion of the ingot.

B. Concavo-convex rounded bottom of mold integral with the body or side walls of mold, to prevent cleavage planes at the base of the ingot, and to allow stripping without danger of finning underneath the mold walls.

C. Suspended conical base closure plug whereby the ingot may be moved upward in the mold.

D. Metal plate seal for preventing sticking of ingot to the stripping plug.

The above substantially are the important features which I have worked out for mass production of big-end-up ingots such as produced in large tonnage by American practice. I have also found that the sink-head of refractory material should be as nearly the maximum diameter of the ingot as may be workable in any specific mold, and that the volume of the sink-head should be at least 10 per cent of the total volume of the fluid ingot in order to assure that segregation of a harmful nature is all contained within the sink-head after solidification of the ingot. This results in approximately 94 per cent of sound steel in body of the ingot.

It might be of interest to your readers to have Sir Robert Hadfield plainly state the important patented features of his mold and of the British practice for producing sound ingots, and I trust that a public letter from him may be forthcoming specifically pointing out the patented features covered by him which he considers essential to carry out the British method of sound steel production.

That rail steels are still generally made from the cold top pyramidal big-end-down ingot is not because the rail manufacturer is unaware that molds and methods are in daily use which could be applied to the production of rail ingots and assure of the soundness of the rails, but is, I believe, primarily caused by the undoubted increased expense of suitably and thoroughly deoxidizing the bath of metal before teeming. This deoxidation unquestionably adds materially to the cost of the production and finishing of the steel, and rail makers, with but few exceptions, prefer to use a steel which is not thoroughly deoxidized, since the latter yields a larger tonnage at less cost per ton.

The railroads are fundamentally responsible for this condition, as it is within their power to specify that the ingots from which the rails are rolled shall be *thoroughly* deoxidized as well as the present knowledge of the art may permit. Buyers of other high-grade products do thus specify, and the steel maker, be it of rails or any other product, will, I feel certain, be governed largely by the requirements of the buyer.

EMIL GATHMANN,

Baltimore, Md.

Vice-President and General Manager,
Gathmann Engineering Co

Endurance of Steel Under Repeated Stresses

Fatigue Tests on Many Commercial and Alloy Steels Develop No Evidence of "Endurance Limit"—
Ultimate Tensile Strength Closely Related to Endurance Stress at 100 Million Cycles—
Special White-Souther Machine and Semi-Logarithmic Graphs Used

BY D. J. MCADAM, JR.

Metallurgist, U. S. Naval Engineering Experiment Station

FOR several years the subject of endurance of steel under repeated stresses has been investigated at the U. S. Naval Engineering Experiment Station. This investigation has included a variety of carbon and alloy steels that have been heat-treated in various ways. For each type of steel, in addition to the endurance tests, tension, torsion, hardness and impact tests have been made.

ENDURANCE TESTING MACHINE

In the endurance tests described in this paper, the test specimen was arranged as a rotating cantilever beam. During every revolution of the specimen under test, it was subjected to definite alternate tension and compression.

The machine used for this purpose has been developed at the U. S. Naval Engineering Experiment Station. It is a modification of the White-Souther machine. As shown in Fig. 1, this machine is composed of units each capable of testing four specimens at once. Although

holder is due to L. E. Foster, assistant foreman of the Naval Engineering Experiment Station. As shown in Fig. 3 the outer end of the tapered sleeve is threaded so that the hexagonal nut *N* can be attached; knurled nut *O* is then adjusted. By means of the interaction of these two nuts the tapered sleeve *L* holding the specimen *E* may be forced into or removed from the hollow tapered specimen holder *D*.

This method of inserting and removing the test specimen is far superior to the method used in the original White-Souther machine. The violence necessary in inserting and removing the specimen by the old method soon put the surfaces of tapered sleeve and sleeve holder in such condition that the specimen was not properly centered and consequently wobbled when revolved. By use of the improved method, however, the hardened surfaces of tapered sleeve and sleeve holder remain true indefinitely, and the centering of the specimen is so accurate that from a distance of several feet it is difficult to see whether or not the specimen is revolving.

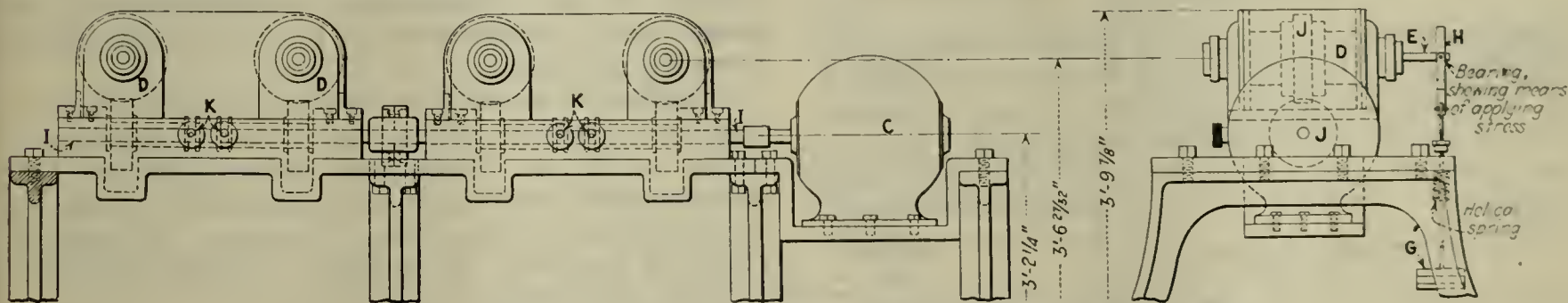


FIG. 1. GENERAL DRAWING OF ENDURANCE TESTING MACHINE

Fig. 1 shows two units on the same side of the motor *C*, the units at the Naval Experiment Station are assembled so that the motor is between two units.

Each of the rotating hollow specimen holders *D* holds two test specimens *E*. Adjustable weights *F* are suspended from the end of every test specimen by means of the rods *G* attached to the ball bearings *H*. Below and at right angles to the specimen holders is a long shaft *I* driven by the motor *C*. Specimen holders are rotated by means of spiral gears *J* on the shaft and on the outside of the hollow cylinders. By means of the clutches *K* the rotation of any specimen holder may be started or stopped while the motor shaft is rotating at full speed.

An enlarged view of one of the specimen holders is shown in Fig. 2. It will be noticed that the hollow specimen holder *D* and the sleeve *L* that surrounds the test specimen *E* are each tapered. The tapered sleeve is split, nearly to the inner end, so that it will fit both specimen and holder.

The method of inserting and withdrawing the specimen and tapered sleeve from the hollow tapered specimen

Early in this investigation it was found that if the load is allowed to act on a test specimen while starting or stopping the machine, the specimen is usually bent so that it is of no further use. For a successful endurance test the load must act on the specimen only while it is rotating at full speed. Evidently at a speed somewhat less than the usual running speed corresponding to the

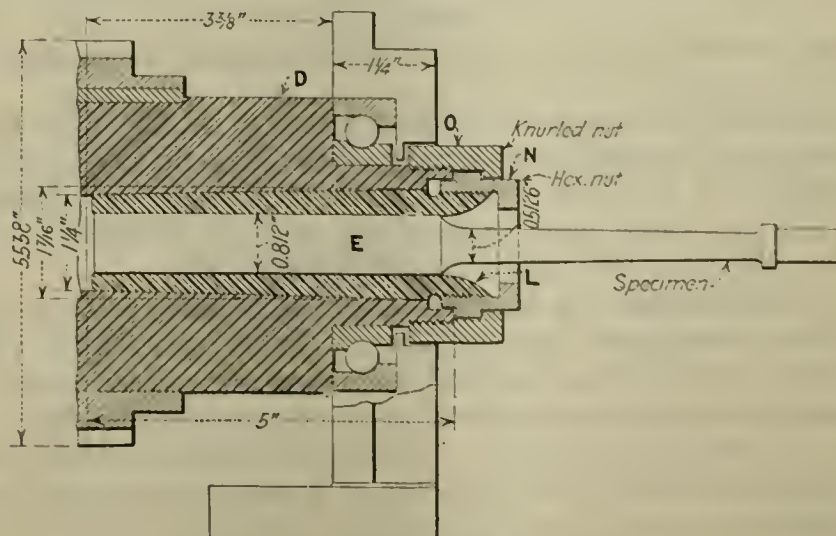


FIG. 2. DETAIL OF SPECIMEN HOLDER

natural frequency of vibration of the weighted specimen, there is excessive vibration of the weighted specimen. The frequency of vibration varies inversely with the load applied and with the types of specimen used is evidently below the usual running speed for loads above about 50 lb. Since the loads used were usually considerably greater than 50 lb., the critical speeds in these investigations were probably always below the actual running speed. Nevertheless, to dampen any synchronous vibrations and diminish their frequency, the weights were suspended by means of helical springs in all the later experiments.

Apparatus, not shown in Fig. 1, was developed for automatically removing the load from the specimen when the speed slackens or the machine stops, consisting of a system of counter-weights, levers and magnetic release. It was developed by L. E. Foster and John Amoss of the Experiment Station.

TEST SPECIMEN

The test specimen originally used in this investigation was of type A shown in Fig. 3. The left end, when under test, is gripped by the tapered sleeve, and is large enough to be used for a tension or alternating torsion test after the rotating cantilever endurance test is finished. In type A (Fig. 3) under test, the maximum stress is at the end of the $\frac{1}{2}$ -in. fillet. The

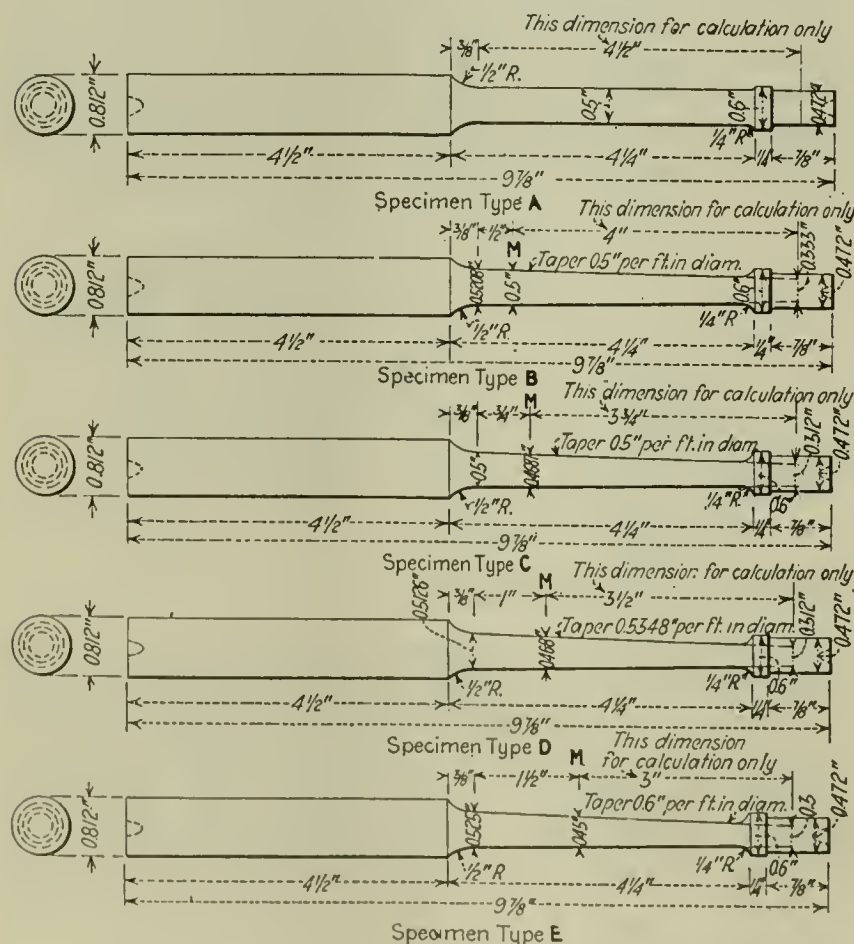


FIG. 3. DIMENSIONS OF ENDURANCE TEST SPECIMENS

finishing tool used was shaped so as to fit the fillet at the plane of maximum stress; sharp tool marks in the region of maximum stress were thus avoided. Very light cuts were taken in finishing, and the greatest care was taken in the entire machining process.

Although type A specimens, made as thus described, gave results as consistent as could apparently be expected in endurance tests, an improved type of specimen was later developed and used. In the improved type of specimen the portion subject to stress is conical instead of cylindrical. The taper is so adjusted that the maximum stress, instead of being at the end of the fillet, is in any desired plane *M* as illustrated by types B to E.

Moreover, while in type A specimens the stress falls off rapidly with distance from the plane of maximum stress, in the other specimens the taper can be so adjusted that the stress is nearly uniform over a considerable length of the specimen.

The principle used in designing the tapered specimen is as follows: If a cantilever beam is made of such shape that the surface is a cubic-paraboloid, the maximum stress will be uniform throughout its entire length. Machining a test specimen to such a shape would

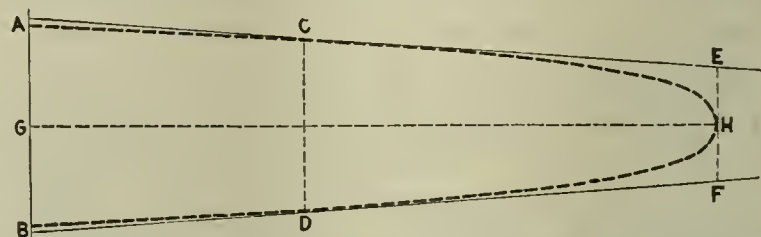


FIG. 4. DETERMINING TAPER AND LOCATION OF PLANE OF MAXIMUM STRESS

evidently be impracticable. Fortunately, however, simple tapered specimens can be so designed that their conical surfaces are tangent to a cubic-paraboloid at any desired plane, as illustrated by Fig. 4. For any such cubic-paraboloid the line *CD*, connecting any two opposite points of tangency, is one and one-half times as long as the line *EF*. In a conical specimen of longitudinal section *ABFE*, all points on the surface except those in the plane passing through *CD* are outside the cubic-paraboloid; *CD* is, therefore, the plane of maximum stress. But, since the conical surface for some distance on either side of the plane of maximum stress in these specimens does not differ greatly from the surface of the corresponding cubic-paraboloid, the stress over a considerable part of the entire length is nearly uniform.

Variation of stress with distance from the plane of maximum stress in the various types of specimen is shown in Fig. 5. Comparison makes it evident that the uniformity of stress is much greater in the tapered specimens than in the type A specimen. In types B, C and D, moreover, the variation of stress over about $1\frac{1}{2}$ in. of the specimen length is slight.

CONCENTRATION OF STRESS AT THE FILLET

The stress at the end of the fillet, even after the most careful machining, is undoubtedly somewhat above the theoretical value. It seemed desirable, therefore, to adopt a type whose plane of maximum stress is so far from the fillet that the specimen will not break there. In such a specimen, the theoretical stress at the fillet would be enough below the maximum stress to offset the excess stress due to the fillet.

To determine the best type of specimen to use, and at the same time to get information in regard to the influence of the fillet in increasing the actual stress beyond the theoretical value, a series of endurance tests was made on specimens of the various types, although these comparative tests were not made until after type A specimen had been in use for some time. Specimens of the various types were made from round rods of mild steel heat-treated in three different ways and stressed sufficiently to cause breakage after a comparatively few revolutions.

The results may be summarized as follows: Of two type B specimens, both broke at the fillet. Of twelve type C specimens, only two broke at the fillet. Of seven type D specimens, only one broke at the fillet. Of four

type *E* specimens, none broke at the fillet. In types *C* to *E* the stress distribution is such as to overcome the excess stress due to the fillet. Since, as shown in Fig. 5, the stress distribution is more uniform in type *C* than in the other types, this was finally adopted for use instead of the original type *A*. Since in this specimen the stress over a length of about 1½ in. does not vary more than about 1½ per cent, it might be expected that, due to slight irregularity of material, fracture may occur anywhere within these approximate limits. It has been found that the position of fracture may vary

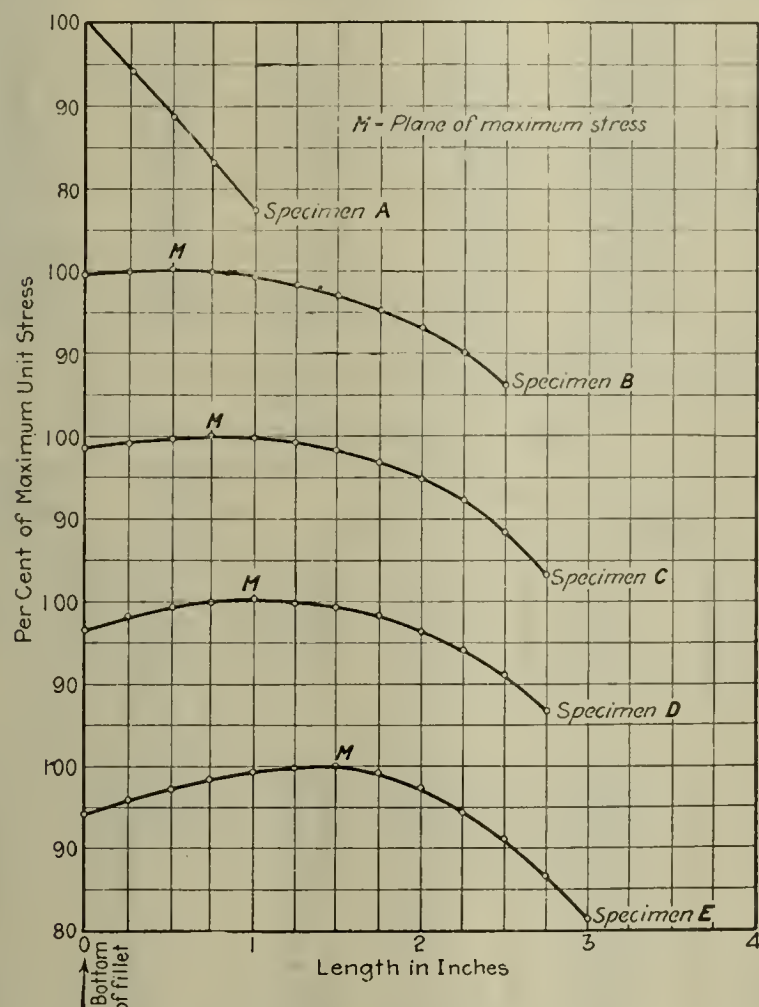


FIG. 5. RELATIVE STRESS IN TAPERED SPECIMENS

throughout several inches of the length of the specimen. Though some type *C* specimens break at the fillet, about as many specimens break at an equal distance the other side of the plane of maximum stress, so it seems probable that the fillet has practically no influence.

The comparative tests on various types of specimen have given some indication of the amount of the excess stress due to the fillet. This excess stress is evidently greater than ½ per cent, the drop in stress in type *B* specimen from the plane of maximum stress to the fillet, but less than 1½ per cent, the corresponding drop in stress in type *C* specimen. It was finally decided that a correction of 1 per cent should be added to the theoretical fiber stress values in all type *A* specimens.

MATERIAL

The Bethlehem Steel Co. co-operated in this investigation by furnishing nearly all the material, R. M. Bird of this company giving valuable aid in suggesting and making provisions for suitable material. It was furnished in the form of rolled rods about 13 ft. long and 1¼ in. to 1½ in. in diameter. The American Rolling Mill Co. also supplied bars of "Armco" ingot iron.

The material is described in Table I. Chemical analysis is shown in Table II. Nearly every kind of steel was heat-treated by the makers in two different ways, to give proportional limits of alloy steels at about 60,000 and 110,000 lb. per sq.in.

Some of the material furnished by the Bethlehem Steel Co. was annealed at the Naval Engineering Experiment Station. In designating this material, the letter *a* has been added to the marking.

TENSION TESTS

Average results of several tension tests on every kind of material are given in Table III. The tests were made on an Olsen 50,000-lb. machine. The test specimen was of the Navy standard type, having a 2-in. test length and a 0.505-in. test diameter. The extensometer was of Riehle type. For every experiment, a stress-strain diagram was drawn, and from this the proportional limit was obtained. Speeds below proportional limit were 0.0183 in. per minute per inch test length, and 0.117 in. beyond that point.

TORSION TESTS

Average results of individual torsion tests for every kind of material are given in Table IV. The machine used was of Riehle type, having a capacity of 60,000 lb. The specimen has a 3-in. test length and ¾-in. test diameter. In calculating the stresses up to the proportional limit, the equation $T = \frac{\pi}{16} SD^3$ was used, whereas in calculating the maximum stresses the equation $T = \frac{\pi}{12} SD^3$ was used, where *T* represents the torque, *S* represents the stress and *D* represents the diameter of the specimen. Speed of testing below the proportional limit was 1.26 deg. per minute, and 160 deg. above that point.

HARDNESS TESTS

Average results of two Brinell and scleroscope hardness tests on each material are given in Table III. The machine used in the Brinell tests was an Olsen compound lever machine with standard 10-mm. ball, and the diameter of the impression was measured by a micrometer microscope.

CHARPY IMPACT TESTS

Results of Charpy impact tests by the Bethlehem Steel Co. and by the Naval Experiment Station are given in Table V. An American-made Charpy impact machine of 31 kg.-m. capacity was used by the Naval Experiment Station. The test specimen was a notched bar 0.394 x 0.394 x 2.165 in. The notch, 1 mm. wide, extended halfway through the cross-section of the specimen, with radius of curvature at the bottom of the notch of ½ mm. With a few exceptions, the notch was formed by drilling a hole 1 mm. in diameter at the center of the specimen and afterward cutting the notch from the side of the specimen to the hole. Some specimens from three of the alloy steels, however, were so hard that they could not be drilled; in these eight specimens the notch was cut with a V-shaped tool having a ½-mm. radius at the edge.

FREMONT AND IMPACT-SHEAR TESTS

The same table also gives results of impact tests made at the Watertown Arsenal by the Fremont method and at the Naval Experiment Station by the impact-shear method.¹ The latter was developed at the Naval Experiment Station, and uses an unnotched specimen ¼ x ¾ in. in cross-section. By moving this specimen forward

¹D. J. McAdam, Jr., "Endurance and Impact Tests of Metals," *Proc., A.S.T.M.*, vol. 16, Part II, (1916).

TABLE I. KEY TO MATERIAL DESIGNATIONS

Mark	Material Kind	Heat-Treatment
A 1	0.13 Carbon steel.....	Annealed 1350°
A 2	0.14 Carbon steel.....	As rolled
B	0.21 Carbon steel.....	As rolled
C 1	0.30 Carbon steel.....	Annealed 1200°
C 2	0.31 Carbon steel.....	Quenched in oil 1525° and annealed at 1200°
D 1	0.48 Carbon steel.....	Annealed 1350°
D 2	0.49 Carbon steel.....	Quenched in oil 1600° and annealed 1150°
E	0.77 Carbon steel.....	Annealed at 1350°
F	Nickel steel.....	To approximate proportional limit of 60,000 lb. per sq.in.
G	High-chromium steel.....	To approximate proportional limit of 60,000 lb. per sq.in.
H 1	Nickel-molybdenum steel....	To approximate proportional limit of 60,000 lb. per sq.in.
H 2	Nickel-molybdenum steel....	To approximate proportional limit of 110,000 lb. per sq.in.
I 1	Chromium-molybdenum steel.	To approximate proportional limit of 60,000 lb. per sq.in.
I 2	Chromium-molybdenum steel.	To approximate proportional limit of 110,000 lb. per sq.in.
J 1	Chromium-vanadium steel....	To approximate proportional limit of 60,000 lb. per sq.in.
J 2	Chromium-vanadium steel....	To approximate proportional limit of 110,000 lb. per sq.in.
K 1	Low-nickel-chromium steel...	To approximate proportional limit of 60,000 lb. per sq.in.
K 2	Low-nickel-chromium steel..	To approximate proportional limit of 110,000 lb. per sq.in.
L 1	High-nickel-chromium steel...	To approximate proportional limit of 60,000 lb. per sq.in.
L 2	High-nickel-chromium steel..	To approximate proportional limit of 110,000 lb. per sq.in.
M 1	Si-Mn spring steel.....	To approximate proportional limit of 60,000 lb. per sq.in.
M 2	Si-Mn spring steel.....	To approximate proportional limit of 110,000 lb. per sq.in.
N 1, 2, 3	Ingot iron.....	As rolled
O 1	0.22 Carbon steel.....	As received
O 2	0.23 Carbon steel.....	Heated to 1600° F., held ½ hour, cooled in oil, reheated to 900° F., held ½ hour cooled in furnace
O 3	0.23 Carbon steel.....	Heated to 1600° F., held ½ hour, cooled in oil, reheated to 1100° F., held ½ hour, cooled in furnace
O 4	0.23 Carbon steel.....	Heated to 1600° F., held ½ hour, cooled in oil, reheated to 1300° F., held ½ hour, cooled in furnace

TABLE II. AVERAGE RESULTS OF CHEMICAL ANALYSES

Material	C	Mn	P	S	Si	Ni	Cr	V	Mo	As
A 1	0.13	0.56	0.008	0.047	0.17	.....	.....	.....	.....	.....
A 2	0.14	0.53	0.008	0.056	0.17	.....	.....	.....	.....	0.010
B	0.21	0.82	0.060	0.080	0.08	0.206	0.017	.....	.....	.....
C 1	0.29	0.52	0.010	0.051	0.17	.....	.....	.....	.....	.....
C 2	0.31	0.47	0.013	0.03	0.16	.....	.....	.....	.....	.....
D 1	0.48	0.60	0.010	0.038	0.19	.....	.....	.....	.....	.....
D 2	0.49	0.63	0.011	0.036	0.18	.....	.....	.....	.....	.....
E	0.77	0.55	0.037	0.047	0.18	.....	.....	.....	.....	.....
F	0.29	0.66	0.005	0.046	0.14	3.70	.....	.....	.....	.....
G	0.21	0.59	0.017	0.017	0.79	0.13	13.31	.....	.....	.....
H 1	0.41	0.45	0.037	0.020	0.20	1.72	.....	.....	0.13	.....
H 2	0.42	0.47	0.38	0.020	0.25	1.68	.....	.....	0.12	.....
I 1	0.40	0.52	0.033	0.024	0.26	.....	0.95	.....	0.10	.....
I 2	0.42	0.53	0.032	0.023	0.25	.....	1.04	.....	0.09	.....
J 1	0.24	0.30	0.046	0.044	0.29	0.173	1.16	0.23	.....	.....
J 2	0.53	0.50	0.005	0.038	0.22	.....	1.46	0.23	.....	.....
K 1	0.43	0.63	0.012	0.038	0.22	0.47	1.10	.....	.....	.....
K 2	0.41	0.64	0.009	0.033	0.20	1.45	1.10	.....	.....	.....
L 1	0.33	0.47	0.007	0.052	0.18	3.18	0.96	.....	.....	.....
L 2	0.33	0.46	0.006	0.051	0.19	3.16	0.95	.....	.....	.....
M 1	0.55	0.65	0.024	0.037	1.97	.....	.....	.....	.....	.....
M 2	0.51	0.66	0.029	0.045	1.96	.....	.....	.....	.....	.....
N	0.023	0.037	0.002	0.031	0.005	.....	.....	.....	.....	.....
O 1	0.23	0.37	0.016	0.033	0.021	.....	.....	.....	.....	.....
O 2, 3, 4	0.23	0.41	0.012	0.033	0.044	.....	.....	.....	.....	.....

TABLE III. AVERAGE TENSION AND HARDNESS TESTS

Material	Maximum Stress Lb. per Sq. In.	Proportional Limit Lb. per Sq. In.	Yield Point Lb. per Sq. In.	Elongation, in 2 In. per Cent	Reduction of Area, per Cent	Brinell Hardness Number	Shore Scleroscope Number
A 1	54,520	26,250	26,250	43.5	70.5	108.9	17.3
A 2	58,220	31,250	31,250	38.8	63.5	118.5	18.7
B	70,710	39,870	40,500	35.3	62.9	142.2	21.0
C 1	69,930	35,000	36,870	34.5	50.1	143.1	21.3
C 2	71,250	37,500	40,000	34.5	67.0	147.2	21.6
D 1	81,400	38,750	38,750	31.3	53.5	156.6	22.9
D 2	101,700	53,800	56,360	25.5	52.5	195.0	27.0
E	111,120	46,250	47,500	17.3	27.3	211.0	26.3
F	92,120	60,000	61,250	29.8	54.8	183.4	23.4
G	97,500	61,250	61,250	30.5	59.8	193.7	26.6
H 1	104,720	51,250	56,250	21.3	41.0	211.0	27.0
H 2	133,350	100,000	102,500	19.8	51.3	244.8	35.4
I 1	92,250	51,250	57,500	27.0	57.5	185.0	28.3
I 2	141,370	112,500	115,000	18.5	50.5	279.2	37.9
J 1	79,550	47,500	49,170	30.7	57.2	162.7	23.1
J 2	146,570	114,000	120,500	17.5	53.4	292.0	37.7
K 1	92,900	48,330	49,170	29.8	57.3	188.3	25.3
K 2	133,690	105,620	108,750	22.3	54.6	268.8	35.3
L 1	103,000	50,000	52,500	27.0	49.5	208.0	22.0
L 2	133,370	105,000	108,750	20.7	58.2	260.4	35.7
M 1	111,750	57,500	60,000	24.5	40.3	226.2	25.5
M 2	157,450	100,000	101,000	16.5	40.0	305.6	36.6
N 1, 2, 3	44,250	20,000	25,000	48.5	74.5	86.6	11.0
O 1	64,250	36,250	37,500	39.0	61.5	.....	.....
O 2	67,500	43,000	44,250	40.0	22.2	.....	.....
O 3	66,500	41,000	42,000	39.0	22.2	.....	.....
O 4	60,000	36,120	37,250	40.0	22.6	.....	.....

TABLE IV. TORSION TEST RESULTS

Average of all determinations					
Material	Maximum Stress, Nominal, Lb. per Sq. In.	Proportional, Limit, Lb. per Sq. In.	Angle of Twist at Prop. Limit, Min.	Angle of Twist at Break, Deg.	Modulus of Rigidity, Lb. per Sq. In.
			Per Linear Inch		
A 1	46,550	19,320	15.5	369.8	12,300,000
A 2	45,910	16,900	17.1	288.1	10,200,000
B	57,530	26,400	22.8	273.9	10,500,000
C 1	54,660	22,330	19.2	225.4	10,500,000
C 2	59,020	26,560	20.3	326.6	12,300,000
D 1	62,490	25,350	22.8	187.1	10,500,000
D 2	76,890	41,650	30.9	245.8	12,000,000
E	80,240	34,410	25.8	105.3	12,400,000
F	68,530	38,940	32.8	212.1	10,900,000
G	72,720	43,460	33.3	232.5	12,300,000
H 1	68,380	31,690	30.0	113.8	9,900,000
H 2	90,250	65,800	55.8	171.1	11,900,000
I 1	69,050	41,650	31.9	264.9	12,100,000
I 2	93,080	76,670	62.9	220.8	11,500,000
J 1	61,940	31,090	25.1	290.8	12,100,000
J 2	96,110	80,900	64.5	149.3	12,400,000
K 1	70,320	35,620	28.3	254.8	11,900,000
K 2	90,450	69,730	54.8	205.7	11,500,000
L 1	71,360	29,580	23.9	243.6	11,700,000
L 2	88,440	66,610	61.4	201.3	10,800,000
M 1	77,890	36,220	30.0	131.8	11,600,000
M 2	102,570	66,410	53.6	120.8	11,500,000
N 3	41,220	17,500	13.8	409.3	11,600,000

TABLE V. IMPACT TEST RESULTS

Material	Charpy Impact					Fremont Impact		Impact Shear	
	Bethlehem Steel Co.		Experiment Station			Watertown Arsenal		Experiment Station	
	No. of Determinations	Ft.-Lb. (Average)	No. of Determinations	Kg.-M. (Average)	Ft.-Lb. (Average)	No. of Determinations	Work Absorbed by Specimen, Kg.-M. (Average)	No. of Determinations (Two Specimens)	Ft.-Lb. (Average)
A 1	4	37.00	8	5.10	36.85	4	23.9	8	36.76
A 2	4	47.02	8	6.96	50.34	4	25.0	8	35.86
B	3	31.05	6	4.23	30.59	4	20.66	8	38.68
C 1	4	18.41	16	2.90	21.01	8	9.91	8	33.12
C 2	4	20.15	8	2.18	15.77	3	8.93	8	39.41
D 1	4	6.52	8	0.52	3.76	4	6.00	8	34.28
D 2	4	7.59	8	0.59	4.28	4	7.62	8	36.27
E	4	7.34	7	0.25	1.85	4	3.87	8	28.26
F	4	36.96	8	5.20	37.65	4	21.15	8	35.60
G	5	14.46	5	2.09	15.16	4	4.85	8	37.03
H 1	4	9.36	8	1.42	10.32	4	5.38	8	28.55
H 2	4	22.41	7	3.10	22.45	4	8.78	8	30.43
I 1	4	26.90	8	3.38	24.45	6	14.73	8	39.91
I 2	4	28.92	8	4.04	29.12	4	11.08	8	27.58
J 1	3	19.66	8	3.07	22.23	3	12.73	8	40.14
J 2	.....	.....	6	1.84	13.35	4	13.55	8	27.64
K 1	4	23.31	8	3.56	25.66	2	7.5	8	38.50
K 2	5	27.27	4	4.26	30.83	4	10.9	8	31.02
L 1	5	32.91	8	4.66	33.71	3	16.8	8	36.07
L 2	4	30.42	5	4.11	29.78	4	13.5	8	30.02
M 1	4	5.80	8	0.44	3.20	4	3.45	8	31.01
M 2	1	11.79	8	0.51	3.69	4	5.82	8	30.50
N 1	.....	.....	3	3.31	23.94	.....	.....	4	36.60

TABLE VI. RELATIONS BETWEEN OTHER PHYSICAL PROPERTIES AND ENDURANCE STRESSES AT 10⁵ AND 10⁸ CYCLES

Material	Endurance Stresses		Ratio Endurance Stresses, 10 ⁵ and 10 ⁸ Cycles	Ratio of Endurance Stress, 10 ⁸ Cycles to		
	At 10 ⁵ Cycles	At 10 ⁸ Cycles		Ultimate Tensile Strength	Brinell Hard- ness	Ultimate Torsional Stress
A 1	35,000	26,000	0.74	0.48	239	0.56
A 2	35,000	24,800	0.71	0.43	209	0.54
B	43,300	33,250	0.77	0.47	234	0.58
C 1	38,400	30,000	0.78	0.43	210	0.55
C 2	37,300	30,000	0.80	0.42	204	0.51
D 1	38,500	35,000	0.91	0.43	223	0.56
D 2	46,150	41,400	0.90	0.41	212	0.54
E	46,000	39,000	0.85	0.35	185	0.49
F	49,800	46,100	0.93	0.50	251	0.67
G	52,750	47,000	0.89	0.48	243	0.65
H 1	53,000	46,600	0.88	0.44	221	0.68
H 2	67,000	57,000	0.85	0.43	233	0.63
I 1	51,200	47,000	0.92	0.51	254	0.68
I 2	72,200	67,500	0.93	0.48	242	0.73
J 1	44,000	36,100	0.82	0.45	222	0.58
J 2	74,000	66,850	0.90	0.46	229	0.70
K 1	45,800	39,150	0.85	0.42	208	0.56
K 2	69,000	54,900	0.80	0.41	204	0.61
L 1	50,000	39,900	0.80	0.39	192	0.56
L 2	70,000	60,000	0.86	0.45	230	0.68
M 1	54,500	49,100	0.90	0.44	217	0.63
M 2	71,000	62,000	0.87	0.39	203	0.60
N 1, 2, 3	28,200	23,600	0.84	0.54	250	0.57
Average.....			0.85	0.44	222	0.60
Average depart.....			0.05	0.033	16	0.05

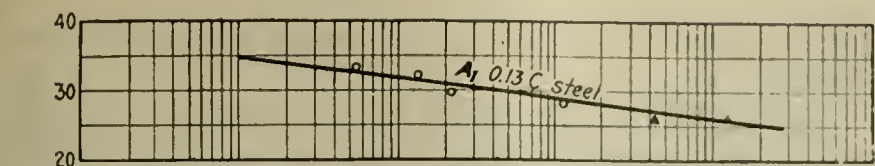


FIG. 6

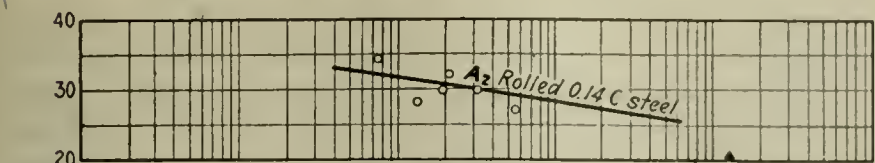


FIG. 7

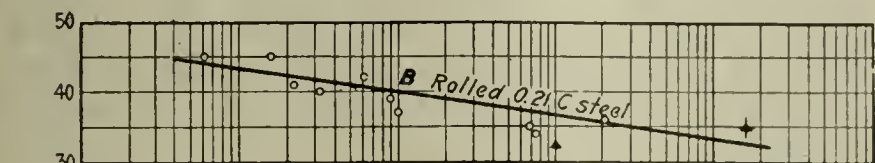


FIG. 8

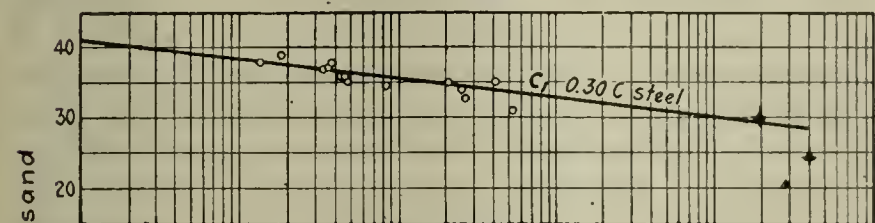


FIG. 9

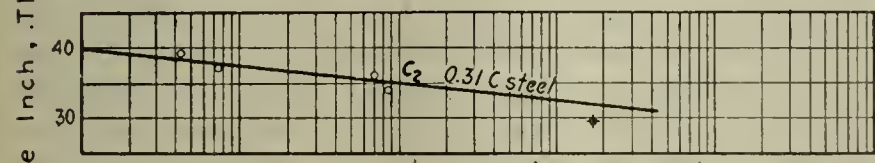


FIG. 10

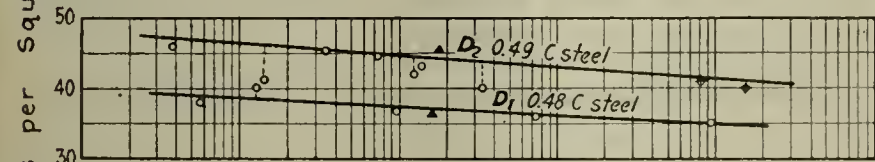


FIG. 11

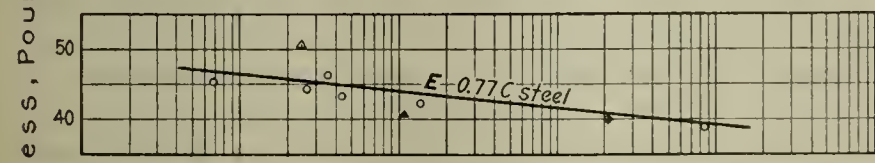


FIG. 12

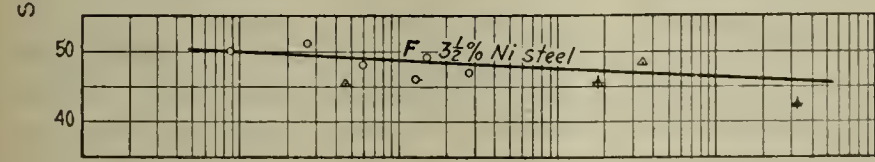


FIG. 13

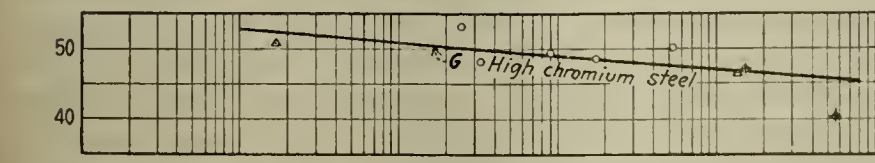


FIG. 14

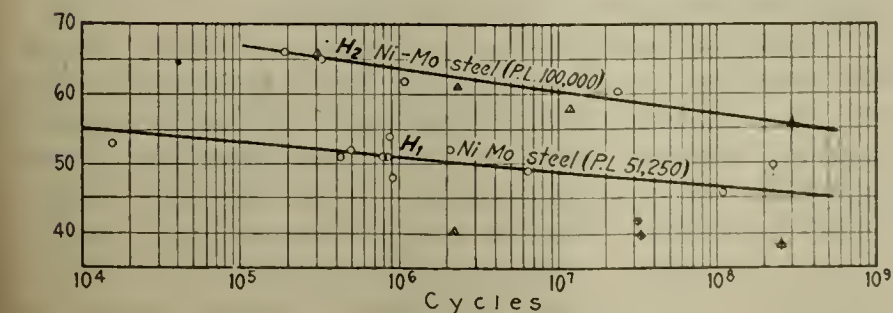


FIG. 15

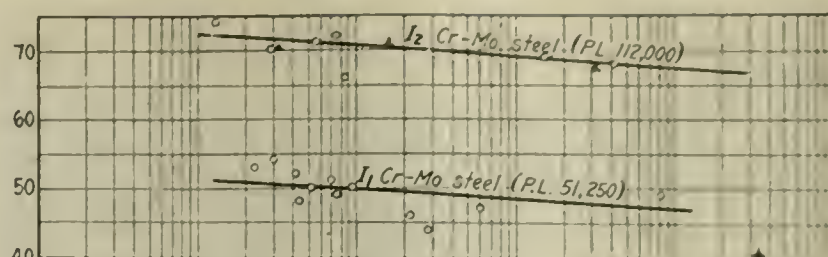


FIG. 16

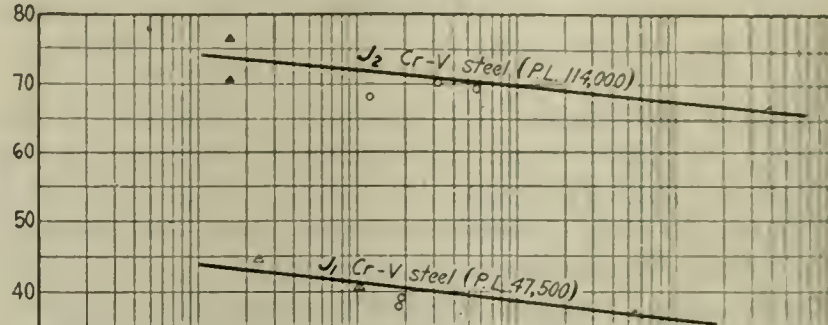


FIG. 17

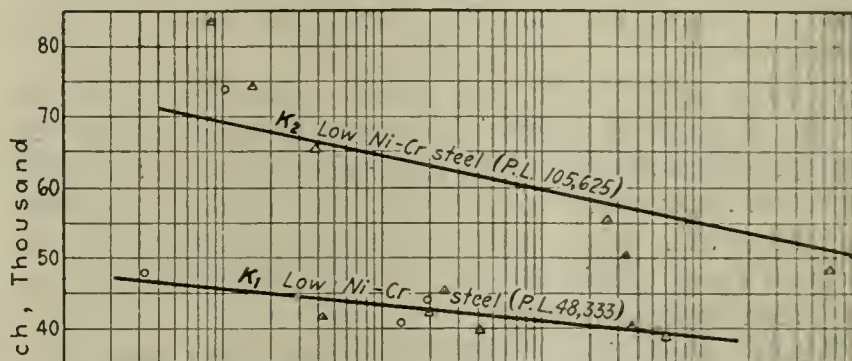


FIG. 18

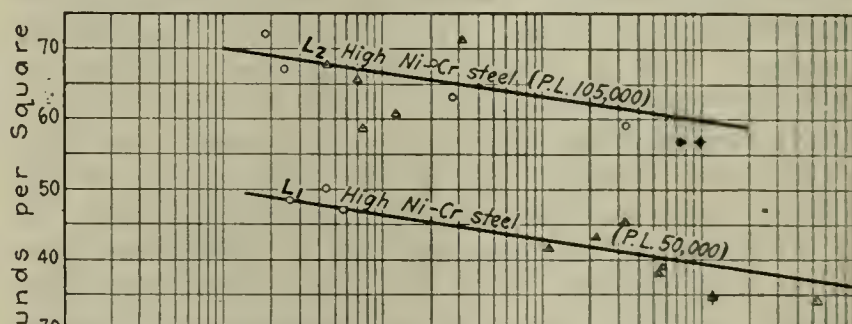


FIG. 19

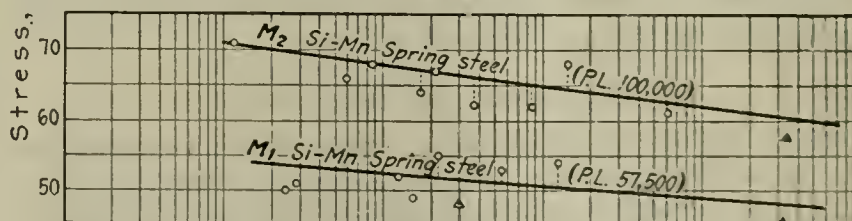


FIG. 20



FIG. 21

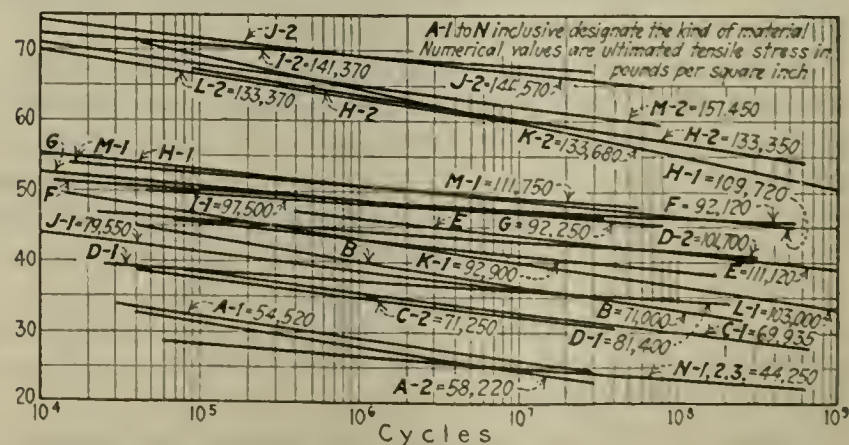


FIG. 22

FIGS. 6 TO 22. ENDURANCE OF STEELS

Fig. 6. Endurance of 0.13 plain carbon steel annealed at 1,350 deg. F.
 Fig. 7. Endurance of 0.14 carbon steel as rolled.
 Fig. 8. Endurance of 0.21 carbon steel as rolled.
 Fig. 9. Endurance of 0.30 carbon steel annealed at 1,200 deg. F.
 Fig. 10. Endurance of 0.31 carbon steel quenched and tempered.
 Fig. 11. Endurance of 0.485 carbon steel quenched and tempered.
 Fig. 12. Endurance of 0.77 carbon steel annealed at 1,350 deg. F.
 Fig. 13. Endurance of 3 1/2 per cent nickel steel.

Fig. 14. Endurance of high chromium (stainless) steel.
 Fig. 15. Endurance of heat-treated Ni-Mo steel.
 Fig. 16. Endurance of heat-treated Cr-Mo steel.
 Fig. 17. Endurance of heat-treated Cr-V steel.
 Fig. 18. Endurance of heat-treated low Ni-Cr steel.
 Fig. 19. Endurance of heat-treated high Ni-Cr steel.
 Fig. 20. Endurance of heat-treated Si-Mn spring steel.
 Fig. 21. Endurance of ingot iron.
 Fig. 22. Assembly of endurance tests.

after each test several tests can be made on every specimen.

In investigating the endurance of the various kinds of steel as many individual tests were made as time and material would permit. Stresses were so adjusted that fracture occurred after periods ranging from a few thousand to many million cycles. The machines were run day and night and interruption of any test previous to fracture of the specimen was avoided whenever possible.

Graphs illustrating the stress-cycle relations as developed by these tests are shown in Figs. 6 to 21 inclusive. Fig. 22 summarizes all the results shown—these curves have the ultimate strength of the material also noted. Circles represent specimens of type C which were broken; triangles represent broken type A specimens; crosses note the specimen had not failed at the time of writing or when the alternating stress test was discontinued.

Though emery cloth and crocus cloth were used on all the specimens, a special wooden form shaped to fit the specimens and fillet was used to support the abrasive on certain specimens not distinguished on the diagrams. Polishing with emery cloth No. 1 and crocus cloth was in such cases continued for 5 or 10 minutes after the specimen appeared smooth.

When the results of these endurance tests were first plotted, both stresses and cycles were represented by logarithmic co-ordinates. The advantage of logarithmic plotting is that it reduces the ordinates representing cycles to a convenient length. It has, however, the disadvantage that it minimizes stress differences, especially at the higher stresses. Since the determination of the effect of stress variations on endurance is the object of the investigation, this disadvantage of logarithmic plotting is rather serious. For this reason semi-logarithmic plotting was finally adopted, the ordinates being made proportional to the stresses and the abscissas to the logarithms of the numbers of cycles.

DISCUSSION OF RESULTS

Since slight irregularities of material and of surface are inevitable, it is not to be expected that the positions representing the individual results for any one kind of material would lie on a line either straight or curved. In attempting to draw idealized graphs representing stress-cycle relations, mathematical averages alone cannot be used. The exercise of judgment is necessary, due weight being given to the type of specimen and the history of each individual experiment.

Examination of the figures will show that the results obtained with carbon steels are usually less variable than those obtained with alloy steels. A comparison of the carbon steels makes it apparent that increase of carbon content increases the variability of results. Of the alloy steels, the irregularities are greatest in the chromium-nickel and silicomanganese steels. Apparently the irregularities in results are due largely to inevitable slight irregularities in composition or constitution of the metal.

A study of all the endurance test results has revealed no evidence of any abrupt change in direction of stress-cycle graphs throughout the cycle range investigated. The evidence seems to indicate that the idealized graphs should be nearly straight lines. Though the lines should probably not be entirely straight, the curvature should apparently be so slight that at present it can be neglected. Straight lines, have, therefore, been drawn in

what seems to be the most probable location of the idealized graphs.

The slopes of these graphs do not differ greatly, and are always much less than would be expected from a study of the publications of previous investigators. For example, Basquin² gives a number of logarithmic graphs, compiled from the results of various investigators, in which the angles of slope are such as to indicate a drop of 50 per cent or more in endurance stress with each thousand-fold increase in number of endurance cycles. Moore and Seeley³ and Moore and Gehrig⁴ show graphs with the same indications. Their curves were obtained from the investigations of Wöhler, from investigations at the Watertown Arsenal, and those at the University of Illinois.

On the graphs of Figs. 6 to 21, however, the average slope indicates that the average drop in endurance stress with a thousand-fold increase in number of endurance cycles is only about 15 per cent, varying, for the twenty-three kinds of material investigated, from 7 to about 29 per cent. The numerous results of this investigation, therefore, seem to show conclusively that for this type of endurance test the drop in endurance stress with increase in number of endurance cycles is not nearly so rapid as has been previously supposed. The discrepancy between these conclusions and those of previous investigators may possibly be due to the fact that their graphs were drawn from comparatively few individual results. Some of their individual results, if given weight, would materially change the directions of the corresponding graphs.

RELATION BETWEEN ENDURANCE AND PROPORTIONAL LIMIT

Comparisons of the pairs of graphs, Figs. 16 to 20 inclusive, shows that doubling the proportional limit by heat-treatment does not increase the endurance strength in anywhere near the same proportion. In fact, the results of all the experiments have shown conclusively that endurance stress bears no definite ratio to proportional limit. This ratio is greatest in annealed material. In ingot iron and annealed steels of low carbon content, the endurance stress for 100,000,000 endurance cycles is above the proportional limit; indeed, in ingot iron this endurance stress is not far from the yield point. In quenched and tempered material, however, the endurance stress may be less than half the proportional limit. While an annealed mild steel specimen stressed to its proportional limit will run for weeks without breaking, a quenched and tempered steel specimen stressed to anywhere near its proportional limit will show the entire range of temper colors up to deep blue and break in a few minutes.

Heat-treatment increases endurance strength in approximately the same ratio in which it increases ultimate tensile strength. The results of all the experiments seem to indicate that the endurance strength of any steel is rather closely related to its tensile strength. This and other relations are illustrated by Table VI, where are listed the endurance stresses for 10^6 and 10^7 endurance cycles, and the ratios between these two members for each kind of steel, a measure of the slope of the graph. The ratios of the endurance stresses for 10^6 endurance cycles to the values for ultimate tensile

²O. H. Basquin, "The Exponential Law of Endurance Tests," *Proc., A.S.T.M.* (1910).

³H. F. Moore and F. B. Seeley, "The Failure of Materials Under Repeated Stress," *Proc., A.S.T.M.*, 1915, Part II.

⁴H. F. Moore and A. H. Gehrig, "Some Fatigue Tests of Nickel Steel and Chrome Nickel Steel," *Proc., A.S.T.M.*, 1919, Part II.

stress, Brinell hardness and ultimate torsional stress are also listed in this table.

Ratios of endurance stresses to ultimate tensile stresses are surprisingly constant, in view of the great variety of material tested. The average ratio is 0.44 and the average departure of individual values from the average is only ± 0.033 . The average ratio of endurance stress to Brinell hardness is 222 ± 16 . As would be expected, the constancy in this ratio is nearly as great as that of endurance to ultimate stress. The average ratio of endurance stress to ultimate torsional stress is 0.60 ± 0.057 ; the constancy is about the same as in the ratio of endurance stress to Brinell hardness.

According to Basquin,⁵ the stress-cycle relations for endurance of metals, under two complete stress-reversals per cycle, can be expressed by the exponential equation

$S = \frac{B}{N^q}$, in which S represents the endurance stress, N represents the corresponding endurance cycles, and B is a constant whose value depends on the material. Since this equation can be written also

$$\log S = \log B - q \log N$$

it can be represented on logarithmic co-ordinate paper by a straight line graph. It seems probable, however, that this straight line relationship is only approximate and that the logarithmic graph has a slight curvature with convexity downward. Extensive investigation would be necessary to decide this definitely, including a number of endurance tests extending to at least 500 million cycles.

When graph slopes are as slight as those shown in Fig. 19, a straight line logarithmic graph would remain nearly a straight line if transformed to semi-logarithmic paper. There would, however, be a slight curvature with convexity downward. Any slight downward convex curvature of a logarithmic graph would, therefore, be magnified by transforming it to semi-logarithmic paper. It seems evident, therefore, that the curvature of stress-cycle graphs can be studied best by the latter method of plotting.

EFFECT OF CHEMICAL COMPOSITION ON ENDURANCE PROPERTIES

A study of the figures shows that in general the graphs are located in the order of the ultimate tensile stress values. This relationship might have been predicted from a study of the constancy of the ratios given in Table VI.

In general, chemical composition seems to influence the endurance stress of a steel only as it influences its tensile stress. This rule may, however, be only approximate, since there are a few apparent exceptions shown in the figures. For example, graph M-2 of silicon-manganese steel has a lower position, and graph G of high-chromium steel has a higher position in the series than would be predicted from a comparison of tensile strength values. Further experiments, however, may make it necessary to make some change in the relative position and slope of these graphs.

Comparison of the graphs showing endurance properties of annealed carbon steels and "Armco" ingot iron as received from the manufacturers shows the influence of carbon on the endurance properties of steel. As would be expected, other things being equal, the endurance stress increases with increase in carbon per-

centage, at least within the range investigated. The apparently anomalous position of the graph representing material B is explained by the fact that this material contains considerably more manganese than the other steels of the series. These graphs would, if assembled on one sheet, be located approximately in the order of their tensile strengths.

SUMMARY

Graphs of endurance test results on either logarithmic or semi-logarithmic paper show no evidence of abrupt change of direction throughout the cycle range investigated. Results of all the tests give cumulative evidence that the idealized stress-cycle graphs on either logarithmic or semi-logarithmic paper should be represented by nearly straight lines.

Semi-logarithmic plotting was finally adopted, since it best represents stress differences, especially at the higher stresses. Semi-logarithmic plotting, moreover, would best reveal any slight downward-convex curvature that may possibly appear as a result of further experiment. In the present state of the evidence the idealized graphs have been represented on semi-logarithmic paper as straight lines.

The angles of slope of these graphs are such as to indicate that for this type of endurance test the drop in endurance stress with increase in number of endurance cycles is not nearly so rapid as has been previously supposed. The average drop with a thousand-fold increase in endurance cycles is about 15 per cent.

The endurance stress for 100,000,000 endurance cycles bears no definite relation to the corresponding proportional limits. The ratio is higher in annealed material than in quenched and tempered material. In ingot iron and annealed mild steels of lower carbon content, the endurance stress for 100,000,000 endurance cycles is above the proportional limit. In quenched and tempered steels, it is often less than half the proportional limit.

The endurance stresses for 100,000,000 endurance cycles have been found to bear a surprisingly uniform relation to the corresponding ultimate tensile stresses. In the many kinds of material investigated, this ratio varies from about 0.35 to 0.54, the highest value being found in ingot iron. The average ratio is 0.44 ± 0.033 .

The ratio of endurance stress to Brinell hardness, and the ratio of endurance stress to maximum torsional stress, are nearly as uniform as the ratio of endurance stress to ultimate tensile stress.

Until further evidence accumulates, it may be stated that chemical composition has little effect on endurance properties other than its effect on ultimate tensile stress.

A comparison of impact test results with the results of endurance tests has shown no definite relationship. Additional experiments, however, are being made, the results of which will be discussed in the future.

ACKNOWLEDGMENTS

The writer's thanks are due to R. M. Bird of the Bethlehem Steel Co. and to the American Rolling Mill Co. for co-operation in this work. The writer wishes to acknowledge with thanks the encouragement in this work given by Captain John Halligan, Jr., U.S.N., head of the Naval Engineering Experiment Station, also the assistance received from Messrs. Foster, Vandermast, Amoss and others employed at the Naval Engineering Experiment Station.

⁵See footnote 2.

The Volume of Air Required in Air Drying

Problems Which Confront the Average Engineer in Attempting to Find the Volume of Air Required in Air Drying—Calculation From Wet Bulb Temperatures and Psychrometric Tables—Charts for 100, 85, and 70 per Cent Ultimate Humidity

By C. T. MITCHELL

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IN AIR-DRYING operations it is convenient and often essential to know what quantity of air, under certain conditions of temperature and humidity, is necessary in order to evaporate a given amount of moisture. This problem is a comparatively simple one to a specialist in air conditioning, but, on account of the many variables involved, is apt to be a perplexing one to the average engineer, who has not the time to devote to its solution in detail. Not finding tables or formulas at hand with the required information, he resorts to approximation. If he has a well-developed sense of proportion, he may make some very good guesses. On the other hand he may not. The writer has never seen any tables or charts published giving the above-mentioned information directly, and has consequently thought it worth while to prepare the accompanying charts, in the hope that some one may find them **worthy of insertion in his scrap book.**

FACTORS AFFECTING ATMOSPHERIC EVAPORATION

It is perhaps not generally realized, at least by those with a non-technical education, that atmospheric evaporation, such as goes on around us every day, consists of two distinct operations. First, there must be heat by which to vaporize the water. Next there must be an abundance of air present to associate with the vapor and carry it away. The drier the air the more water vapor it will be able to carry and the quicker will be the evaporation.

The humidity of the air in drying operations under atmospheric conditions is consequently quite as important as the temperature. It is easy to imagine that when air is highly saturated an enormous quantity of it will be required to absorb a small amount of moisture. This fact seems almost too simple to bear repetition, and yet the writer has seen the doors of dry rooms closed in order "to keep the heat in," when there was no means of circulation except through the door itself.

Since the pressure is constant in most air-drying operations, the present article deals with only two variable factors, temperature and humidity, the air being taken at constant pressure, and approximately 30 in. barometer. Most drying is done under these conditions, and a vast proportion of it, fortunately, is possible without technical guidance and with a fair amount of efficiency. Yet the average laundress would no doubt be astonished to hear that several thousand pounds of atmosphere must come in contact with the clothes hanging on her lines before they are dry. We venture to say also that many engaged in drying material of a much more refractory nature than clothes would be more or less astonished were they able to visualize the enormous quantities of air which must pass through their dry rooms, unassisted save by natural circulation. Some of

them might even be inclined to doubt the figures as given in the charts. For their benefit an explanation will be given as to how the curves were plotted.

COOLING OF AIR DURING EVAPORATION

The problem is as follows: A certain volume of air, say a cubic foot, is brought into contact with moist material and permitted to remain there until saturated. If we know the weight of moisture in the unit of air before evaporation and subtract it from the weight of moisture in the air after evaporation, then divide the result into the number of pounds of moisture to be evaporated, it is evident that we will arrive at the number of cubic feet of air necessary, at the initial temperature and humidity. The problem is complicated, however, by the fact that the temperature of the air drops during evaporation and that each degree drop lowers the saturation point. What temperature will it finally arrive at? Also, when the air cools, it shrinks slightly in volume, but this is offset again to a certain extent by an increase in the volume due to the addition of the vapor to the original. Since we know that the latent heat of evaporation of the moisture to be removed has been borrowed from the cubic foot of air itself, we might balance these two heat quantities and arrive at the result in this way. Since the latent heat varies with the temperature and there are several other variables in the problem, with no possibility of establishing sufficient equations for a solution, we find that it would be necessary to work out the result by trial. As this would be very cumbersome and open to inaccuracies and arguments as to the correctness of the values used for the specific heat of moist air, we search for another method of solution, and find one ready made for us—namely, the tabulations of the wet and dry bulb thermometer readings as embodied in Carrier's psychrometric chart. The wet bulb temperature has been defined as the temperature to which the evaporation of water from a wet cloth cools the mercury bulb of a thermometer when slung through the air. The following definition seems more expressive if less noncommittal, however: The wet bulb temperature is the approximate ultimate temperature to which air may be cooled by the process of evaporation. This brings out the distinction between the wet bulb temperature and the dew point. The dew point is the temperature at which air reaches the saturation point when cooled by external means. The two are different and the explanation may be illustrated as follows.

DISTINCTION BETWEEN WET BULB TEMPERATURE AND DEW POINT

Imagine two sealed boxes, each box containing 1 cu.ft. of air, the temperature and humidity of the air in both boxes to be the same. The sides of the boxes

must be perfectly insulated against heat interchange with the outside air, and each box must be capable of expanding or contracting with change of temperature, so as to keep the barometric pressure constant inside the box. In one box is a brine coil through which brine of a gradually lowering temperature is circulated. The air in the box is thus slowly cooled to the point where moisture begins to deposit on the coil. The circulation of brine is now continued at constant temperature until all the air in the box is at the same temperature as the brine. This temperature is the dew point of the original air. Into the other box we inject a tiny spray of water, and by means of a small pump located inside the box itself, we continue the spray effect, using the same water over and over again until the air has become saturated and will absorb no more. To avoid criticism we will assume that the temperature of the water at the beginning of the experiment is the same as the wet bulb temperature of the air. The temperature of the air in this box is now found to correspond to the wet bulb temperature of the air before injection of water. It is evident that the temperature in the box with the brine coil will be the lower of the two, because the brine has been continually removing heat, while no heat has been added or taken away from the other box. This may be also proved in another way: The atmosphere in the box with the brine coil has neither lost nor acquired moisture, while in the other box a definite amount of moisture has been absorbed. Since the

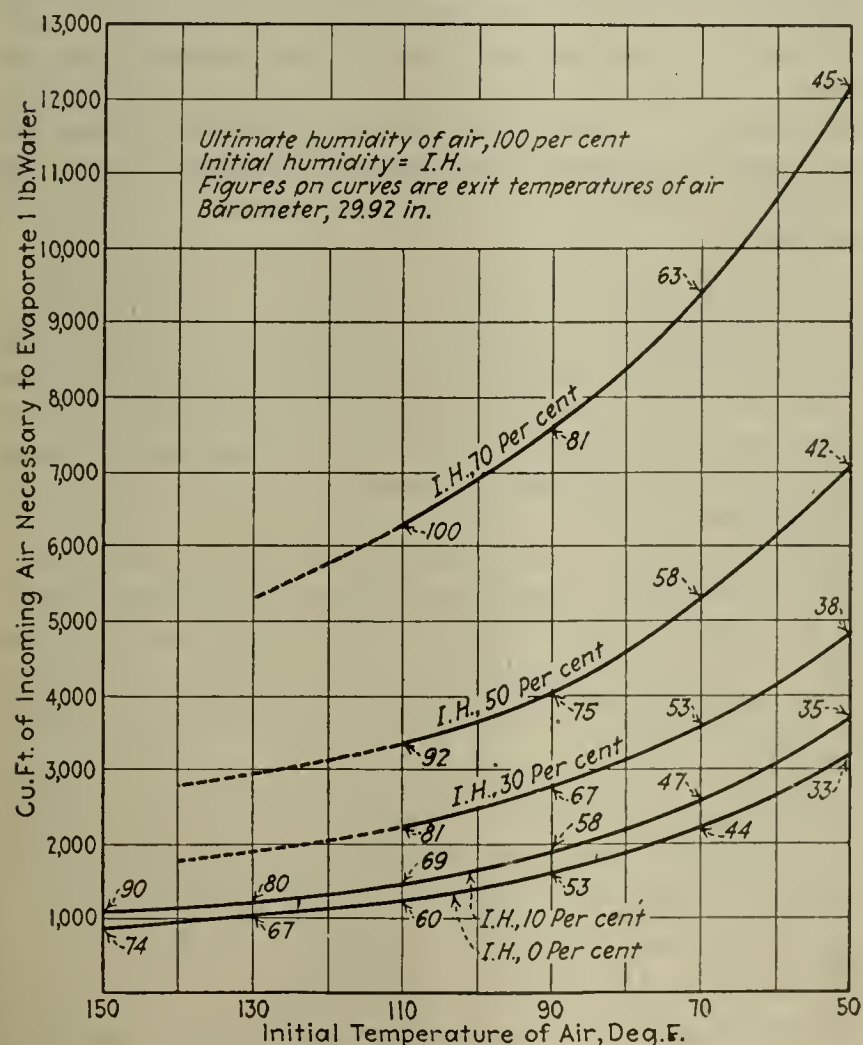


FIG. 1. VOLUME OF AIR REQUIRED IN AIR DRYING, ULTIMATE HUMIDITY OF AIR, 100 PER CENT

atmosphere in both boxes is in a saturated condition at the conclusion of the experiment, we know that the atmosphere containing the most moisture must be at the higher temperature, other things being equal.

Experiments of this kind would be difficult to carry out in practice, except in a laboratory. The wet bulb, or sling psychrometer, is a simple instrument, however, and gives readings which approximate very closely to the temperature in the box with the water spray. By

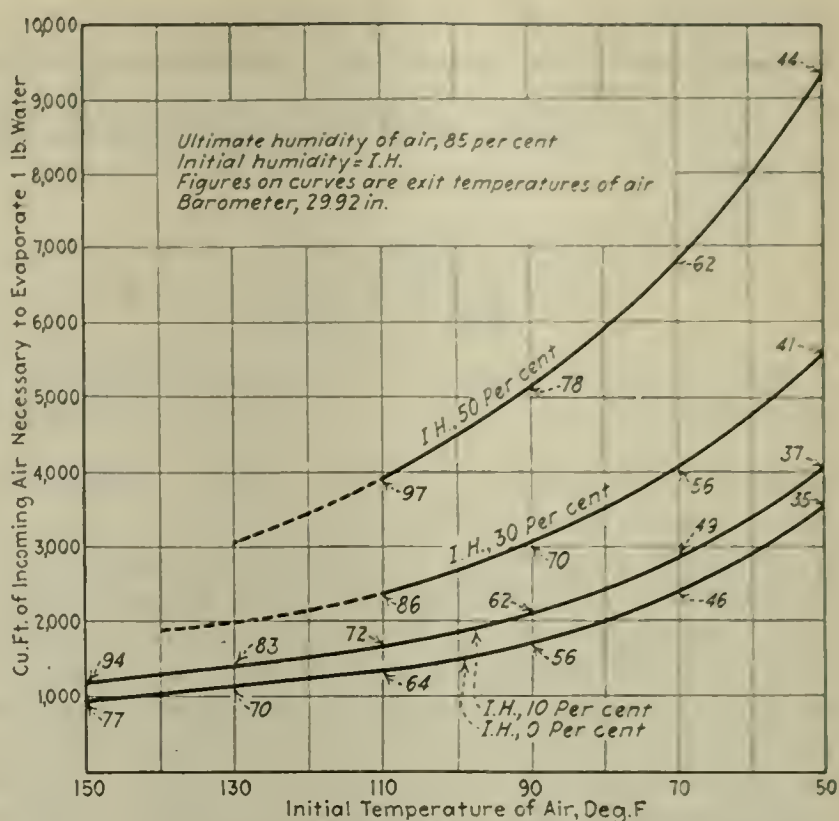


FIG. 2. VOLUMES OF AIR REQUIRED IN AIR DRYING, ULTIMATE HUMIDITY OF AIR, 85 PER CENT

passing the wet, muslin-covered bulb rapidly through the air, the utmost cooling possible by evaporation is accomplished, which means that the atmosphere adjacent to the bulb is in a saturated condition.

CALCULATION OF VOLUME OF AIR REQUIRED

To return now to the problem: A unit volume of air (surrounded by other air subject to the same conditions and therefore not affected by heat interchange) comes in contact with moisture in a drying room, absorbs all it can hold, in the case of 100 per cent evaporation, and passes out. Its exit temperature is evidently the wet bulb temperature and may be read at a glance from the psychrometer chart or from tables, provided the original temperature and humidity of the air are known. Suppose, for instance, that the initial temperature of the air is 90 deg. F. and that it carries 50 per cent humidity. The wet bulb temperature is 75 deg. Consequently the air will pass out of the dry room, if saturated, at 75 deg. A cubic foot of air in this condition holds 0.001346 lb. of water. Before entering the dry room a cubic foot of the same air contained 0.001066 lb. of water. We cannot subtract one directly from the other in order to find the net moisture acquired, because the volume has changed. We must therefore start with more than a cubic foot, so that when we reduce the temperature to 75 deg. (without adding moisture) we shall have exactly a cubic foot. This is very easily done by means of the ratio of absolute temperature; since no condensation occurs in the process of cooling, the initial moisture in the air is in a superheated condition and follows the same law of expansion and contraction as the air itself. We have another slight correction to make, since the outgoing air has taken on moisture and therefore added to its volume. Looking up the vapor pressure of saturated steam at 75 deg. F. we find it to be 0.4288 lb. absolute. Now the total pressure of the air and steam combined is 14.7 lb., since we have assumed this condition at the start. The difference is

$$14.7 - 0.4288 = 14.2712$$

If the air had been dry at the start, the correction in volume would be $\frac{14.27}{14.7}$. But it already contains a

considerable amount of moisture, and a mental calculation shows us that the acquired moisture in the outgoing air is only about one-fifth of the total ($0.001346 - 0.001066 = 0.00028$, which is approximately one-fifth of 0.001346). Therefore the correction in volume is as follows:

$$\frac{14.7 - \frac{0.4288}{5}}{14.7} = \frac{14.614}{14.7}$$

This correction happens to be almost negligible, in this particular case. We can now write out the result,

$$0.001346 - \left[0.001066 \times \frac{460 + 90}{460 + 75} \times \frac{14.614}{14.7} \right] = 0.000258 \text{ lb.}$$

of moisture acquired per cubic foot of outgoing air. Dividing into 1, we find that for every pound of moisture evaporated by air at 90 deg. 50 per cent humidity, 3,876 cu.ft. of saturated air at 75 deg. must pass out of the dry room. As it is more convenient to express this in terms of the entering air, we apply the same correction as above, and obtain the result which is incorporated in the accompanying charts—namely, about 4,000 cu.ft.

PREPARATION OF THE CURVES

The curves in Figs. 1, 2 and 3 were all plotted in this manner. Calculations were all made and checked on the slide rule, as greater accuracy than this would seem to be superfluous. In fact, an accuracy of 90 per cent (assuming 100 per cent accuracy for the wet bulb records themselves) is probably all that could possibly be desired by anybody, since these curves are in no sense a contribution to scientific knowledge, but merely

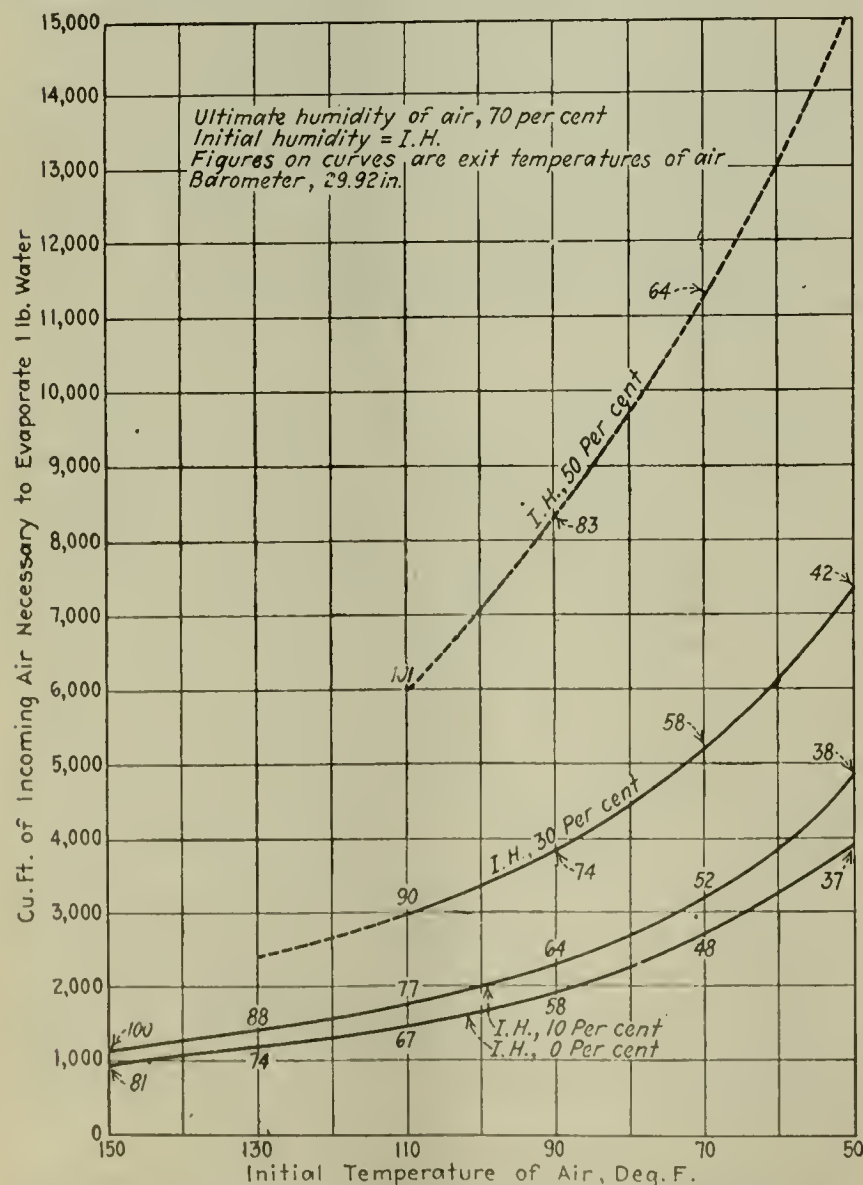


FIG. 3. VOLUMES OF AIR REQUIRED IN AIR DRYING, ULTIMATE HUMIDITY OF AIR, 70 PER CENT

an aid to the engineer or plant manager in working out problems. The inevitable irregularities in the curves were smoothed out in tracing, but in no case to affect the accuracy of the reading more than 10 per cent. There are certain conditions of initial high temperature and high humidity where a slight error in the temperature reading would make a very large error in the quantity of air. In these cases the curve was either omitted, or, where the result was reasonably certain, drawn with dotted lines. Exit temperatures of the air have been shown in small figures, at regular intervals along the curves. These temperatures could be expressed by a series of curves running counter to the others, but it was felt that this would unnecessarily crowd the diagram. Three conditions of ultimate humidity, 100, 85 and 70 per cent, have been considered in Figs. 1, 2 and 3 respectively. The calculations are the same for all three, since the exit temperature of air at a given humidity may be read from the psychrometric diagram just as readily as the wet bulb temperatures.

DEDUCTIONS FROM CURVES

It is thought the curves will be interesting to many who are not immediately concerned with their practical value. The most outstanding thing which they illustrate is the importance of low initial humidity for efficiency in drying. For instance, it is seen that a given volume of air at 50 deg. with 10 per cent humidity will absorb as much moisture as the same volume of air at 100 deg. with 50 per cent humidity. By the flattening of the curves, as the initial temperatures pass beyond 110 deg., we are led to assume, also, that further increases in temperature are not attended with proportionate increases in efficiency, wholly outside of the difficulties and expense which high initial temperatures entail.

CONFIRMATION OF USE OF WET BULB TEMPERATURE

In conclusion, those who are skeptical as to the use of the wet bulb temperature as the basis of these calculations may check the results independently of the psychrometric diagram, as follows: Taking the same example we used before, which will serve as well as any other, let

H = latent heat of steam at 75 deg. F. = 1049.46.

p = pounds of water evaporated = 0.000258.

S = specific heat of air at 90 deg., 50 per cent humidity = say 0.245.

w = weight of a cubic foot of same air at 75 deg. F. = 0.073.

t = drop in temperature of the air due to evaporation.

Now, since no heat has been added or taken away, the following equation is true:

$$Hp = S \frac{14.6}{14.7} wt$$

The slight correction to the quantity w is necessary since we are borrowing heat units from the air before it has taken on its quota of moisture and become an exact cubic foot.

Substituting the values and solving for t , we obtain

$$t = \frac{1049.46 \times 0.000258}{0.245 \times \frac{14.6}{14.7} \times 0.073} = 15.2 \text{ deg.}$$

which checks as closely as could be expected with the 15 deg. drop registered by the wet bulb.

New York City.

Importance of the Olefine Gases and Their Derivatives

V—Ethylene Chlorhydrin and Ethylene Oxide*

Problems in the Manufacture of Ethylene Chlorhydrin From Ethylene and Hypochlorous Acid—
Properties—Examples of Chemical Reactivity—Production and Characteristics
of Ethylene Oxide—Other Derivatives of Ethylene Chlorhydrin

BY G. O. CURME, JR., AND C. O. YOUNG

THE two chemical derivatives of ethylene which have shown the greatest promise of winning the recognition of the industrial chemist within recent years are those which form the subject of this paper—namely, ethylene chlorhydrin and ethylene oxide. The latter being related to the former as a direct derivative formed by a simple process, they are very similar indeed in their chemical reactivity and constitute together a supplementing pair of reagents, which are characterized by their intensity of reaction and the valuable nature of the products which they may yield. To a student of the development of our organic chemical industry the position of these reagents today seems very similar to that of formaldehyde in the year 1893. At that time formaldehyde was first announced to the industrialists as available in commercial quantities, after having been known to laboratory investigators for many years. The history of its rapid increase in value to the industry needs no recounting.

Today ethylene chlorhydrin, having passed through a difficult period of factory experimentation, has emerged in a position such that it is now capable of production on any desired commercial scale, and at a commercial price. That it is destined to find a large application in synthetic chemistry is assured from the achievements already to its credit.

PREPARATION OF ETHYLENE CHLORHYDRIN

Ethylene chlorhydrin, ($\text{ClCH}_2\text{CH}_2\text{OH}$), which has also been known as β -chlor-ethyl alcohol and glycol chlorhydrin, was first described by Wurtz¹ in 1859. Wurtz prepared it from the already known ethylene glycol by addition of hydrochloric acid. A few years later Carius² described the more direct synthesis by the addition of hypochlorous acid to ethylene, which was the basic reaction on which the present commercial processes have been founded. Carius prepared the hypochlorous acid by the action of mercuric oxide on chlorine, which naturally would not lend itself well to large-scale commercial operation on grounds of expense. Since this original discovery that hypochlorous acid in dilute aqueous solution does add to ethylene with formation of ethylene chlorhydrin, a great deal of work has been done on other methods of generating hypochlorous acid so that it might suitably be added to the gaseous ethylene.

A contribution from the Mellon Institute of Industrial Research of the University of Pittsburgh.

*This article, the last of a series of five, treats of the technical significance of two related ethylene derivatives which are just commencing to be recognized by industrial chemists for their valuable chemical reactivity and which are now available commercially through the development work carried out by the Carbide & Carbon Chemicals Corporation. Parts I, II, III and IV were published Nov. 16, p. 907, Nov. 23, p. 957, Nov. 30, p. 999, and Dec. 7, p. 1049, respectively.

¹Wurtz, *Ann.*, vol. 110 p. 125 (1859).

²Carius, *Ann.*, vol. 126, p. 197 (1863).

Lauch,³ Bamberger,⁴ Schweitzer⁵ and others worked upon the idea of adding a weak acid to a solution of liquid bleach ($\text{NaOCl} + \text{NaCl}$) with the idea of liberating the free hypochlorous acid in the presence of ethylene but not the stronger hydrochloric acid. Among the acids used were boric acid, carbonic acid and sodium bicarbonate. These procedures were an improvement in the arts and to the writers' knowledge can be used to give consistent yields of ethylene chlorhydrin, although expensive in operation. A patent on the process of adding an excess of sodium bicarbonate to an alkaline solution of sodium hypochlorite in the presence of ethylene was granted to Walker⁶ in 1910. McElroy⁷ has taken out a series of patents on the production of ethylene chlorhydrin by the action of chlorine on ethylene and oil gas in the presence of steam, and in an electrolytic cell, although with results that do not seem as successful as those obtained by earlier processes. According to Norris⁸ the Badische Anilin und Soda Fabrik has used a process which consisted in bubbling a mixture of ethylene and carbon dioxide through a suspension of bleaching powder contained in a lead vessel. It was by this process that the chlorhydrin used for mustard gas production by the Germans during the great war was largely obtained. Gomberg⁹ found that concentrations of 5 to 8 per cent of ethylene chlorhydrin could be obtained by passing ethylene and chlorine into cooled water, but stated that above that concentration largely ethylene dichloride was formed by further reaction, owing to the action of the accumulated hydrochloric acid in solution. Brooks,¹⁰ in a recent critical survey of the manufacture of chlorhydrins, describes a similar process of his own, wherein the liberated hydrochloric acid is taken up by added salts of weak acids, such as borax or sodium bicarbonate. In this case also the ethylene dichloride reaction seems to intervene after a concentration of 5 to 6 per cent of ethylene chlorhydrin has been built up. In a process developed by the writers, which has been made the subject of a pending patent application, it has been found possible by use of a recirculation system to build up a concentration of 10 to 12 per cent of ethylene chlorhydrin with no appreciable ethylene dichloride formation, at the same time avoiding the necessity of contaminating the system with foreign salts or gaseous materials. Ethylene chlorhydrin has been in limited commercial

³Lauch, *Ber.*, vol. 18, pp 2, 287 (1885).

⁴Bamberger, *Ann.*, vol. 288, p. 81 (1895).

⁵Schweitzer, *Ber.*, vol. 40, p. 94 (1907).

⁶Walker, U. S. Pats. 972,952 (1910) and 972,954 (1910).

⁷McElroy, U. S. Pats. 1,253,615, 1,253,616, 1,253,617, 1,264,535, 1,295,339, 1,315,229.

⁸Norris, *J. Ind. Eng. Chem.*, vol. 11, p. 817 (1919).

⁹Gomberg, *J. Am. Chem. Soc.* vol. 41, p. 1414 (1919).

¹⁰Brooks, *CHEM. & MET. ENG.*, vol. 20, p. 629 (1920).

use in Germany for some time and recently has been advertised for sale in this country as well as in France.

The pure material produced by any of the above processes is a colorless liquid of faint ethereal odor. It has a boiling point of 128 deg. C. at 740 mm. and a density of $D^{16} = 1.2130$. It is miscible with water in all proportions. As is characteristic of the alcohols, ethylene chlorhydrin also forms a constant boiling mixture. This mixture has been found to contain 42.3 per cent chlorhydrin and 57.7 per cent water by weight and boils at 96.0 deg. C. at 740 mm. It has the density $D^{16} = 1.0970$. By suitable rectification this constant boiling mixture can be separated from the more dilute aqueous solutions in which it is first produced and as such can best be brought upon the market. The process of concentration to the absolute or 100 per cent chlorhydrin is not exceptionally difficult, but adds materially to the cost of the product, as is the case with the alcohols.

The anhydrous ethylene chlorhydrin is a remarkable solvent in that it possesses the valuable solvent characteristics of both the alcohols and the organic chlorides. For this reason it is miscible with water as well as most organic liquids, and dissolves materials of all classes from inorganic salts to the cellulose esters. Patents on its use as a solvent for cellulose acetate have been taken out.¹¹ It has the disadvantage, however, that it is readily hydrolyzed, which limits its use as a solvent.

CHEMICAL REACTIVITY

The chief value of the ethylene chlorhydrin, as stated above, is its great chemical reactivity. Possessing as it does a two-membered carbon chain with a reactive, but different, radical on each of the two ends, it offers a bivalent ethylene radical which can be used for an unlimited number of syntheses. To renew the analogy with formaldehyde, its great advantage in synthetic work is that it offers a bivalent radical, namely, methylene ($-\text{CH}_2-$) which can join with two different groups and bind together like or unlike radicals into a highly complex molecule. With ethylene chlorhydrin the same is the case, except that the uniting bivalent radical in this case is different, namely, ethylene ($-\text{CH}_2\text{CH}_2-$) and therefore the series of derivatives will be of a different but no less valuable class.

One particular case where the value of ethylene chlorhydrin has been commercially developed is in the synthesis of indigo, as described in the patent of the Badische Anilin und Soda Fabrik.¹² In this case the chlorhydrin unites directly with aniline to give hydroxyethyl aniline, and this material in turn is condensed by a simple caustic fusion to a material that may readily be oxidized to indigo. This process is reported to be in extensive use in Germany and in Switzerland today, and is stated to have material advantages over the other syntheses. It was the chlorhydrin originally intended for this synthesis that was used to produce the first mustard gas. The same mustard gas (β, β' -dichlorethyl sulphide) synthesis is again characteristic of the bivalent reactivity of ethylene chlorhydrin.¹³ Here ethylene chlorhydrin is treated with sodium sulphide, giving thiodiglycol as a first product of reaction. This substance then forms mustard gas directly by addition of strong hydrochloric acid solution.¹⁴ Again, phenyl ethyl alcohol is produced from brombenzene and ethyl-

ene chlorhydrin by the Grignard reaction,¹⁵ and novocain¹⁶ through the reaction of ethylene chlorhydrin and amino benzoic esters. These examples serve only as an indication of the variety and scope of reactions in which a bivalent radical, capable of selective addition on either end, can accomplish simplified and elegant reactions in the field of commercial organic synthesis.

PRODUCTION OF ETHYLENE OXIDE

From ethylene chlorhydrin solutions by action of strong caustic alkali, a rather unusual reaction occurs in which hydrochloric acid is split off from the chlorhydrin and ethylene oxide is formed directly. This reaction was first described by Wurtz¹⁷ in 1859. In many repetitions of this process by successive investigators no essential improvements have been worked out.

The ethylene oxide (CH_2)₂O prepared in this manner is a colorless liquid with a characteristic pungent odor, similar to that of pure ethylene. It is quite volatile, boiling at 12.5 deg. C. at 746 mm. It has the density $D^{16} = 0.8966$. It is miscible with water in all proportions. On account of its low boiling point, this material must be handled as a gas in any commercial work, but when liquefied in steel cylinders it is easily transported and very easily applied in any reaction.

Forming as it does a three-membered ring, ethylene oxide is characterized by its great chemical reactivity and undergoes practically the same reactions as does the chlorhydrin. In some cases it reacts even more easily. Since it can very readily be prepared in the anhydrous condition and also contains no chlorine, it is preferable in many reactions on this account. The two reagents supplement each other handsomely.

OTHER DERIVATIVES OF ETHYLENE CHLORHYDRIN

Other direct derivatives of ethylene chlorhydrin also appear to have commercial value. Of these ethylene glycol ($\text{CH}_2\text{OH}.\text{CH}_2\text{OH}$) has already attracted considerable interest, being produced readily by the action of sodium bicarbonate on chlorhydrin solutions.¹⁸ This material has already been used in many applications where it has been shown that it can replace glycerine to good advantage, as in manufacture of explosives,¹⁹ in moistening tobacco, in cosmetics, extracts and in other such uses.

Glycol monacetate ($\text{CH}_2\text{OH}.\text{CH}_2\text{OCOCH}_3$) is another direct derivative, and has attracted some attention as a solvent. In particular it is claimed to aid in dyeing artificial silk from cellulose acetate.²⁰ Glycol diacetate ($\text{CH}_2\text{OCOCH}_3$)₂ is another derivative, and as a high boiling solvent (b.p. 186 deg. C.) deserves some attention.

This list of higher syntheses involving chlorhydrin and its derivatives as well as that of its direct derivatives might well be continued to much greater length, but such a detailed review is beyond the scope of this paper. It is hoped, however, that it has been possible in the relatively few instances cited to show that, along with the other technical products of the olefine gases, ethylene chlorhydrin offers a new field of development to the organic chemical industry.

¹⁴This synthesis was not adopted by the Allied Powers to produce the mustard gas for the past war, as no commercial chlorhydrin process was at that time satisfactorily developed. As an operating process it is, however, the safest and yields the highest grade of material.

¹⁵Grignard, *Ann. Chim. Phys.* (8), vol. 10, p. 23 (1907).

¹⁶*J. Soc. Chem. Ind.*, vol. 39, p. 43 (1920).

¹⁷Wurtz, *Ann.*, vol. 110, p. 126 (1859).

¹⁸French Pat. 458,733 (1913).

¹⁹Barab, U. S. Pats. 1,307,033 and 1,307,034 (1919).

²⁰Ger. Pat. 228,867 (1907).

¹¹Ger. Pat. 288,267 (1914). U. S. Pat. 1,026,614 (1912).

¹²U. S. Pat. 778,772 (1904).

¹³V. Meyer, *Ber.*, vol. 19, p. 3260 (1896). H. T. Clarke, *J. Chem. Soc.*, vol. 101, p. 1583 (1912).

The Electrolytic Oxidation of HCl to Perchloric Acid*

Earlier Methods for the Preparation of Perchloric Acid—Apparatus and Procedure for Studying Electrolytic Oxidation of Hydrochloric Acid—Experimental Data—Type of Cell Developed From Results of Preliminary Work—Bibliography

By H. M. GOODWIN† AND E. C. WALKER, 3D‡

THE purpose of the following investigation was to determine the best conditions under which hydrochloric acid could be electrolytically oxidized to perchloric acid, and to devise a cell for carrying out the process on a practical scale. That perchloric acid can be formed by the electrolysis of hydrochloric acid has long been known, the fact having been noted by Count Stadion¹ in 1816. In 1898 Haber² investigated the electrolysis of hydrochloric acid solutions and stated that when dilute solutions are electrolyzed, small amounts of perchloric acid are formed.

Up to the time this investigation was undertaken, in 1916, perchloric acid was made by one of the following methods:

1. By heating a concentrated solution of chloric acid. As pure chloric acid is not readily prepared and the yield of perchloric acid is low, this method is of little practical value.³

2. By the action of fluosilicic acid on potassium perchlorate and subsequent distillation of the filtrate of dilute perchloric acid. This method is obviously difficult and of theoretical interest only.⁴

3. By the action of sulphuric acid on barium perchlorate with subsequent concentration and distillation. The chief objection is that the barium salt is expensive.⁵

4. By steam distillation under reduced pressure of a mixture of potassium perchlorate and sulphuric acid. A good yield is claimed by this method.⁶

5. By the action of concentrated hydrochloric acid on sodium perchlorate and concentration of the filtrate until excess of hydrochloric acid is driven off.⁷ Mathers⁸ states that this method yields 95 per cent of the theoretical acid, and with cheap sodium perchlorate would seem to be the best method thus far proposed.

6. By the action of aqua regia on ammonium perchlorate. This method is stated by Willard⁹ to give good results, but owing to the explosive nature of ammonium perchlorate is restricted in its use.

All of these methods, except the first, presuppose the formation of perchlorates and the subsequent liberation

of the free acid. In the following experiments the attempt was made to form the acid directly from hydrochloric acid without the intermediate formation of one of its salts.

In oxidizing the chlorine ion to the perchlorate ion it must of course pass through the chlorous and chloric stages. The theory of the formation of the chloric ion and chlorates and the best conditions for effecting this electrolytically are well known. The mechanism of the further electrolytic oxidation of the chlorate to the perchlorate ion was studied by Oechsli¹⁰ in 1903 and more recently in a comprehensive article by Bennett and Mack¹¹ in 1916. The former holds that the perchlorate ion is formed only under conditions of sufficiently high overvoltage to permit the preferential discharge of chlorate ions, which then by secondary reactions with the water form chloric and perchloric acid. Bennett and Mack on the other hand maintain that experimental evidence bears out the view that perchlorate formation is due to the direct oxidation of the chlorate ion by nascent oxygen present in a state of high concentration in an anode at which there exists a high oxygen overvoltage. For a detailed discussion of these two theories Bennett and Mack's paper should be consulted.

Whatever the mechanism of the process may be, the facts seem well established that chlorate ions are most readily oxidized to perchlorate ions in acid solution, at low temperature, high current density and at electrodes, like smooth platinum, which give a high oxygen overvoltage. Chlorate ions, on the other hand, are more efficiently formed at higher temperatures, lower current densities and in concentrated solutions.

APPARATUS AND PROCEDURE

To ascertain the extent to which hydrochloric acid can be oxidized to perchloric acid under varying conditions, a large number of experiments were first carried out in the apparatus described below. This consisted of two concentric cylinders—the inner, a platinum tube 22 cm. long and 0.55 cm. diameter, which served as anode, and the outer of copper 20 cm. long and 6 cm. diameter, which served as cathode. The platinum tube passed through the center of a rubber stopper large enough to close the lower end of the copper cylinder. The stopper and upper parts of the copper tube not in contact with electrolyte were covered with paraffine to prevent corrosion by the action of free chlorine.

The temperature of the cell was regulated by passing a current of water through the anode and up and around the outer copper cylinder, the whole cell being placed in a beaker.

In series with the cell were an ammeter, a rheostat

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¹Stadion, *Gilberto Ann.*, vol. 52, pp. 197 and 339. See also *Liebig's Ann.*, vol. 56, p. 281; *Ann. chim. phys.* (3), vol. 7, p. 298.

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³Millon, *Ann. chim. phys.* (3), vol. 7, p. 310; Penny, *Liebig's Ann.*, vol. 37, p. 203.

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⁵Henry, *Liebig's Ann.*, vol. 31, p. 345.

⁶Vorlander and Schilling, *Liebig's Ann.*, vol. 210, p. 369; Natl- velle, *J. prakt. chem.*, vol. 26, p. 404; Van Wyk, *Z. anorg. chem.*, vol. 32, p. 115; vol. 48, p. 4; Van Ernster, *Z. anorg. chem.*, vol. 52, p. 270; Kenny, Thesis, Mass. Inst. Tech.

⁷Kreider, *Am. J. of Sci.*, 3rd series, 1895, vol. 49, p. 443.

⁸Mathers, *J. Am. Chem. Soc.*, 1910, vol. 32, p. 66.

⁹Willard, *J. Am. Chem. Soc.*, 1912, vol. 34, p. 1480.

¹⁰Oechsli, *Z. Electrochem.*, 1903, vol. 9, p. 807.

¹¹Bennett and Mack, *Trans. Am. Electrochem. Soc.*, 1916, vol. 29, p. 323.

and a copper coulometer. The voltage across the cell terminals was recorded at intervals by a voltmeter.

Preliminary experiments showed that the amount of perchloric acid produced by the electrolysis of hydrochloric acid depended upon: (1) Duration of electrolysis. (2) Current density on the anode. (3) Concentration of HCl. (4) Temperature of electrolyzing cell. (5) Anode material.

The usual procedure was therefore to keep four of these factors constant and vary the fifth over a sufficient range. For example: all the above conditions were kept constant except the duration of electrolysis. This factor was varied so that data were obtained to determine the products of electrolysis from the time when approximately 3 ampere-hours had passed, to the time when all the available acid had been converted to perchloric acid. Thus, successive portions of 150 c.c. of HCl were electrolyzed at constant current density, acid concentration, temperature and anode material at different values of ampere-hours passed until complete data had been obtained for these conditions.

The next step was to change the current density and make another series of electrolyses, keeping this new value of current density constant with the other factors, while a new set of data was being obtained at various ampere-hours.

When the current density had been varied over a sufficient range, the concentration of the acid was changed and the above-described system of runs was repeated with varying current density and ampere-hours for this new concentration of acid.

At the completion of the electrolysis, the electrolyte was removed from the cell and shaken with mercury to remove the free chlorine. After filtering out the mercurous chloride, the filtrate was analyzed for chloride, chlorate and perchlorate. Three aliquot portions were pipetted off into Erlenmeyer flasks. The first was titrated with N/10 NaOH, using phenolphthalein, to give the total acid. The second portion was acidified with HNO_3 and titrated for chloride by adding an excess of AgNO_3 , boiling to coagulate the AgCl and titrating the excess of silver nitrate with ammonium sulphocyanate, using ferric-ammonium alum as an indicator. The third portion was acidified with dilute nitric acid and an excess of a 10 per cent solution of ferrous sulphate added to reduce the chloric acid. After boiling for 10 minutes an excess of silver nitrate was added and the chloride-chlorate chlorine determined as

before. The perchloric acid was thus determined by difference.

The results obtained from a number of typical runs made with this apparatus are shown in the accompanying table. The volume of solution electrolyzed in each case was 150 c.c.

A study of the figures in the table shows:

1. That in dilute solutions, N/10, as much as 50 per cent of the original acid may be converted into perchloric acid, the larger part of the remaining acid being lost as chlorine.

2. That with increasing concentration, the per cent which can be thus converted rapidly diminishes, decreasing to 10 per cent in half normal solution. The loss as chlorine rapidly increases (approaching 100 per cent for concentrations over N/1).

3. The per cent of chloric acid, on the other hand, in the electrolyzed liquor increases with increasing initial concentration.

4. Increasing the current density 100 per cent (from 0.1 to 0.2 amp. per square centimeter), increases the percentage conversion to perchloric acid slightly (from 41.6 to 44 per cent), while the percentage energy increase is much greater (25.8 to 37.9 watt-hours).

5. Increasing the temperature from 20 to 40 deg. tends to decrease the perchloric acid yield, but to increase that of chloric acid present. The energy consumption is at the same time decreased.

With the above results as a guide, the design of a new type of cell was next undertaken in which the oxidation of hydrochloric acid to perchloric could be carried out continuously.

FINAL FORM OF CELL

Without entering into the details of the construction and operation of a number of forms of apparatus which developed difficulties for long-continued operation, the final form only, which gave excellent service, will be here described.

The form of the cell was that of a long, narrow rectangular trough flared at the top. Its dimensions were 18 in. long by 6 in. deep by 1 in. wide (45.7 x 15.2 x 2.5 cm.). It was hammered out of a sheet of silver 30 x 14 x 0.005 in. thick (76 x 35.5 x 0.013 cm.), and was without any seams. This trough, which served as the cathode, was reinforced and supported in a copper mesh frame (two wires to the inch of No. 16 B. & S. gage (0.13 cm.), to which it was soldered at several

DATA ON ELECTROLYSIS OF DILUTE HCl SOLUTIONS

Amp Hr.	Current Density Amp per Sq.Cm.	Normality of HCl at Start	Normality of HCl at Present	Per Cent HCl Present	Per Cent HCl Lost by Chlorine Evolution	Per Cent HCl Converted to HClO_3	Per Cent HCl Converted to HClO_4	Equivalent of HClO_3 per Liter	Equivalent of HClO_4 per Liter	Watt-Hours	Watt-Hours per Gram HClO_4 Produced
Temperature 20 Deg. C.											
4	0.137	0.0984	0.0138	14.0	41.2	1.50	43.0	0.00148	0.0423	30.0	47.4
5	0.137	0.0984	0.00806	8.20	43.5	1.00	48.0	0.00098	0.0472	38.1	53.9
6	0.137	0.0984	0.00384	4.00	46.0	...	50.0	...	0.0492	46.1	62.6
4	0.137	0.251	0.0500	19.9	59.0	5.38	15.0	0.0135	0.0370	22.1	39.8
5	0.137	0.251	0.0310	12.4	62.0	3.75	20.0	0.0094	0.0500	28.5	38.0
6	0.137	0.251	0.0200	7.98	64.0	1.99	25.0	0.0050	0.0620	35.1	37.8
7	0.137	0.251	0.0110	4.38	65.4	0.50	29.4	0.0012	0.0736	41.7	37.8
4	0.137	0.510	0.160	31.4	60.9	6.45	2.36	0.0329	0.0120	17.5	97.2
5	0.137	0.510	0.110	21.6	65.6	5.66	4.96	0.0289	0.0253	22.6	59.6
6	0.137	0.510	0.073	14.3	70.2	4.90	7.61	0.0250	0.0388	28.0	48.1
7	0.137	0.510	0.0550	10.8	74.9	4.12	10.2	0.0210	0.0520	33.7	43.1
4	0.204	0.251	0.0570	22.7	57.0	2.15	17.9	0.0054	0.0450	27.3	40.5
5	0.204	0.251	0.0390	15.5	60.0	1.39	22.4	0.0035	0.0563	35.0	41.5
6	0.204	0.251	0.0290	11.6	62.5	0.70	26.8	0.0017	0.0672	43.0	42.7
7	0.204	0.251	0.0200	7.97	63.0	...	30.1	...	0.0755	51.2	45.3
4	0.102	0.0984	0.0123	12.5	44.0	3.10	41.6	0.00305	0.0410	25.8	42.0
4	0.171	0.0984	0.0152	15.5	38.9	...	45.0	...	0.0443	33.8	51.0
4	0.204	0.0984	0.0157	16.0	38.8	0.60	44.0	0.0006	0.0433	37.9	58.5
Temperature 40 Deg. C.											
3	0.137	0.217	0.0430	19.85	64.9	13.4	1.84	0.0290	0.0040	13.5	225
5	0.137	0.217	0.0182	8.39	72.5	13.9	6.2	0.0280	0.0135	25.0	123
8	0.137	0.217	0.0020	0.92	73.5	6.0	19.6	0.0130	0.0425	44.0	69

points. A silver outlet tube was welded in the bottom of the cell by silver solder. The cell was immersed in a water bath, a strong spray of cooling water being continuously sprayed over both sides of the cell from perforated pipes placed in the bath. By regulating the rate of flow of the spray, the temperature of the cell could be adjusted within wide limits. Sheet silver was finally chosen for the cell, after copper, iron, nickel, Monel, lead and silver-plated copper had been tried out, and all found to develop difficulties in long-continued electrolysis from the corrosive action of the chlorine.

In the endeavor to find a protective coating which would resist the action of chlorine outside the cell, paraffine, ceresin, shellac, asphalt, asphalt paint and a solution of Grade A Bakelite in amyl acetate were used. Of these the last, when properly applied, dried and baked at a temperature not exceeding 150 deg. C., proved very satisfactory.

The anode was of sheet platinum, approximately 5 x 16 in. (12.7 x 41 cm.) in area, and 0.0015 in. (0.0038 cm.) thick, suspended in the center of the cell from a heavy copper rod to which it was clamped. All copper parts and contacts were protected by Bakelite. The anode was held down in place by a glass rod and glass balls attached to the lower edge.

In a continuous run the hydrochloric acid flowed into the cell from a reservoir containing a stock solution and the electrolyzed liquor ran off into two 12-in. fused silica Vitreosil evaporating dishes arranged in cascade in which the perchloric acid was concentrated. The flow of the liquid was controlled by an automatic electric regulator, perfected by E. C. Walker and F. W. Hall. The evaporation was continued until a 60 per cent solution of perchloric acid which boils under atmospheric pressure at 160 deg. C. was obtained. For use in analytical work this solution was distilled; the product thus obtained contained only a slight impurity of silica accompanied by alumina which probably came from the evaporating dishes.

With a single cell of this type about 50 lb. of 50 per cent pure perchloric acid was made during the course of the investigation. The following data taken on one series of experiments illustrate the extent to which the original hydrochloric acid could be converted to perchloric acid:

Initial concentration of hydrochloric acid, 0.5 N.
Average current, 150 amp.
Average voltage, 8 volts.
Average current density (anodic), 0.16 amp. per square centimeter.
Average rate of flow of liquor through cell, 25 to 30 liters per hour.
Average temperature, 18 deg. C.

Run 1.

Concentration of HCl at end, 0.0179 N.
Concentration of HClO₃ at end, 0.0255 N.
Concentration of HClO₄ at end, 0.0738 N.

The product from this contained too great a percentage of chloric acid. It was therefore brought up to 0.5 normal by the addition of hydrochloric acid and again electrolyzed in the cell with the following results:

Run 2.

Concentration of HCl at end, 0.171 N.
Concentration of HClO₃ at end, 0.0089 N.
Concentration of HClO₄ at end, 0.2015 N.

This solution contained 20 g. of perchloric acid per liter. By again bringing up the acidity and electro-

lyzing, a solution of the following composition was obtained:

Run 3.

Concentration of HCl at end, 0.01117 N.
Concentration of HClO₃ at end, 0.0078 N.
Concentration of HClO₄ at end, 0.286 N.

In the first and worst case in which the original acid was subjected to electrolysis by passing once through the single cell, a yield of approximately 800 g. of 60 per cent acid per 24 hours at an expenditure of 28,800 watt-hours, or about 26 watt-hours per gram of acid (60 per cent), was obtained.

There is no doubt that better results could be obtained by the use of two cells, in the first of which the best conditions for the production of chloric acid were maintained—i.e., fairly strong acid, high temperature and medium density—while in the second the products of the first cell would be electrolyzed under the most favorable conditions for the oxidation of chloric to perchloric acid—namely, more dilute solution, low temperature and high current density.

The results obtained with our apparatus demonstrated, however, that a high grade of perchloric acid could be produced in quantity by the electrolysis of hydrochloric acid.¹²

In conclusion, it may be of interest to add that with the acid obtained the salts of the following metals were prepared: Strontium, zinc, copper, manganese, nickel, cobalt, iron (ferrous and ferric), tin, bismuth, gold, beryllium and uranium.

These salts are all very soluble in water, and with the exception of the ferrous, nickel, cobalt and zinc salts, are decidedly hygroscopic. The use of perchlorates, especially of the lead salt, for electroplating purposes is well known from the work of Mathers,¹³ as they are very stable and not readily reduced by hydrogen. Ferrous perchlorate is also remarkably stable as regards oxidation.

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¹²The process has since been perfected and used by the Genesee Chemical Co., Batavia, N. Y., for the manufacture of perchloric acid.

¹³U. S. Pat. 931,944.

Material Handling as a Factor in Eliminating Industrial Waste*

By H. V. COES

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MODERN civilization is the direct result of the application of the principles of subdivision of labor. This in turn has resulted in labor-saving inventions, and material-handling devices have played an important part in this development. Yet today, in spite of equipment and methods now available, material is handled constantly in identically the same manner as in the early stages of civilization.

Why is this? In the opinion of the author, it is due to a number of influences, such as: (1) Ignorance of methods and equipment available. (2) Lack of standardization of materials, methods, containers to be handled to permit installation of and economical use of material-handling apparatus. (3) Insufficient comparative economic data. (4) Improper engineering. (5) Poor salesmanship and selling policies. (6) Lack of a central organization to educate the public and to act as a clearing house for economic and technical information.

There has recently been published an Encyclopedia of Material Handling, prepared by recognized authorities. This is a step in the right direction and it should prove of considerable assistance, particularly in eliminating ignorance of methods and equipment.

be an economic one. The question of will it pay should not be begged. Capital has been wasted, pioneers discouraged, the public bewildered because of undertakings not conforming to this test.

Hunt¹ postulates these principles as follows:

1. In handling material, perform only the handling operations that are absolutely necessary.

2. Perform these operations in the way that obtains the lowest cost.

When a simple plan for handling materials has been developed, the financial returns of the installation will, in the absence of labor difficulties, largely determine the wisdom of the installation. It may pay to install apparatus and it may not, according to conditions such as: (a) Constancy or intermittency of the work, (b) character of the operation itself and (c) results of analysis which follows.

A specific example of the saving effected by the introduction of proper methods of handling materials occurred in the case of a certain paper mill. The mill was 60 years old or more, and had grown around itself in a manner that presented a number of problems difficult to solve. After a policy for rehabilitation and extension had been worked out, it was possible to predict future material-handling costs, based upon improvements that would obtain under the rehabilitation plan and application of the proper material-handling equipment to the problems in hand. Table I illustrates the varied

TABLE I. ESTIMATED ANNUAL COST OF PRESENT AND PROPOSED METHODS OF HANDLING MATERIAL IN A CERTAIN PAPER MILL
(Based on Average Quantities Consumed in Year 1919 and 6 Months 1920)

Material	Unit	Average Annual Consumption	Present Cost*		Estimated New Investment	Proposed Cost*		Annual Saving		Equipment Selected
			Unit	Total		Unit	Total	Unit	Total	
Alum.....	Ton	207	\$10.60	\$2,862	\$5,500	\$1.87	\$505	\$8.73	\$2,357	Locomotive crane and power mule
Ash disposal.....	Ton	4,800	2.08	10,000	15,000	0.42	2,000	1.86	8,000	Pneumatic conveyor
Bleach.....	Ton	875	2.80	2,450	.....	2.00	1,750	0.80	700	Locomotive crane and power mule
Clay (china).....	Ton	1,800	4.48	8,064	11,100	1.60	2,880	2.88	5,184	Pneumatic conveyor
Lime.....	Ton	2,500	1.60	4,000	1,950	0.50	1,250	1.10	2,750	Pneumatic conveyor
Lumber: box.....	M.B.M.	1,000	4.85	4,850	400	2.25	2,250	2.60	2,600	Loco. crane and gravity conveyor
Lumber: strips.....	M.B.M.	100	6.00	600	.....	3.50	350	2.50	250	Loco. crane and gravity conveyor
Pulp wood.....	Cord	10,000	4.10	41,000	60,000	1.67	16,700	2.43	24,300	Loco crane and pneumatic conveyor
Rosin.....	Ton	250	6.55	1,637	6,000	1.00	250	5.55	1,387	Loco. crane and power mule
Soda ash.....	Ton	545	2.40	1,310	500	0.50	273	1.90	1,037	Pneumatic conveyor
Sulphite pulp.....	Ton	5,500	4.10	23,000	14,000	1.95	10,500	2.15	12,500	Power mule
				\$99,773	\$114,450		\$38,708		\$61,065	

* The present costs include maintenance and repairs but no fixed charges, or other overhead items. The proposed costs include fixed charges of 20 per cent.

It is a well-recognized fact in industrial-plant operation that the last 20 per cent of operating efficiency is the hardest to obtain, and yet shows the highest return. Thousands of plants in this country do not show an operating efficiency of more than 50 per cent, as compared with those plants that have an operating ratio as high as the present state of the art will permit. There are many reasons for this low operating ratio, but we are concerned only with the losses due to inadequate and inefficient material handling.

Industrial costs are composed of the following factors: (1) Material, (2) production labor, (3) factory burden or overhead, (4) general administration expense and (5) sales expense.

As a usual thing, indirect or non-productive labor is charged out to factory burden. A very large portion of this labor is used in picking up, putting down and transporting material of all kinds. Hence one place to start in reducing factory burden is to reduce waste in labor and expense in this indirect-labor item by substituting adequate and properly adapted material-handling equipment and methods.

The initial test of any method, system or device should

material to be handled, but one would need to know the physical handicaps at the mill to appreciate fully the necessity for and the difficulty of obtaining a right solution of the problem. The preliminary testing and checking of the equipment installed indicate that the savings will be readily obtained and in some cases exceeded as operating proficiency increases.

The public, industrial executives and business men generally are not in possession of sufficient data and economic facts to make them realize the astounding wastes going on all around. Engineers and manufacturers are largely to blame for this. The industrial executive usually knows how much per piece or per unit it costs to produce a given article, but rarely knows what it costs per unit to handle the materials entering into the manufacture of the article itself or the cost of handling the finished article. It is only recently that industrial plants have been designed or laid out on a material-handling basis.

If the manufacturer will get the engineer's point of view and the engineer the manufacturer's, and both will get the economic viewpoint, much good will result, fewer mistakes be made, and society and industry will benefit and prosper.

* Abstracted from a paper presented at the annual meeting, New York, Dec. 5-9, of the American Society of Mechanical Engineer and printed in *Mechanical Engineering* for December, 1921.

¹"Handling Materials in Factories," by William F. Hunt.

American Practice in High-Speed Steel Manufacture

Impressions on American Tool Steel Manufacture Received on a Trip of Inspection Covering Several Plants
—Importance of Pure Raw Materials and Metallurgical Control of All
Steps in Process Is Emphasized

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IT MAY be interesting to recount impressions received during a trip of inspection, when eight of the largest tool steel mills in this country were visited, six of which are using the crucible process, the two others melting their high-speed steel in the electric furnace. Several of the mills using the crucible process are now experimenting with the electric furnace method of melting and are obtaining very satisfactory results. The majority of the high-speed steel produced in Europe is crucible melted, although Sweden is manufacturing some electric furnace high-speed steel. One must use just as pure raw materials in electric-furnace practice as it is necessary to use in crucible melting if as high-grade product is expected. Too many mills using electric furnaces have found to their sorrow that they cannot produce a dress suit from a pair of overalls!

The crucible process of melting steel dates back to centuries before Christ, when the Chinese melted steel in crucibles, but it is not the intention to sketch its history, absorbing though that subject may be. The process as used today by most of the large tool steel mills in this country, is as follows:

The base, usually high-grade muck bar,¹ is carefully weighed. Most mills use about 50 lb. to the charge (90 or 100 lb.). Before the war Swedish iron was used to a large extent in this country for the high-speed base, but has recently been difficult to procure. It is the opinion of some American manufacturers, and vigorously disputed by others, that just as good a base is made in this country. One of the mills informed me they were using "Armco" iron for the base, another mill uses a special open-hearth product; but the majority of the plants have found that muck bar, which is almost pure iron, gives the best results.

High-speed scrap is then weighed. This consists of crop ends, bar ends, etc., and usually makes up about 25 per cent of the charge, or 25 lb. In the medicine room, so called, the ferro-alloys are very carefully weighed and placed in pails, which also contain ground brick dust for a fluxing agent. These alloys, such as ferrotungsten, ferrovanadium, ferrochromium, ferromanganese and ferrosilicon, constitute the remaining 25 per cent of the charge. The ferro-alloys are refined in the electric furnace and usually carry the following percentages of the alloying element:

Ferrotungsten.....	75 to 85 per cent tungsten
Ferrovanadium.....	33 to 35 per cent vanadium
Ferrochromium.....	60 to 70 per cent chromium
Ferromanganese.....	75 to 80 per cent manganese
Ferrosilicon.....	48 to 50 per cent silicon

¹Muck bar is genuine wrought iron. Impurities existing in pig iron of special grade are oxidized in a puddling furnace, the pasty iron sponge removed from the furnace in a ball or lump, most of the slag squeezed out, and the rough bloom resulting is rolled directly into a flat bar known as muck bar or puddle bar. Short pieces of muck bar are bundled, reheated to welding heat and rolled one or more times before being marketed in the form of wrought iron bar or pipe.

The proportion of the various alloys added as well as the amount of base and scrap used depends of course on the analysis required. Sometimes it is necessary to add wash metal—a white iron containing 3 to 4 per cent carbon, low in manganese, phosphorus, sulphur and silicon—to raise the carbon, while some mills add a small amount of charcoal. However, carbon is usually controlled by varying the amount of scrap and ferrochromium.

The material is now ready to be charged into crucibles. Crucibles used in America are made of a half-and-half mixture of flake graphite and binding clay. To prevent the graphite in the crucibles dissolving in the steel, they are usually lined with pure clay, lasting for four to six heats, the crucibles then being used for carbon tool steel melting. One mill superintendent states that he does not use this clay lining, but melts high-speed steel in crucibles which have been used for three or four melts of carbon tool steel. He says that steel absorbs only a very little carbon from crucibles which have been used several times.

Ferro-alloys, especially the ferrotungsten, are added near the center of the charge, to insure thorough mixing.

In order to maintain a neutral atmosphere, graphite covers are placed on the crucibles, which are then lowered into the furnace, each "hole" usually providing room for six crucibles. The size of the furnace is expressed by the number of crucibles it contains, such as thirty, thirty-six or forty-two crucible pot furnaces, and would contain, therefore, five, six or seven "holes." These furnaces are of the regenerative type, usually producer gas fired, and will melt the heat in 3½ to 4½ hours. After thorough melting, the heat continues for ½ hour more to permit gases in the molten steel to escape and to bring the steel to the proper casting temperature. This is known as the "killing" process.

Workmen then pull out these pots with large tongs. As it is necessary for them to straddle the open hole while it is at a temperature of around 3,000 deg. F. (1,650 deg. C.), they first wrap their legs and body in burlap, put on heavy shoes with wood and iron soles, drench themselves with cold water and after covering their hands and arms with water-soaked bags are ready for "pulling out." Considering the fact that these crucibles weigh over 100 lb., the job is not an easy one. Steel in these crucibles is then poured into molds or into a large preheated ladle and poured from the latter into the molds. The latter practice is more popular in this country and gives a more uniform analysis, ingot to ingot.

Raw materials used in electric furnace melting depend to a large extent on the available scrap supply. One large producer of electric furnace high-speed steel lists

the following as his raw materials: Muck bar, high-speed scrap, ferrotungsten, ferrochromium, ferrovanadium, ferromanganese, ferrosilicon, wash metal, limestone, lime, fluorspar, silica and ground electrodes. Another well-known manufacturer of high-speed steel states that limestone should never be used in the electric furnace process, for when it is present the heat melts with an oxidizing slag, causing a large loss in alloys. Lime in any form also slows the furnace working, and he states that there is always enough slag left in the furnace to take care of the subsequent heat while melting. He is also of the opinion that it is not necessary to introduce silica into the furnace, and that retort carbon should be used for carburizing in place of ground electrodes, because of the greater purity of the former. Such variations of opinion are given merely as a matter of record, without an attempt to appraise them critically.

Raw materials should be carefully analyzed, for it must be remembered that it is desirable to use just as pure materials in electric furnace melting as it is necessary to use in the crucible process. Anything showing high phosphorus, sulphur, nickel, arsenic, tin, copper, antimony or bismuth should not be used.

USUAL FURNACE OPERATIONS

Furnace operations, as usually carried out, are as follows: Limestone, if used, is first charged on the bottom of the furnace, wash metal next, then muck bar, high-speed scrap and ferrotungsten. The amount of high-speed scrap added usually runs from 30 to 40 per cent, one mill, however, claiming that 70 per cent scrap may be used if properly selected. Electrodes are then lowered, current turned on, and the steel melted, usually under neutral conditions. From 2 to 3 hours is required to bring the charge to a molten condition and approximately 600 kw.-hr. per ton of steel is consumed. A sample for analysis is usually taken at this point.

Slag is now removed and a new slag made of lime, fluorspar and ground electrodes, which maintains a strongly reducing atmosphere as well as a basic reaction toward the metal, thus eliminating oxygen and sulphur. A higher temperature is also usually used during this period to produce the desired chemical reactions. As soon as the bath is thoroughly deoxidized, ferrochromium, ferrotungsten and ferromanganese are added; ferrovanadium, the last alloy added, is usually introduced about 30 to 45 minutes before tapping; a short time before the heat is tapped ferrosilicon is introduced. Silica in small quantities is occasionally used to thin the slag. One large American mill usually makes five analyses during melting, the first being made as soon as the steel is melted, the others taken from time to time after recarburization, depending largely on the slag conditions. The last test is taken shortly before tapping. Five analyses obtained by this mill on one of their heats ran as follows:

	Test No. 1 Per Cent	Test No. 2 Per Cent	Test No. 3 Per Cent	Test No. 4 Per Cent	Test No. 5 Per Cent
Carbon.....	0.43	0.43	0.59	0.59	0.69
Silicon.....	....	....	....	....	0.29
Manganese.....	....	....	....	....	0.35
Sulphur.....	....	....	....	....	Trace
Phosphorus.....	....	....	....	....	0.019
Tungsten.....	17.29	....	....	....	18.48
Chromium.....	1.90	....	....	....	4.03
Vanadium.....	0.26	....	....	....	.98

When the heat is ready to tap, the slag is grayish white, containing carbide, and producing acetylene gas when thrown in water. One ~~melter~~ thinks that it is

poor practice to work under a carbide slag, as the different ingots poured may show a carbon variation of from 0.05 to 0.15 per cent, depending on the strength of the slag. Other operators say it would be almost an impossibility to eliminate this carbide slag.

Hot electric metal must be "killed" the same as in the crucible process. Correct pouring temperature as well as the condition of the metal is determined by pouring and examining small test ingots, and when the metal is ready the furnace is tilted and the steel poured into a heated ladle. After the hot steel is permitted to stand in the ladle several minutes to allow the trapped non-metallic particles to rise to the surface, the steel is teemed into molds.

Mills making electric-furnace high-speed steel claim the following advantages for their process over the crucible melted product:

1. Any desired temperature can be obtained.
2. More accurate chemical control is possible.
3. Impurities in original raw materials may be eliminated.
4. Better mixing of ingredients is effected.

The advantages of the crucible melted high-speed steel over the electric furnace material are said to be as follows:

1. A more careful examination of base materials is required.
2. Steel is melted in small units.
3. A neutral atmosphere is maintained in the crucible.
4. Unsurpassed ingots are poured by hand.

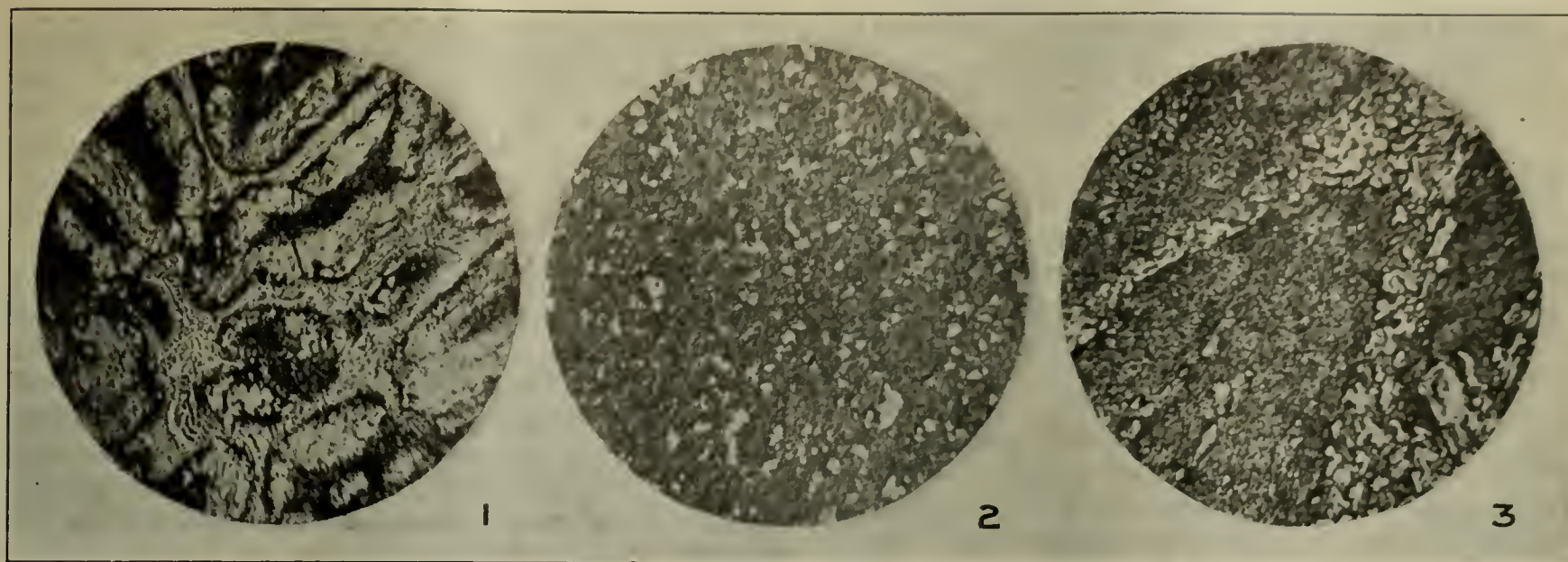
INGOT PRACTICE

Liquid steel, produced from either of the above processes, is usually cast into split iron molds with solid bottoms. These molds are tapered, and set with the large end up. On top of these molds rest preheated hot tops, or "dozzles," fireclay shells whose outside dimensions are the same as the inside dimensions of the molds. These hot tops act as reservoirs holding molten steel to feed the shrinkage cavities and eliminate piping to a marked degree. Molds are smoked so as to eliminate surface defects on the ingot.

When the ingots have cooled sufficiently, they are stripped from the molds. At this point the practice varies in different mills visited by the writer. The majority immediately anneal the ingots after they are stripped so as to remove all casting strains and to refine the grain as much as possible. Some mills omit this annealing operation, thinking that no benefits are derived.

The ingots are usually sampled for complete analysis, and whether annealed or unannealed are then carefully examined for surface defects. Imperfections are ground or chipped out. A small corner is also usually broken off and the fracture examined.

Ingots are now charged into large heating furnaces, coal or oil fired, and allowed to remain until they have been thoroughly heated to a temperature of approximately 2,100 deg. F. (1,149 deg. C.). They are then hammered by large steam hammers and reduced to billets. The piped end is then cropped off, usually amounting to from 10 to 20 per cent of the weight of the ingot. Billets are again carefully examined for surface defects, usually the entire surface is ground, and a careful examination of a fractured surface is also made. Billets are then charged into reheating furnaces and heated through to the proper temperature for further reduction. In most cases billets are annealed



FIGS. 1 to 3

Fig. 1. Structure of high-speed ingot;
3½ in. square.
× 300

Fig. 2. Structure of ¾ in. hammered and
annealed bar made from ingot of Fig. 1.
× 300

Fig. 3. Undesirable segregations in 8½
in. hammered bar.
× 300

before being reheated. Finishing to size is done either under hammers or in rolls. A short time ago some interesting experiments were conducted by Messrs. Andrew and Green of the Armstrong-Whitworth Co., England, to ascertain the comparative effect of hammering or rolling on the microstructure of high-speed steel, and no difference was observed, contrary to the widely held opinion that hammering produces a better product than rolling.

Finished bars are usually placed in large tubes, the ends sealed and the tubes then rolled into annealing furnaces, equipped with from four to twelve pyrometers connected to autographic recorders. Furnaces and contents are then brought up to from 1,500 to 1,600 deg. F. (816 to 870 deg. C.), held there for a considerable length of time, then slowly cooled in the furnace, an operation requiring from 2 to 3 days. It will usually produce a Brinell hardness of from 196 to 235, depending on the size of the material being annealed. A few mills use a packing material such as charcoal and ashes in the large tubes, but it is claimed that greater uniformity is obtained without this. A rapid method of annealing high-speed steel is to heat to 1,650 deg. F. (899 deg. C.) cool slowly to 1,300 deg. F. (704 deg. C.) and then air-cool. This will give a Brinell hardness of from 228 to 269, but the method is not used much in this country, as the consumers usually require a softer material.

Annealed bars are then carefully examined with a file for surface defects, their size measured, and both ends nicked and broken to examine the fracture for grain and pipe. Material is also tested for Brinell hardness. Most of the mills follow their steel through the different operations; it is identified with the proper heat number so as to know the analysis and history of the finished stock.

Fig. 1 shows the structure of a high-speed ingot as cast; Fig. 2 the bar produced from that ingot. The cellular structure has been entirely broken up by working, and a fine-grained structure produced with uniform distribution of carbides. A reduction of 85 to 90 per cent is required to break up the cellular structure and diffuse the envelopes. A section of an 8½-in. round high-speed steel bar in the annealed state is shown in Fig. 3. Carbide segregations and the envelope formation present in this annealed material have not been broken up by the manufacturing operations, nor

were they subsequently eliminated in a hardening treatment, although the time and temperature were sufficient to overheat the steel. It is a well-known fact that envelope structures and massive carbide areas will not go into solution upon hardening, and quite often these are the cause of cracking or short life of tools made from them. Large high-speed rounds are never free from these carbide laminations, due to insufficient reduction; forged blanks are therefore finding wide use, as then the steel has been hammered in both directions, and if properly done, this breaks up this segregated structure.

One impression left on the writer after inspecting the various tool steel mills was the influence of the metallurgical department on the quality of the finished product. An accurate chemical control of the raw materials and the finished product is essential if a good, uniform product is to be manufactured. Metallurgical supervision of the casting, cogging and annealing temperatures insures material properly fabricated. In one of the large mills the metallurgical department had full control of all inspection. All of the mills visited had adequate chemical laboratories, and in the majority of cases well-equipped physical testing departments and metallographic laboratories. It was quite noticeable that in some the metallurgical equipment was not used nearly as much as in some of the other mills visited, and I might add that the latter were the plants whose products are ranked among the best in the country.

One often hears it said, mostly by men connected with the tool steel industry, that the analysis of high-speed steel is no indication of its cutting qualities. This statement is true, for in more than one instance two different brands of high-speed steel, with approximately the same analysis, have shown altogether different cutting qualities. This does not mean, however, that the analysis specification is not important and should not be enforced. A large number of rejections have been made because of insufficient carbon, tungsten or vanadium, for such material would surely produce inferior tools. It is, of course, a mistake to purchase high-speed steel under a chemical analysis only, as the microstructure, Brinell hardness and fracture in hardened bar are of such importance that they should be included in the specifications. Yet control of the chemical composition is a step toward uniformity, which is of great importance to any steel product.

Apparatus for Studying Thermal Decomposition of Oil Shales

BY RALPH H. MCKEE AND E. E. LYDER

THE distillation of oil shale may be accomplished in almost any kind of a heating device from which air is excluded and which can be raised to the temperature of decomposition of the pyrobituminous substance. The results obtained usually vary with each method used and the manner in which the distillation is carried out. For a study of the manner in which shales decompose under the influence of heat and the temperature at which they break down to form oils, as well as the effects of steam, gases and various reagents on them it is necessary to have an apparatus in which all of the conditions may be accurately governed and known. These factors may be closely controlled and the quantities measured by means of a small rotary furnace described in this paper. The heating is done by gas, which makes it applicable to almost any laboratory, and the temperature is controlled automatically, as will be indicated later.

The method and apparatus may be used for test work both for oil yield and ammonia, but they are particularly adapted for the study of conditions under which the shale decomposes and the apparatus is on a sufficiently large scale to give results approximately parallel to those obtained in commercial retorting.

Most methods used to date involve starting the shale at relatively low temperature and continually raising the temperature until the oil is completely removed. Recent work has shown that important information may be gained by heating the shale to definite and known temperatures. For instance, it has been shown by the authors² that shale pyrobitumens decompose at quite definite temperatures to form bitumens and that the decomposition takes place over a relatively short range (within 10 deg. C.). Different shales may have different temperature ranges and the determination of these may be important.

¹The term pyrobitumen (after Abraham, "Asphalt and Allied Substances") is used to designate the material in shale which, on destructive distillation, yields bitumens.

²"Thermal Decomposition of Shales," *J. Ind. Eng. Chem.*, vol. 13, p. 613 (1921).

It is also believed that the future economic production of motor fuel from shales will depend upon the efficient cracking of this heavy bitumen first formed. An apparatus and method adopted to the study of the best conditions for the cracking of this heavy bitumen are, accordingly, very desirable.

RETORT

The retort used was of the horizontal rotary type, one which when filled with 1-in.-mesh shale held about 25 lb. The furnace and heating equipment are the stock type made by the American Gas Furnace Co. of Elizabeth, N. J., and are known as that company's heating machine No. 84. This is one of the company's older type machines, but some of its newer ones are essentially the same in principle and operation, thus being equally well adapted to this work. Inasmuch as this is a stock type furnace, a detailed description is unnecessary, but a general description of the furnace and a detailed discussion of the modifications adapting it to work with oil shale are desirable and will be given.

A drawing of the furnace and complete set-up is shown in Fig. 1. Briefly, the furnace is a steel cylindrical shell, about 3 ft. long with 4-in. fireclay insulation, inside of which is a series of burners and a rotating tube in which the shale, in a wire mesh cartridge, is placed. The heating compartment *B* contains the burners, ten in number, arranged five on a side and at the top of the furnace, as shown in the illustration. It is heated by gas blasted with compressed air (about 4 lb. pressure). The gas and air are led in through the pipes *b* and *b'*.

TEMPERATURE CONTROL

The heating is closely controlled by means of a heat regulator *E*, which is the same as is used on some assay furnaces. It is made by the same company. This regulator is operated by compressed air as power taken from the air line and controlled by means of a base-metal pyrometer *p*, which extends into the firebox proper. This base metal pyrometer, being subjected to the direct heat of the flame in the firebox, makes the apparatus very sensitive and the control, therefore, quite accurate. There was found no difficulty in controlling

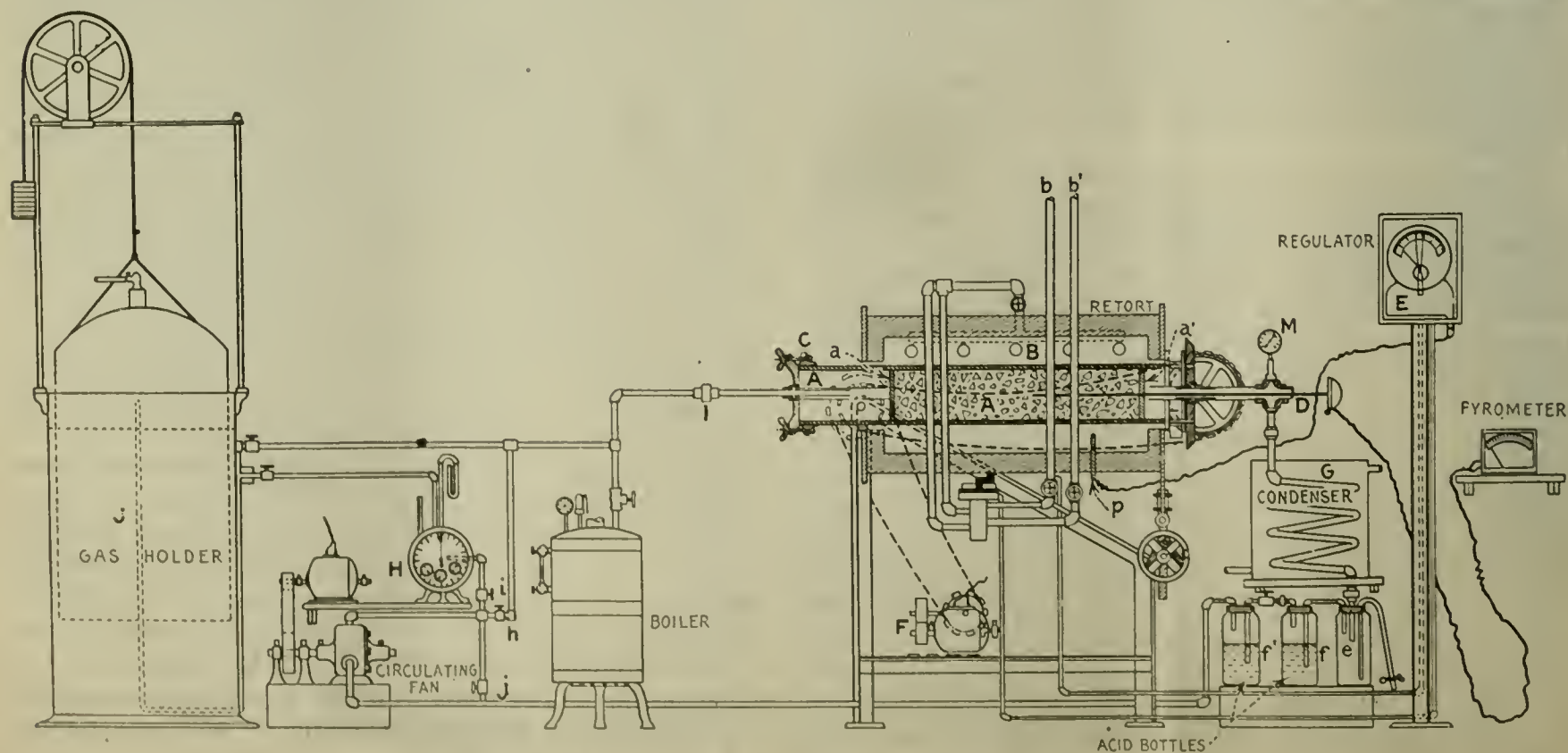


FIG. 1. APPARATUS FOR THE DISTILLATION OF SHALES

the temperature on the interior of the furnace, as measured by the pyrometer *D*, to within 10 deg. C.

The tube *A*, which is revolved by the motor *F* geared by a sprocket and bevel gear, as shown in the figure, extends through the furnace. It is 48 in. long, 7½ in. internal diameter, and ½ in. wall. The material of which this particular tube was made is nichrome, but the material usually supplied with the furnace is iron, and for shale distillation processes iron is adequate. Each end of the tube is closed off by heads fastened on by set-screws and thumb-screws, as shown. Stuffing boxes are provided at either end in order that the gases may be carried in and the vapors carried out without the admission of air. In order to confine the shale to the zone between the burners, perforated plates *a* and *a'* were set in. These were held in place by 1½-in. tubes screwed into the end plates. These tubes were perforated so that the gases collecting behind the plates would be carried out by the incoming steam or gas, thus avoiding dead gases. A space behind *a'* is also desirable so that the carbon and finely divided shale being carried out by the gases will settle before it passes into the vapor lines. The tube rotated at about 1 r.p.m.

VAPOR CONDENSATION

A convenient water-cooled condenser was made by using a galvanized iron tank 20 in. deep and about the same diameter. Through this was coiled about 15 ft. of ¾-in. pipe. In shale work it is often desirable to use air condensation before the vapors pass into a water condenser. This may be easily accomplished in this apparatus by erecting a 4-ft. riser where the pressure gage is shown at *M* and equipping it with a drain at the bottom and vapor line to the water condenser from the top. For this riser, 1½-in. pipe is sufficient.

The condensate was caught in glass bottles *e*, *f*, and *f'*, and the permanent gases carried back to measuring or circulating devices through the lead pipe as shown. The container *e*, in which all of the liquid products were caught, is fitted with a drain in order that they may be drawn off and measured from time to time. The containers *f* and *f'* may be filled with dilute sulphuric acid for washing out the ammonia if it is desired to determine this constituent. The boiler was a small low-pressure laboratory type furnishing the desired amount of steam. A circulating fan was installed, as it was desired to study the effects of various gases.

This equipment, supplemented by gas holders and measuring device such as wet test meter, etc., was found elastic enough to meet almost any condition desired in shale distillation work.

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Industrial Reconstruction of the French Devastated Region

A note in the November, 1921, issue of *Technique Moderne* shows some figures on the industrial reconstruction of the French devastated region. It is stated that of the 4,805 plants in this region employing 835,298 workmen before the war, only 3,284—i. e., 79.5 per cent—had resumed partial operation as late as Oct. 1, 1921, employing only 397,985 workmen—i. e., only 46.7 per cent of pre-war times. The percentages of workmen now employed in the devastated departments, with the pre-war figures as 100, are: Vosges, 62.2; Meurthe et Moselle, 56.3; Nord, 55.7; Ardennes, 45.3; Marne, 38.0; Aisne, 24.7, and Pas de Calais, 31.9.

Potash in the United States During 1920*

BY M. R. NOURSE

AT THE beginning of 1920 the fear of large imports of foreign potash sales still harassed the domestic potash industry, but as imports did not meet the demand and as prices on imported material early in the year were not materially lower than the prices on domestic salts, a large proportion of the sixty-six plants reporting production remained in operation throughout most of the year.

About 225,000 short tons of potash (K_2O) was imported in 1920. This, with the 48,077 short tons of domestic output, made the available quantity about equal to that normally used in each of the five years immediately preceding the World War. Because of the low prices received for their produce, many of the farmers of the country were unable to take up the promissory notes given by them for fertilizer in the spring of 1920 and were unable to buy the fertilizer they required in the fall. This condition, coupled with the abundance of potash on the market, resulted in a cancellation by the fertilizer-manufacturing companies of orders for domestic potash and greatly reduced the prices of all potash fertilizer materials. As a consequence all the Nebraska plants were closed by the end of December.

The price of potassium chloride (muriate) in the New York market ranged from \$1.75 to \$2.60 a unit during 1920. The net price for the same grade of material from 1911 to 1913 was 76c.

The approximate average prices per unit of potash (K_2O) of the domestic output f.o.b. plant for the same years are estimated as follows:

1915.....	\$3.14	1918.....	\$4.11
1916.....	4.37	1919.....	2.31
1917.....	4.29	1920.....	1.80

The sales for the year amounted to 139,963 tons of crude material, containing 41,444 short tons of potash (K_2O), valued at \$7,463,026, an average price of \$1.80 a unit. The stocks reported on hand at the end of the year were 32,378 short tons of crude material, containing 8,999 short tons of potash.

The plants operating for the primary purpose of producing potash—most of those utilizing brines, alunite, silicate rocks and wood ashes—produced 39,877 tons of potash (K_2O), or about 83 per cent of the total. The output of those producing potash as a byproduct was 8,200 short tons of K_2O .

SALINES

Seventeen plants were in operation in 1920 for the extraction of potash from natural brines. Eleven of these were in the alkali-lake region of western Nebraska (two plants were operated by one company), three were in California and three in Utah. As in several former years, the alkali-lake region of western Nebraska produced more potash than any other locality; the individual plant producing the largest quantity of potash (K_2O) was that of the Utah-Salduro Co. at Salduro, Utah. Some of the plants producing potash from natural brines were operated throughout the year, but by the end of the year all the Nebraska plants and

*Advance Sheets Mineral Resources of the United States, 1920—Part II.

TABLE I. POTASH PRODUCED IN THE UNITED STATES, 1915-1920, CLASSIFIED ACCORDING TO SOURCES

Source	1915-16		1917		1918		1919		1920	
	Crude Material (Short Tons).	Available Content of Potash (K ₂ O) (Short Tons).	Crude Material (Short Tons).	Available Content of Potash (K ₂ O) (Short Tons).	Crude Material (Short Tons).	Available Content of Potash (K ₂ O) (Short Tons).	Crude Material (Short Tons).	Available Content of Potash (K ₂ O) (Short Tons).	Crude Material (Short Tons).	Available Content of Potash (K ₂ O) (Short Tons).
Mineral:										
Natural brines:										
Nebraska lakes.....	*13,910	4,068	61,053	14,558	116,662	28,854	36,176	9,072	85,245	20,934
Other brines.....	2,981	790	18,823	6,094	32,390	10,862	37,395	12,518	45,438	15,681
Alunite.....	16,891	4,858	79,876	20,652	149,052	39,716	73,571	21,590	130,683	37,515
Dust from cement mills.....	*3,036	1,518	7,153	2,402	6,180	2,621	6,599	2,294	4,151	2,976
Dust from blast furnaces.....	*5,435	504	13,582	1,621	12,652	1,549	11,665	1,258	10,168	1,147
Silicate rocks.....	185	11	2,133	185	2,954	205	1,101	94	2,203	173
Organic:	46	25	.....	.....	201	105	1,307	127	160	51
Kelp.....	*5,416	1,574	11,306	3,572	14,029	4,804	368	132	410	205
Molasses distillery waste.....	7,775	1,799	8,589	2,846	11,792	3,467	8,791	2,892	9,420	3,253
Steffens waste water from beet-sugar refineries.....	380	46	2,642	369	8,795	1,374	12,423	5,601	9,201	3,394
Wood ashes.....	†825	412	1,035	621	1,100	673	807	484	438	263
Miscellaneous industrial wastes.....	124	63	645	305	931	289	2	2	.....	.....
	40,113	10,810	126,961	32,573	206,786	‡54,803	116,634	32,474	166,834	48,077

*Production was made from this source in 1915. †Figures for 1915 not available. ‡Some of the material produced in 1918 was sold in 1919.

that of the Salt Lake Potash Co., which utilized brines from Great Salt Lake, were closed.

The pioneer company of the Nebraska district, the Potash Reduction Co.—also one of the pioneers of the American potash industry—made the largest production of potash salts in this district.

It is stated that the cost of producing a unit of potash (K₂O) at the Nebraska plants in 1920, including an item for depreciation, was a little more than \$2. Doubtless the cost was considerably increased because of the dilution of the brines by the heavy rainfall in the spring and summer, which made concentration both difficult and expensive.

Of the three companies in Utah reporting a production of potash sales from brines in 1920 two utilized the waters of Great Salt Lake, and the third utilized the brines of Salduro Salt Marsh, in the extreme western part of the State.

The Salt Lake Potash Co., having a plant on the north shore of Great Salt Lake near Kosmos and producing potash from the waters of the lake by a solar evaporation process, has a yearly capacity of about 40,000 tons. Its product is a low-grade mixture of potassium sulphate and potassium chloride. At the end of the year the plant was closed because of the unsettled condition of the potash market, the high cost of labor and the difficulties of transportation. The Salt Lake Chemical Co., which has for a number of years been producing potassium salts at its plant at Burmester, on the south shore of Great Salt Lake, is a subsidiary of the Diamond Match Co.

The Utah-Salduro Co. at Salduro, 60 miles west of Great Salt Lake, produced more potash salts in 1920 than any other company in the United States. The deposit from which the potash is extracted has been described in former reports of the United States Geological Survey. The composition of the brine is similar to that of the artificial brines of the German potash works. Solar evaporation produces crude salts containing potassium, sodium and magnesium chlorides. These crude salts are boiled with hot brine and on cooling yield high-grade potassium chloride. Both high- and low-grade salts are marketed. Solar evaporation permits great saving of fuel. During 1920 the Utah-Salduro Co. was granted patent to 30,607 acres of land in the Great Salt Lake Desert.

Practically all the potash made from alunite in 1920 was produced by the Mineral Products Corporation,

with plant at Marysville, Utah, now owned by the Armour Fertilizer Works. An accident during the summer of 1920 retarded production somewhat, but new machinery designed to reduce materially the cost of producing potash was partly installed before the plant was shut down early in 1921. The demoralized condition of the fertilizer industry and the consequent lowered price of German sulphate, together with high freight rates, are given as the reasons for closing this plant, which produced a high-grade potassium sulphate and was a pioneer in the domestic potash industry.

The only commercial potash produced from silicate rocks reported to the United States Geological Survey for 1920 was a small quantity made by the Liberty Potash Co. from the wyomingite of Green River, Wyo. The plant of this company was run intermittently from November, 1919, to February, 1920. The product was a low-grade chloride. Since the plant was closed much additional experimental work has been done, and hopes are entertained of refinancing the project and putting it on a sound operating basis.

Only the Government experimental potash-kelp plant at Summerland, Cal., was in operation during 1920 on kelp as a source of potash salts. The capacity of the plant was not increased, but the energies of the force were directed to the development of byproducts, principally bleaching powder and iodine, both of which are now commercialized and placed on the market. The plant capacity for these materials, however, is not yet sufficient to put the experiment on a profitable basis. The output of potash from this plant has increased and the cost of production has steadily decreased. The output in June, 1920, was officially stated as 2 tons a day of 80 per cent muriate.

Status of the Luxembourg Iron Industry

In the review of the Luxembourg iron industry published in the Nov. 10 issue of *Stahl und Eisen* the following figures are conspicuous:

Locality	Blast Furnaces	Blast Furnaces in Operation June 30, 1921	Sept. 30, 1921
Belval	6	4	5
Esch	11	3	5
Steinford	3	1	1
Differdange ..	10	3	2
Dommeldange ..	3	0	0
Dudeldange	6	3	4
Rodange	5	2	1
Rumeldange ...	3	0	0
Total	47	16	18

Distillation Studies of Nitric Acid and Sulphuric-Nitric Acid Mixtures—I

Experimental Data on the Equilibria Existing Between Aqueous Nitric Acid Solutions and Their Vapors at Various Temperatures and Pressures—Effect of Dissociation of the Nitric Vapors
—The Phenomena of Maximum Boiling Point

BY PAUL PASCAL

With the experimental assistance of Mr. Garnier

THE preconcentration of synthetic nitric acid from the arc process or the oxidation of ammonia, the final concentration of this acid, even the denitration of waste acids from nitrations, raise a very general question in regard to the equilibria between aqueous nitric acid solutions or mixed acids and their vapors at various temperatures and pressures.

Although in large-scale apparatus of high output this equilibrium is not rigorously attained, an exact knowledge of it has a great practical interest. It has, therefore, appeared worth while to assemble herein the results which we have collected on this question.

As thus far falling in this category one can scarcely but cite the partial work of Saposchnikow [*J. Phys. Chem. russe.*, vol. 37, p. 374 (1905)] on the HNO_3 vapor pressure of mixed acid, and that of Creighton and Smith [*J. Frank. Inst.*, vol. 179, p. 161 (1915) and vol. 180, p. 703]¹ on the distillation of aqueous nitric acid and several nitric-sulphuric acid mixtures under various pressures. And yet this last work appeared just at a time when the results of our research began to find industrial application and a short time before the appearance in *Comptes rendus* [vol. 165, p. 589 (1917)] of a résumé of all our work.

This scarcity of numerical data relative to the commonest operations of the chemical industry has struck all physical chemists who have come in contact with the plant; it provides a free field for numerous and certain very interesting researches, particularly on ternary sulphuric-nitric acid mixtures, which we have specially studied.²

Study of the Binaries: Water, Nitric Acid

It is very difficult to avoid a partial decomposition when a concentrated nitric acid is boiled, and a false boiling point is always found on account of the dilution of the nitric acid vapor by its products of decomposition.

Aston and Ramsay [*J. Chem. Soc.*, vol. 65, pp. 167-73T (1894)] already, in their classical studies on surface tensions, observed that it was impossible to carry an almost colorless acid analyzing 99.8 per cent HNO_3 , above 78.2 deg. C. without boiling, due to the formation in the supernatant atmosphere of a little nitrous product.

Küster & Münch [*Z. anorg. Chem.*, vol. 43, p. 350 (1907)] state that "absolute" HNO_3 , of 100 per cent, colorless in the solid condition, already showed traces of decomposition from the time it melted.

It does not appear that Creighton and Smith were able completely to escape this inconvenience, and moreover in their experiments the pressure was measured at a distance from the boiling liquid, and hence there might be a marked difference (2 to 3 deg., sometimes 6 deg.) between the temperatures of the boiling liquid and the vapor emitted.

Since we could no more hope to prevent the dissociation, at least in the case of anhydrous acid, we preferred to determine its vapor pressure statically.

VAPOR PRESSURE OF PURE NITRIC ACID

The apparatus which was used was quite reminiscent of that employed in our work on the diamagnetism of organic compounds [*Ann. Chim.*, vol. 25, p. 304 (1912)].

The saturated vapor pressure of the liquid was measured by the increase in pressure resulting from its introduction into a space maintained at a uniform temperature and where the volume of the gas phase was maintained constant so that the correction of the expansion of the atmosphere could be avoided.

The increase in pressure was measured, below 30 deg., by a manometer of vaseline oil, freed from its alterable constituents by prolonged shaking with concentrated nitric acid; above 30 deg. by a column of mercury, protected by a layer of the same oil. All these operations were carried out under shelter from direct light.

The determinations offer no reliability above 75 deg.; often even before arriving at this temperature dissociation occurred, initiated by dust or by the too extended maintenance of an elevated temperature; even the vaseline oil was soon attacked. When working with a 100 per cent acid, prepared according to Küster & Münch, we obtained the figures in Table I, which agree well

TABLE I. VAPOR PRESSURE OF 100 PER CENT NITRIC ACID

Temp., Deg. C.	Mm. Hg	Temp., Deg. C.	Mm. Hg
20	23	50	200
26	38	62	350
29	50	74	530
40	112	75	540

enough, with a slight extrapolation, with a normal boiling point lying between 86 and 87 deg., in the absence of all dissociation.

At low temperatures our figures are distinctly lower than those which Creighton and Smith obtained by measuring the boiling point at a given pressure; but at 50 to 60 deg. agreement is re-established and maintained.

HEAT OF EVAPORATION OF NITRIC ACID

It is known that Clapeyron's formula may be written:

$$L = \frac{T}{J} u' \frac{dp}{dT}$$

Translated from *Ann. Chim.*, 1921, New Series, vol. 15, pp. 253 to 290, by F. C. Zeisberg, Chemical Department, E. I. du Pont de Nemours & Co.

¹Note: The first of these is by Creighton and Githens, the second by Creighton and Smith. F. C. Z.

²See Pascal and his collaborators, *Bull. soc. chim.*, 1918-1920, *passim*.

if the specific volume of the liquid as compared with that of the saturated vapor is neglected. If the vapor is regarded as a perfect gas, we may write:

$$pu' = \frac{RT}{M}$$

M being the molecular mass; from which, finally:

$$L = \frac{RT^2}{JM} \times \frac{1}{p} \times \frac{dp}{dT}$$

It is thus found that at 86 deg. $L = 120$ cal. and at 75 deg. $L = 125$ cal., values which almost coincide with the direct determinations of Berthelot. It is noted, moreover, that the heat of vaporization, calculated from the vapor pressure curve, increases distinctly as the temperature decreases, as if at low temperatures the vapor suffered a notable polymerization.

THE BOILING OF AQUEOUS NITRIC ACIDS

Several different but nearly similar apparatus were employed in the course of these experiments, all inspired by the twofold desire to obtain a sample of the vapors and the liquid without interrupting the distillation and to define as perfectly as possible the temperature and the pressure at which the two phases were in equilibrium.

In its most perfect form, achieved in the preliminary experiments, the distillation apparatus comprised a boiling vessel, a vapor cooler and a total condenser for the vapors, all of sealed glass.

A Würtz flask, of 5-liter capacity, half filled with liquid was heated on a sand-bath. It was entirely sur-

second extended only into the vapors. Under normal operation, before withdrawing any samples, they agreed within about 0.5 deg. and the upper part of the air-bath was about 5 deg. above this boiling point.

The cooler was a simple tube cooled on the outside by circulating water at 14 deg. and sealed directly to the condenser. This latter part of the apparatus consisted

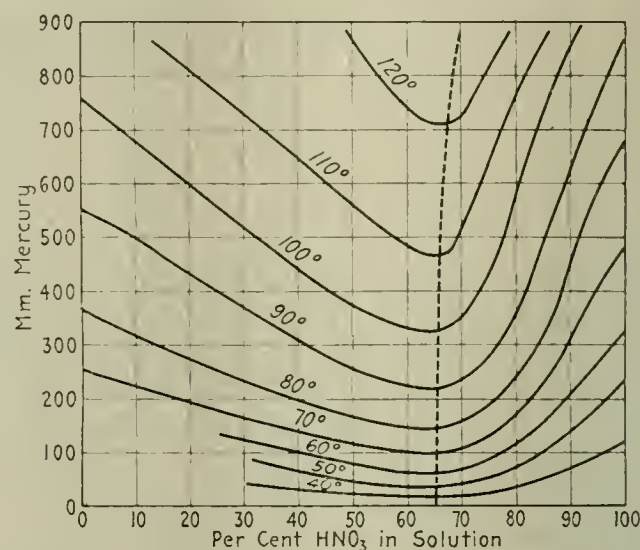


FIG. 2. BOILING POINT CONTOUR LINES

essentially of three reservoirs A , B , C ; the first served as a measuring device, the second as a sampler, the third as a guard tube. To C was connected the water-jet pump which exhausted the apparatus, or the reservoir of compressed air used when boiling points above atmospheric pressure were studied.

The measuring tube A had a diameter of 2 cm. and a length of 10 cm. and was graduated; it was surrounded by a cooling bath (if necessary acetone and carbon dioxide snow) to condense all the vapors; B was a Cloez bubbling tube closed by a cock R_6 .

The various cocks shown in the illustration are of different types. R_2 , R_3 and R_6 are simple stop-cocks; R_1 is a stop-cock with an opening through the plug, which enables connection to be made with the atmosphere and B or C , to relieve the vacuum there; R_5 is a three-way cock, of which the openings may take various positions, as 1, 2, 3 or 4. (See Fig. 1.)

The flask being filled by suction through the tube T_1 , R_1 is closed, R_2 is opened, R_6 is closed to the air and R_5 is turned into position 1. Heating is commenced and then as the boiling point, determined by a previous experiment, is approached, the water-jet pump is started to establish the desired pressure.

The ebullition is permitted to become regular to mix the liquid thoroughly and 4 to 5 c.c. at least of liquid is collected in A to rinse the apparatus well. This rinsing liquid is evacuated to the guard tube C by closing R_2 and setting R_5 in position 4, and immediately thereafter the two cocks are replaced in their original positions.

If at this time both thermometers in the Würtz flask indicate the same constant temperature, 2 or 3 c.c. of liquid is collected in the graduated tube, but this time is allowed to pass into the sampler by closing R_2 and putting R_5 in position 3.

After this operation R_5 is replaced in position 4, R_2 is reopened and by means of R_1 the sampler B is connected with the atmosphere, in order that the rinsing acid wetting its walls may be removed through R_6 . A new portion of liquid is then transferred to the sampler, now well rinsed by the condensed acid, by repeating the above operation, and is withdrawn for analysis.

The measuring tube A , in short, serves to measure

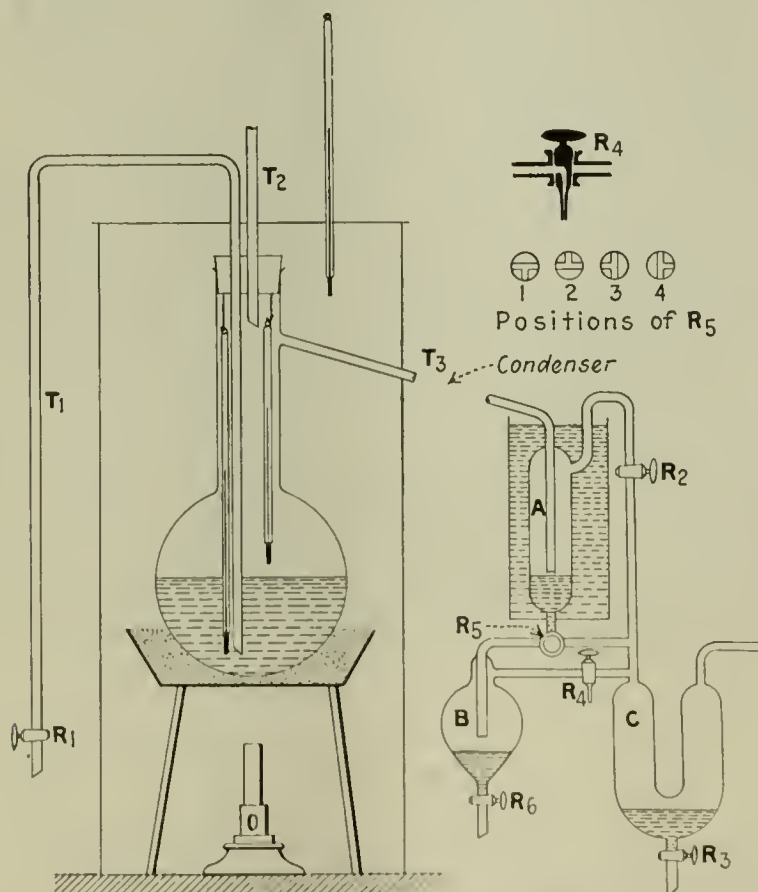


FIG. 1. DISTILLATION APPARATUS

rounded by an asbestos jacket provided with glass windows heated interiorly as needed by lamps with carbon filament. Thus all condensation of vapor was avoided before the cooler was reached. (See Fig. 1.)

A standpipe T_1 and a stop-cock R_1 served to empty and fill the apparatus; the tube T_1 connected the flask with a manometer and vacuum regulator; T_1 served to carry away the vapors.

Two thermometers were placed inside the flask; the bulb of the first was immersed in the liquid, that of the

TABLE II. DISTILLATION EQUILIBRIA FOR THE SYSTEM
NITRIC ACID:WATER

Nitric Acid of About 25 per Cent					
Pressure, Mm. Hg	Boiling Pt., Deg. C.	Liquid		Vapor	
		HNO ₃	NO ₂	HNO ₃	NO ₂
190	65.5	23.8	<0.1	1.40	<0.1
237	72	24.0	<0.1	1.71	<0.1
465	93	24.6	<0.1	1.80	<0.1
566	100	24.0	<0.1	2.20	<0.1
760	106.5	24.2	<0.1	2.16	<0.1
870	115.5	25.2	<0.1	1.6	<0.1
Nitric Acid of About 34 per Cent					
40	40.2	36.0	<0.1	5.2	<0.1
116	59.0	33.1	<0.1	5.0	<0.1
318	87.5	33.2	<0.1	4.95	<0.1
458	97.5	34.0	<0.1	5.1	<0.1
570	104.0	33.0	<0.1	5.3	<0.1
680	108.5	32.99	<0.1	4.8	<0.1
760	112	33.0	<0.1	5.9	<0.1
Nitric Acid of About 50 per Cent					
40	45.8	51.0	<0.2	21.2	<0.2
116	66.5	50.0	<0.2	20.0	<0.2
317	95.0	49.2	<0.2	18.5	<0.2
458	105.5	50.5	<0.2	21.2	<0.2
570	111.0	49.8	<0.2	16.0	<0.2
760	118.5	49.8	<0.2	19.85	<0.2
870	124.2	50.2	<0.2	15.2	<0.2
Nitric Acid of About 60 per Cent					
40	52	61.0	<0.2	50.02	<0.2
116	70.2	60.65	<0.2	42.0	<0.2
317	98.5	61.0	<0.2	45.0	<0.2
353	104	61.2	<0.2	50.2	<0.2
463	109.5	60.98	<0.2	50.4	<0.2
517	112.5	60.85	<0.2	50.5	<0.2
553	113.5	61.2	<0.2	51.0	<0.2
622	115.5	61.2	<0.2	50.1	<0.2
670	117.5	60.95	<0.2	50.02	<0.2
725	120.5	61.0	<0.2	45.2	<0.2
763	121.6	61.0	<0.2	41.0	<0.2
Nitric Acid of 65 to 68 per Cent					
40	52.6	64.96	<0.2	65	<0.2
116	72.0	66.2	<0.2	65.9	<0.2
116	72.1	66.4	<0.2	66.4	<0.2
324	102	64.0	<0.2	50.0	<0.2
458	109	67.6	<0.2	66.9	<0.2
465	110.1	65.6	<0.2	64.95	<0.2
574	113.9	68.2	<0.2	68.10	<0.2
760.2	121.9	68.4	<0.2	68.4	<0.2
870	126.0	64.5	<0.2	58.9	<0.2
870	126.3	66.62	<0.2	65.10	<0.2
1,010	130.6	65.19	<0.2	65.10	<0.2
Nitric Acid of About 70 per Cent					
40	52.0	70.2	<0.2	85.0	<0.2
116	71.5	70.0	<0.2	86.2	<0.2
325	98.5	70.2	<0.2	79.2	<0.2
408	104	69.9	<0.2	80.2	<0.2
458	108	69.5	<0.2	80.0	<0.2
570	113.5	69.9	<0.2	77.2	<0.2
754	121	70.1	<0.2	84.0*	<0.2
Nitric Acid of About 75 per Cent					
40	47.6	74.72	0.35	94.80	0.31
116	67.0	74.52	0.35	90.77	0.31
325	93.0	75.52	0.35	89.57	0.35
408	103.0	74.62	0.35	86.56	0.35
540	110.0	74.02	0.35	94.56	0.35
760	118.0	75.12	0.35	91.50	0.35
Nitric Acid of About 80 per Cent					
40	43	79.81	0.21	97.78	<0.2
116	56	81.71	0.21	97.6	<0.2
458	91	81.70	0.21	97.98	<0.2
570	98	80.70	0.22	96.58	<0.2
760	112	79.73	0.22	96.7	<0.2
870	120.5	80.40	0.22	95.6	<0.2
Nitric Acid of About 85 per Cent					
40	38	84.45	0.41	98.35	0.41
116	52.5	85.45	0.40	98.75	0.51
345	78	84.45	0.40	98.45	0.31
458	84	84.65	0.40	98.65	0.2
570	92	84.65	0.40	98.15	0.2
760	99	84.65	0.40	97.45	0.2
Nitric Acid of About 90 per Cent					
40	32.5	89.52	0.5	99.84	0.1
116	47.5	90.05	0.4	99.25	0.5
315	63	90.92	0.5	99.59	0.23
458	75	90.59	0.3	99.66	0.1
570	80.3	90.69	0.3	99.63	0.2
760	90.5	89.65	0.4	99.41	0.2
870	100.0	91.6	0.4	98.5	0.2
Nitric Acid of About 95 per Cent					
40	29	94.52	0.35	99.43	0.4
116	43.5	94.92	0.28	99.65	0.25
458	69	94.67	0.31	99.62	0.2
760	85.5	95.38	0.45	99.63	0.2
870	90.5	95.0	0.45	99.69	0.2
Nitric Acid of About 98 per Cent					
40	27.5	97.62	0.28	99.47	0.31
116	41.5	97.50	0.29	99.33	0.41
315	59.0	97.64	0.41	99.47	0.38

*This appears to be a typographical error in the original article for 74.0.—F. C. Z.

the volume of liquid distilled during these operations and permits a determination of the average composition of the acid which furnished the liquid used for the analysis, owing to the knowledge which we have of the composition of the acid remaining in the distilling flask.

In order to make our results more expressive, we have assembled the results in Table II by grouping under the same head the acids whose composition is about the same. Each partial table thus practically gives the vapor tension curve of the acids of different strengths, and as the pressures have practically the same value in each group, we have at a glance the composition of the liquids and the vapors in equilibrium with them under these pressures at all the temperatures of our experiments. We have given in the "vapor" column the composition of the condensed liquids; they occasionally contained nitrogen peroxide in small quantity, but the resulting proportion of this substance is not necessarily exactly like that which existed in the atmosphere of the apparatus.

It is possible, moreover, to correct for the slight variations in strength and pressure for a single series by tracing the surface of the boiling points θ , which has the concentrations c for abscissas and the pressures p for ordinates. Fig. 2 gives the contour lines of this surface projected on a horizontal plane of reference.

Vertical sections of this surface, parallel to the horizontal axes of co-ordinates, represent either the curves

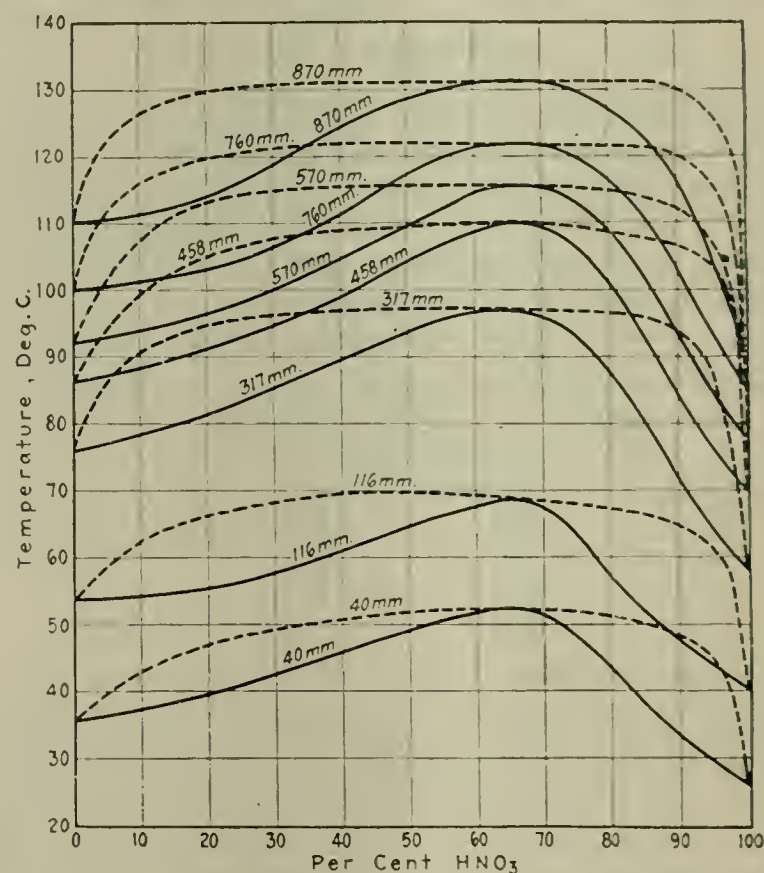


FIG. 3. BOILING POINT CURVES

of vapor pressures corresponding to a given strength, or the boiling point curves as a function of the strength, for a given pressure.

The system of original curves, projected upon the plan θp , bends back upon itself around the hinge formed by the curves which correspond to 65 to 68 per cent HNO₃ strengths for which the existence of a maximum boiling point is observed. The boiling point curves as a function of the strength are shown by the groups of Fig. 3, on which have been plotted the curves relating to the average pressures used in our experiments—namely, 40, 116, 317, 458, 570, 760 and 870 mm. This graph is completed by the vapor curves (dotted) obtained in the same experiments.

DISSOCIATION OF THE NITRIC VAPORS

In all the preceding experiments it was impossible to prevent a partial dissociation of the vapors as soon as the strength of the acid exceeded 58 per cent HNO₃ and the temperature 50 deg. C. When at the same time both of these limits were exceeded, the atmosphere of

the apparatus became slightly colored and there distilled over a mixture of unaltered nitric vapors, oxides of nitrogen, oxygen and water vapor, in which the partial pressure of nitric acid was necessarily below the value indicated by the manometer. There must then be produced an apparent lowering of the boiling point of the acid supposedly distilling without decomposition, and only the "natural" boiling point is observed, to adopt the expression so frequently used by the Dutch school.

Moreover, a small extrapolation of the preceding boiling point curves to the co-ordinate for anhydrous nitric

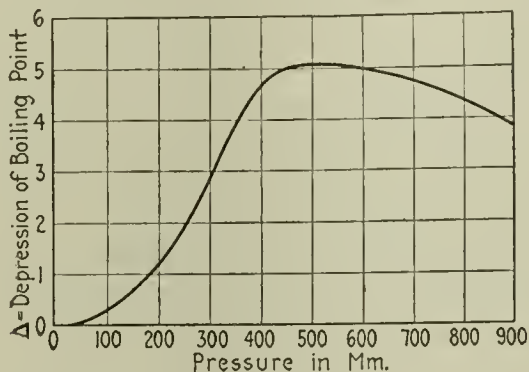


FIG. 4. BOILING POINT DEPRESSION

acid yields for this substance apparent boiling points E_a below the real boiling points E_r , which may be deduced from the vapor pressure curves; it is due to this fact, no doubt, that the disagreement originates between our numbers, measured statically, and those of Creighton and Smith, measured dynamically.

At any rate, we observed the figures given in Table III.

TABLE III. BOILING POINT DEPRESSION CAUSED BY DISSOCIATION

P., Mm.	E_r	E_a	Δ
870	91.0	87.0	4.0
760	86.5	82.0	4.5
570	77.5	72.5	5.0
458	70.5	65.5	5.0
317	60.0	56.8	3.2
116	40.4	40.0	0.4
40	26.2	26.2	0.0

The depression of the boiling point, shown by Fig. 4, does not show up at low pressures, for then the liquid distills at low temperatures; it is decreased by high pressures, which partially oppose the dissociation; the maximum deviation occurs around 500 mm. and attains a value of 5 deg. We have indicated a slightly higher depression in a preliminary note in *Compt. rend.*, vol. 165, p. 589 (1917).

MAXIMUM BOILING POINT

We naturally also encountered the well-known phenomenon of a maximum boiling point, corresponding to the time when the acid is emitting a vapor of the same composition as the liquid.

Varying the pressure modifies both the temperature at which this phenomenon occurs and the concentration of the acid which gives rise to it. Thus, we have observed the following results:

Pressure, Mm. Hg	Max. Conc., per Cent HNO_3	Max. Temp., Deg. C.
40	65.0	52.6
116	66.4	72.1
317	66.4	99.0
458	66.4	109.0
760	68.4	121.9
870	68.4	125.5

These values agree with those of Creighton and Smith, who determined, at three different pressures, the final composition of the acid obtained by distilling

various acids of an initial concentration lying between 60 and 80 per cent, thus:

Pressure, Mm. Hg.	Concentration	Temperature, Deg. C.
760	68.18	121.7
360	67.15	99.9
110	66.8	74.2

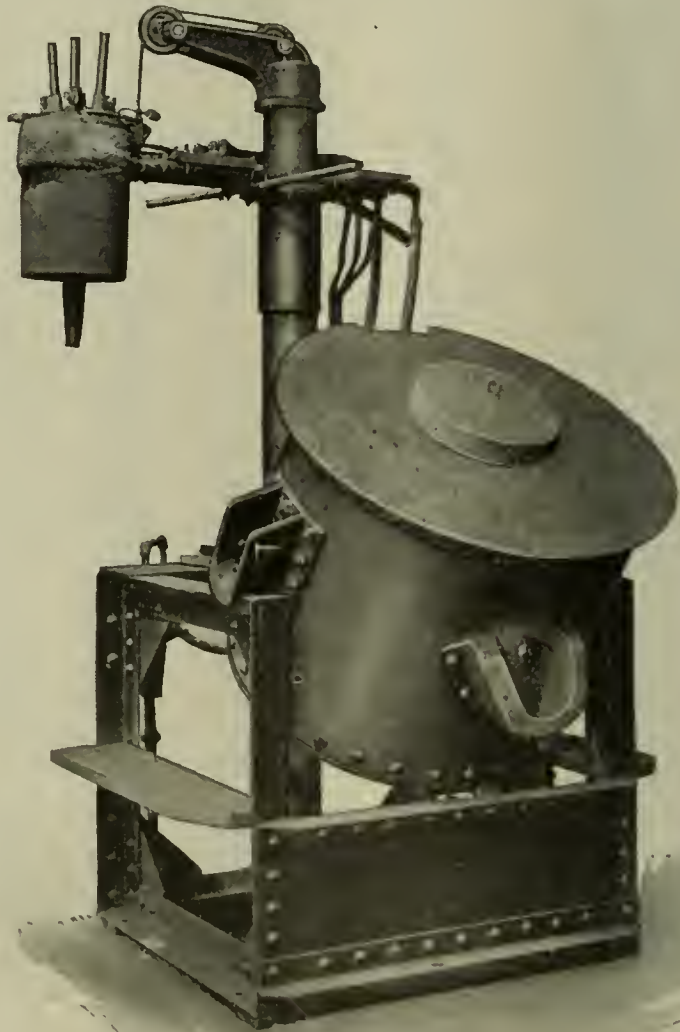
Diminution of the pressure thus displaces the maximum slightly in the direction of a lower nitric acid content. (See Fig. 2.)

Scientific Faculty of Lille.

(Part II, dealing with the system water:nitric acid:-sulphuric acid and the practical application of these data, will be published in a subsequent issue.)

The Repel-Arc Furnace

THE Repel-Arc furnace¹ essentially consists of a metal framework supporting the furnace bowl and a mast which carries the electrode holder or torch. The frame is substantially made of standard shapes, riveted together. No foundation is required, except in the 1- and 1½-ton sizes. The bowl is made of boiler plate, with seams riveted. It is mounted on trunnions so that it can be tilted for pouring. Small furnaces are tilted by hand; the larger sizes by motor and screw. The bowls



REPEL-ARC FURNACE IN OPERATION IN A FOUNDRY
SPECIALIZING IN SMALL STEEL CASTINGS

are made amply large, to admit of a thick lining, so as to keep heat losses at a minimum. The roof is made of firebrick.

Supported from the mast arm and counter-weighted so that it can be easily raised and lowered is the heating element, sometimes called the torch. This consists of a cylinder with one end closed, made of crucible material. Through the closed end of this cylinder are three round holes in which are placed cast alloy supports for the carbons or electrodes. Each of the three electrodes is

¹S. von Schlegell, U. S. Pat. 1,352,541, Sept. 14, 1920.

carried in a sleeve which rests on the support so as to be pivoted or be free to swing. They are counter-weighted so that the lower ends swing into contact when the current is off. This simple expedient of mounting the carbons so that they are free to swing to and from each other makes the furnace self-regulating.

On account of the fact that the furnace is three-phase and automatically self-regulating, no special transform-

to electrode if it ceases between the electrode and the metal. This constant maintenance of the arc makes the operation of the furnace steady and uniform.

QUICK POURING AND CHARGING

Again, when ready to pour, the heating element is raised in an instant and swung out of the way. The shell can then be tilted forward for pouring. As soon as the pouring is completed, the next charge can be put through the roof opening, the electrodes swung into place and the furnace started again. This saves time and heat, prevents breaking electrodes and makes it possible to repair the lining without disturbing the roof. With the charge prepared in advance, it is an easy matter to pour, recharge and start a 500-lb. furnace in 5 minutes.

To adjust the furnace so that it draws any given amount of power from the line, it is only necessary to move the adjustable counter-weights on the electrode holders. This makes it possible to change the heating rates at will. The vertical movement of the torch as a whole also makes it possible to maintain the arc at the desired distance from the metal, without affecting the electrical operation of the furnace.

Another feature of importance is the fact that the shell or bowl is removable. By having two shells, one can be used for ferrous and one for non-ferrous metals; or one can be relined or the lining patched while the other is in use.

Repel-Arc furnaces are made in the following standard sizes for 22-volt, three-phase operation: $\frac{1}{8}$, $\frac{1}{4}$, $\frac{1}{2}$, 1 and $1\frac{1}{2}$ ton capacity. On account of the ability to make use of both the direct and indirect system, all furnaces are adapted to the melting of all metals which can be successfully handled in an electric arc furnace, such as steel, iron, copper, brass, nickel, aluminum, Monei metal and the many alloys used in the various industries.

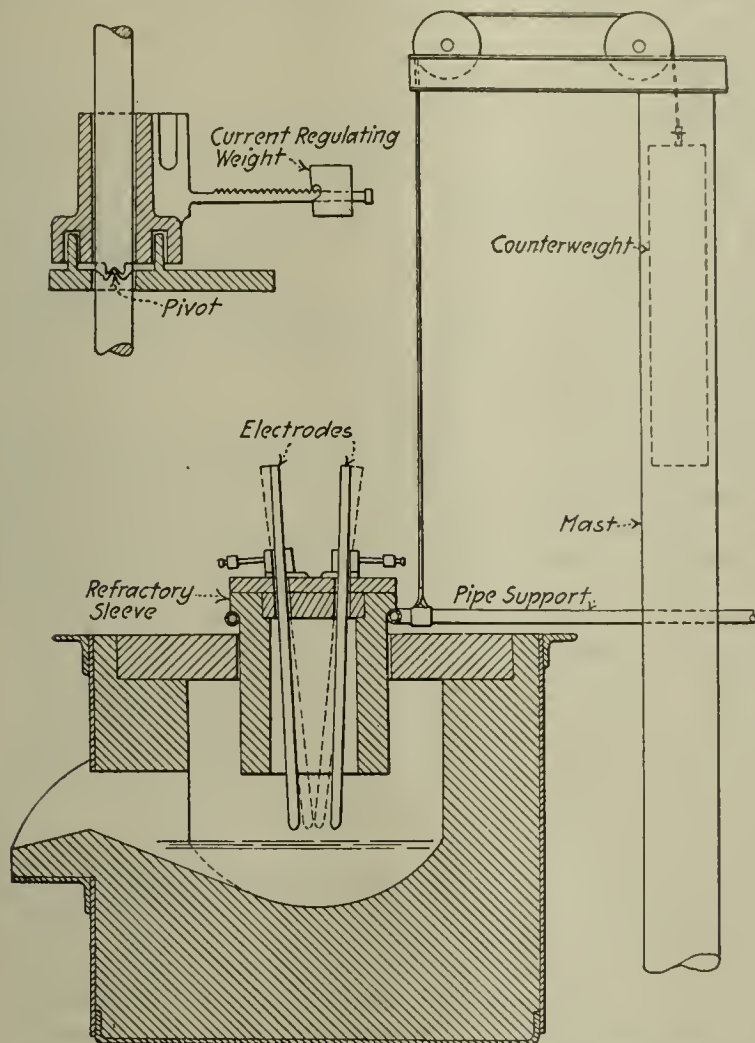
An Improved Scleroscope

AS IS well known, in hardness testing the surface resistance of metals must be overcome as by application of a given force on a spherical point. This operation leaves permanent indentations of a size varying in proportion to the material's resisting power or hardness.

The older way had been to measure the indentation under a microscope or depth gage, then to convert into suitable hardness degrees. This method, however, is not practical on hardened steel, and otherwise it is so uncertain and painstaking as to render it almost unavailable for regular commercial use.

The Shore direct reading principle, embodied in the scleroscope, is more convenient and is applicable to not only soft metals but the hardest steels as well. To this end is utilized a diamond-tipped hammer, which, after falling, indents the metal microscopically and then rebounds to a graduated height which is in exact inverse proportion to the size of the said indentation. Notwithstanding the great speed at which this instrument may thus be operated, full accuracy is maintained. Comparatively little or no nervous fatigue is involved, hence it has best met all requirements of economical and commercial hardness measuring.

In view of this fact, that the scleroscope has met with universal approval and adoption is perhaps needless to mention. The demands made on it recently, however, have been so intensive and often under such adverse



A CROSS-SECTION OF THE REPEL-ARC FURNACE AND ENLARGED SECTION OF AN ELECTRODE HOLDER, ILLUSTRATING THE PRINCIPLE OF OPERATION

ers are required. It can be connected to any 220-volt, three-phase motor supply circuit of proper capacity.

The instant the switch is closed the electrical repulsion and rapid evolution of gases between the carbons force them apart and draw the arc. If the current tends to increase, the carbons are forced further apart, increasing the length of the arc and keeping the current from rising. If the current reduces, the carbons move closer together, shortening the arc and keeping up the current. If the power is shut off and turned on again, the arc is immediately re-established.

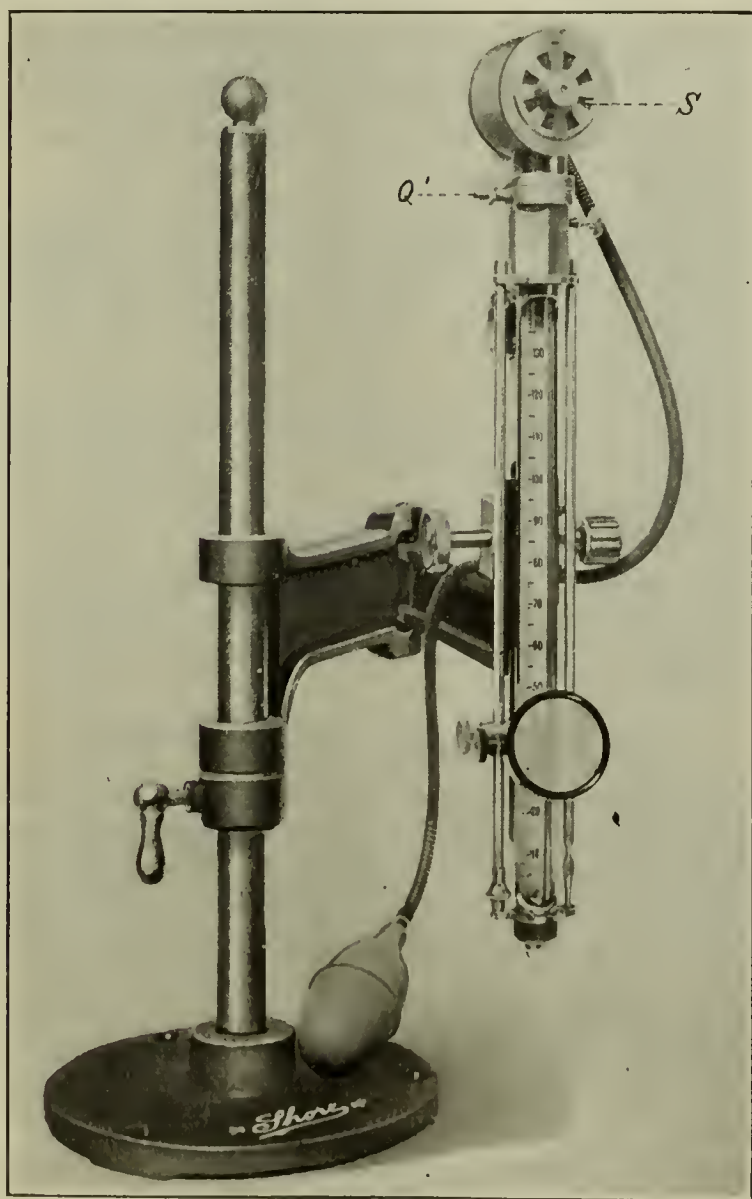
BOTH DIRECT AND INDIRECT ARC

A distinct advantage of this new furnace is the fact that it can be operated both as a "direct arc" and an "indirect arc" furnace, which adapts it to the melting of metals of different kinds. The electrode holder can be raised and lowered as a unit. When melting metal of high volatility, the arc can be maintained entirely between the electrodes at the desired distance above the metal. Again, when melting down metal requiring greater heat, the arc can be lowered so as to take place wholly or partly between the electrodes and the metal itself. After the metal is molten, the arc can be maintained entirely between the electrodes and the molten mass if desired. In melting down a charge the arc is not broken by the falling away of the metal as it is melted, because the arc is still maintained from electrode

conditions that its manufacturer, the Shore Instrument & Manufacturing Co., has made a closer study of the advanced conditions of its application, with a view to improving it further. The results were very satisfactory and it is announced that the scleroscope formerly known as Model C has, by virtue of modifications, been listed as Model C-1. The refinements made so increase the flexibility of the operating mechanism that it will give more uniform service even though the adjustments are comparatively approximate and the working conditions, including the skill of the operator, are less favorable.

FEATURES OF THE NEW SCLEROSCOPE

Among the features are: (1) special fine screen *S*, for eliminating dust from the operating mechanism; (2) the leather operating piston formerly used has been replaced by one of tungsten steel, which is practically



IMPROVED SCLEROSCOPE

indestructible; (3) the former rigid adjustments of the hammer-hook mechanism have been replaced by a flexible adjustment *Q* which also greatly prolongs the life of the glass tube; (4) the hammer hooks have been provided with shock shoulders, which eliminate breakage of disalignment of these parts. In addition, more highly perfected glass tubing is being employed.

Altogether, the refinements that have been added to the Improved Scleroscope Model C-1 have greatly increased the ease of operation under all conditions and speeds. This advantage will be appreciated by the painstaking laboratory man, as well as by the modern precision manufacturer, whose problem is one of quantity production.

Synopsis of Recent Chemical & Metallurgical Literature

Combined Iron and Steel.—Dr. Percy Longmuir read a paper on this subject before the Birmingham (England) Metallurgical Society, and is reported by *The Iron and Coal Trade Review*, Oct. 28, 1921, p. 617, to have said that composite articles of iron and steel had been made in Sheffield for 50 years. They are particularly useful for cutters operating at high speed on organic fibers (wood, paper, grass, wool), withstanding vibration and sudden impact better than all-steel tools. A steel cutting surface backed with tough iron may be hardened to equal hardness over its entire face, and needs only regrinding for sharpening, whereas a solid steel blade would break under work if hardened throughout. The former will bend under a shock which would shatter the latter.

Welding soft iron to hard steel is beyond the smith's skill, even though some of them can weld high-carbon metal when making "double shear" steel. It has often been proposed (and done) to pour molten steel about hot wrought-iron bars, or thrust them into the mold after pouring. After rolling, the wrought iron is found to have preserved its identity, but shows the characteristics of "burnt" metal—i.e., "tenderness" and brittleness.

A more successful method consists in using a mold with a vertical partition, filling one half with crucible steel, and almost instantly the partition is removed as the remainder of the mold is filled with molten iron. On cooling, the composite ingot is found to be securely welded; it is dressed, cogged into a bar, and rolled into plates, ready for annealing, forming into tools, and hardening. Excessive piping was very rare in ingots which had been properly welded, and the latter was purely a matter of good workmanship. The raw materials were of best stock and crucible melted, and treated according to tool steel practice. Although high-speed steel and other complex alloys have been used, the ordinary materials are as follows:

	C	Si	Mn	S	P	Brinell
Low-carbon iron...	0.08 to 0.15	0.05	0.30	0.035	0.035	120
Steel	0.75 to 1.40	0.10	0.30	0.03	0.03	

A knife made from the combined iron and steel gave a Brinell hardness on the steel face of from 600 to 627 at distances ranging from 1 to 4 in. from the cutting edge. A solid steel knife of the same shape and for the same purpose had a Brinell hardness of 512 1 in. from the edge, 444 at 2 in., 228 at 3 in. and 207 at 4 in.

Stainless Iron.—We have already published a note¹ to the effect that stainless iron has been marketed in England for automobile bodies. Dr. Leslie Aitchison has now read a paper before the British Institution of Automobile Engineers (November, 1921, meeting) on "Chromium Steels and Irons." He noted that freedom from corrosion is definitely an attribute of chromium; 25 per cent of nickel not being the equal to one-half that amount of Cr in this respect. It is not well appreciated that the properties of the steels are profoundly affected by carbon; too high carbon may accelerate corrosion, but on the other hand carbon as low as 0.07 gives easily forged metal little subject to surface defects. It is thus very useful for sheet, strip or intricate drop forgings, even if weaker than stainless "steel" (C 0.40±). Its price, too, is lower. The effect of carbon can easily be seen by comparing steels containing approximately 0.20 Si, 0.20 Mn, 12.00 Cr, 0.50 Ni:

Carbon Content	Maximum Stress After Quenching and Drawing at—			
	500° C.	600° C.	700° C.	750° C.
0.07	144,800	98,200	80,800	73,400
0.15	179,000	112,800	93,600	87,800
0.37	210,000	128,200	108,000	
1.01	.....	.....	88,800	73,600

A lower chromium steel (C 0.11, Cr 4.72) has strength slightly less than the first one given above, but rusts fairly easily.

¹CHEM. & MET. ENG., Oct. 12, 1921, p. 717.

Current Events

in the Chemical and Metallurgical Industries

Fails to Produce Gasoline From Peat in Court

In the course of the civil action alleging fraud (see CHEM. & MET. ENG., vol. 24, p. 985; June 1, 1921) which William H. Doolittle, of Woodmere, L. I., brought against Louis E. Enricht, president of the Enricht Peat Gasoline Co., Inc., the inventor was given an opportunity to demonstrate his process in the Nassau County Court before Judge Lewis J. Smith.

On Dec. 8 Charles Krainzler, of Farmingdale, testified that he had been secretary of the company until convinced that it was not a legitimate enterprise. He then resigned. (See CHEM. & MET. ENG., vol. 24, p. 506, March 23, 1921.) He also testified that the gasoline which was apparently produced from the peat really came from a secret receptacle in the apparatus which was filled prior to the demonstration. Accordingly, previous to the court demonstration on Dec. 9, the entire apparatus was taken apart and carefully inspected by three chemical experts, Dr. William B. Stoddard, Dr. Irving Hochstadter and F. J. Kenny. Difficulty was experienced in attempting to take apart the suction-pressure pump and a recess was granted to enable Mr. Enricht, accompanied by the experts and both attorneys, to take the pump to a garage and open it.

Before the apparatus was assembled, Dr. Stoddard explained to the jury the function of each part as he understood it from his inspection and from the inventor's diagrams, never having seen the apparatus in operation. The equipment differed somewhat from that described on page 214 of the Feb. 2, 1921, issue of CHEM. & MET. ENG. In the first place, there was no mention of methanol, the only product being gasoline. A bicycle pump served to force air through a copper coil inclosed in a brass case and then through the combustion chamber in which the peat was to be burned. This was connected to a catalyst chamber containing staggered baffle plates supporting the catalyst. A three-compartment trough for water formed the bottom of the chamber. Next came a sort of gas holder formed of a capped brass pipe fitting closely inside a piece of iron pipe. A second catalyzer chamber followed. The gases could be drawn through all this apparatus by the suction side of the double-acting pump referred to above, and forced under pressure through the remaining parts, which consisted of a soldered brass can and a small receiving tank.

About 2 o'clock Mr. Enricht began to assemble the apparatus under the close scrutiny of the experts and the jury. Innumerable small bolts had to be put in place and tightened, so that it was 5 o'clock before the inventor announced that everything was in readiness for the test.

After filling the base of the first catalyzer with water, peat was placed in the combustion chamber and ignited. Vigorous operation of the bicycle pump soon filled the court room with smoke. The heavy suction-pressure pump was then manned by a court attendant. Smoke continued to pour out, the pumps wheezed and the court attendants were relieved as they became fatigued. After several minutes, Mr. Enricht gave up the experiment, explaining, however, that the apparatus was not air tight after having been re-assembled and that consequently he could not maintain the required pressure. In answer to a question by the judge, he admitted that the demonstration was over. His attorney attempted to arrange for a further demonstration after the apparatus had been made air tight, but the judge refused permission.

On the witness stand, Mr. Enricht admitted that his name had been Henricht in Germany and that he had been fined \$500 in the federal court in Chicago in 1902 for using the mails for fraudulent purposes in connection with a land deal. In answer to one question he insisted that he never claimed to make gasoline, but that his product was naphtha or rather hexane, C_6H_{14} . He also admitted that in spite of

the protest of the plaintiff's lawyer, he had worked the suction-pressure pump vigorously while taking it to the garage, that he had removed what appeared to be gelatine from the barrel of the pump after it had been opened in the garage and that naphtha was found in one of the rubber tubes connected to the pump. He stated that this naphtha must have remained in the pump since the last demonstration, although this was made about 2 months ago.

A copy of a citation from the United States Patent Office in regard to an application for patent filed Sept. 25, 1920, was also introduced into the record. All claims were rejected because the process was clearly inoperative and contrary to the now known laws of physics and chemistry. For further consideration the affidavits of several impartial witnesses would be required. It was suggested that the Bureau of Standards or the Bureau of Mines might be willing to test the process, if requested. The need for having two separate catalyst chambers with merely a gas holder between was questioned, as well as the reason for using such a high pressure, since the supposed product, C_6H_{14} , is a liquid under normal conditions.

The trial was still on as this magazine went to press.

German Potash Syndicate Captures American Market

At a meeting of the New York Section of the American Chemical Society Friday evening, Dec. 9, Dr. John E. Teeple, chairman of the section, announced that according to a copy of a contract in his possession, thirty-four American users and distributors of potash for agricultural purposes have entered into an agreement whereby at least 75 per cent of the requirements of the group for the period from June 1, 1921, to April 30, 1922, shall be purchased from the Deutsches Kalisyndikat.

As set forth in the copy of the contract, the total of the minimum purchases on a 75 per cent basis for all thirty-four companies is only 35,680 short tons of K_2O , a figure well within the productive capacity of the American potash plants. Yet it is understood that the American firms were not given a fair opportunity to bid, although they expressed willingness to meet foreign prices.

Dye Investigation Ordered

The United States Senate has authorized its Committee on the Judiciary to investigate "the charge that the dye industry is controlled by a combination of corporations which is in fact a monopoly and has employed agents, attorneys and lobbyists to influence Congress in behalf of special legislation to the interest of such monopoly, and to investigate the activities and methods of importers of dyes from Germany and their agents, attorneys and lobbyists to influence Congress in behalf of special legislation and to investigate the dye and chemical industries of the United States and the supply and distribution methods within the United States and elsewhere of the German dye and chemical industries with a view to recommending proper legislation."

That portion of the resolution which refers to the investigation of the practices of importers was an amendment to the original resolution proffered by Senator Frelinghuysen.

During the consideration of the amendment, Senator Frelinghuysen made an extended speech in which he stated that ample reason did not exist for any such investigation and that the purpose behind it is entirely unfriendly to the great American industry. In his address, Senator Frelinghuysen had suggested that the Department of Commerce, with its commodity specialists, is better equipped to conduct the investigation than is the Committee on the Judiciary.

The sub-committee which will conduct the investigation had not been appointed at the time of this writing.

More Plants Increasing Operations

Rubber. The Excell Rubber Co., Wadsworth, Ohio, has resumed operations, following a shut-down for a number of weeks. The company has been reorganized.

The Ajax Rubber Co., Trenton, N. J., has resumed production at its plant, following a shut-down due to a strike of operatives. A settlement has been reached and about 1,000 men have returned. The mill will operate on a full-time, or three-shift, basis for the manufacture of automobile tires.

The Millville Rubber Co., Millville, Mass., a division of the United States Rubber Co., specializing in footwear products, has increased its working force for a night-shift operating schedule.

The B. F. Goodrich Co., Akron, Ohio, is increasing production in its automobile tire department approximately 1,200 tires a day, making a total output of close to 10,000 tires daily at the present time. About 500 employees have been added to the working force in different departments.

Ceramic. The Homer Laughlin China Co., Newell, W. Va., and East Liverpool, Ohio, is operating at capacity and close to normal.

The Warwick China Co., Wheeling, W. Va., has placed its plant on a full-time production basis.

Crane & Co., Chicago, Ill., have placed their recently acquired plant of the Mutual Enamelware Co., Chattanooga, Tenn., on a production basis. The name has been changed to the Crane Enamelware Co.

The American Bisque & Novelty Pottery Co., Williams-town, W. Va., is operating at capacity, and plans for plant extensions for greater output.

The Robinson Clay Products Co., Akron, Ohio, has developed greater production at its plant, and plans to maintain operations at a comparatively high rate throughout the winter period.

The Edwin M. Knowles China Co., East Liverpool, Ohio, with other plants at Chester and Newell, W. Va., has adopted a normal working schedule at all plants.

The Carr China Co., Grafton, W. Va., has increased production at its plant.

The Chelsea China Co., New Cumberland, W. Va., has advanced operations at its plant to a point close to normal.

Iron and Steel. The United States Cast Iron Pipe & Foundry Co., East Burlington, N. J., has increased production to a point of from 45 to 50 per cent of normal at its different foundries.

The East Penn Foundry Co., Macungie, Pa., manufacturer of brass, iron and other castings, is operating at full capacity, with good advance orders for future production.

The E. & G. Brooks Iron Co., Birdsboro, Pa., has placed its local sintering plant on a double operating shift. The plant was destroyed by fire some time ago and has been completely rebuilt, with installation of new machinery.

The Wickwire-Spencer Steel Co., Buffalo, N. Y., has increased operations at its local finishing mill to a point of about 75 per cent of normal. One blast furnace is in operation. Production is being increased at the New England mills of the company.

The Carnegie Steel Co., Steubenville, Ohio, has placed its local plant on a 60 per cent capacity basis.

The Gulf States Steel Co., Gadsden, Ala., is said to be planning to blow in its local blast furnace early in January.

The Fabricated Steel Co., Leetonia, Ohio, has resumed operations after a curtailment of a considerable period.

Miscellaneous. The American Cellulose & Chemical Mfg. Co., Amcello, near Cumberland, Md., has commenced production at its new local plant for the manufacture of celloid, artificial silk, etc., and daily shipments of material will be made. A gradual increase will be made in the working force as conditions warrant.

Industrial Plants in Georgia Expand

The Georgia Manufacturers' Association, Atlanta, reports that industrial conditions are better in the state than at any time for the past year. A recent canvass shows that 55 per cent of manufacturing plants are operating at full capacity; 35 per cent under a part-time schedule; and about 10 per cent of state plants are idle.

First Report of Federal Power Commission

Judging from the applications which followed the passage of the federal water-power act of 1920, the Federal Power Commission concludes in its first annual report that the production and use of hydro-electric power in the United States will be the outstanding industrial fact of the next 25 years. In 16 months, following the passage of the act, there were filed with the commission 185 applications for preliminary permit and 85 applications for license to develop water power, aggregating 11,060,000 primary and 5,766,000 secondary horsepower. To complete these projects would mean a capital expenditure exceeding in the aggregate two billion dollars. The following table shows the geographical distribution of applications:

DISTRIBUTION OF APPLICATIONS BY STATES

	No. of Applications	Horsepower	
		Primary (90 per Cent of Time)	Estimated Installed Capacity
Alaska.....	31	217,200	279,060
Alabama.....	4	35,025	147,000
Arizona.....	13	3,544,160	4,750,000
Arkansas.....	4	94,100	169,000
California.....	80	2,118,810	4,057,075
Colorado.....	4	50,660	100,900
Connecticut.....	2	20,000	32,000
District of Columbia.....	1	47,300	50,000
Florida.....	4	6,540	12,100
Idaho.....	12	90,650	189,185
Illinois.....	1	41,450	50,000
Kentucky.....	1	96,000	160,000
Louisiana.....	1	40,000	55,000
Minnesota.....	7	38,150	79,300
Mississippi.....	1	.....	.....
Missouri.....	4	8,000	55,000
Montana.....	14	319,875	532,450
Nevada.....	1	(Transmission Line)	.....
New Jersey.....	3	361,400	432,300
New Mexico.....	1	2,750	25,000
New York.....	16	1,712,845	2,192,830
North Carolina.....	3	3,160	16,400
Ohio.....	2	210	250
Oklahoma.....	3	34,880	54,000
Oregon.....	10	466,060	832,860
Pennsylvania.....	1	38,400	80,000
South Carolina.....	2	2,000	8,000
South Dakota.....	1	(Transmission Line)	.....
Utah.....	6	918,015	1,212,465
Virginia.....	2	29,760	110,000
Washington.....	18	699,930	1,112,640
West Virginia.....	2	11,200	20,000
Wisconsin.....	1	10,000	20,000
Wyoming.....	4	1,410	1,410
Total.....	260	11 059,910	16,826,225

Up to Nov. 1 final action has been taken on 59 applications, in which 27 preliminary permits and 31 licenses were authorized, involving 1,415,600 primary and 2,627,000 installed horsepower. Of the projects under license construction is now under way on the following:

	Primary	Installed Hp.
Henry Ford & Son, Inc., Hudson River, N. Y.....	3,640	6,100
Niagara Falls Power Co., Niagara River, N. Y.....	341,500	572,230
Southern California Edison Co., Big Creek, Cal.....	165,000	545,000
Alabama Power Co., Coosa River, Ala.....	21,760	110,000
Snow Mountain Power & Water Co., Eel River, Cal..	9,500	16,670
Western States Gas & Elec. Co., American River, Cal..	6,400	6,400
Wisconsin-Minnesota Light & Power Co., Chippewa River, Wis.....	10,000	20,000
(Preliminary construction only)		
Total.....	557,800	1,276,400

The commission finds itself handicapped in passing on many engineering and economic problems due to a ruling of the Comptroller of the Treasury that the commission is not empowered to employ persons other than its executive secretary. This makes it necessary to rely upon assignments or detail of individuals from other executive departments of the government, which is a very unsatisfactory method of administration. The commission feels that the law should be amended to permit it to employ the proper engineering personnel.

Civil Service Examinations

Vacancies in the Chemical Warfare Service, Edgewood Arsenal, Edgewood, Md., will be filled from the following examinations:

Chemist, \$3,600 to \$5,000 a year; associate chemist, \$2,500 to \$3,600; assistant chemist, \$1,800 to \$2,500. Applications for these positions will be received on Form 2118 until Jan. 10, 1922. Chemical laboratorian, \$1,200 to \$1,500; examination will be held Jan. 11, 1922.

Practical Use of Helium Demonstrated

"The practical use of helium as a gas for the inflation of airships has been demonstrated beyond a doubt." This statement was authorized by the Navy Department after the successful flight of the C-7 from Hampton Roads to Washington and return. The men in charge of the trip declare that the ship maneuvered very much better than when inflated with hydrogen and since the gas does not expand and contract as rapidly as hydrogen, it makes for economical operation. During the entire time that the C-7 was inflated, there was no helium lost by valving. The most striking deduction from the trip, however, is that, heat conductivity of helium being less than hydrogen, it practically eliminates the variation in the lifting power of different portions of the bag. This is of the greatest value



THE FIRST HELIUM-FILLED AIRSHIP

in maneuvering. In addition, helium is twice as heavy as hydrogen, and therefore the bag possesses twice the stability as when inflated with hydrogen. Much greater speed can be attained with a helium-filled ship. An extract from the Navy Department's statement issued in connection with the flight is as follows:

"Helium, next to hydrogen, is the lightest gas known. It has 92 per cent of the lifting power of hydrogen and for military purposes possesses an inestimable advantage over hydrogen in that it is non-flammable. The natural gas wells in the United States afford a practical monopoly of the known sources of supply. According to the latest estimates, helium is escaping into the atmosphere at the rate of 1,250,000 cu.ft. a day, or at a rate sufficient to fill four large airships a week. The refrigeration process is employed to obtain helium. In this process every constituent present in the natural gas is liquefied except helium, which is expelled into suitable containers for storage. The application of this process to the extraction of helium has not been perfected, but the line of development is reasonably clear."

Dr. Joseph S. Ames, chairman of the National Advisory Committee for Aeronautics, is recommending that the government acquire and seal for future use the best helium-producing gas fields; that experiments must be continued in the development of an efficient and economical process for the extraction of helium. He states that with large reserves of helium and the development of types of airships to realize fully the advantages in the use of helium, America would possess resources with which no other nation could compete.

Extra Zone Postage on Chem. & Met. Canceled

The extra zone postage west of the Mississippi River, which has been charged for some time past on **CHEMICAL & METALLURGICAL ENGINEERING** and other McGraw-Hill papers, has been canceled by action of the company. There has been no change in the rates of postage charged by the government, but the owners of **CHEMICAL & METALLURGICAL ENGINEERING** felt that by absorbing this extra cost they could remove a frequent complaint of discrimination against Western subscribers. Extra postage heretofore charged to Canada, Alaska, Hawaii, Philippines, Porto Rico, Canal Zone, Cuba, Mexico, Honduras, Nicaragua, Dominican Republic, Salvador, Peru, Colombia, Bolivia and Shanghai, China, has also been canceled.

Annual Report of the Secretary of Commerce

Herbert Hoover has transmitted to the President the ninth annual report of the Secretary of Commerce, covering the fiscal year 1920-1921. On assuming office March 4, 1921, the Secretary gave attention first to reorganization of departmental expenditures and second to the reorganization of bureaus in his department directly concerned with industry and trade, in order that they might give better service. The reorganization of departmental expenditures has enabled the department to revise its estimates of expenditures for the fiscal year 1921-1922 with a net saving of about four million dollars, or 16½ per cent of the available appropriation.

The Secretary calls attention again to the great need of a government-owned building for the department; of a national archives building of fireproof construction; and of a revision of the increase of per diem allowance for traveling expense from \$5 to \$7.

The Bureau of the Census, in addition to its regular duties, has been assigned the work of compiling statistics for a monthly report known as the Current Survey of Business, to show the trends of business and industry throughout the country. This monthly report has already proved useful to the business public and plans are under way for its improvement. Attention is called to the possibility of assigning to the Bureau of the Census investigations of other government bureaus, such as the Geological Survey, Bureau of Mines, etc. This suggestion is made in the interest of avoiding duplication of work.

The Bureau of Foreign and Domestic Commerce has improved its foreign service through commercial attachés and trade commissioners. Membership changes in personnel have been made in the interest of more efficient work. The report gives in considerable detail the work of the bureaus' representatives in different parts of the world, with typical examples of the practical value of this service. Monthly cable service is published in *Commerce Reports*, comprising strictly up-to-date information from the bureau's representatives throughout the world. *Commerce Reports* has been revised in size and make-up, much to the advantage of both the bureau and the readers. The practice of grouping various articles under commodity headings is an improvement of considerable value.

The work of the Bureau of Standards has been devoted to weights and measures, electrical standards, investigations in heat and pyrometry, optics, engineering physics, metallurgy, ceramics, and miscellaneous materials. The chemical division co-operates with all other divisions of the bureau, as well as with other departments of the government. Thus valuable assistance has been given to the Bureau of Engraving and Printing in connection with the production of engraved plates by electrolytic methods. The chemical division has also served the Air Service of the Army and Navy by testing balloon fabrics. It also rendered service to industry in general by preparing and distributing 4,016 standard samples of metals and alloys.

Federal Trade Commission Amends Complaint Against Steel Corporation

The complaint of the Federal Trade Commission against the United States Steel Corporation and its subsidiaries has been amended to make its charges more specific and to simplify the issue and expedite the hearings. The issue in the amended complaint is the same as that contained in the original complaint.

The original complaint charges the corporation and its subsidiaries with discriminating in price between the purchasers of all of its rolled steel products. The amended complaint makes precisely the same charges with respect to each particular rolled steel product. The amended complaint, as did the original, charges that such discriminations are in violation of the Clayton and federal trade acts for the reason that they are not made because of any difference in the grade, quality or quantity of the product sold, nor because of different cost of selling or transportation, nor because the different prices were made in good faith to meet competition.

Additional Commodity Divisions, Department of Commerce

In view of the propitious start made by the commodity divisions of the Department of Commerce, the President and the director of the budget have approved a request for an appropriation of \$540,000 for the continuance of the work in the interest of the export industries during the next fiscal year. This is an increase of \$290,000 over the amount appropriated for this work during the current fiscal year. It is proposed to set up seventeen additional commodity divisions, as follows: vegetable oils and breadstuffs; meat and dairy products; canned goods; cotton and cotton goods; wool and woolen goods; petroleum; dyes and drugs; heavy chemicals; paints, varnishes and tanning materials; hardware and tools; glass and earthenware; paper; non-ferrous metals; transportation and communication; foreign investments; advertising, packing and credit methods; maps and commercial geography. The existing commodity divisions are: iron and steel; lumber; shoes; rubber goods; heavy machinery; implements and vehicles; automobiles; electrical goods; foodstuffs; textiles; fuels; leather; office appliances; specialties. The iron and steel division is receiving an allotment of \$17,000; the lumber division \$14,000, the shoe division \$12,500 and rubber goods division \$14,000. The other existing divisions are each allotted \$15,000 for their annual expenses. It is planned that each of the new divisions is to be allotted \$15,000. In each case the chief of the division is to receive a salary of \$6,000 and the assistant chief \$2,000.

For the general work of promoting commerce, Congress is asked to appropriate \$524,050, an increase of \$199,050 over the appropriation for the current year. Under this appropriation it is proposed to establish new trade commissioner offices in Russia, in Greece and in Canada. It is also the plan to undertake special technical investigations in connection with iron and steel in England, Belgium, Germany and France; in connection with lumber, in the Scandinavian countries; in connection with electrical goods, in Germany, France and Belgium; in connection with fuels, in England, Belgium and Germany; in connection with leather, in Germany, Spain, Holland and Belgium. Similar investigations are to be undertaken covering office appliances and specialties.

In addition, \$213,650 is asked to promote further the commerce between the United States and Latin America. This is an increase of \$113,650 over the current year's appropriations. A portion of the increase is to be applied to the establishment of new trade commissioner offices in Cuba, Colombia, Uruguay and Venezuela. New technical investigations are to cover chemicals, hardware, tools, implements, glass and glassware and foodstuffs.

For promoting commerce in the Far East, \$235,650 is asked. This is an increase of \$85,650. It is proposed to establish under that appropriation new trade commissioner offices in Delhi, Bombay or Calcutta and in Canton. New technical investigations to be undertaken in the Far East would cover textiles, vegetable oils, silks, fibers and petroleum.

Chilean Nitrate Situation

Large nitrate sales in London have greatly encouraged the Chilean producers, according to advices reaching the Department of Commerce. The agreement reached between the Nitrate Producers' Association and the Nitrate Pool, of London, caused a decided rise in the exchange value of the Chilean peso. A part of this gain was lost because of the report that the agreement provided for a material reduction of existing stocks in Europe before further exports were to be attempted. The recent brisk demand for nitrate, however, promises to consume the European stocks in a shorter time than had been expected.

The consul at Iquique reports September nitrate production to have been 1,493,229 quintals. In September of 1920 the production was 4,501,850 quintals. The present rate of production is practically double the rate of exportation, with the result that stocks in Chile are increasing rapidly. The consul states that 29,000,000 quintals has been estimated as the probable 1921 production. The 1920 production of nitrate was 55,514,000 quintals.

Dental Amalgams

No organization not primarily devoted to dental interests ever met in the Dental Dispensary at Rochester until Monday evening, Dec. 5, when the local branch of the American Chemical Society assembled there to hear an address on "Dental Amalgams" by Dr. Arthur W. Gray of Milford, Del.

Dr. Harvey J. Burkhardt, director of the dispensary, gave a short talk concerning the work he and his associates are doing in preventive dentistry, starting first with the children in the schools.

Dr. Gray, in his address, said that dental amalgams are made by the dentist when he mixes dental alloy and mercury before putting the mixture in the cavity to be filled. Some of the best amalgams when hardened have the strength of steel. The older amalgams were not nearly so good and frequently broke.

A dental alloy is made of silver and tin containing from 40 to 70 per cent of silver. Small amounts of other metals such as copper, zinc and gold or platinum are sometimes used. The metals are weighed, then melted and cast into ingots. Any iron that may be present is then removed and the alloy is annealed.

The dentist mixes the alloy with mercury, any excess of which should be expressed. As amalgam is packed into the cavity still more of the mercury is pressed out. The polishing should not be done the same day because of changes taking place in the amalgam. After the alloy is in the tooth it hardens rapidly at first and then more slowly for a week or 10 days. Sometimes it will contract so much as to leave a crevice around the filling, or it may expand so as to crack the teeth.

Alloys of a lower silver content are easy to amalgamate, but they will crush. The alloys of high silver content are much harder to work; they retain much more mercury and are far more lasting. Low-silver alloys were used up to 1895 and unfortunately some are still used because they are easier to handle and cheaper.

The first well-organized and comprehensive work on dental alloys was done by Dr. G. V. Black, a dentist with a medical education, and an old-time scientist. This work was carried on from 1895 to 1897. If an alloy is cut up into shavings it will continue to change for months and even years. It becomes easier to work and expands less. Dr. Black thought this aging was due to oxidation, but later decided it was due to temperature, the higher the temperature the faster the aging. He organized a class of manufacturers and taught them how to make alloys and how to anneal them so there would be no changes. In 1905 Dr. Ward through many experiments showed the necessity for controlling the temperature while annealing.

Dr. Gray is convinced that the contraction of the amalgam is due to the formation of a silver mercury compound when the silver-tin alloy is mixed with mercury. Later this crystallizes and there is an expansion. By extensive experiments Dr. Gray has found out the effects upon contraction and expansion by using different temperatures, different pressures and length of time for trituration. These were made very clear by graphs used with the lantern slides. Following the lecture Dr. Gray showed samples of alloys.

Illinois Short Course in Ceramic Engineering

The regular biennial two weeks short course in ceramic engineering will be given next January at the University of Illinois, between Jan. 23 and Feb. 4. The subjects covered will include elementary physics and chemistry; the origin, classification, winning and refining, and testing of clays; the shaping, drying and burning of clay products; bodies and glazes; the technology of glass; refractories and refractory products; kiln construction; coal and gas fuels; engines and boilers, dynamos and motors, equipment control; pyrometry; drafting and reading of drawings; and business law.

The complete program will be ready for distribution early in January and copies may be obtained by addressing the Department of Ceramic Engineering, University of Illinois, Urbana, Ill. The course is open to all who are interested and can be taken to advantage by any one having a common school education. There are no tuition fees.

Institute of Baking Is Opened in Chicago

The American Institute of Baking, behind which is the American Bakers' Association, has recently transferred its activities from Minneapolis and become established at 1135 Fullerton Ave., Chicago. The institute has absorbed the Wahl-Henius Institute, together with the property at the above location. The history of the Wahl-Henius Institute begins 35 years ago with the establishment of a crude analytical laboratory operated by Dr. Max Henius and Robert Wahl, two analytical and consulting chemists. The institute operated for many years in the study of scientific brewing; and with the new change will come the working over of the plant to serve the bread-baking industry.

Mechanically speaking, there is little difference in the processes of analyzing and experimenting in bread and beer, so with comparatively few changes the building has become a workshop of the baking industry, with an experimental brewery turned into a practical bakery plant.

The institute has four large laboratories and a special laboratory for students; class rooms, lecture rooms, scientific library, auditorium and many other facilities. Dr. H. B. Bernard has moved from Minneapolis to Chicago to become head of the combined organization. Under his direction the institute is to put the baking industry under higher technical control by producing scientific bakers.

Report of the Chemist, Department of Agriculture

In his report of July 1, 1921, as chief of the Bureau of Chemistry, Department of Agriculture, Dr. C. L. Alsberg reviews the work of the various laboratories under his direction. The work of the bureau is of two kinds: Scientific research and enforcement of the food and drugs act. In the realm of scientific research the bureau has established a number of laboratories devoted to special purposes. The report concerns itself in detail with the work of these various laboratories and must be consulted for a comprehensive idea of their investigations. The names of the various laboratories, suggestive of their scope, are as follows: Water and beverage; microchemical; microbiological; cattle food and grain investigation; pharmacognosy; drug division; pharmacological; carbohydrate; oil, fat and wax; citrus byproducts; food research; dehydration; protein investigation; phytochemical; leather and paper; insecticide and fungicide; and color investigation.

One of the most important parts of the bureau's work has been conducted in office of development, which was established in 1920. It has engaged in various activities looking toward the commercial development of discoveries of the bureau's staff, with a view to creating an industrial outlet for agricultural products. The office of development work has also made some excellent investigations of grain-dust explosions and fires.

Proper Functions of Trade Associations to Be Defined

What functions and activities trade associations may legally engage in will soon be announced by the government. E. W. McCullough, manager of the fabricated production department of the Chamber of Commerce of the United States, told the American Face Brick Association in annual convention Dec. 2 at White Sulphur Springs, W. Va. He said that such a statement would have been issued before this but for the fact that several government cases are now pending against certain trade associations, involving such questions as the proper use of statistics, open price plans and averages in cost accounting.

According to Mr. McCullough, Secretary Hoover desires closer contact with the industries through their associations, but Secretary Hoover has intimated that such organizations should put themselves in position to speak for their industries by including in their membership the largest possible representation, and also through the perfection of their machinery for gathering, analyzing and compiling all desirable information of service not only to themselves but to the government and the public as well.

It is to make for such co-operation that the government is expected to define the proper functions of a trade association, Mr. McCullough said.

Chemical Items in U. S. Budget

While the outstanding chemical appropriation in the federal budget is that of \$1,500,000 for the Chemical Warfare Service, there are chemical activities in practically every executive department and in some of the independent agencies. In many cases the money for chemical activities is not segregated. Those which are segregated are as follows:

Bureau of Chemistry. For investigating chemical problems relating to the composition, action and application of insecticides and fungicides, \$20,000; for collaborating with other departments desiring chemical investigations, \$14,000; for investigations relating to the application of chemistry to agriculture, \$75,400; for the investigation of table sirup and sugar, \$10,000; for the investigation of naval stores, \$10,000; for the investigation of methods for the prevention of grain dust explosions, \$25,000.

Bureau of Standards. To develop color standards with special reference to their industrial use in connection with dyestuffs, inks and pigments, \$10,000; to study methods of measurement and technical processes in the manufacture of clay products, \$25,000; for the investigation of the problems involved in the production of optical glass, \$25,000; for metallurgical research, \$40,000; high-temperature investigation, \$10,000; for the distribution of standard materials to be used in checking chemical analyses and in the testing of physical measuring apparatus, \$10,000; for an investigation of radioactive substances, \$10,000.

Bureau of Mines. For investigations concerning the utilization of heavy clay products, cement, feldspar and other non-metallics, \$35,000; for work at mining experiment stations (a part of which is of a chemical nature), \$175,000.

Geological Survey. For chemical and physical researches including researches with a view of determining geological conditions favorable to the presence of potash, \$40,000.

In connection with the budget, the navy announces its salary scale for technical service. It is as follows: Chief chemist, \$11.36 per day; chemist, \$10.56, \$10.24, \$9.84, \$9.44, \$9.04, \$8.72, \$8.32, \$7.92, \$7.60, \$7.20 per day; assistant chemist, \$6.88, \$6.40, \$6.08, \$5.68, \$5.36, \$4.88 per day; chief metallurgist, \$3,000 per annum; assistant chief metallurgist, \$8.32 per day; chemical engineer, \$9.44 per day; laboratorians (chemical), \$5.36, \$4.56; superintendent, acid plant, \$9.04 per day.

Secretary Weeks Favors Gas Development

In view of what is being said to be taking place in the executive sessions of the Conference on Limitation of Armament, particular significance is attached to the position taken by the Secretary of War in the report which he submitted to Congress on Dec. 8. In that report he made the following reference to chemical warfare:

In reviewing our chemical production, it is apparent that the World War brought a new industry into the field of war production and therefore into close relation with the problem of preparedness for national defense. The preponderantly commercial character of this industry, the necessary progress of which as an element in our industrial system carries with a corresponding efficiency in its application to war purposes, conveys the practical assurance that we shall not prove deficient in the production of war chemicals. At the same time, the close relationship between the production of chemicals for war and the preparation of chemical products for peaceful industry compels a realization of the great benefits to our commercial chemical progress resulting from the activities of the War Department in respect to chemical warfare. Since our Chemical Warfare Service is well organized to keep abreast of our developments, there is every hope that we shall be adequately equipped in respect to chemical preparation for war. Though we may be opposed in principle to the use of poison gas, I am of the opinion that we cannot safely presume a similar attitude on the part of possible opponents and neglect the development of chemical weapons if we wish to insure a successful defense in a possible war. Therefore, since the development is of direct industrial benefit, and will not be wasted in any eventuality, I hope for the continued support of this activity by Congress and by the chemical industries themselves.

Arms Conference Action on Gas

No official confirmation or denial is forthcoming of the report that the American advisory committee has recommended that the use of gas in warfare be outlawed. It is known that very different opinions are held by a number of individual members of the advisory committee, although it is admitted that other influential members of that committee are actively seeking to write into any international agreement that may be reached a paragraph pledging the signatory powers to make no use of gas in warfare.

While Japan was expected to be most active in the effort to outlaw chemical warfare, no such activity has developed. Italy has been apparently the prime mover. The argument advanced by some of the Italians is that their country does not possess the raw materials for chemical munitions, and therefore would be put at a disadvantage if unrestricted use of gas were to be permitted.

Personal

DR. F. W. BOYER has been elected president of the Excell Rubber Co., Wadsworth, Ohio, succeeding Ross Trump.

WILLIAM A. DURGIN has been given a leave of absence from the Commonwealth Edison Co., Chicago, to direct the new activities of the Department of Commerce toward the elimination of waste in industry by simplifying and standardizing commercial practices. Mr. Durgin's new organization will form a subdivision of the Bureau of Standards.

RICHARD A. FEISS of Cleveland, Ohio, was elected president of the Taylor Society at its recent meeting in New York. Other officers were elected as follows: Vice-presidents, Horace K. Hathaway, Philadelphia, and Robert B. Wolf, New York; treasurer, Edward W. Clark, 3d, Philadelphia; managing director, Harlow S. Person, New York; directors, Ray M. Hudson, Peoria, Ill.; J. C. Heckmann, New York; Ida M. Tarbeli, New York; Levi H. Ballou, Walpole, Mass.

H. J. ROLLS, Buffalo, N. Y., has been elected vice-president of the Buffalo Paint, Oil and Varnish Club, succeeding William P. Mott.

DR. EDGAR F. SMITH, president of the American Chemical Society, addressed the South Jersey Section at Carneys Point, N. J., Nov. 22. His subject was "The Early History of Chemistry in America." Officers of the local section elected for the ensuing year included Dr. C. E. Burke, chairman, and Dr. H. D. Gibbs, counselor.

HENRY A. TOBELMANN, metallurgist for the New Cornelia Copper Co., Ajo, Ariz., has resigned to accept a position in New York City. Mr. Tobelmann has been continuously in the service of the Calumet & Arizona Mining Co. since 1906, first at Bisbee, later at Douglas and finally at Ajo, where he had much to do with the development and operation of the hydrometallurgical process there used.

Obituary

BENJAMIN F. GREENE, manager for the Westmoreland Chemical Color Co., Philadelphia, Pa., at New York, died recently at the Long Island College Hospital at the age of forty-nine years.

ROBERT B. HAWLEY, president of the Cuban-American Sugar Co., New York, died at his home, 36 Gramercy Park, Nov. 27, aged seventy-two years. He founded the company of which he was head in 1900, and since that time had been a prominent figure in the industry.

GUSTAV LEVOR, a pioneer leather manufacturer, president of G. Levor & Co., with tannery at Gloversville, N. Y., died at New York City, Nov. 23, aged seventy-one years. The company of which he was head was established in 1875, developing into one of the largest industries in this section.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, Dec. 12, 1921.

The chemical market during the past week could be described as fair in some quarters, while in others a falling off was noticeable. The general opinion of leading factors, however, is that an irregular market may be expected temporarily due to outside influences incidental to this period of the year. There is no doubt that a decided change for the better will take place early in the spring of 1922 and there is no lack of confidence regarding business conditions over next year. Large producers reported a good volume of business with their regular consuming trade for shipment over 1922. The probability of further reductions of freight rates might have had a tendency to unsettle prices and in some cases practically to cause the discontinuance of actual production. On the other hand, there is a great deal of consolation shown by the marked improvement in the steel trade. The increased activity in the oil industry has meant the speeding up of new construction and steel mills have been operating at increased capacity. Soap factories are running in normal shape, but textile mills have slowed down to a considerable extent. Glass manufacturers are reporting conditions very favorable, with furnaces working at the highest point of the year. Spot prices have shown a little more flexibility than they did during the past two weeks. Imported sulphide of soda is lower. Prussiate of soda is easier. Imported caustic potash is a trifle lower under a continuance of a quiet inquiry. Bleaching powder is holding quite firm and this also holds true of domestic soda ash. Export sales of solid caustic soda were recorded during the week to Japan and South American countries, but the volume was smaller than noted a week ago. There was a rumor that foreign producers of caustic soda fell down on deliveries to Italy, which allowed the placing of orders involving several thousand tons in the American market. Oxalic acid is holding well under recent quotations. It is understood among large dealers that an order embracing several thousand kegs of chlorate of potash has been placed in Mexico. Prices for this material have been very irregular on spot owing to the free supplies and the limited consuming channels. Although there was no change in spot prices on this commodity, there was a pronounced tendency to keep prices firm. Shipment prices for high test granular salammmoniac were reduced and goods were offered in the late trading at lower prices c.i.f. New York.

CHEMICALS

Spot *bichromate of soda* is attracting only moderate attention and scattered sales are reported a 7½@8c. per lb. In most instances the lower figure was easily available on firm business. The tone of the market was steady, with offerings of a more or less general nature. Manufacturers of *bicarbonate of soda* continue to name 2c. per lb. for barrels f.o.b. works. Kegs are held at ¼c. per lb. higher. Spot offerings are heard around the trade at \$2.30@\$3.35 per 100 lb. A fair inquiry was noted from regular consuming channels, but there was very little additional business recorded. Trade conditions in *caustic potash* have remained quiet and the tone of the market appeared somewhat easier. Sales of imported material were recorded at 5½c. per lb. for the 88-92 per cent grade. The general quotation ranges from 5½@5¾c. per lb., according to quantity. Shipment material is obtainable at \$5.30@\$5.40 per 100 lb. c.i.f. New York. Dealers of *nitrite of soda* quote the market at 6¾c. per lb. and state that small sales are about the only feature of the market. It is quite possible that on a round lot a slight concession might be granted. Imported *prussiate of soda* is quoted a trifle lower on spot and the demand was not as brisk as noted a week ago. Small lots of this material are around the market at 14¼@14¾c. per lb. Shipment prices are holding firm at 14¼c. per lb. It is very doubt-

ful if better than this figure could be done on any future arrivals. *Muriate of potash* is also quoted a trifle easier at \$35 per ton, basis 80 per cent. It is understood that some business has been placed a shade under this figure when round lots were concerned. The market has not shown any real signs of activity on this commodity for the past month and keen competition has driven prices down to a new low level. Leading producers of *copper sulphate* have advanced their prices. The carload price for standard 99 per cent, large crystals, is \$5.65 per 100 lb. Smaller quantities are held at 5½c. per lb. and upward, depending upon the size of order. The advance is believed due primarily to the upward tendency of the copper metal. The domestic demand was rather slow during the month of November. The foreign demand, however, has noticeably increased and American sulphate producers have been able to withstand the competition of foreign interests in Italy and other important centers. Prices for imported white granular *salammoniac* were reduced during the week and the market was established at 5¼c. per lb. for shipment, c.i.f. New York. This is the lowest figure recorded since the war. Domestic producers quote 7c. per lb., f.o.b. works. Prices for light *soda ash* in single bags on spot are being well maintained at \$2.10 per 100 lb. for domestic goods. Some small lot sales have gone through at \$2.15. Brokers around the city are quoting the imported material at \$1.75 per 100 lb. ex-dock New York. Ash in barrels is held at \$2.30@2.40. Leading producers report a fair inquiry for forward shipments and state that sales over next year have been made at \$1.40@1.45 per 100 lb., in single bags and \$1.60 in barrels, basis 48 per cent, f.o.b. works. Sales of spot *arsenic* have been recorded at 6c per lb. The demand is irregular, although business in general has shown some improvement. Shipment material is somewhat firmer with sellers naming 5½c. per lb. Second hands offer solid *caustic soda* at \$3.90@4 per 100 lb. An additional call was noted from South America and the Orient and new business has been placed with these countries. Producers seem to be experiencing a good demand from their consuming trades and state that satisfactory business has been placed for delivery over 1922. Large contracts have been closed at \$2.75 per 100 lb., basis 60 per cent, f.o.b. works.

The general quotation for moderate quantities on contract is \$2.90 per 100 lb. basis 60 per cent, works. Buyers of *cream of tartar* are taking the imported material in moderate quantities at prices ranging from 25@26c. per lb. The market has shown a fair degree of activity since prices have been lowered and quotations held firm in the late trading. Prominent sellers of *oxalic acid* quote the market at 15c. per lb., spot New York. Odd lots were sold down to 14½c. per lb. The demand continues quite active.

COAL-TAR PRODUCTS

The coal-tar products market during the past week has undergone very little change. First hands seem to be getting prices on many products under their own control. This fact has not brought about any stability or uniformity in market prices. Sales during the early part of the week were confined mostly to small lots, but the aggregate amount was quite satisfactory. Inventories are keeping many mills from buying regular requirements and buyers are not disposed to place any forward business until this annual function is out of the way. *Phenol* is in very good demand and *paranitraniline* seemed a little firmer at the close of the week. *H acid* is also a trifle steadier since low-priced goods have become scarcer. First hands in *benzene* are in complete control of the market with no resale goods procurable. Quotations range from 27@33c. per gal. for future delivery. Coke-oven operations have increased to a limited extent and are now about 40 per cent normal. The increased output has not been felt to any extent in the benzene market. Foreign inquiries for *phenol* are being recorded in good volume, but there have not been many sales, as prices demanded by the buyers are quite frequently well below the general market. The tone of the market remains very firm, with prime stocks held up to 15c. per lb. Government surplus stocks are quoted at 12c. per lb., while resale material around the city ranges from 10@10½c. per lb.

The St. Louis Market

ST. LOUIS, Dec. 9, 1921.

Business for the month of November showed an appreciable increase over previous months and it is not expected that the approach of the stocktaking period will cause a cessation in buying for this month, which is based on the fact that the majority of the manufacturers and dealers have consistently kept their stocks at a minimum. Just at the present time buyers are chiefly concerned in covering their requirements for next year by contract, but these are not being freely offered by the producers. Importations continue to be heavy, but the general trend of prices is firm.

ALKALIS

The *alkali* market is somewhat dull. Only small quantities are moving at the prevailing price of \$4 per 100 lb. for the solid in drums f.o.b. point of production. The flake is somewhat more active at 25c. advance over the solid, 76 per cent material. *Soda ash* is in nominal demand, with the same price of \$3 per 100 lb. in barrels prevailing. There has been no change in *bicarbonate* or *sal soda*, the price remaining at \$2.90 and \$2.15 respectively and the market is very dull.

CHEMICALS, DRUGS AND PHARMACEUTICALS

Ammonia water, 26 deg., is in steady demand. The demand and inquiries for *sulphate ammonia*, pure granular, continues to be very good at this time. *Bismuth salts* are moving fairly well in spite of the fact that this is the off season and the keen competition. The *bromide* market is firm with a good volume of business being transacted. *Carbon bisulphide* has fallen off, as the demand from the grain storing trade has been satisfied. In our last letter we called attention to *creosotes* and *guaiacols* being seasonable articles, and factors now report that these commodities are moving very lively, indicating that there is a good demand from the consuming channels, and wholesalers should carry liberal stocks. *Glycerine* is in strong demand, with prices advancing to 15c. in drums. Users are now contracting for their requirements over next year, causing the advance. Business on *hydrogen peroxide* at the present moment is scattered. *Iodides* are moving very nicely with a firm market. Increase in demand for *lithium salts* is reported. The demand for *narcotics* is exceptionally good. The demand at the present for photographic materials is not important in volume. Last week producers advanced their prices on *acid salicylic* and *soda salicylate* and yesterday *acid acetyl salicylic* followed suit. Further uplifts would not prove surprising. *Sulphur commercial* is moving slowly at \$2 per 100 lb. in 25-bag lots, with a slight advance for smaller quantities. There is practically no business in the special brands. *Zinc oxide* is in good demand and makers are very optimistic of the future, expecting an increased demand; the price remains at 7½c. in barrels and 7¼c. in bags f.o.b. works for standard brands. There has been no dropping off of orders for *zinc stearate*. In fact, during the last period, an increase has been manifest.

ACIDS

The heavy commercial mineral acids are assuming a better position and moving in larger volumes. *Carbolic acid*, medicinal grade, continues to move through regular channels. *Acid acetic* is rather slow. *Gallic acid* and *tannic acid* are moving pretty well.

VEGETABLE OILS AND NAVAL STORES

Castor oil is very firm, with the price of 12½c. in barrels and 12c. in returnable drums still prevailing. *Linseed oil* is moving very low due to the dull season in the paint industry. *Turpentine* has advanced slightly, now selling at 84½ in single barrels with a 4c. differential on 5-bbl. lots.

PAINT MATERIALS

The dull season in the paint industries has had a very decided effect on the *barytes* market. The movement is practically nil, although the old price of \$23.50 still holds. Manufacturers expect very little business until after Jan. 1. There has been no change in the *lithopone* market. *Whiting* is moving slowly at \$15 per ton.

The Iron and Steel Market

PITTSBURGH, Dec. 9, 1921.

Steel ingot production in November was at the rate of about 23,750,000 gross tons a year, representing about 45 per cent of the total capacity, against rates of 44 per cent in October, 32 per cent in September, 30 per cent in August and 21 per cent in July. The October rate had been the highest since February.

While the comparison by months shows a continuous increase since July, the November output was not altogether as large as would be expected from the increases in operations that occurred late in October and early in November, and it is evident that a high point was reached not later than the middle of November, since when there has been declining production. A fair estimate is that the rate at present is scarcely over 40 per cent.

The decrease in steel production is a tardy reflection of the dullness that stole over the market at the middle of October, and as the market has not become more active lately, except in tubular goods, further decreases in the rate of operation are to be expected. It appears that some mills are making a special effort to run just now, to give employees some money for the holiday season, and it is not improbable that a number of mills will be closed in the last week or two of the month or the fore part of January.

CHARACTER OF DEMAND

In sheets there is a decreasing demand, chiefly or wholly on account of the season of the year. If allowance be made for the sheet tonnage that goes into large construction work and the manufacture of machinery, and allowance also be made for its being between seasons for the automobile trade, the sheet demand may be regarded as not far from normal. Tin-plate demand is normal for the season, and prospects are that 1922 will be a full normal year in tin-plate consumption. Wire products suffer chiefly from two influences, the season of the year and the fact that buying power of farmers is greatly restricted while the farmer is less disposed than usual to spend what money he has.

STEEL PRICES

Except for the cutting in line pipe and some descriptions of oil-country goods, noted above, steel prices are substantially unchanged. It is obvious that there is a sagging rather than any advancing tendency, but demand is so light, running almost wholly to very small orders, that there is little encouragement to sellers to shade prices. The real final "shake-out" in prices is still to come. It will come when buyers enter the market more freely and offer attractive orders for either prompt or extended delivery. The declines, however, will be quite small compared with what was occurring up to last August.

Bars, shapes and plates generally are quotable at not outside a range of 1.50@1.60c., showing no important change for several weeks. Sheets are quotable at 2.25c. for blue annealed, 3c. for black and 4c. for galvanized. They are well held at these prices, but the market is undergoing no serious test. The \$4.75 tin-plate price is also holding well.

In wire products the swing back to prices ruling before the Sept. 12 advance is now almost complete, although the advanced prices are apparently obtained on small orders in many cases. Contracts entered in anticipation of the Sept. 12 advance were for 60 days, but have been extended where necessary.

PIG IRON

The increased activity in pig iron reported from some districts is not observed in the Pittsburgh valley market, where the only transaction of any consequence reported is a sale of 3,500 tons by a steel interest, out of surplus, to the Trumbull Steel Co., which in this connection abandons its plan of starting its blast furnace Jan. 1, so that the incident is not of a particularly bullish character. The market remains quotable at \$20 for bessemer, \$19 for basic and \$20.50 for foundry, f.o.b. valley furnaces.

Connellsville coke is weaker still, furnace coke not being quotable at over \$3, with possibilities of the price being shaded, while foundry coke of ordinary grade is not strong at \$4. On contracts higher prices are of course asked, but there is scarcely any interest on the part of consumers.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots		Less Carlots	
Acetic anhydride.....lb.			\$0.40 - \$0.45	
Acetone.....lb.	\$0.12½ -	\$0.12½	.13 -	.13½
Acid, acetic, 28 per cent.....100 lbs.	2.75 -	3.00	3.25 -	3.50
Acetic, 56 per cent.....100 lbs.	5.50 -	5.75	6.00 -	6.50
Acetic, glacial, 99½ per cent, carboys, 100 lbs.	10.00 -	10.50	10.75 -	11.00
Boric, crystals.....lb.	.12½ -	.12½	.13 -	.13½
Boric, powder.....lb.	.13 -	.13½	.14 -	.14½
Citric.....lb.			.44½ -	.46
Hydrochloric.....100 lb.	1.25 -	1.50	1.60 -	1.75
Hydrofluoric, 52 per cent.....lb.	.12 -	.12½	.12½ -	.13
Lactic, 44 per cent tech.....lb.	.09½ -	.10	.10½ -	.12
Lactic, 22 per cent tech.....lb.	.04½ -	.05½	.06 -	.07
Molybdic, C.P.....lb.	3.25 -	3.50	3.60 -	4.00
Muriatic, 20 deg. (see hydrochloric).....				
Nitric, 40 deg.....lb.	.06½ -	.06½	.06½ -	.07
Nitric, 42 deg.....lb.	.06½ -	.07	.07½ -	.07½
Oxalic, crys. tals.....lb.	.14½ -	.15	.15½ -	.16
Phosphoric, 50 per cent solution.....lb.	.13 -	.13½	.14 -	.18
Picric.....lb.	.20 -	.25	.27 -	.35
Pyrogallol, resublimed.....lb.			1.90 -	2.00
Sulphuric, 60 deg., tank cars.....ton			11.00 -	12.00
Sulphuric, 60 deg., drums.....ton			13.00 -	15.00
Sulphuric, 66 deg., tank cars.....ton	17.00 -	18.00		
Sulphuric, 66 deg., drums.....ton	21.00 -	22.00	22.50 -	23.00
Sulphuric, 66 deg., carboys.....ton				
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	21.00 -	22.00		
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	23.00 -	23.50	24.00 -	24.50
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	31.00 -	32.00	33.00 -	34.00
Tannic, U. S. P.....lb.			.75 -	.85
Tannic (tech.).....lb.	.45 -	.48	.50 -	.55
Tartaric, imported crystals.....lb.			.26 -	.26½
Tartaric acid, imported, powdered.....lb.			.27 -	.28
Tartaric acid, domestic.....lb.				.35
Tungstic, per lb. of WO.....lb.			1.10 -	1.20
Alcohol, Ethyl.....gal.			4.65 -	5.00
Alcohol, Methyl (see n ethanol).....				
Alcohol, denatured, 188 proof.....gal.			.42 -	.43
Alcohol, denatured, 190 proof.....gal.			.43 -	.44
Alum, ammonia, lump.....lb.	.03½ -	.03½	.04 -	.04½
Alum, potash, lump.....lb.	.03½ -	.04	.04½ -	.04½
Alum, chrome lump.....lb.	.08 -	.08½	.08½ -	.09
Aluminum sulphate, commercial.....lb.	.01½ -	.02	.02½ -	.02½
Aluminum sulphate, iron free.....lb.	.02½ -	.02½	.03 -	.03½
Aqua ammonia, 26 deg., drums (750 lb.) lb.	.07½ -	.07½	.08 -	.08½
Ammonia, anhydrous, cyl. (100-150 lb.) lb.	.31 -	.32	.33 -	.35
Ammonium carbonate, powder.....lb.	.07 -	.07½	.08 -	.09
Ammonium chloride, granular (white) sal ammoniac.....lb.	.06½ -	.07	.07½ -	.07½
Ammonium chloride, granular (gray) sal ammoniac.....lb.	.06½ -	.07	.07½ -	.07½
Ammonium nitrate.....lb.	.07½ -	.07½	.07½ -	.08½
Amylacetate tech.....gal.			2.40 -	2.65
Arsenic oxide, (white arsenic) powdered lb.	.06 -	.06½	.06½ -	.07
Arsenic, sulphide, powdered (red arsenic) lb.	.12 -	.12½	.12½ -	.13
Barium chloride.....ton	48.00 -	49.00	50.00 -	55.00
Barium dioxide (peroxide).....lb.	.20 -	.21	.22 -	.23
Barium nitrate.....lb.	.06½ -	.07	.07½ -	.08
Barium sulphate (precip.) (blanc fixe) lb.	.04 -	.04½	.04½ -	.05
Bleaching powder (see calc. hypochlorite).....				
Blue vitriol (see copper sulphate).....				
Borax (see sodium borate).....				
Brimstone (see sulphur, roll).....				
Bromine.....lb.	.27 -	.28	.28½ -	.30
Calcium acetate.....100 lbs.	1.75 -	2.00		
Calcium carbide.....lb.	.04½ -	.04½	.05 -	.05½
Calcium chloride, fused, lump.....ton	23.50 -	24.00	24.50 -	25.50
Calcium chloride, granulated.....lb.	.01½ -	.02	.02½ -	.02½
Calcium hypochloride (bleach'g powder) 100 lb.	2.50 -	2.60	2.65 -	3.25
Calcium peroxide.....lb.			1.40 -	1.50
Calcium phosphate, tribasic.....lb.			.15 -	.16
Camphor.....lb.			.91 -	.95
Carbon bisulphide.....lb.	.06½ -	.06½	.07 -	.07½
Carbon tetrachloride, drums.....lb.	.10½ -	.10½	.11 -	.12
Carbonyl chloride, (phosgene).....lb.			.60 -	.75
Caustic potash (see potassium hydroxide).....				
Caustic soda (see sodium hydroxide).....				
Chlorine, gas, liquid cylinders (160 lb.) lb.	.08 -	.09	.09½ -	.10
Chloroform.....lb.			.40 -	.43
Cobalt oxide.....lb.			2.00 -	2.10
Copperas (see iron sulphate).....				
Copper carbonate, green precipitate.....lb.	.19 -	.19½	.20 -	.21
Copper cyanide.....lb.			.50 -	.62
Copper sulphate, crystals.....100 lb.	5.65 -	5.70	5.75 -	6.25
Cream of tartar (see potassium bitartrate).....				
Epsom salt (see magnesium sulphate).....				
Ethyl Acetate Com. 85%.....gal.			.70 -	.80
Ethyl Acetate pure (acetic ether, 98% to 100%).....gal.			.95 -	
Formaldehyde, 40 per cent.....lb.	.10½ -	.11	.11½ -	.12
Fusel oil, ref.....gal.			2.50 -	3.00
Fusel oil, crude.....gal.			1.50 -	1.75
Glauber's salt (see sodium sulphate).....				
Glycerine, C. P. drums extra.....lb.			.15 -	.16
Iodine, resublimed.....lb.			3.50 -	3.60
Iron oxide, red.....lb.			.12 -	.18
Iron sulphate (copperas).....ton	15.00 -	16.00	17.00 -	20.00
Lead acetate.....lb.			.10½ -	.12½
Lead arsenate, powd.....lb.	.15 -	.15½	.15½ -	.16½
Lead nitrate.....lb.			.15 -	.20
Litharge.....lb.	.08 -	.08½	.08½ -	.09
Lithium carbonate.....lb.			1.40 -	1.50
Magnesium carbonate, technical.....lb.	.08 -	.08½	.09 -	.10
Magnesium sulphate, U. S. P.....100 lb.	2.50 -	2.75		
Magnesium sulphate, technical.....100 lb.			1.10 -	1.75
Methanol, 95%.....gal.			.62 -	.63
Methanol, 97%.....gal.			.64 -	.65
Nickel salt, double.....lb.			.12 -	.12½
Nickel salt, single.....lb.			.14 -	.14½
Phosgene (see carbonyl chloride).....				
Phosphorus, red.....lb.	.45 -	.46	.47 -	.50
Phosphorus, yellow.....lb.			.32 -	.35
Potassium bichromate.....lb.	.11 -	.11½	.11½ -	.12

	Carlots	Less Carlots
Potassium bitartrate (cream of tartar).... lb.	\$.15 - .16	\$0.25 - \$0.26
Potassium bromide, granular..... lb.	.15 - .16	.15 - .20
Potassium carbonate, U. S. P..... lb.	.04 - .06	.05 - .06
Potassium carbonate, 80-85%..... lb.	.06 - .06	.06 - .12
Potassium chlorate, crystals..... lb.	.05 - .05	.40 - .45
Potassium cyanide..... lb.	.05 - .05	.06 - .08
Potassium hydroxide (caustic potash).... lb.	.07 - .07	2.60 - 2.75
Potassium iodide..... lb.	.17 - .18	.08 - .09
Potassium nitrate..... lb.	.28 - .29	.21 - .21
Potassium permanganate..... lb.	.22 - .22	.29 - .30
Potassium prussiate, red..... lb.		.23 - .23
Potassium prussiate, yellow..... lb.		
Rochelle salts (see sodium potas tartrate)		
Salammoniac (see ammonium chloride)		
Salt soda (see sodium carbonate)		
Salt cake (bulk)..... ton		18.00 - 20.00
Silver cyanide..... oz.		1.10 - 1.20
Silver nitrate..... oz.		.45 - .46
Soda ash, light..... 100 lb.	1.75 - 2.10	2.15 - 2.50
Soda ash, dense..... 100 lb.	2.25 - 2.30	2.35 - 2.60
Sodium acetate..... lb.	.04 - .04	.04 - .05
Sodium bicarbonate..... 100 lb.	2.30 - 2.35	2.40 - 2.75
Sodium bichromate..... lb.	.07 - .08	.08 - .08
Sodium bisulphate (nitre cake)..... ton	5.00 - 5.25	5.50 - 6.50
Sodium bisulphite powdered, U.S.P..... lb.	.04 - .05	.05 - .06
Sodium borate (borax)..... lb.	.05 - .06	.06 - .07
Sodium carbonate (salt soda)..... 100 lb.	1.80 - 1.90	2.00 - 2.20
Sodium chloride..... lb.	.06 - .07	.07 - .08
Sodium cyanide..... lb.	.28 - .28	.29 - .30
Sodium fluoride..... lb.	.11 - .12	.12 - .14
Sodium hydroxide (caustic soda)..... 100 lb.	3.90 - 4.00	4.05 - 4.50
Sodium hyposulphite..... lb.		.03 - .03
Sodium nitrite..... lb.	.06 - .07	.07 - .07
Sodium peroxide, powdered..... lb.	.25 - .26	.27 - .30
Sodium phosphate, dibasic..... lb.	.04 - .04	.04 - .05
Sodium potassium tartrate (Rochelle salts)		.21 - .24
Sodium prussiate, yellow..... lb.	.14 - .14	.14 - .15
Sodium silicate, solution (40 deg.)..... 100 lb.	1.00 - 1.05	1.10 - 1.30
Sodium silicate, solution (60 deg.)..... 100 lb.	2.30 - 2.40	2.45 - 3.00
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	1.30 - 1.50	1.60 - 2.00
Sodium sulphide, fused, 60-62 per cent (conc.) lb.	.04 - .04	.05 - .05
Sodium sulphite, crystals..... lb.	.03 - .03	.04 - .04
Strontium nitrate, powdered..... lb.	.13 - .14	.14 - .20
Sulphur chloride, red..... lb.	.06 - .06	.06 - .07
Sulphur, crude..... ton	18.00 - 20.00	
Sulphur dioxide, liquid, cylinders extra..... lb.	.08 - .08	.09 - .10
Sulphur (sublimed), flour..... 100 lb.		2.25 - 3.10
Sulphur, roll (brimstone)..... 100 lb.		2.00 - 2.75
Tin bichloride..... lb.	.09 - .09	.09 - .10
Tin oxide..... lb.		.37 - .38
Zinc carbonate..... lb.	.14 - .14	.15 - .16
Zinc chloride, gran..... lb.	.09 - .09	.09 - .10
Zinc cyanide..... lb.	.42 - .44	.45 - .47
Zinc dust..... lb.	.11 - .11	.11 - .12
Zinc oxide, XX..... lb.	.07 - .07	.08 - .09
Zinc sulphate..... 100 lb.	3.00 - 3.25	3.30 - 3.50

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude..... lb.	\$1.10 - \$1.15
Alpha-naphthol, refined..... lb.	1.25 - 1.30
Alpha-naphthylamine..... lb.	.30 - .32
Aniline oil, drums extra..... lb.	.18 - .20
Aniline salts..... lb.	.24 - .26
Anthracene, 80% in drums (100 lb.)..... lb.	.75 - 1.00
Benzaldehyde U.S.P..... lb.	1.35 - 1.45
Benzidine, base..... lb.	.90 - 1.00
Benzidine sulphate..... lb.	.75 - .85
Benzoic acid, U.S.P..... lb.	.62 - .65
Benzoate of soda, U.S.P..... lb.	.52 - .55
Benzene, pure, water-white, in drums (100 gal.)..... gal.	.27 - .32
Benzene, 90%, in drums (100 gal.)..... gal.	.25 - .28
Benzyl chloride, 95-97%, refined..... lb.	.25 - .27
Benzyl chloride, tech..... lb.	.20 - .23
Beta-naphthol benzoate..... lb.	3.75 - 4.00
Beta-naphthol, sublimed..... lb.	.70 - .75
Beta-naphthol, tech..... lb.	.30 - .34
Beta-naphthylamine, sublimed..... lb.	1.75 - 1.85
Cresol, U. S. P., in drums (100 lb.)..... lb.	.15 - .16
Ortho-cresol, in drums (100 lb.)..... lb.	.24 - .26
Cresylic acid, 97-99%, straw color, in drums..... gal.	.70 - .80
Cresylic acid, 95-97%, dark, in drums..... gal.	.65 - .70
Cresylic acid, 50%, first quality, drums..... gal.	.45 - .50
Dichlorobenzene..... lb.	.06 - .09
Diethylaniline..... lb.	.95 - 1.10
Dimethylaniline..... lb.	.45 - .60
Dinitrobenzene..... lb.	.23 - .27
Dinitrochlorobenzene..... lb.	.20 - .25
Dinitronaphthalene..... lb.	.30 - .35
Dinitrophenol..... lb.	.35 - .40
Dinitrotoluene..... lb.	.25 - .30
Dip oil, 25%, ear lots, in drums..... gal.	.30 - .35
Diphenylamine..... lb.	.60 - .70
H-acid..... lb.	1.00 - 1.10
Meta-phenylenediamine..... lb.	1.10 - 1.15
Monochlorobenzene..... lb.	.12 - .14
Monoethylaniline..... lb.	1.65 - 1.70
Naphthalene crushed, in bbls..... lb.	.07 - .08
Naphthalene, flake..... lb.	.07 - .08
Naphthalene, balls..... lb.	.08 - .09
Naphthionic acid, crude..... lb.	.70 - .75
Nitrobenzene..... lb.	.12 - .15
Nitro-naphthalene..... lb.	.30 - .35
Nitro-toluene..... lb.	.15 - .17
Ortho-amidophenol..... lb.	3.00 - 3.10
Ortho-dichlor-benzene..... lb.	.15 - .20
Ortho-nitro-phenol..... lb.	.77 - .80
Ortho-nitro-toluene..... lb.	.15 - .20
Ortho-toluidine..... lb.	.20 - .25
Para-amidophenol, base..... lb.	1.40 - 1.45
Para-amidophenol, HCl..... lb.	1.70 - 1.80
Para-dichlorobenzene..... lb.	.12 - .15
Paranitroaniline..... lb.	.75 - .80
Para-nitrotoluene..... lb.	.80 - .85
Para-phenylenediamine..... lb.	1.70 - 1.75
Para-toluidine..... lb.	1.25 - 1.40
Phthalic anhydride..... lb.	.40 - .50

Phenol, U. S. P., drums..... lb.	1.14 - 1.15
Pyridine..... gal.	2.00 - 3.50
Resorcinol, technical..... lb.	1.50 - 1.60
Resorcinol, pure..... lb.	2.00 - 2.25
Salicylic acid, tech., in bbls..... lb.	.20 - .21
Salicylic acid, U. S. P..... lb.	.22 - .23
Salol..... lb.	.70 - .72
Solvent naphtha, water-white, in drums, 100 gal..... gal.	.25 - .28
Solvent naphtha, crude, heavy, in drums, 100 gal..... gal.	.14 - .16
Sulphanilic acid, crude..... lb.	.27 - .30
Tolidine..... lb.	1.30 - 1.35
Toluidine, mixed..... lb.	.43 - .45
Toluene, in tank cars..... gal.	.25 - .28
Toluene, in drums..... gal.	.28 - .31
Xylidines, drums, 100 gal..... lb.	.40 - .45
Xylene, pure, in drums..... gal.	.40 - .45
Xylene, pure, in tank cars..... gal.	.45 - .45
Xylene, commercial, in drums, 100 gal..... gal.	.33 - .35
Xylene, commercial, in tank cars..... gal.	.30 - .30

Waxes

Prices based on original packages in large quantities.

Bayberry Wax..... lb.	\$0.20 - \$0.21
Beeswax, refined, dark..... lb.	.24 - .25
Beeswax, refined, light..... lb.	.28 - .30
Beeswax, white pure..... lb.	.34 - .38
Candelilla wax..... lb.	.24 - .24
Carnauba, No. 1..... lb.	.45 - .46
Carnauba, No. 2, North Country..... lb.	.23 - .23
Carnauba, No. 3, North Country..... lb.	.14 - .14
Japan..... lb.	.21 - .21
Montan, crude..... lb.	.04 - .04
Paraffine waxes, crude match wax (white) 105-110 m.p..... lb.	.04 - .04
Paraffine waxes, crude, scale 124-126 m.p..... lb.	.03 - .04
Paraffine waxes, refined, 118-120 m.p..... lb.	.03 - .04
Paraffine waxes, refined, 125 m.p..... lb.	.04 - .04
Paraffine waxes, refined, 128-130 m.p..... lb.	.04 - .04
Paraffine waxes, refined, 133-135 m.p..... lb.	.05 - .05
Paraffine waxes, refined, 135-137 m.p..... lb.	.05 - .05
Stearic acid, single pressed..... lb.	.09 - .09
Stearic acid, double pressed..... lb.	.09 - .09
Stearic acid, triple pressed..... lb.	.10 - .10

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on earload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl..... 280 lb.	\$5.30 - 5.35
Rosin E-I..... 280 lb.	5.40 - 5.50
Rosin K-N..... 280 lb.	6.05 - 6.75
Rosin W. G.-W. W..... 280 lb.	7.00 - 7.25
Wood rosin, bbl..... 280 lb.	6.25 - .
Spirits of turpentine..... gal.	.82 - .
Wood turpentine, steam dist..... gal.	.80 - .
Wood turpentine, dest. dist..... gal.	.78 - .
Pine tar pitch, bbl..... 200 lb.	. - 6.00
Tar, kila burned, bbl. (500 lb.)..... bbl.	. - 9.50
Retort tar, bbl..... 500 lb.	. - 9.50
Rosin oil, first run..... gal.	.36 - .
Rosin oil, second run..... gal.	.39 - .
Rosin oil, third run..... gal.	.46 - .
Pine oil, steam dist., sp.gr. 0.930-0.940..... gal.	\$1.90 - .
Pine oil, pure, dest. dist..... gal.	1.50 - .
Pine tar oil, ref., sp.gr. 1.025-1.035..... gal.	.46 - .
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla..... gal.	.35 - .
Pine tar oil, double ref., sp.gr. 0.965-0.990..... gal.	.75 - .
Pine tar, ref., thin, sp.gr. 1.080-1.060..... gal.	.35 - .
Turpentine, crude, sp. gr. 0.900-0.970..... gal.	1.25 - .
Hardwood oil, f.o.b. Mich., sp.gr. 0.960-0.990..... gal.	.35 - .
Pinewood creosote, ref..... gal.	.52 - .

Solvents

73-76 deg., steel bbls. (85 lb.)..... gal.	\$0.37 - .
70-72 deg., steel bbls. (85 lb.)..... gal.	.35 - .
68-70 deg., steel bbls. (85 lb.)..... gal.	.34 - .
V. M. and P. naphtha, steel bbls. (85 lb.)..... gal.	.23 - .

Fertilizers

Ammonium sulphate, bulk and d. bags..... 100 lb.	\$2.30 - 2.90
Blood, dried, f.o.b., N. Y..... unit	4.00 - .
Bone, 3 and 50, ground, raw..... ton	30.00 - 32.00
Fish scrap, dom., dried, f.o.b. works..... ton	2.90 - 3.00
Nitrate soda..... 100 lb.	2.30 - 2.35
Tankage, high grade, f.o.b. Chicago..... unit	2.75 - 3.00
Phosphate rock, f.o.b. mines, Florida pebble, 68-72 p.e..... ton	4.50 - 6.50
Tennessee, 78-80 p.e..... ton	8.50 - 9.00
Potassium muriate, 80 p.e..... ton	35.00 - 37.00
Potassium sulphate..... unit	.90 - 1.00

Crude Rubber

Para-Upriver fine..... lb.	\$0.23 - .23
Upriver coarse..... lb.	.13 - .14
Upriver caucho ball..... lb.	.13 - .13
Plantation—First latex crepe..... lb.	.18 - .18
Ribbed smoked sheets..... lb.	.18 - .19
Brown crepe, thin, clean..... lb.	.15 - .
Amber crepe No. 1..... lb.	.17 - .

Oils

VEGETABLE

The following prices are f.o.b. New York for earload lots.

Castor oil, No. 3, in bbls..... lb.	\$0.10 - \$0.10
Castor oil, AA, in bbls..... lb.	.11 - .12
China wood oil, in bbls. (f.o.b. Pac. coast)..... lb.	.13 - .13
Cocanut oil, Ceylon grade, in bbls..... lb.	.09 - .09
Cocanut oil, Cochin grade, in bbls..... lb.	.10 - .10
Corn oil, crude, in bbls..... lb.	.08 - .08
Cottonseed oil, crude (f. o. b. mill)..... lb.	.07 - .07
Cottonseed oil, summer yellow..... lb.	.08 - .09
Cottonseed oil, winter yellow..... lb.	.09 - .09

Linseed oil, raw, car lots (domestic).....	gal.	.67	—	.68
Linseed oil, raw, tank cars (domestic).....	gal.	.62	—	.63
Linseed oil, in 5-bbl lots (domestic).....	gal.	.70	—	.71
Olive oil, Denatured.....	gal.	\$1.15	—	\$1.20
Palm, Lagos.....	lb.	.07	—	.07½
Palm, Niger.....	lb.	.06½	—	.06½
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.08½	—	.08½
Peanut oil, refined, in bbls.....	lb.	.11	—	.11½
Rapeseed oil, refined in bbls.....	gal.	.83	—	.84
Rapeseed oil, blown, in bbls.....	gal.	.88	—	.90
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.09	—	....
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.07½	—	....

FISH

Light pressed menhaden.....	gal.	\$0.40	—	....
Yellow bleached menhaden.....	gal.	.42	—	....
White bleached menhaden.....	gal.	.45	—	....
Blown menhaden.....	gal.	.48	—	....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$23.00	—	23.50
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	15.00	—	17.00
Barytes, crude, 88% @ 94% ba., Kings Creek.....	net ton	10.00	—	12.00
Barytes, floated, f.o.b. St. Louis.....	net ton	23.00	—	24.00
Barytes, crude, first grade, Missouri.....	net ton	6.00	—	7.00
Blanc fixe, dry.....	lb.	.04	—	.04½
Blanc fixe, pulp.....	net ton	45.00	—	55.00
Casein.....	lb.	.15	—	.16
Chalk, Precipitated, domestic, extra light.....	lb.	.04½	—	.05
Chalk, Precipitated, domestic, light.....	lb.	.04	—	.04½
Chalk, Precipitated, domestic, heavy.....	lb.	.03½	—	.04
Chalk, Precipitated, English, extra light.....	lb.	.04	—	.05
Chalk, Precipitated, English, light.....	lb.	.04½	—	.05
Chalk, Precipitated, English, dense.....	lb.	.04	—	.04½
China clay (kaolin) crude, f.o.b. mines, Georgia.....	net ton	6.50	—	8.50
China clay (kaolin) washed, f.o.b. Georgia.....	net ton	9.00	—	10.00
China clay (kaolin) powdered, f.o.b. Georgia.....	net ton	13.00	—	20.00
China clay (kaolin) crude f.o.b. Virginia points.....	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points.....	net ton	13.00	—	20.00
China clay (kaolin), imported, lump.....	net ton	12.00	—	20.00
China clay (kaolin), imported, powdered.....	net ton	25.00	—	30.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	net ton	5.00	—	7.50
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27.00	—	30.00
Fullers earth, f.o.b. Mines.....	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Pa.....	net ton	15.00	—	18.00
Fullers earth, powdered, f.o.b. Fla.....	net ton	18.00	—	....
Fullers earth, imported, powdered.....	net ton	24.00	—	27.00
Graphite, Ceylon lump, first quality.....	lb.	.06	—	.07
Graphite, Ceylon chip.....	lb.	.04½	—	.05
Graphite, high grade amorphous crude.....	lb.	.00½	—	.02½
Kieselguhr, f.o.b. mines, Cal.....	per ton	40.00	—	....
Kieselguhr, f.o.b. N. Y.....	per ton	55.00	—	60.00
Magnesite, calcined.....	per ton	50.00	—	65.00
Pumice stone, imported.....	lb.	.03	—	.40
Pumice stone, domestic, lump.....	lb.	.05	—	.05½
Pumice stone, domestic, ground.....	lb.	.06	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore.....	net ton	....	—	10.00
Quartz (acid tower) 1½ @ 2 in., f.o.b. Baltimore.....	net ton	....	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	....	—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange fine.....	lb.	.68	—	.70
Shellac, orange superfine.....	lb.	.78	—	.80
Shellac, A. C. garnet.....	lb.	.58	—	.60
Shellac, T. N.....	lb.	.68	—	.70
Soapstone.....	ton	12.00	—	15.00
Sodium chloride.....	long ton	12.50	—	13.00
Talc, paper-making grades, f.o.b. Vermont.....	ton	11.00	—	18.00
Talc, roofing grades, f.o.b. Vermont.....	ton	8.50	—	13.00
Talc, rubber grades, f.o.b. Vermont.....	ton	11.00	—	18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	7.50	—	11.00
Talc, imported.....	ton	30.00	—	40.00
Talc, California talcum powder grade.....	ton	18.00	—	25.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	per ton	\$50.00	—	....
Carborundum refractory brick, 9-in. { less than carlot	1,000	1250.00	—	....
Carborundum refractory brick, 9-in. { carlot lots	1,000	1100.00	—	....
Chrome brick, f.o.b. Eastern shipping points.....	net ton	52- 55	—	....
Chrome cement, 40-45% Cr ₂ O ₃	net ton	30- 32	—	....
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in car lots, f.o.b. Eastern shipping points.....	net ton	33- 35	—	....
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	35- 40	—	....
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	30- 35	—	....
Magnesite brick, 9-in. straight.....	net ton	65- 70	—	....
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	77	—	....
Magnesite brick, soaps and splits.....	net ton	98	—	....
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	40- 42	—	....
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	42- 45	—	....
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	35- 38	—	....

Ferro-Alloys

All f.o.b. Works

Ferrocobalt-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00	—	\$225.00
Ferrochrome per lb. of Cr. contained, 6-8% carbon, carlots.....	lb.	.12	—	....
Ferrochrome, per lb. of Cr. contained, 4-6% carbon, carlots.....	lb.	.13	—	....
Ferromanganese, 76-80% Mn, domestic.....	gross ton	58.00	—	60.00
Ferromanganese, 76-80% Mn, Foreign, C. I. F. Atlantic Seaport.....	gross ton	54.00	—	58.35
Spiegeleisen, 18-22% Mn.....	gross ton	25.00	—	27.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.25	—	....
Ferrosilicon, 10-15%.....	gross ton	38.00	—	40.00
Ferrosilicon, 50%.....	gross ton	57.00	—	59.00
Ferrosilicon, 75%.....	gross ton	120.00	—	125.00
Ferrotungsten, 70-80%, per lb. of contained W.....	lb.	.40	—	.45
Ferroumium, 35-50%, of U, per lb. of U content.....	lb.	6.00	—	....
Ferrovandium, 30-40%, per lb. of contained V.....	lb.	4.25	—	4.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content.....	net ton	\$8.00	—	\$10.00
Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃	ton	22.00	—	23.00
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard.....	ton	22.00	—	23.00
Coke, foundry, f.o.b. ovens.....	net ton	4.25	—	4.50
Coke, furnace, f.o.b. ovens.....	net ton	3.25	—	3.50
Fluorspar, gravel, f.o.b. mines, New Mexico.....	net ton	12.00	—	....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	20.00	—	22.00
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01½	—	.01½
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	.23	—	.24
Manganese ore, chemical (MnO ₂).....	net ton	55.00	—	60.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.45	—	.50
Monazite, per unit of ThO ₂ , c.i.f., Atlantic seaport.....	unit	30.00	—	....
Pyrates, Spanish, fines, c.i.f., Atlantic seaport.....	unit	.12	—	.12
Pyrates, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.13	—	.13
Pyrates, domestic, fines, f.o.b. mines, Ga.....	unit	.11	—	.12
Rutile, 95% TiO ₂ per lb. ore.....	lb.	.15	—	....
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	2.50	—	2.75
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	2.75	—	3.00
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	1.25	—	1.75
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.25	—	2.50
Vanadium pentoxide, 99%.....	lb.	12.00	—	14.00
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1.00	—	....
Zircon, washed, iron free, f.o.b. Pablo, Florida.....	lb.	.04½	—	.13

Non-Ferrous Metals

New York Markets

	Cents per Lb
Copper, electrolytic.....	13.75
Aluminum, 98 to 99 per cent.....	19.00
Antimony, wholesale lots, Chinese and Japanese.....	4.50
Nickel, ordinary (ingot).....	41.00
Nickel, electrolytic.....	44.00
Monel metal, shot and blocks.....	35.00
Monel metal ingots.....	38.00
Monel metal, sheet bars.....	40.00
Tin, 5-ton lots, Straits.....	31.50
Lead, New York, spot.....	4.70
Lead, E. St. Louis, spot.....	4.35 @ 4.40
Zinc, spot, New York.....	5.30 @ 5.35
Zinc, spot, E. St. Louis.....	4.85 @ 4.90

OTHER METALS

Silver (commercial).....	oz.	\$0.66½
Cadmium.....	lb.	1.00-1.25
Bismuth (500 lb. lots).....	lb.	1.50 @ 1.55
Cobalt.....	lb.	3.00 @ 3.25
Magnesium (f.o.b. Philadelphia).....	lb.	1.25
Platinum.....	oz.	80.00
Iridium.....	oz.	150.00 @ 170.00
Palladium.....	oz.	55.00-60.00
Mercury.....	.75 lb.	46.00-47.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled.....	21.25
Copper bottoms.....	28.75
Copper rods.....	19.75
High brass wire.....	17.25
High brass rods.....	14.75
Low brass wire.....	18.75
Low brass rods.....	19.25
Brazed brass tubing.....	25.50
Brazed bronze tubing.....	30.50
Seamless copper tubing.....	21.25
Seamless high brass tubing.....	18.50

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current	Cleveland	Chicago
Copper, heavy and crucible.....	9.75 @ 10.25	9.25	9.50
Copper, heavy and wire.....	9.25 @ 9.50	8.50	8.50
Copper, light and bottoms.....	7.50 @ 8.00	7.50	7.25
Lead, heavy.....	3.50 @ 3.75	3.25	3.25
Lead, tea.....	2.25 @ 2.35	2.25	2.25
Brass, heavy.....	4.25 @ 4.50	4.50	5.00
Brass, light.....	3.25 @ 3.50	3.25	3.50
No. 1 yellow brass turnings.....	4.00 @ 4.25	4.25	4.50
Zinc.....	2.00 @ 2.25	2.00	2.25

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ½ in. and larger, and plates ½ in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes.....	\$2.78	\$2.88	\$2.78
Soft steel bars.....	2.68	2.78	2.68
Soft steel bar shapes.....	2.68	2.78	2.68
Soft steel bands.....	3.28	3.48	3.28
Plates, ½ to 1 in. thick.....	2.78	2.88	2.78

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Arkansas

BATESVILLE—The American Manganese Co. has awarded a contract to the E. C. McCombs Co. for the completion of the concentrating plant at its Polk Southard Mines, to be equipped for a daily output of about 25 tons. The plant is estimated to cost about \$150,000.

California

CHICO—The Standard Oil Co. has awarded a contract to J. J. Brooks, Sacramento, Cal., for the rebuilding of its local oil-distributing plant on Nord Ave., estimated to cost about \$25,000. Work will be begun at once.

LONG BEACH—The Red Seal Refining Co. has acquired property on West Anaheim St. as a site for the erection of a new oil refinery, estimated to cost close to \$1,000,000, with machinery. Plans will be drawn at an early date. H. L. Hagerman is treasurer.

Connecticut

NEW HAVEN—Fire, Dec. 1, destroyed a portion of the plant of the Seamless Rubber Co., Hallock Ave., with loss estimated at close to \$100,000. The company is a subsidiary of the United Drug Co., Boston, Mass.

WINDSOR LOCKS—Following the acquisition of the Windsor Lock Paper Mills by the J. N. L. Smythe Co., 32-34 South Sixth St. Philadelphia, Pa., the former company has been dissolved and a new corporation formed under state laws and name of the Windsor Lock Paper Mills Co., Inc., capitalized at \$200,000. The new company will increase the capacity of the plant. The incorporators are A. T. Johnson, A. W. Hyde and J. H. Williams, 261 White St., Hartford, Conn.

Illinois

CHICAGO—The Crane Co., 836 South Michigan Ave., manufacturer of sanitary fixtures, steam specialties, etc., is having plans prepared for the erection of a 2-story foundry at 4100 South Kedzie Ave., to be 160 x 500 ft. and estimated to cost in excess of \$700,000 with equipment. Graham, Anderson, Probst & White, 8 East Jackson Blvd., are architects. W. J. Clark, company address, is construction engineer.

CHICAGO—The Abbott Laboratories, 4753 Ravenswood Ave., manufacturers of chemicals, have construction under way on a new plant at Fourteenth and State Sts., North Chicago, estimated to cost about \$400,000. It will consist of a number of buildings, with main structure 4-story and basement. It is proposed to expand the present plant in the spring and ground for additional structures will be broken at that time. E. H. Ravenscroft is vice-president in charge of construction.

CHICAGO—The Nemo Dye Works is building a new 1-story mill and steel construction factory, 209 x 215 ft., for commercial dyeing at 4203 Grand Ave. Paul Gerhardt is architect; estimated cost, \$250,000.

CHICAGO—Barrett & Barrett Mfg. Co., producer of apple products, is building a 7-story factory 100 x 61 ft. at 357 West Ontario St. Paul Gerhardt is architect; estimated cost, \$300,000.

Indiana

JONESBORO—The Indiana Rubber Co., Pearl and First Sts., is planning for the construction of a 3-story addition, 60 x 125 ft. Plans will be drawn and work commenced in the coming spring.

TERRE HAUTE—The Columbian Enameling & Stamping Co. has construction under way on a 1-story and part basement addition, to be used for enameling and other operations. Roehm Bros., 30 North Fifth St., are contractors.

Kentucky

OWENSBORO—The Indian Refining Co., Lawrenceville, Ill., is planning for the

construction of a new local distributing plant, with extensive pipe-line and pumping system for oil service, estimated to cost in excess of \$500,000.

LOUISVILLE—The Standard Sanitary Mfg. Co., Bessemer Bldg., Pittsburgh, Pa., is completing plans for the erection of its proposed local plant addition, Sixth and A Sts., to be 1-story, 56 x 375 ft., and estimated to cost close to \$100,000. It will be equipped as an enameling works. O. P. Ward, Lincoln Building, Louisville, is architect.

Massachusetts

REVERE—The Suburban Gas & Electric Co., 150 Beach St., has awarded a contract to the C. H. Tenney Co., 201 Devonshire St., Boston, Mass., for the erection of a gas holder, with auxiliary gas works, on Proctor St., estimated to cost about \$185,000.

Michigan

DETROIT—The Goodyear Tire & Rubber Co., 88 Custer Ave., has completed plans and is taking bids for extensions and improvements in its plant on Hastings St., near the Grand Blvd. Smith, Hinchman & Grylls, 710 Washington Arcade, are architects.

Missouri

KANSAS CITY—The Corn Products Refining Co. is planning for the early operation of its new local plant, in course of erection for a number of months past, and proposes to develop an extensive grinding capacity and output shortly after the first of the year. The plant will represent an investment of close to \$4,000,000.

Nevada

CALLVILLE—The West End Chemical Co. is planning for extensive developments and operations at its local borax properties for the production of colemanite and refined borax. Work will be concentrated to handle a contract calling for a minimum of 60,000 tons of colemanite and a maximum of 240,000 over a certain number of months. F. M. (Borax) Smith, San Francisco, Cal., is president of the company.

New Jersey

TRENTON—The General Chinaware Corp. has acquired the old Willits pottery, and will establish a new local plant for the manufacture of dinnerware products. Machinery will be installed at once using only a portion of the plant at the present time. The remainder will be leased for other manufacturing service.

NEWARK—The Linden Tanning Co., 440 Frelinghuysen Ave., has filed plans for the erection of an addition to its plant.

NEWARK—The Gulf Refining Co., Doremus Ave., will commence the immediate erection of a 2-story building at its plant, estimated to cost about \$60,000.

New York

CUYLERVILLE—The Sterling Salt Company of New York has contracted with Dwight P. Robinson & Co., Inc., of New York City for the design and construction of a salt warehouse and conveying equipment here.

North Carolina

MOUNT HOLLY—The Kendrick Brick & Tile Co. has plans under way for enlargements in its plant, to include the installation of new machinery, drying equipment and other apparatus. It is proposed to increase the production from 75,000 to over 100,000 bricks a day. N. B. Kendrick heads the company.

WILMINGTON—The Texas Oil Co., 701 Barrone St., New Orleans, La., has acquired a tract of property totalling about 35 acres at Wilmington, for the construction of a new oil-distributing plant. At a later date, it is proposed to use a portion of the site for an oil refinery. The company is operating a plant in Mississippi.

Ohio

LORAIN—The Briggs Chemical Co. is planning for the rebuilding of the portion of its plant, destroyed by fire, Nov. 18,

with loss estimated at about \$60,000. A. H. Babcock is president.

Oklahoma

MCALISTER—The Chamber of Commerce is developing plans for the organization of a local company for the establishment of a brick-manufacturing plant, estimated to cost about \$75,000, including machinery. A tile department will also be installed, with output of about 20,000 roofing tiles per day. The brick plant will be equipped for a daily production of 60,000 bricks.

ARDMORE—The Coline Oil Co. has acquired a tract of local property totalling about 40 acres to be used for the erection of a tank farm and oil-distributing works. The initial installation will consist of twenty-five 55,000-bbl. steel tanks.

Oregon

GRESHAM—John A. Moge has acquired a local site for the construction of a new foundry for the production of iron and other metal castings.

Pennsylvania

NEW HOPE—The American Clay Products Co. is planning to have its local plant, in course of erection for some months past, ready for service early in the coming year. Work is now under way on kilns and other manufacturing departments. The plant will be devoted to the production of vitrified brick and it is proposed to provide ultimately for an output of close to 500,000 bricks per day.

READING—The Colonial Chemical Co., Schuylkill Ave. and River Road, has preliminary plans under way for the erection of a new 2-story plant, 25 x 100 ft. High & Huber, 11 North Fifth St., are architects.

PHILADELPHIA—Philip Hauck & Son, 1237-39 North Fourth St., will soon commence the erection of an addition to their paper and paper box plant, to be 3-story, 37 x 90 ft.; and estimated to cost close to \$30,000. Harry H. Wehmeyer, 509 West Cumberland St., has the construction contract.

PHILADELPHIA—Fire, Dec. 1, damaged a portion of the plant of F. Weber & Co., 1220 Buttonwood St., manufacturers of paints, oils, chemicals and other artists' materials, with loss reported in excess of \$300,000.

Tennessee

NASHVILLE—The Farmers' Mutual Phosphate Co., 1047-48 Lemcke Annex, Indianapolis, Ind., is planning for the erection of a new plant at its properties at Centerville, near Nashville, to be known as Plant No. 3, with daily capacity of about 300 tons of phosphate, and a new mixing plant on an Indiana site. To carry out the details of the project, the company has arranged for a bond issue of \$250,000. The company is now operating a 300-ton plant at Centerville, and a 100-ton operating unit is nearing completion; it will be placed in service in January.

Texas

KINGSVILLE—The Kingsville Commission Co. is considering the erection of a new leather tannery. Plans will be prepared at an early date. Marcus Phillips is manager.

DALLAS—L. D. Lansdale and Charles A. Mangold, both of Dallas are perfecting plans for the construction of a new plant on the site of the Love Field repair depot of the government for the manufacture of sulphuric acid. A company will be organized to operate the plant, which will have an initial capacity of about 50 tons per day, and estimated to cost close to \$200,000, including machinery. One of the plant units will be devoted to the production of electrolyte acid for battery service. George A. Sprague, Dallas, is also interested in the new company.

CORPUS CHRISTI—T. B. Williams, Box 290, is organizing a new company to construct and operate a local leather tannery. Plans and details of the new plant will be arranged at an early date.

MARSHALL—The Darco Co., a subsidiary of the Atlas Powder Co., du Pont Bldg., Wilmington, Del., with headquarters at the same location, has broken ground for its proposed new local plant for the production of a new type of carbon. The initial works will have an annual output of about 6,000 tons of material, and will cost in excess of \$500,000. W. J. Webster is president.

WACO—The Waco Oil & Refining Co. is considering plans for enlargements in its oil refinery for increased capacity. It is proposed to build a new pipe line from the

Mexia, Tex., fields to the local plant. W. A. Rogers is president.

Wisconsin

GREEN BAY—The Fort Howard Paper Co. has construction in progress for a 3-story paper mill in the East Side section, to be 100 x 120 ft., and estimated to cost about \$85,000. The building contract has been awarded to the Rudolph M. Hansen Co., 113 Walnut St.

MILWAUKEE—The American Hide & Leather Co., Fourteenth St., is taking bids for the rebuilding of its local tannery, recently destroyed by fire, and will soon award contract. The works will comprise four buildings, with main structure, 200 x 300 ft., 4-story, estimated to cost close to \$700,000, including equipment. Lockwood, Greene & Co., 38 South Dearborn St., Chicago, Ill., are architects. R. A. Riker is superintendent.

Capital Increases, Etc.

THE CONNECTICUT METAL & CHEMICAL Co., New Britain, Conn., has filed notice of change of name to the Stanley Chemical Co.

THE NEWARK PAPER BOX Co., 95 Eighth Ave., Newark, N. J., has filed notice of increase in capital from \$10,000 to \$200,000.

THE SAN ANTONIO PORTLAND CEMENT Co., San Antonio, Tex., has filed notice of increase in capital from \$250,000 to \$300,000.

Ray F. Hamlin and John M. Crawford have been appointed receivers for the **AVALLON RUBBER MFG. Co.**, Akron, O.

THE SUN RIVER CHEMICAL Co., 1914 Broadway, New York, N. Y., has filed notice of increase in capital from \$300,000 to \$400,000.

THE METAL STAMPING Co., Thirteenth St., Brooklyn, N. Y., has filed notice of increase in capital from \$25,000 to \$1,000,000.

THE SOUTH PORTO RICO SUGAR Co., 62 Cedar St., New York, N. Y., is arranging for a bond issue of \$6,000,000, for general operations, expansion, etc.

THE ERIE-BUFFALO TUBE Co., Erie, Pa., has recently filed a voluntary petition in bankruptcy, with liabilities stated at \$158,092.29, and assets, \$238,816.10.

THE VACAMA MICA Co., a Delaware corporation, has filed notice of intention to operate at Waynesboro, Pa.

THE CARTHAGE SULPHITE PULP & PAPER Co., Carthage, N. Y., has arranged for a bond issue of \$600,000, the proceeds to be used for general operations, expansion, etc.

THE PIERCE OIL CORP., 25 Broad St., New York, N. Y., has disposed of a bond issue of \$2,000,000, the proceeds to be used for general operations, financing, etc.

An involuntary petition in bankruptcy has been filed against the **PULP & FIBRE PRODUCTS Co.**, Scotch Plains, N. J.

New Companies

THE FLORIDA-LOUISIANA REFINING Co., Shreveport, La., has been incorporated under Florida laws with capital of \$150,000, to manufacture refined oil products, with proposed plant in the vicinity of Jacksonville, Fla. H. C. Leete is president and general manager; and A. C. Lea, treasurer, both of Shreveport.

PETER BARAN & SONS, INC., Harrison, N. J., has been incorporated with a capital of \$125,000, to manufacture leather products. The incorporators are Arthur Read, William V. Azzoll and Peter Baran, First and Bergen Sts., Harrison.

THE BERRYMAN RUBBER & TIRE Co., New York, N. Y., has been incorporated with a capital of \$200,000 to manufacture automobile tires and other rubber products. The incorporators are H. M. Wise, E. Gibbs and E. J. Sisley. The company is represented by Lee, Aron & Wise, 7 Dey St., New York.

MILLBOND CHEMICALS, LTD., Boston, Mass., has been incorporated with a capital of \$50,000, to manufacture chemicals and chemical byproducts. Julius Robbins is president; Benjamin Zakon, vice-president; and Milton H. Balch, 104 Temple St., West Newton, Mass., treasurer.

THE JORDAN PAPER BOX Co., 339 North Crawford Ave., Chicago, Ill., has been incorporated with a capital of 200 shares of stock, no par value, to manufacture paper boxes and allied paper products. The incorporators are George S. Marks, Frank H. and William R. Jordan.

THE MATTERN OIL & GREASE Co., Oil City, Pa., has been incorporated with a

capital of \$20,000, to manufacture lubricating oils, greases and kindred products. R. B. Mattern, Oil City, is treasurer.

THE LAMSON ASPHALT & CHEMICAL Co., New York, N. Y., has been incorporated under Delaware laws with capital of \$150,000, to manufacture chemicals, dyestuffs and kindred products. The company is represented by the United States Corporation Co., 65 Cedar Street, New York.

THE CONNECTICUT HARD RUBBER Co., 600 State St., New Haven, Conn., has been organized under state laws to manufacture rubber products. J. A. Moffitt, 25 West 45th St., New York, is president; and A. A. Smith, 96 Howard St., New Haven, secretary and treasurer.

THE KUYKENDAL CHEMICAL Co., Columbia, S. C., has been incorporated with a capital of \$50,000, to manufacture chemicals and chemical byproducts. The incorporators are C. M. and F. R. Kuykendal, both of Rock Hill, S. C.

THE WALLABOUT PAPER SPECIALTIES CORP., Brooklyn, N. Y., has been incorporated with a capital of \$30,000, to manufacture paper products. The incorporators are J. Karper, L. and J. Blazer. The company is represented by Samuel Blazer, 52 Wall St., New York.

THE UNITED GULF STATES OIL COMPANIES, INC., New York, N. Y., has been incorporated under Delaware laws with capital of \$10,000,000, to manufacture petroleum products. The incorporators are H. E. Ellis, J. L. Cunningham and W. H. Mayhar. The company is represented by the Charter Service Corp., 149 Broadway, New York.

THE M. C. S. CHEMICAL CORP., Jersey City, N. J., has been incorporated with a capital of \$50,000, to manufacture chemicals and chemical byproducts. The incorporators are E. Burke Finnerty, Morris B. Dorman and Frank W. Hastings, Jr., 15 Exchange Pl., Jersey City.

THE MT. JEWETT FIRECLAY Co., Bradford, Pa., has been incorporated with a capital of \$50,000, to operate fireclay and other clay properties. R. G. Vogel, Bradford, is treasurer.

THE NORTON LEATHER Co., Salem, Mass., has been incorporated with a capital of \$50,000, to manufacture leather products. Michael H. Norton is president; and Joseph P. Norton, 100 School St., Salem, treasurer.

THE FRANCO-UTAH OIL Co., Salt Lake City, Utah, has been incorporated under Delaware laws, with capital of \$5,000,000, to manufacture petroleum products. The incorporators are D. H. Gustaveson and J. W. Musser, both of Salt Lake City. The company is represented by the Corporation Service Co., Wilmington, Del.

THE ESSEX PRODUCTS Co., Main and Terry Sts., Belleville, N. J., has been incorporated with a capital of \$125,000, to manufacture chemicals and chemical byproducts. The incorporators are Howard R. Lewis and Harry V. Fisher.

THE CONSOLIDATED STAMPING & MFG. Co., Gaylord and Plymouth Sts., Detroit, Mich., has been incorporated with a capital of \$500,000, to manufacture stamped metal and other metal products. The incorporators are Archibald A. Hitchcock, Harry M. Coates, and Robert T. Carr, 54 Tyler Ave., Highland Park, Mich.

THE RED DIAMOND CHEMICAL Co., Wilmington, Del., has been incorporated with a capital of \$100,000 under state laws, to manufacture chemicals and chemical byproducts. The company is represented by the Corporation Service Co., Wilmington.

THE GREAT EASTERN REFINING CORP., Huntington, W. Va., has been incorporated with a capital of \$200,000, to manufacture refined oil products. The incorporators are Fred W. Dulancy, John F. Grossenbach, both of Huntington; and T. H. Gillman, Ashland, Ky.

THE EVERLASTING ROOF TILE CORP., Brooklyn, N. Y., has been incorporated with a capital of \$50,000, to manufacture clay roofing tile and other burned clay products. The incorporators are N. N. Payne, D. J. Horgan and T. P. Killilea. The company is represented by Fitzgerald, Stapleton & Mahon, 25 Broadway, New York.

THE FRYE CHEMICAL Co., INC., Montclair, N. J., has been incorporated with a capital of \$50,000, to manufacture chemicals and affiliated products. The incorporators are Walter T. Lindsay, John A. Bennett, and A. C. Kotze, 460 Bloomfield Ave., Montclair.

THE MISSISSIPPI OIL Co., Wilmington, Del., has been incorporated under state laws with capital of \$2,000,000, to manufacture petroleum products. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington.

THE GREAT EASTERN CHEMICAL Co., Wilmington, Del., has been incorporated under state laws with capital of \$50,000, to manufacture chemicals and chemical byproducts. The company is represented by the Colonial Charter Co., Ford Bldg., Wilmington.

THE SOUTH BEND OIL REFINERIES, INC., South Bend, Ind., has been incorporated with a capital of \$100,000, to manufacture refined oil products. The incorporators are W. J. Kennedy, Karl G. King and J. L. Nolan, all of South Bend.

THE SALEM FLINT GLASS Co., Salem, W. Va., has been incorporated with a capital of \$10,000, to manufacture glass products. The incorporators are H. L. Bee, B. S. Bischoff and F. R. Davis, all of Charleston, W. Va.

THE VERSIL CHEMICAL Co., New York, N. Y., has been incorporated with a capital of \$5,000, to manufacture chemicals and chemical byproducts. The incorporators are H. and M. Spatt and A. L. Lazarus, 154 Nassau St., New York.

THE ZANTHONE MFG. Co., Philadelphia, Pa., is being organized under state laws to manufacture cellulose products. The incorporators are John C. Dempsey, J. Harold Felton and Frank Devlin. Application for a state charter will be made on Dec. 12. The company is represented by Porter, Foulkrod & McCullagh, 1106 Commonwealth Bldg., Philadelphia.

THE TRINITY RUBBER PRODUCTS Co., 35 Drift St., New Brunswick, N. J., has been incorporated with a capital of \$25,000, to manufacture rubber products. The incorporators are Charles H. Durham, Ernest L. Daniels and John F. Westburgh.

THE SEYDEL CHEMICAL Co., Nitro, W. Va., has been incorporated with a capital of \$1,500,000, to manufacture chemicals and allied products. The company is headed by Herman Seydel, head of the company of the same name now operating at 86 Forrest St., Jersey City, N. J., and Richard S. Bicknell, Nitro.

THE SECURITY PETROLEUM & REFINING Co., New York, has been incorporated under Delaware laws with capital of \$100,000, to manufacture refined oil products. The company is represented by the United States Corporation Co., 65 Cedar St., New York.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its seventy-fourth meeting at Toronto, Canada, Dec. 26 to 31, 1921.

AMERICAN CERAMIC SOCIETY will hold its twenty-fourth annual meeting at St. Louis, Feb. 27 to March 2, 1922.

AMERICAN CHEMICAL SOCIETY will hold its spring meeting at Birmingham, Ala., April 4 to 7, 1922.

AMERICAN ENGINEERING COUNCIL will hold its next meeting in Washington, Jan. 5-6.

AMERICAN FOUNDRYMEN'S ASSOCIATION will hold its next convention and exhibit at Cleveland, O., during the week of April 24, 1922. Meetings will be held in the spring instead of in the fall as heretofore.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its spring meeting in New York the week of Feb. 20, 1922.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stettens Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

The following meetings are scheduled to be held in Rumford Hall, the Chemists' Club, New York: Jan. 6—American Chemical Society, regular meeting; Jan. 13—Society of Chemical Industry, Perkin Medal; Feb. 10—American Electrochemical Society (in charge), Society of Chemical Industry, Société de Chimie Industrielle, American Chemical Society, joint meeting; March 10—American Chemical Society, Nichols Medal; March 24—Society of Chemical Industry, regular meeting; April 21—Society of Chemical Industry (in charge), American Electrochemical Society, Société de Chimie Industrielle, American Chemical Society, joint meeting; May 5—American Chemical Society, regular meeting; May 12—Société de Chimie Industrielle (in charge), American Chemical Society, Society of Chemical Industry, American Electrochemical Society, joint meeting; May 19—Society of Chemical Industry, regular meeting; June 9—American Chemical Society, regular meeting.

CHEMICAL & METALLURGICAL ENGINEERING

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R. S. McBRIDE
CHARLES N. HULBURT
Assistant Editors
CHESTER H. JONES
Industrial Editor
J. S. NEGRI
Managing Editor

Volume 25

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Number 25

Talking

And Working

A GENTLEMAN of the Central West who has been traveling around the country a good bit in the past few weeks expresses the conviction that Americans have got into a habit of talking too much. Nearly everywhere he went he found a "convention" in session or in prospect, and some of these conventions he attended. The chief aim of the speakers at the conventions was to tell their hearers what was wrong with the United States and the world generally and what other people had to do in order to make things right for us. The same gentleman had been in Europe for a couple of months and he draws a comparison unfavorable to us, saying that the people of France, Belgium and Germany are working hard, while the British are gradually getting to work.

Of course, there are conventions and conventions. It is one thing to tell a gathering of farmers what the gold bugs are doing and another thing to tell what ought to be done to potato bugs. One is constructive and destructive (to the potato bugs), while the other is not even destructive. At a convention of engineers those in attendance get ideas, or should get ideas, whereby when they get home they can do better work. When a convention of business men or farmers is told the various things that are wrong with the United States and numerous other countries and how times will not be good until things are righted, are those in attendance fortified to do harder and better work when they get home?

This is a sort of mob psychology. One does not need to attend meetings or conventions to observe it. We do not escape the talk by avoiding reading the *Congressional Record*, for we encounter it in the daily newspapers, on the street, practically everywhere. It is another form of "the world owes us a living," for it requires no close analysis to see that much of the talk is motivated by the idea "If the rest of the world would just behave itself, I could make some money."

At bottom most of the thoughts expressed are selfish. There is the talk about railroad freight rate reductions. We want to buy our goods more cheaply and have a broader market for the things we want to sell. Before the war the talk was that freight rates ought to be advanced, because we wanted railroad orders. We want conditions in Europe to get settled so that we can sell our goods to Europe. But just think of what the rest of the world could say about us along that line! The rest of the world owes us in funded debt about eleven billion dollars and there is in addition four billion or more of unfunded balance in favor of the United States, making a total of fifteen billion or more, and then men are shouting that they want the rest of the world to get in shape to buy our goods. The rest of the world would like us to provide an opportunity to pay something

against what they already owe us. They have sent us this year about half a billion dollars in gold and the gold reserves of the Federal Reserve system are now nearly equal to the combined gold reserves of all other countries, while people in the United States are explaining when they can get listeners that the other countries ought to stabilize their currencies.

Undoubtedly we are talking too much along lines that do not get the talker or the hearer anywhere, but rather encourage a disposition to wait until something turns up, until freight rates are reduced or the French army is disbanded or the German indemnity is paid or Russia gets on its feet or the federal taxing system is revised again. If we really must talk let us talk about working. If we can't find work of the kind we used to do, let us think up something new. The movie shows seem to be getting along quite well. They aim to offer the public something new each week.

We Congratulate

Mr. Dawes

THE FIRST budget of the United States Government has been presented to Congress. In many particulars it is an admirable document. And in one particular scientists and engineers should be especially pleased with it—the treatment which has been accorded the technical and scientific work of the federal departments.

The effort in drafting the budget has been to curtail expenses, an effort which every taxpayer will strongly commend. But apparently the effort to reduce the cost of government has not been rashly and recklessly undertaken to the detriment of really worth-while projects. In fact there seems to have been a real distinction made between apparent and real economy in the reduction of expenditures. Of all the technical and scientific bureaus, very few have suffered reduction in the appropriation recommended for their scientific investigations and their constructive engineering effort. There have, indeed, been actual increases recommended for most of these institutions.

For the Bureau of Mines, Patent Office, Geological Survey, Bureau of Standards, Chemical Warfare Service and several others, the increases recommended to Congress for total appropriations are from 5 to 25 per cent greater for the coming fiscal year than the sums which have been provided during the current year. The increases thus provided are intended in some cases for increasing salaries of the scientific staff, notably to increase the standard of salaries paid to the senior members of the staff. Certainly this is a move in the right direction, in order that the quality of the work done by these institutions may not suffer indefinitely because of the wholly inadequate salary scale which has prevailed in many lines. A few new and much needed investigations are also proposed for important scientific and industrial problems of wide interest.

Chicago Business Men

Clearing Labor Situation

EVENTS during the past fortnight indicate, very clearly that the tide has definitely turned in labor circles. No one set of circumstances has more strongly shown the revulsion against unfair practices on the part of labor than the results obtained by the Citizens' Committee to enforce the Landis award in the building trades, covered in our editorial in the Nov. 23 issue. Chicago, long the stronghold of labor agitators and malicious strike promoters, will harbor these business criminals no longer. Even the more recent strike of the stockyards workers is broken by hordes of hungry men who seek work in the face of physical danger. Another week should mark the end of this phase.

The Landis Award Committee, incorporated in Illinois "not for profit," has now accomplished many things. Fifty-five subdivisions of the Association of Commerce have pledged solid support. The chairman has signed a blanket insurance policy for several million dollars to protect property owners who observe the terms of the award from the vandalism of wrecking crews. Pledges have been given by sixteen mortgage banks that loans will be made only where the Landis award is being followed. A million-dollar loan has recently been denied a big subdivision contractor because of his refusal to abide by the rules.

The carpenters' union situation has been settled by the committee. This union failed to comply with the working conditions and wage scale laid down by Judge LANDIS, and the open shop has been definitely established. A large number of carpenters, more than are actually needed, have deserted the union band-wagon to work for \$1 per hour rather than starve.

The committee is calling in violators of the award as rapidly as the scouts can discover them. Of 800 different jobs visited to date, 102 violators have been discovered. On the other hand, the contractors are not allowed to cut wages below the amounts fixed by Judge LANDIS. No mechanic on award jobs need fear that his wages will be slashed below the rate.

All fair-thinking citizens are behind the work. They know the committee is acting for them as a contract enforcer, not as a contract breaker. Arbitrary unionism is dying in Chicago. The year 1922 will be a hard one for strikers. Making the award stick is not only a great thing for Chicago. Precedents are being established that will have a far-reaching effect for better business and happier communities over the whole country.

Organization as a

Factor in Research

LATELY we read a report of the Committee of the Privy Council for Scientific and Industrial Research of Great Britain which consisted in a statement of pounds, shillings and pence expended under various heads. Of course we must keep accounts, and watch expenditures, but it is often the habit of the layman to call for figures in regard to the progress of work in laboratories when it is impossible to tell it in figures. Statements of costs may be the poorest possible index of the progress of research. We know of a laboratory, an excellent and fruitful institution, that was nearly upset by a complicated cost system that required of every member of the staff that he record every minute of his time, and charge it to some specific account. This was about as sensible as to ask a commercial traveler to work out his expense account while he is selling goods.

In the British report quoted, the Advisory Council made a supplementary memorandum which met the difficult task of explanation and comment with ability; but the point we desire to emphasize in this connection is that, while expenditures are needed for the prosecution of research, there is a factor of still greater importance which is a far better indicator of progress than a list of expenditures, and that is the organization of the laboratory.

This is the point we want to emphasize. A research laboratory must be a living thing; an organization within itself. We cannot establish it even by selecting men according to their past performances. They must achieve the art of working together. One of the greatest mistakes is to hold that men produce better if they dislike one another and each one wants to get ahead of his fellows in performance. Explanations are necessary as work proceeds, and the habit of working together and of understanding one another among members of a staff makes explanations not only possible, but short. Otherwise an immense amount of unnecessary work is done to no effect, because the man who does it fails to understand its aim.

There is a curious psychology in organization. The greater the number of persons that are engaged in an organization the less is their common understanding. It stands to reason that what A knows is only partly shared by B, and if C joins the group there is still less that he shares with both A and B. Every added person decreases the measure of understanding common to all. But when the habit of working together is formed they can make their thoughts known one to another with little or no effort. A mere hint from A will illumine B and C, and under this joint illumination a new power arises. Our inhibitions are brushed away. We venture to propose things and to do things that theretofore we were too shy, too bashful, too lazy, too inert to propose. With this quality, resolution becomes contagious, and when every member of a laboratory staff is resolved to achieve a definite result and this resolution grows so strong that the quality of faith is added to it, then we are not indulging in idle vagaries when we hope for results. They come bounding along, provided, of course, those who constitute the staff are not idle dreamers.

Peace-Time Uses

For Gas Bombs

EVERY time we read a press account of the riotous actions of leaderless mobs, men or women, we can't help thinking how salutary would be the effect of a little tear gas judiciously distributed. Mobs are hard to handle because they are without leaders and cannot be appealed to by reasonable means. The whole history of mob violence, in this or in other countries, shows how difficult it has been to handle them even when met by force or resort to violent means. Hitherto it has been necessary to call upon the police or the military, with resulting casualties that are deplored by even those in authority. But we now have a weapon that should be even more effective, not only because it will disperse mobs, but because one experience with tear gas is likely to be remembered for a long time and thus deter the potential mobber from engaging in that pastime again. The physical effect would only be temporary, but psychologically a dose of gas would have a beneficial and lasting influence. It seems to us that the time is ripe for the commercial exploitation of this method of controlling unruly citizens.

Engineers Honor Marshal Foch

IN CONFERRING upon Marshal FOCH honorary membership in the four national institutes of civil, electrical, mechanical and mining engineering, those bodies gave a fitting touch to the close of a strenuous visit to America by the recipient. Probably no guest from a foreign country has ever received more honors at the hands of his hosts, but it was particularly appropriate that the Marshal should have been recognized by engineers. As stated by Colonel PARSONS, commander of the Eleventh Engineers in France, in an introductory address, Marshal FOCH "directed a greater mass of human energy than any other man has ever done," and consequently had exhibited in the highest degree the qualities of an engineer, more particularly because he "successfully directed this mass for the highest uses of mankind." In acknowledging the honor bestowed upon him, the Marshal said that "it was due largely to the engineers and the engineering industries that the war was brought to a successful close," thus recognizing one of the most potent forces in the war, though perhaps it was and still is popularly the least recognized and appreciated. In honoring Marshal FOCH, the engineering societies honored themselves and gave a further impetus to the recognition of the importance of engineering.

Chemists and Time Clocks

WE REFERRED in our issue of Nov. 23 to the fact that in the Navy Department chemists are rated as artisans on a per diem basis. We have since learned that under a ruling made in September, on recommendation of a wage board consisting of a naval officer, a clerk from the office of the Secretary of the Navy and a representative of the American Federation of Labor, all technical employees and day laborers are now engaged on a per hour basis.

What is the use of this sort of tumblebug management? Why try to make head work look as much as possible like hand work? The man whose business it is to think must have freedom to think. We can all march in lock-step under compulsion—if we have our legs intact—but we can't think in lock-step and develop the thoughts and ideas that add to human progress and which are the things that are wanted of us.

We know one chemist who does his best work, thinks his best thoughts, while shaving in the morning. That, however, is no reason why "the shaving hour" should be made sacred to chemists or that the American Federation of Labor, which has nothing to do with the subject, should recommend time-and-a-half or double for the chemists' matutinal lathering and scraping. The chemist is a professional man. He may have remarkable manual dexterity or be singularly lacking in this respect and require laboratory assistants to do his work better than he can. What he is wanted for is his thinking, and he has had to develop his habits of thought in his own way. If he had not done this, he would not be wanted as a chemist.

The time clock is a useful invention to check off the work of men who predetermine their conditions of employment. In a laboratory, except for laboratory helpers, it is likely to be the most expensive piece of apparatus in the establishment. Thinking is not only work, but about the most difficult hunting of the present day is to find men who can and will think. Then why

should we equip the position of a thinking man with hindrances which discourage thought?

We have great admiration for the honorable Secretary of the Navy as a man, but we wish he would read this. He can't pay much for chemists, and he needs them; needs good ones. Therefore he should not make such an absurd ruling no matter what a board of incompetent advisers may think. Often the whole issue between a positive and a negative result depends on whether the chemist at work on the problem takes a walk around the block by himself in the fresh air or not. There's too much unnecessary commanding and forbidding going on, and the cost of it is a halt to progress.

Chicago Chemists Show Progress

RECENTLY it was our good fortune to attend one of the regular meetings of the Chicago Section of the American Chemical Society, and we were struck with a plan of organization that seems to have worked successfully and which may be adapted to other large sections of the Society. Attendance at the monthly meetings of the Chicago Section has increased to such an extent that it became necessary to devise some means whereby a larger number of individuals could participate in the proceedings and particularly whereby the younger members could be encouraged to express themselves. At the suggestion of Dr. PAUL N. LEECH, chairman of the program committee, the Section adopted a plan of holding four group sessions following the principal program of the evening. Each month the majority of the members who attend the general session remain to participate in group meetings devoted to various phases and branches of chemistry. Here the everyday problems of the members of the groups are discussed freely and intimately. The whole scheme has been remarkably successful and is typical of the ingenuity and initiative that frequently characterize our Western friends. Precedent and formality are waived if they impede progress. The example is worthy of emulation in other sections where conditions warrant.

A Loss to the Cause Of Leather Chemistry

IN THE death of ARTHUR H. GALLUN, of Milwaukee, prominent in the manufacture of leather, the cause of chemical research in this industry has suffered a serious loss. With exceptional vision he supported vigorously the application of chemistry to the production of leather. For years he struggled to awaken in his fellow tanners a realization of the value and power of fundamental chemical research, but the time was not ripe and his preachments fell upon ears that refused to hear. Undaunted, he generously endowed research work at Columbia University, the results to be published freely so that the industry might see for itself the value of applied chemistry. With the same object in view, he inspired his own laboratories to contribute to the development of the science and assisted in the organization of the Leather Division of the American Chemical Society. At the time of his death he was trying to persuade the leather industry to establish at Columbia University a department of leather chemistry that should become second to none in the world. We regret his passing because the leather industry sorely needs the pioneer work he was doing so well. It will yet bear fruit, but not as soon as if he were here to give it his wise, far-seeing and energetic support.



American Institute of Chemical Engineers, Baltimore Meeting, December 6-9

Papers Presented at the Annual Winter Meeting Stress the Relation of the Chemical Engineer to the National Defense—Government Plants at Edgewood and Annapolis and Many Baltimore Chemical Industries Are Inspected—Election of Officers

BALTIMORE, during the four days Dec. 6-9, was the scene of the fourteenth annual meeting of the American Institute of Chemical Engineers. The many chemical industries of the vicinity and the close proximity to Edgewood Arsenal, the Naval Academy at Annapolis, and the Disarmament Conference in session at Washington served to give an appropriate background to the discussion of the theme of the meeting, which was "Chemical Engineering and the National Defense." An unusually large proportion of the Institute's membership was on hand to contribute to the symposium on this important subject and incidentally to enjoy the pleasant arrangements and entertainments provided by an enterprising local committee, headed by a very efficient local chairman, Albert E. Marshall.

During the first business session of the convention, which was called promptly to order on Dec. 6 by President David Wesson, many important items of the Institute's business were transacted. Following the reading of a number of reports by the secretary, Dr. John C. Olsen, and others, Dr. Arthur D. Little presented the final report of the committee on chemical engineering

education. This committee has made a most comprehensive study of the courses offered by the universities and colleges of the country and has prepared a report which strongly emphasizes the need for reorganizing existing methods of instruction in chemical engineering. The report points out the extreme difficulty in obtaining comparable data in the seventy-three institutions which teach this subject. This was due not only to the extraordinary number of subjects included in the chemical engineering courses, but also to the divergence in the weighting of courses among the various universities. In referring to the 210 subjects being taught, the committee was of the opinion that more than half were unnecessary. For instance, it is somewhat difficult to justify 49 subdivisions of chemistry and 35 of mechanical engineering.

The committee tabulated fourteen recommendations and conclusions which were as follows:

- (1) There is an undesirable multiplication of subjects included in the chemical engineering courses.
- (2) Wherever possible intricate subdivision of subjects should be avoided.
- (3) A thorough grounding in chemistry and physics is essential.
- (4) An effort should be made to standardize the naming of courses.
- (5) There





should be less divergence in weighting courses. (6) Instruction in civil engineering, sanitary engineering and electrical engineering (beyond the fundamentals) might well be omitted. (7) Specialization by industries is considered advisable in the usual 4-year curriculum. (8) Small institutions where locality and special conditions call for training in certain industries may, however, be considered as exceptions to this rule. (9) Poor English and inaccurate report writing are recognized as prominent points of weakness in most engineering graduates. (10) Sources of information should be studied during the student's senior year. (11) The course in chemical engineering should best follow three years' preparation in mathematics, economics and the sciences. (12) The difficulties of chemical engineering as a profession should be emphasized. (13) Courses should be arranged to give a professional degree to chemical engineers completing satisfactory work in the industries. (14) The use of students as instructors, even in elementary courses, should be deprecated.

It was voted that the committee's report be printed immediately by the council and that later the Institute should arrange to devote a meeting to the consideration of this subject, in which meeting representatives of the educational institutions might participate.

ATMOSPHERIC POLLUTION

Prof. James R. Withrow presented the report of the committee on atmospheric pollution. He called particular attention to the notable work of Dr. P. J. O'Gara of the American Smelting & Refining Co., Salt Lake City, Utah, and stated that the committee had urged Dr. O'Gara to publish the results of his investigations at the earliest possible date. In view of the prospective publication of the results of this and other extensive smelter fume investigations, the committee recommended that the Institute adopt no program of research, but rather hold itself in readiness to cooperate with the chemical manufacturers' associations and others interested in legislation and other methods

of regulating atmospheric pollution. It was further urged that all chemical manufacturers recognize the far-sighted policy of settling promptly and out of court all just claims and that they fight to the limit all unjust claims because of the far-reaching damage which may result from precedents accidentally established through erroneous court decisions.

STUDENT CHAPTERS AND ANNOUNCEMENT OF NEW OFFICERS

Prof. A. H. White reported for the committee on student chapters. He submitted an amendment to the constitution of the Institute which provided for establishing student chapters in universities of recognized standing. The proposed plan is somewhat similar to that of the American Society of Civil Engineers in that while the student branches are recognized, there is no provision for student membership. According to regular procedure the amendment is to be sent out to the members for their approval.

Under the program of stated business the proposal was made to change the society's name to "The Institute of Chemical Engineers," but following a very eloquent and patriotic appeal by C. Burrows Morey, it was unanimously voted to retain "American" in the Institute's name.

Hugh Kelsea Moore, in discussing the method of nominating officers, protested against the appointment of a nominating committee and suggested that the method outlined in the Institute's constitution should be followed in future elections. Prof. Ralph H. McKee then announced the result of the canvass of ballots for next year's officers, which was as follows: Henry Howard, president; Albert W. Smith, first vice-president; Hugh K. Moore, second vice-president; Harlan S. Miner, third



vice-president; John C. Olsen, secretary; F. W. Frerichs, treasurer; Charles F. McKenna, auditor. The new directors elected were William H. Bassett, Arthur C. Langmuir and Alfred H. White.

The only address to be given during the first session was by L. W. Wallace, executive secretary of the Federated American Engineering Societies, who spoke of the work this organization had done during the first year of its existence and then outlined some of the important activities which are being contemplated. He especially stressed the need for an organized campaign in behalf of the Patent Office. The deplorable conditions existing there are causing delays of serious consequence to industry.

VISITS TO CURTIS BAY INDUSTRIES AND EDGEWOOD ARSENAL

During the afternoon an excursion was made to the chemical industries at Curtis Bay. The plant of the U. S. Industrial Alcohol Co. was inspected and the visitors witnessed the operation of stills which were producing 95 per cent alcohol at the rate of 60,000 gal. per day. At the plant of the Davison Chemical Co. experiments were shown with silica gel to demonstrate its use in the making of sulphuric acid and ice, in drying air for blast furnaces and in refining gasoline and petroleum distillates. On the return trip the chemical engineers stopped at the plant of the American Refractories Co., where special magnesite and chromite bricks were being manufactured.

Approximately two hundred members of the Institute and of the Maryland Section of the American Chemical Society arrived at Edgewood shortly after 10 a.m. Dec. 7. Special facilities had been provided for a thorough inspection of the laboratories and manufacturing plants of the Arsenal. Especial interest was manifested in the chlorine, phosgene and chlorpicrin plants as well as in the factory which is turning out a daily production of 100 gas masks of the latest approved type.

Brigadier-General Amos A. Fries, chief of Chemical Warfare Service, addressed the party at luncheon. He declared that an effort was being made to stampede the Disarmament Conference against chemical warfare. The proponents of this propaganda include a number of well-meaning sentimentalists and so-called peace advocates, but a considerable proportion of them are to be recognized as self-interested enemies of the chemical industry. Chemical warfare, said General Fries, is the natural means of defense of a scientific people and, he declared, causes less permanent disability than any other weapon of warfare. Quoting statistics from the Surgeon-General's office, he showed that but 27.3 per cent of the men admitted to the hospitals during the late war suffered from gas injuries alone, that deaths directly attributable to gas were only 2 per cent of the total fatalities, and furthermore that the man injured by gas had twelve times as many chances for recovery as the man whose wounds were caused by shells or high explosives.

After the address by General Fries the party was taken to the testing range, where a demonstration of various gases and smoke materials was staged. The visitors, among them a number of ladies, stood on a slight hill and to their left, behind a rise of ground, were the various implements of chemical warfare. The first to be demonstrated was the Livens projector, which was used to lay down a dense cloud of smoke caused by the bursting of titanium tetrachloride projectiles.

Stokes mortars were fired next, the shells being loaded with phosphorus. As they burst down the field throwing bits of fire far out into the air, another huge smoke cloud was raised. Artillery firing of 75-mm. gas shells followed, in which an attempt was made to demonstrate the accuracy of this method. The toxic smoke candles and hand grenades containing gases gave the visitors an idea of some of the post-war developments in chemical warfare. The grenades, which were filled with tear gas, were thrown so that the gas would drift away from the crowd. Some one, however, tossed one to the windward and as the gas settled over the spectators, most of them, weeping copiously, hurried away from the scene.

PRESIDENTIAL ADDRESS

The symposium on Chemical Engineering and the National Defense was opened by President Wesson on the morning of Dec. 8. Prof. Alfred H. White, who had been prevented from delivering his address on "Explosives and Fertilizers" at the earlier meeting, briefly summarized the principal points in his paper. Because of the importance of the subject and its treatment by Prof. White, arrangements have been made to have the address published in its entirety in an early issue of CHEMICAL & METALLURGICAL ENGINEERING.

The presidential address of Dr. Wesson dealt with the Institute of Chemical Engineers and the national defense. In his opening remarks President Wesson said:

In the selection of meeting places for the Institute during the past years an effort has been made to have papers presented which bear definitely on the industries visited. Thus at Savannah we had the industries of the South and the cotton oil industry in particular. In Canada we had the products of the forests and mines and the manufacture of paper stock. At the New Orleans and Louisiana meeting we had sugar, salt and sulphur. At Detroit the automobile engaged our attention, and now, assembled in Baltimore with its vast chemical industries, the proximity to Edgewood Arsenal and the Disarmament Conference, it seems that the proper keynote to our meeting should be "Chemical Engineering and National Defense."

The speaker then traced the development of warfare, particularly in relation to chemistry and the part which chemical engineering plays in the national defense. In this connection he pointed to the accomplishments of the Institute:

A glance through our membership roll will show the parts which our members take and have taken in building up the many industries of our country and keeping them on a sound economic basis. A study of these varied industries will show that while developed fundamentally for the beneficent demands of peace, they have proved towers of strength in time of war.

Founded as it was with high ideals based on a sound code of ethics, the Institute has developed slowly but surely along conservative lines. It has now outgrown its swaddling clothes and with a broad-minded interpretation of its membership rules has increased the number of its members to a point where it has become a body of considerable influence in technical, educational and national affairs. With all of the best minds of our profession co-operating to advance the industries of our country so that in its chemical resources it may be second to none, the Institute has a great field of usefulness before it, and will play a most important part in the national defense of the future.

THE IMPORTANCE OF RESEARCH

A paper by Dr. Raymond F. Bacon on "The Future Warfare" and another by Maximilian Toch entitled "Chemistry and the Next War" served to show the future possibilities offered by the development of chemical warfare. Both speakers emphasized that these

developments would come only through intensive research. Dr. Bacon's statement was as follows:

One of the greatest lessons of the war, which so far has gone almost unheeded, was that large-scale research can solve practically any problem. We had in Washington a research organization in which were gathered many of the best brains of the country. That research organization was able to solve every problem put up to it by those in command of the military forces. It showed that things which seemed to be impossible to do could be done and done in a rather short time by research backed by adequate resources of brain power and apparatus. The total cost of that organization, put together and run admittedly not at the highest efficiency in the stress of war time, was about two million dollars, and for this comparatively small sum no one could deny that results were obtained which did more toward winning the war than any two hundred million dollars spent in other ways.

If this government would efficiently spend a few million dollars a year on war research, methods would surely be devised which would make us absolutely safe from attack without the necessity of maintaining such extensive army and navy organizations as at present.

Harrison E. Howe further stressed this important subject in his address on "Fundamental Research in Conservation and Defense."

"The warfare of the future," said Mr. Howe, "seems sure to be of a decidedly different character than that which was known previous to the World War. Those concerned with our defense in the future are pretty sure to think in terms of molecules, atomic structure and perhaps atomic energy, rather than in millions of men and fleets of battleships. Our most potent defense, therefore, lies in knowledge to be acquired only through continued research."

In concluding his paper the speaker summarized his argument with the statement that "a certain amount of waste can be eliminated in industry, natural resources can be conserved and broad national interests forwarded to a great extent by the proper application of our present chemical knowledge. Our full duty as chemists and chemical engineers cannot be done, however, unless we are able to engage upon programs of serious fundamental research."

THE KEY POSITION OF THE CHLORINE INDUSTRY

Dr. Benjamin T. Brooks presented a well-prepared paper dealing with the chlorine industry as an essential factor in our national defense. The fact that this industry is not in a critical position, such as the dye and organic chemical industry, perhaps explains why there has been no organized publicity calling attention to its vital relation to the manufacture of toxic gases. He cited that the United States military program of Aug. 12, 1918, called for the daily production of 646 tons of gas, a predominating proportion of which was to be made from chlorine. Among the war-time uses for chlorine other than in the manufacture of gas, Dr. Brooks called attention to the production of bleaching powder for the manufacture of chloroform and for preparing the well-known Dakin solution and for sterilizing drinking water in the camp and in the field, and also the use of chlorine in manufacturing several of the best smoke-screen materials, tetrachloride of tin, titanium tetrachloride and silicon tetrachloride.

The chemical products made by Edgewood Arsenal and its affiliated plants consisted of phosgene, chlorpicrin, mustard gas, diphenylchlorarsine, brombenzylcyanide, chloracetophenone, "D.M." titanium tetrachloride and tin tetrachloride, all of which substances require chlorine in their manufacture.



WASHINGTON'S MONUMENT AT MT. VERNON PLACE, BALTIMORE

This was the first monument to be erected by any state to the memory of George Washington.

One factor in the situation, which is by no means the least important, has been the improvements in the methods of transporting liquid chlorine. In this connection the speaker said:

The small cylinder, containing 100 to 150 lb. of liquid chlorine, with which you are all familiar, was developed in Germany, but the tank car, holding 15 tons, and the large drum, holding 1 ton, of liquid chlorine are American developments. The first 1-ton containers were made in 1910, but their first extensive use came during the war period, when these containers were employed for shipping liquid chlorine to France. A special form of tank car, carrying chlorine in these 1-ton containers, has been developed, this method of transportation having all of the advantages of a 15-ton tank car, is comparably safer, and since these drums are removable from the car, they render storage and handling of liquid chlorine in large quantities a very simple matter. Another factor in the increased production of liquid chlorine is probably the improved liquefying process, consisting in the entrainment of chlorine in a falling column of concentrated sulphuric acid, by which means it is compressed under the necessary pressure. This simple method was given to the government by the Mathieson Alkali Works through Colonel C. F. Vaughn, and subsequently has been installed in other industrial plants.

SOME PREVENTABLE LOSSES IN THE CHEMICAL INDUSTRY

John S. Spicer, chemical engineer for the Pennsylvania Department of Labor and Industry, in an interesting communication called attention to the serious drain on man power and the increasing losses caused by industrial accidents. Reports from approximately one thousand chemical plants in Pennsylvania show that during 1920 there were sixty-two fatalities and that during the first 9 months of the current year fifty-eight lives were lost in these same plants. In other words, the indications are that the chemical industry of Pennsylvania, in spite of the fact that the number of workers is less, will probably experience a large increase in the number of fatal accidents. As an indication of the direct monetary loss, it is of interest to know that the compensation which must be paid this year by the chemical manufacturers of Pennsylvania will amount to almost a third of a million dollars. Furthermore, it is estimated that these industrial accidents entail a loss of 36,000 man-days and thus prevent the manufacture of approximately two million dollars worth of chemical

products. Considering the fact that these figures represent the losses incurred in but a single state, it is obvious that the engineers must co-operate to make the chemical industry less dangerous to the employee and more profitable to the management.

MEETING AT JOHNS HOPKINS UNIVERSITY

Following a pleasant afternoon spent in an inspection of the grounds and buildings of the Naval Academy at Annapolis, the chemical engineers returned to Baltimore for a joint meeting at Johns Hopkins University with the Maryland Section of the American Chemical Society. Dr. J. C. W. Frazer delivered a popular address on carbon monoxide and its oxidation at room temperatures by means of a catalyst. Although the army gas masks used during the late war did not provide adequate protection against this gas, there are a number of reasons why carbon monoxide is impractical as a poison gas. It is not nearly as toxic as most war gases, and because of its density it readily diffuses. It is therefore difficult to maintain a lethal concentration in the field. Its critical temperature is such that it cannot be liquefied, and hence is not easily transportable. However, carbon monoxide is produced by incomplete combustion both on the field and in the battleship and submarine and therefore adequate protection must be provided against it. One of the possible protective measures was the development of a catalyst which would oxidize carbon monoxide at room temperature with oxygen from the air. In order to serve satisfactorily in the canister of a gas mask, the reaction must proceed to completion in a fraction of a second.

Dr. Frazer outlined the work which has led to the development of a particularly efficient catalyst.¹ This material consists of an intimate mixture of extremely finely divided manganese dioxide and silver oxide, although it has been found practical to replace the silver oxide with copper oxide. The physical condition of the catalyst, its porosity and moisture content are factors greatly affecting its efficiency. When used in the canister it has been found desirable to place a layer of calcium chloride or similar drying material immediately ahead of the catalyst.

Prof. R. W. Wood gave an interesting address on "Ultra-Violet Light" and presented some remarkable experimental demonstrations. One of the most practical applications of ultra-violet light in warfare was the development of a signaling instrument using invisible rays which focused on a phosphorescent screen. The electric searchlight and reflector method which had previously been used was unsatisfactory because it was visible and therefore likely to attract enemy fire. The screen used in the instrument devised by Prof. Wood was coated with barium-platinum sulphide on which the rays of ultra-violet light produce a very noticeable green phosphorescence. Other military uses for the invisible "lights" were for guiding ships in convoys, for identifying airplanes which had been camouflaged to represent those of the enemy, and in detecting secret communications which had been written with invisible ink.

FINAL BUSINESS SESSION

The report of meeting of the council was discussed at the last business session of the convention during the morning of Dec. 9. The proposal of the Detroit mem-

bers that the Institute establish local sections was not approved in its entirety, although the council recognized the right of such sections to exist informally as long as their actions were not binding to the Institute. Prof. Badger's communication pointing out the inadequacy of the present published sources of chemical engineering abstracts was referred to a committee consisting of Messrs. Badger and Howe.

A resolution calling attention of Congress to the critical position of the domestic organic chemical industry and urging that adequate protection be given this industry was introduced by Prof. Ralph H. McKee and was passed unanimously. A second resolution informing the American delegation to the Disarmament Conference, the advisory committee thereto and the members of Congress of the imperative necessity of maintaining our Chemical Warfare Service was presented by Dr. Raymond F. Bacon and unanimously adopted.

The name of Brigadier-General Amos A. Fries was proposed for honorary membership in the Institute and the council was instructed to present his name to the members for immediate consideration.

Robert M. Yerkes, chairman of the information service of the National Research Council, reported that the council has organized a free information service which is acting as a clearing house for scientific and engineering interests. The purpose of this informational bureau is to facilitate research in all of the natural sciences and in the application of their results, and to render available to all who are intelligently interested in science and its applications reliable information about methods of research, research results, etc. Chemical engineers are cordially invited to avail themselves of this aid as they have occasion.

NEW PRODUCTS FROM PETROLEUM

Prof. J. H. James of Carnegie Institute of Technology read an original paper on the subject of "Some New Petroleum Products," starting with petroleum as the raw material. Dr. James has obtained a series of novel chemical products which appear to have a broad field of industrial application. The process used is essentially the vapor phase, catalytic oxidation of aliphatic hydrocarbons. Among the products thus obtained are certain oxygenated acids with resin-like properties which may perhaps be utilized as cheap varnish gums and paint film substitutes, an unsaponifiable oil which can be used in lubricating greases, and finally a new fuel which might be called an "oxidized kerosene." The methods of procedure and the yields obtained are given in Prof. James' paper, which is to appear in a subsequent issue of this magazine.

USES OF LIME AND GLASS IN CHEMICAL INDUSTRY

M. E. Holmes, manager of the chemical department, National Lime Association, presented a paper entitled "An Outline of the Uses of Lime." The importance of this material to the chemist and chemical engineer is not always recognized nor is it generally known that practically 60 per cent of the total output of lime is consumed in the chemical industries. Mr. Holmes' paper and chart showing the many uses of lime for construction, agricultural and chemical purposes will be published in an early number of CHEMICAL & METALLURGICAL ENGINEERING.

A. E. Marshall, consulting engineer, of Baltimore, outlined some recent developments in the use of glass as a construction material for the chemical industries.

¹A paper describing the preparation of this catalyst and its properties is to appear in the September, 1921, number of the *Journal of the American Chemical Society*, the publication of which has been delayed by printers' strike.

The speaker stated that the idea of conveying warm glacial acetic acid through a distance of 100 ft. in 6-ft. lengths of 2½-in. glass tubes had occurred to him after observation of a somewhat similar use of glass in an English plant where hydrochloric acid was being made by the salt-cake process. He has since found that manufacturers in this country are equipped to make much larger glass pipes (up to 6 in.) and various other shapes so that there is a promising possibility of developing glass in plant construction, particularly in condensing, conveying and catalytic processes in which transparency is a real advantage. Discussion by Messrs. H. K. Moore, A. S. Cushman and others brought out many additional applications of glass in large-scale chemical processes.

REGENERATIVE EVAPORATION

Prof. W. L. Badger presented an interesting review of the subject of regenerative evaporation. A brief abstract of his remarks follows:

The idea of compressing the vapors from an evaporation to the point where they could be re-used for heating was first proposed in 1840. At that time the evaporation industries were not ready for such ideas. It was advanced again in 1872 and in 1882. The idea was then fully appreciated, but inadequate mechanical equipment prevented its adoption.

Within the last decade much attention has been given to this question, a number of machines developed, and many patents taken out. There is a voluminous literature on this subject, but most of it is from those who are directly interested in one or another of the devices offered.

That it is possible, by regenerative evaporation, to attain multiple effect efficiency in a single effect is the claim of most of these articles. This is perfectly true. However, the work necessary to compress a pound of steam from the pressure of the vapor space to that of the heating space is approximately proportional to the temperature range through which compression is effected. Hence to make the power consumption reasonable, it is necessary to choose a small working temperature drop. If the solution which is evaporated has an appreciable elevation of boiling point, the vapor must be compressed through the useful temperature range, plus this elevation. In many cases this useless work of compressing through the boiling point elevation will be greater than the useful work of compression through the working temperature range. Hence the working temperature drop must be less than 10 deg. C., and in some cases as low as 3 deg. C.

In the case of a multiple effect evaporator, only in the first effect of a triple or quadruple effect will the temperature drop be small enough to permit the operation of a regenerator. In such a case the problem is very complicated and a general answer cannot be given. Each case has to be decided in the light of its own conditions, though there will be a large fraction of all the cases in which the regenerator will not prove economical.

DEVELOPMENTS OF CHEMISTRY IN FRANCE

The last speaker to be introduced by President Wesson was Prof. Cavalier, president of the University of Toulouse and professor of metallurgy in that institution. He gave an illustrated address on the development of chemistry in France, particularly in connection with the growth and progress in methods of instruction. The universities and colleges in France now have an annual enrollment of 400 to 500 students in chemistry, and a large proportion of these are being trained as chemical engineers.

During the afternoon the visitors were given an opportunity to visit Baltimore plants engaged in chemical and allied lines of manufacture. Special automobiles were provided and parties were conducted through the plants of the Baltimore Copper Works, Standard Oil Co., Maryland Glass Co., Emerson Drug Co., McCor-



NIGHT VIEW OF BALTIMORE'S BUSINESS DISTRICT

mick & Co., National Enameling & Stamping Co., and Baltimore Tin Decorating Co.

CONVENTION BANQUET

The annual dinner at the Emerson Hotel, Friday evening, marked the formal closing of the Institute's meeting in Baltimore. The toastmaster was Albert E. Marshall and the after-dinner speakers included Major Atkinson, personal representative of Brigadier-General Fries, Dr. Charles L. Reese of Wilmington, Dr. W. B. D. Penniman and Henry F. Baker of Baltimore, Dr. C. B. Morey of Buffalo, the Institute's secretary, Dr. J. C. Olsen, the retiring president, David Wesson, and President-Elect Henry Howard. In outlining his policies on the problems confronting the Institute, Mr. Howard declared that he favored a revision of the qualifications for membership, which should not, however, in any way lower the high standards of the Institute. After definitely establishing these standards, an effort should be made to increase the Institute's membership until it included all properly qualified chemical engineers. President Howard expressed the hope that the Institute's cordial relations with other scientific and professional organizations might continue and urged the members to co-operate heartily with the American Chemical Society, but at the same time keep in mind the need for maintaining the Institute as an independent organization of American chemical engineers.

New Magnet Steel

The large amount of apparatus, particularly precision and measuring instruments, possessing permanent magnets, generally of small dimensions, necessitates the finding of a metal highly susceptible to the acquisition and retention of magnetic properties. An important steel from this point of view, called K.S., discovered by a Japanese, has the composition: Carbon, 0.4 to 0.8 per cent; cobalt, 30 to 40 per cent; chromium, 1.5 to 3 per cent; tungsten, 5 to 9 per cent. It is very brittle and very hard, and great care has to be exercised in its manufacture. Its characteristics are surprising; its coercive range is about three times that of the best tungsten steel; the area of the hysteresis curve is also three times as great; the remanent magnetism is relatively very high; lastly, shocks and prolonged heating have a negligible effect on the magnetization. In shock tests, a slight diminution in remanent magnetism was observed—6 per cent after 850 impacts by dropping from a height of 1 meter to a cement floor.—*The Ironmonger*, Oct. 22, 1921.

Some Business Aspects of the 1921 Revenue Act

BY ROBERT MURRAY HAIG*

AMONG the numerous changes made by the new tax bill signed by President Harding on Nov. 23, five stand out as of great importance from the point of view of the business man and the investor. These are:

(1) The abolition of the excess profits tax as of Jan. 1, 1922, coupled with an increase in the income tax on corporations at that time from 10 to 12½ per cent.

(2) The reduction in the surtax rates on individual incomes which comes into effect at the same time.

(3) The establishment, with the beginning of next year, of a new class of income to be known as capital gain, subject to a maximum rate of 12½ per cent.

(4) The broadening of the definition of the "closed transaction," effective for the current year, which makes possible many exchanges of property for property without subjecting the gain to taxation.

(5) The recognition, beginning this year, of a net loss from one year's operation as an offset against any profits which may accrue in the two following years.

The first two changes have been the subject of wide comment, but the other changes, being of a somewhat more technical character, have been less discussed and their significance is less fully appreciated.

NEW CLASS OF "CAPITAL GAINS"

The most revolutionary section in the new act is section 206, which sets up a new division of income. After the first of next year money made by individuals by selling or exchanging property "held for profit or investment" is subject to a maximum rate of 12½ per cent, instead of the regular rates, which range as high as 58 per cent (normal plus surtaxes). This is hedged about by several restrictions. The individual may not take advantage of the permission to use the 12½ per cent rate unless he is willing to pay at least 12½ per cent on his other income as well. The property "held for profit or investment" must have been so held for more than two years and may not include property "held for the personal use or consumption of the taxpayer or his family," or property which properly is subject to inventory. It is not necessary, however, that the property be connected with his trade or business.

The reason for the adoption of some such section as this is plain, whatever one may think of the wisdom of choosing this particular method of meeting the situation. As everyone knows, many sales of property have been postponed or entirely blocked by the unwillingness of prospective sellers to take their profits when they would immediately become subject to heavy surtaxes. This, of course, handicapped business. The solution adopted was practically to wipe out the offensive surtaxes on profits from this class of transactions.

One anomalous result of the selection of this solution, however, is that under this new arrangement a dollar of profit made from property which has grown in value is taxed at the maximum only 12½c., whereas a dollar made otherwise may be taxed as much as 50c. For example, in the case of a bond bought at a discount and sold at a profit, every dollar of interest on the bond may pay a tax nearly five times as great as every dollar

of appreciation in the value of the bond, a fact which is likely to effect profoundly future methods of corporate financing.

Much more could be said regarding the effects of this new section from the points of view of equity and of administration, but what is of particular interest here is to point out the very substantial relief granted by it to investors in property which appreciates in value.

THE "CLOSED TRANSACTION"

The advantage to the investor in property which is gaining in value, conferred by the section just described, is accentuated by the liberal provisions governing the "closed transaction." (Section 202.) This has long been a troublesome section of the field of income tax procedure. When one exchanges property for cash, no question arises. The transaction is "closed" and one accounts for his gain to the tax collector. But when one barter instead of sells, receiving other property instead of cash for his property, very serious questions arise. There are sometimes differences of opinion as to the value of the property received, which lead to disputes and litigation. The old law went so far as to say that, in the case of such trades, the property received was to be treated as cash "to the amount of its fair market value, if any" (with certain exceptions in the case of a corporate reorganization, 1918 law, section 202). The new law goes much further. It now states positively that no gain or loss on trades shall be recognized unless the property received on the trade "has a readily realizable market value." The phrase, "readily realizable," adds a new and liberalizing element.

Even more important, however, are the exceptions made to the general rule. Even though the property received has such a "readily realizable market value," one need not account for the gain in certain cases. This is one:

"When any such property held for investment or for productive use in trade or business (not including stock in trade or other property held primarily for sale) is exchanged for property of a like kind or use."

How the Treasury will interpret this section is, of course, as yet unknown, but it would be a very narrow interpretation which would exclude exchanges of bonds or real estate for real estate. In other words, so long as one "barter" or "trades" his property for other similar property instead of selling it for cash, he need not account for his gains to the Treasury for tax purposes. Even if he does sell for cash, as has been noted above, he is subject to a tax of only 12½ per cent.

NET LOSSES

With one minor exception included in the 1918 law, it has been the practice since the beginning of income taxation in this country to treat each year as a unit and to refuse to permit the fact that one has lost money this year to affect the amount of profits he must report the following year. Each accounting period has been carefully "insulated" from other accounting periods. This practice has worked much hardship and the new law breaks away from the old precedents by inserting a provision, effective for 1921 (section 204, with a restriction on mines), which permits a net loss suffered in one year to be offset against any net income in the two next succeeding years. In other words, losses may be used to blot off subsequent gains, but losses are "outlawed" for this purpose after the expiration of two years.

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Destructive Distillation of Mixtures of Oil and Coal

A Comparative Study of Destructive Distillation Experiments on Coal, Oil and Mixtures of the Two in the Form of an Amalgam—Yield of Distillation Products—Composition of Tars—Nature of Light Oils—Quality of Gas—Residues

By JOSEPH D. DAVIS,* PALMER B. PLACE† AND G. S. SCOTT‡

IN THE course of investigations into the properties of mixtures of oil and coal made by the Bureau of Mines in co-operation with the Trent Process Corporation, a comparative study was made of the behavior of these mixtures and their constituents on destructive distillation. Mixtures of a petroleum oil and bituminous coal were first distilled under carefully controlled conditions, and then charges of the same oil and coal were distilled separately under similar conditions.

The quantity and quality of the distillation products were determined and results were compared. This comparison furnished a basis for judging whether greater values in products can be obtained by distillation of oil and coal in mixtures than by their separate distillation. In making the mixtures, the method use by the Trent process in cleaning coal was followed. The paste or plastic emulsion of oil and coal obtained is called "amalgam."¹

When finely pulverized wet coal is mixed with approximately one-third its weight of oil, and agitated with a large excess of water, the coal and oil agglomerate to form a paste or amalgam. A large portion of the extraneous ash originally in the coal remains suspended in the water, with which it can be decanted from the amalgam. If the latter is now thoroughly drained and kneaded after the manner of working butter, most of the excess water enclosed can be removed. This, in brief, constitutes the Trent process for cleaning coal.

The effectiveness of the process for cleaning coal has been studied² by the bureau, and the results of the study show, in general, a high ash reduction and good recovery of combustible from coals of medium and high rank. With coals of the lowest rank, such as lignites, the process is only moderately successful, owing to the difficulty attending the preparation of coherent amalgam. Oil losses to water and refuse are small, and apparently it would be practical to rotate the same oil in the cleaning process if some efficient method were devised for recovering it from the amalgam, so a distillation process naturally suggested itself.

The oil used in making amalgams may be recovered from them by distillation. If it is completely volatile below the decomposition temperature of the coal, recovery is good and neither oil nor coal is appreciably altered in the process. If, however, a heavy, high-boiling oil is used, good recovery cannot be obtained without destructive distillation, in which case the distillates will contain decomposition products of both coal and oil. Generally a rich gas is also obtained, and

the tendency is toward the production of a better coke than would be obtained from the coal alone on account of the cementing power of the oil residue. Even non-coking bituminous coals, when destructively distilled in heavy oil amalgams, will yield coke of fair quality and at least as much oil as would be obtained by refining the oil separately. The oil distilled from such amalgams is, of course, mixed with tar from the coal. In this connection it is important to know how the distillation products from heavy oil amalgams compare, both in quantity and quality, with those obtainable from the same quantities of oil and coal distilled separately. Any appreciable loss sustained through distillation of the mixed materials would tend to limit the choice of oils used in the cleaning process to those of low boiling range; any gain realized should be obtained also with oil-coal mixtures other than Trent amalgams.

The experimental work described later concerned only one class of oil and one class of coal. It was designed to show, by destructive distillation of amalgams and their constituents under exactly the same conditions:

(1) The comparative quantities of oil, residue and gas yielded by amalgams and by like quantities of oil and coal distilled separately. (2) The comparative qualities of oil and gases obtained. (3) The extent of cracking brought about by virtue of pre-mixing.

Theoretical Considerations

The theory of destructive distillation has not been developed sufficiently to enable one to predict with confidence from theoretical considerations the effect on their distillation products of pre-mixing such materials as oil and coal, the chief reason for this being a lack of knowledge of the chemistry of destructive distillation in general. It is known, however, that the chemical reactions involved are very sensitive to slight changes in distillation conditions, such as temperature, pressure and heating rate. It is important, therefore, in making comparisons, as with the problem at hand, to maintain similar conditions for all comparative experiments.

Chemically, there seems to be no interaction of oil and coal during formation of amalgams, and it is doubtful whether there is interaction in the retort before decomposition begins. During decomposition one would not expect reaction between the decomposition products of oil and coal, but, owing to the relatively large volume of vapors from the mixture, one might well expect more primary distillation products from the coal than when distilled alone, and less cracking of the oil vapors. The effect, purely physical, of large vapor volume would be to withdraw the vapors rapidly from the hot zone of the retort, thus tending to prevent secondary decomposition. The mixture of oil and coal considered here is certainly quite different physically from a simple sum of three parts oil and seven parts coal.

Amalgam is, in effect, a physical reaction product

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¹The term amalgam is used here in its broadest sense—that is, to designate an intimate mixture of materials.

²Perrott, G. St. J., and Kinney, S. P., "The Use of Oil in Cleaning Coal," CHEM. & MET. ENG., vol. 25, Aug. 3, 1921, p. 182.

obtained on adding oil to wet coal in the proper proportions, and what may be called the driving force in this reaction is surface tension. Oil wets the coal by preference, and water wets the mineral matter, and both must be held at the respective surfaces with appreciable force, depending on the extent of surface affected. Theoretically, the distances through which such forces act are of molecular dimensions; that is, the nearer the thickness of the liquid film approaches to the diameter of a molecule the greater the force with which the film is held. With each succeeding layer of liquid molecules, the force of attraction diminishes.

Nelson and Hulett³ computed the amount of moisture in a film of molecular thickness spread over colloidal coal particles in 1 c.c. of the substance, and found approximately 0.06 c.c., or over 5 per cent of the weight of the coal. This water is so condensed that it has practically no vapor pressure at room temperature. The coal is sensibly dry. The same writers show experimentally that some moisture is retained by the coal at temperatures as high as 230 deg. C. Since, in a mixture of coal, oil and water, the oil wets the coal preferentially, one must assume that the force attracting the oil film to the coal is greater than that attracting the water; and one would expect films of heavy oils, particularly those of vapor pressure lower than that of water, to be held by the coal up to temperatures at which it begins to decompose.

INDICATION OF MAGNITUDE OF SURFACE FORCES

The amount of oil held at the surface of coal particles in an amalgam is difficult to estimate, and there is no direct method for measuring the surface forces involved. The writers found, however, on subjecting a navy fuel oil amalgam to pressure in a hydraulic filter press, that at pressures up to 31,000 lb. per sq.in., 5 per cent of the oil was still retained in the residue. This residue contained only a trace of water, which could be removed by drying at 105 deg. C., although the coal contained originally about 1 per cent moisture removable at that temperature.

³Nelson, O. A., and Hulett, G. A., "The Moisture Content of Cereals," *J. Ind. Eng. Chem.*, vol. 12, No. 1, Jan. 1, 1920.

TABLE I. ANALYSIS OF MATERIALS USED
Proximate Analysis of Big Muddy Coal

	Per Cent
Moisture.....	5.78
Volatile matter.....	31.87
Fixed carbon.....	52.42
Ash.....	9.93
Total.....	100.00
Sulphur.....	1.28

Fractionation of the Oil

Temperature, Deg. C.	Per Cent Distilling (Volume)
130 to 225	1.1
225 to 250	4.8
250 to 275	14.3
275 to 300	20.1
300 to 325	21.7
325 to 350	30.9
Residue.....	5.8
Loss.....	2.0

Analysis of Fractions

Cut, Deg. C.	Acids, per Cent	Bases, per Cent	Unsaturates,* per Cent	Aromatics,* per Cent	Paraffines, per Cent	Sp. Gr.
130 to 250	1.4	0.0	4.3	17.1	77.2	0.820
250 to 275	1.0	0.0	4.0	7.0	88.0	0.833
275 to 300	4.0	0.0	4.0	13.0	79.0	0.841
300 to 325	0.0	0.0	8.0	8.0	84.0	0.849
325 to 350	...	...	...	...	...	0.872

* Oil soluble in 95 per cent H_2SO_4 , gravity 1.84, is called here "unsaturates"; "aromatics" are those oils insoluble in 95 per cent H_2SO_4 , but soluble in 37N H_2SO_4 .

It might be argued that distillation of the surface oil in an amalgam is analogous to distillation under pressure, a condition known to favor cracking reactions and the production of light liquid products. As a matter of fact, however, mixtures distilled in this research did not consistently produce more light liquid products than the constituents, but more and richer gas was obtained, and the tars contained a higher percentage of pitch. Cracking reactions were, therefore, favored by pre-mixing the materials, but the tendency was toward the formation of gaseous products rather than condensable liquids, as in the case of oil cracking under pressure. Actually, considerably more oil is required to make a coherent amalgam than can be accounted for in a film a few molecules thick enclosing

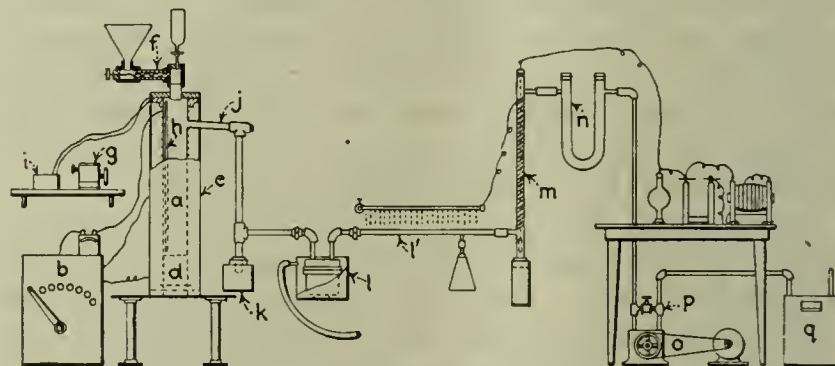


FIG. 1. COAL DISTILLATION APPARATUS

the coal, even if the individual coal particles are of colloidal size. Apparently, the distillation of this excess oil is not affected by the presence of the coal, and the total cracking effect observed in the distillation of the mixtures was due to the forces in the thin film.

The distillation of amalgams or mixtures containing large quantities of enclosed water results in the steam distillation of some of the heavy oils at temperatures below their normal boiling points. It is not believed, however, that steam has any appreciable effect on that portion of the oil in the molecular film enclosing the coal, since the vapor pressure of this oil must be very low. Further, parallel distillation tests made, wherein for one test the mixtures were made up dry, and for the other they were worked and air-dried to remove excess water, yielded approximately the same products. In other words, amalgams from which all excess water has been removed behave in the same way as dry mixtures on distillation.

Experimental Data

In order that the tests made at different temperatures in the distillation series of this paper be comparable, the same materials were used in all cases. The coal used was bituminous, and was obtained from the Big Muddy Coal & Iron Co., Herrin, Ill. The oil, a topped crude of asphaltic base, designated as navy fuel oil, was supplied by the Trent Process Corporation. Its specific gravity was 0.875 at 20 deg. C., and the viscosity 125 seconds Saybolt at 25 deg. C. The proximate analysis of the coal is given in Table I, together with fractionation results for the oil and an analysis of the oil fractions.

A sketch of the apparatus used is shown in Fig. 1. The retort *a* was made from a 48-in. length of heavy 6-in. iron pipe, which was insulated with asbestos paper and wound with nichrome wire for electric heating. The sheet metal casing *e* held a packing of infusorial earth for heat insulation. The top of the retort was provided with a hopper and worm *f* for uniform feeding of amalgam and coal; a 500-c.c. separatory funnel

served for feeding the oil. The distillation vapors and gases from the retort passed out through the pipe *j*, over the tar trap *k*, and into the water-cooled condensers *l* and *l'*, where most of the water and tar were condensed. A Cottrell precipitator *m* served to remove tar mists remaining in the gas, and the U-tube *n*, which was filled with gas-mask charcoal, retained light oils carried by the gas. A rotary pump *o* with an adjustable bypass *p* was used to keep a uniform pressure on the retort, and gas volumes were measured by the dry meter *q*.

TEST PROCEDURE

The distillation conditions for these tests approached those prevailing in the cracking of gas oil for the carburation of water gas. The object was a complete and rapid breaking up of the materials, as it was believed that by this treatment the cracking of oils and tars would be thorough; differences in cracking tendency of the materials would be exaggerated, and therefore easy to detect by analyzing the products. The method consisted in feeding the charges in small increments into the retort, previously heated to the temperature decided upon, this temperature being maintained as nearly constant as possible during the experiment.

Five series of tests were made, one at each of the temperatures 400, 500, 600, 700 and 800 deg. C. Each series included three distillations—one of the amalgam, one of the oil and one of the coal.

Amalgams were distilled first, and in each case a uniform rate of feed was maintained, which gave a fairly constant rate of gas evolution. This was noted, and in subsequent distillations of oil and coal separately at the same temperature the feed was adjusted to give a similar rate of gas evolution. Thus the gases and vapors from amalgam, coal and oil, respectively, remained in the retort for the same period. No fixed weight of charge was predetermined. The runs were continued until it was judged that a sufficient quantity of distillation products had been collected for chemical examination. All parts of the condensing train were weighed before and after each run, and the adhering tars were removed as thoroughly as possible and mixed for analysis. Light oils caught in the charcoal absorber were analyzed separately.

On account of their complexity, analysis of the tars presented considerable difficulty. Methods for the analysis of petroleum were not strictly applicable, nor were those used in the analysis of coal tar. After con-

siderable experimentation, the methods described by Weiss⁴ for the analysis of coal tar were adopted, with slight modification. Briefly, the procedure was as follows:

A sample of 300 c.c. of the tar was dehydrated in a standard Barrett copper retort, fitted with a copper condensing trough, according to the method of Weiss, by heating continuously to 170 deg. C. The water distilling was collected in a 100-c.c. graduate, where its volume could be read directly. Any light oil distilling with the water was returned to the retort, after which the tar, now dry, was fractionated. Cuts were taken every 25 deg. All fractions boiling under 200 deg. C. were united, as were also those boiling between 200 and 350 deg. C., and the united fractions were analyzed for tar acids, tar bases, unsaturated compounds and paraffines.

The analysis was carried out in standard Barrett graduated separatory funnels, and consisted in washing the distillates successively with 10 per cent caustic soda for acids, 20 per cent H_2SO_4 for bases, 95 per cent H_2SO_4 (1.84 sp.gr.) for unsaturates, and 37N H_2SO_4 for aromatics. The contraction in the oil volume observed after repeated washings with the reagents represented the amount of the several constituents present. The residue unattacked by reagents represented paraffines. In this connection it must be observed that the washing test with 95 per cent H_2SO_4 , although it was formerly depended on in the petroleum industry, has recently⁵ been shown to give results of only approximate accuracy. This is particularly true with mixtures containing the higher olefines. However, since some idea of the amount of unsaturated compounds present in the distillates was highly desirable, and since this method was the only one available, it was used as giving approximate results and of value for comparison.

As would be expected from such a series of distillation tests on a small scale, the experimental error was rather large and an absolute interpretation cannot, therefore, be placed on the figures obtained. Their chief significance lies in their value for purposes of comparison, and the following general conclusions may be drawn:

(1) The amalgams at all temperatures yield less resi-

⁴Weiss, J. M., "Methods of Analysis Used in the Coal-Tar Industry," *J. Ind. Eng. Chem.*, vol. 10, No. 9, p. 732; vol. 10, No. 10, p. 817; vol. 10, No. 11, p. 911; vol. 10, No. 12, p. 1006.

⁵Brooks, B. T., and Humphrey, Irwin, "The Action of Concentrated Sulphuric Acid on Olefines, With Particular Reference to the Refining of Petroleum Distillates," *J. Am. Chem. Soc.*, vol. 40, No. 5, p. 822.

TABLE II. FIELD OF DISTILLATION PRODUCTS

Test No.	Charge	Temp. Deg. C.	Run—Kind	Yields, per Cent of Charge				Yields, per Ton Charge						Remarks
				Residue	Tar	Gas	Light Oils	Residue Lb.	Tar, Gal.	Gas, Cu. Ft.	Light Oils, Gal.	Light Oils, Gal.	Light Oils, Total	
9	Amalgam..	400	Continuous..	57.7	14.1	2.5	0.12 (1.9)	1,154	33.7	750	0.38	4.6		Charge 30% oil, 70% coal
14	Coal.....	400	Continuous..	75.7	2.5	3.3	0.51 (0.26)	1,514	6.0	980	1.5	0.9	....	
21	Oil.....	400	Continuous..	67.8	30.0	2.2	 (2.9)	1,356	71.8	600	....	9.2	....	
	Sum.....			73.3	10.8	3.0	 (1.05)	1,467	25.7	866		3.4		
11	Amalgam..	500	Continuous..	54.9	12.5	11.2	0.97 (0.93)	1,089	29.9	4,470	3.0	6.2	9.2	Charge 30% oil, 70% coal
18	Coal.....	500	Continuous..	70.9	2.0	9.1	0.12 (0.15)	1,418	4.8	2,970	0.4	0.5	0.9	
24	Oil.....	500	Continuous..	24.9	51.4	17.9	1.10 (5.3)	498	123.0	5,300	3.1	16.9	20.0	
	Sum.....			57.1	16.8	11.7	0.57 (1.7)	1,143	40.4	3,670	1.1	5.4	6.5	
20	Amalgam..	600	Continuous..	45.7	19.0	23.6	2.70 (1.63)	914	45.5	10,650	7.2	6.3	13.5	Charge 30% oil, 70% coal
19	Amalgam..	600	Batch.....	52.2	20.0	13.8	1.50 (2.00)	1,044	47.8	5,650	3.7	7.2	....	
17	Coal.....	600	Continuous..	63.7	12.7	19.7	1.70 (2.1)	1,274	30.4	6,430	4.6	7.3	11.9	
23	Oil.....	600	Continuous..	13.3	30.9	51.2	4.00 (5.14)	266	74.0	16,900	11.1	17.4	28.5	Charge 30% oil, 70% coal
	Sum.....			48.6	18.2	29.1	2.40 (3.0)	972	43.5	9,570	6.5	10.3	16.8	
30	Amalgam..	700	Continuous..	47.9	13.7	23.0	2.80 (1.0)	958	44.4	10,100	6.7	1.8	8.5	
26	Coal.....	700	Continuous..	62.8	4.5	24.4	0.75 (0.29)	1,256	10.8	10,750	2.1	0.8	2.9	Charge 30% oil, 70% coal
22	Oil.....	700	Continuous..	19.8	27.2	49.5	2.60 (4.3)	396	65.0	19,320	7.0	12.7	19.7	
	Sum.....			49.9	11.3	32.0	1.30 (1.5)	999	27.1	13,320	3.5	4.4	7.9	
6*	Amalgam..	800	Continuous..	51.7	13.1	23.2	1.90	1,034		19,800	4.1			Charge 25% oil, 75% coal
7*	Coal.....	800	Continuous..	72.0	4.0	19.1	0.23	1,440	....	10,000	0.55	....	....	
8*	Oil.....	800	Continuous..	50.6	9.3	39.2	0.87	1,012	....	20,050	2.1	....	....	
4	Amalgam..	800	Batch.....	53.7	24.4	5.4	0.59 (1.15)	1,074	58.4	3,400	1.7	5.2		Charge 25% oil, 75% coal
	Sum.....			66.6	5.3	24.1	0.40	1,333	....	12,630	1.0	....	....	

* Results for residue and tar uncertain, fixed carbon carried over from retort into tar trap.

due than would be obtained by distillation of their constituents separately.

(2) The amalgams yield a greater quantity of tar than their constituents except at 500 deg. C., where conditions favor the complete distillation of the oil without excessive cracking into gas.

(3) The amalgams yield a larger volume of gas than

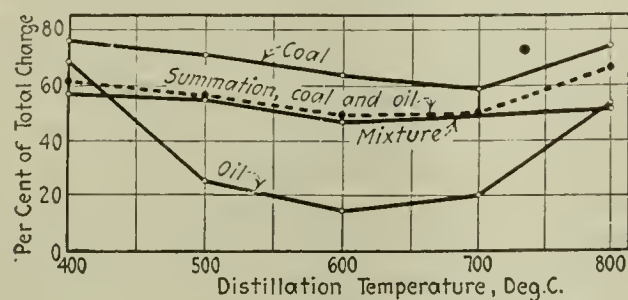


FIG. 2. RESIDUE VARIATION WITH TEMPERATURE

the constituents as a rule, and incidentally it has uniformly a higher heating value than that from constituents (see Table IV), but its specific gravity is lower.

(4) The total light oil yield is usually greater for the amalgams. The difference in yield, however, is small, perhaps within the limit of experimental error.

(5) At 800 deg. all tars are almost completely cracked into gases and fixed carbon.

Table II gives the yield figures for all distillation tests of amalgam, coal, oil, and the sum. This last item was calculated from the separate distillations of coal and oil, and represents what would be obtained by distilling 30 parts of oil and 70 parts of coal separately, and combining the products. The graphs in Figs. 2, 3, 4 and 5 show the variation in yield of the products,

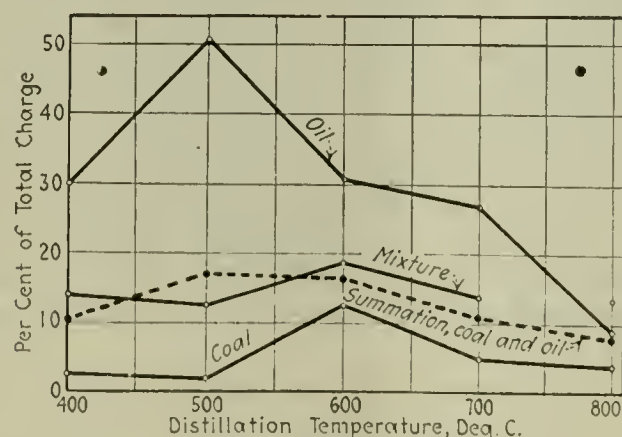


FIG. 3. TAR YIELD VARIATION WITH TEMPERATURE

residue, total oil, light oils and gas respectively, with temperature.

In the case of batch distillations of amalgam included in Table II for temperatures 600 and 800 deg. C., the total charge was placed in the cold retort and heated gradually to distillation temperature. At both temperatures there was a much larger yield of gas by the continuous method, the high yield apparently being at the expense of the residue at 600 deg. C., and at the expense of the tar at 800 deg. C.

Comparing the behavior of the amalgam with that of its constituents on distillation, as shown by the quality of the tars (Fig. 6), it is clear that it is the more sensitive to temperature. At 400 deg. C. the distillation residue is practically the same as that calculated for the sum of its constituents, but with higher distillation temperatures it becomes much greater than that for the sum. A higher percentage of pitch carbon in the amalgam tars is indicated, and hence a more extensive cracking with rising temperature. Corre-

sponding to this, one might expect an increase of unsaturates and aromatics in the amalgam tars, but as a matter of fact these tars contain less aromatics and unsaturates at the higher temperatures than that calculated for them. The products of the cracking must therefore be found in the gas, and, as previously shown, this is borne out by a higher yield of richer gas for the amalgams.

As would be expected, the paraffine content of the tars drops rapidly with rising temperature for all continuous distillations to practically zero at 70 deg. The paraffine content of the amalgam tars is lower than the calculated values for all distillation temperatures except 400 deg. C. This is further evidence of the more complete thermal decomposition of amalgam tars.

In general, the oils known to be largely composed of paraffines originally react in the same way as the coal under the influence of heat. The constituents of

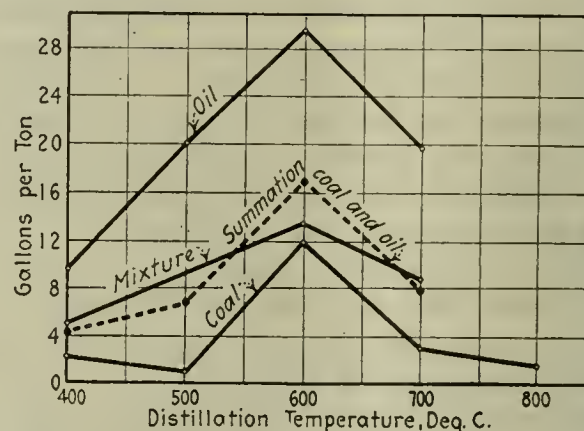


FIG. 4. TOTAL OILS BOILING UNDER 200 DEG. C.

the tars vary similarly with rising temperature. Neglecting compounds that produce phenols, it can be argued that the volatile constituents of coal are largely of a paraffine nature.⁶

Table III gives the composition of the tars, and Figs. 6, 7, 8 and 9 show the variation in tar quality with temperature.

Tars from batch distillations at 600 and 800 deg. C., wherever the whole amalgam charge was placed in the cold retort and heated gradually to the distillation temperature, show much less thermal decomposition than tars obtained by the continuous method. The paraffine content even at 800 deg. was 41 and 65.8 per cent; whereas the tars from the continuous method were so broken up that analysis was impractical. Actually, most of the tar from the batch distillation came off at much lower temperatures than 800 deg. C.—that is, during

⁶Whitaker, M. C., and Suydam, J. R., "A Comparative Study of the Thermal Decomposition of Coal and Some of Its Products of Carbonization," *J. Ind. Eng. Chem.*, vol. 10, 1918, p. 431.

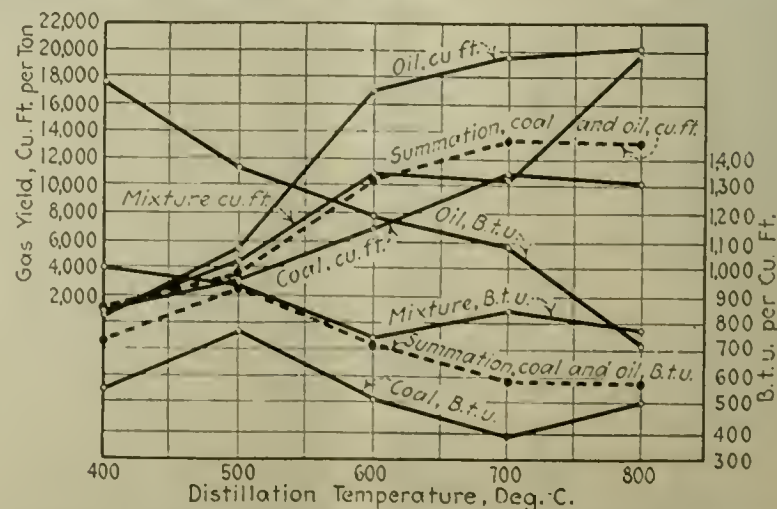


FIG. 5. VARIATION IN GAS YIELD AND IN HEATING VALUE WITH TEMPERATURE

TABLE III. COMPOSITION OF TAR

Boiling 0-200 Deg. Boiling 200-350 Deg. -- Fractions 0-200 Deg., per Cent -- Fractions 200-350 Deg., per Cent--

Test No.	Charge	Temp., Deg. C.	Run, Kind	First Drop at Deg. C.	Per Cent	Sp.Gr. 15 Deg. C.	Per Cent	Sp.Gr. 15 Deg. C.	Residue, per Cent	Acids	Bases	Unsaturates	Aromatics	Paraffines	Acids	Bases	Unsaturates	Aromatics	Paraffines
9	Amalgam	400	Continuous	..	13.77	0.822	72.83	0.879	13.40	7.0	1.0	44.0	19.0	29.0	4.5	1.0	21.5	19.3	53.7
14	Coal	400	Continuous	85	15.20	0.890	26.80*	0.956	58.00	32.0	2.9	36.0	22.0	7.1	46.4	1.4	37.9	11.4	2.9
21	Oil	400	Continuous	60	12.92	0.759	77.29	0.832	9.79	2.2	1.1	35.6	22.2	38.9	1.30	0.30	14.00	18.30	66.10
	Navy fuel oil, analysis 150 deg.				1.33	0.820	93.07	0.848	5.60	...	...	...	...	...	...	...	...	...	...
11	Amalgam	500	Continuous	65	20.66	0.951	37.50	0.970	41.84	11.4	4.3	63.0	21.3	0.0	2.7	5.4	54.0	20.0	17.9
13	Coal	500	Continuous	90	9.66	0.933	41.30*	...	49.04	28.8	4.0	40.0	18.0	10.0	...	...	...	...	...
24	Oil	500	Continuous	..	13.79	0.864	62.37	0.886	23.84	2.6	3.1	47.1	31.4	15.8	1.4	0.7	28.4	25.2	44.3
20	Amalgam	600	Continuous	80	13.90	0.890	17.80*	0.980	68.30	9.7	4.6	84.5	2.2	0.0	7.5	5.0	65.0	22.5	0.0
19	Amalgam	600	Batch	80	15.14	0.845	68.79	0.865	16.07	13.2	2.2	29.4	24.1	31.1	6.13	1.5	16.6	11.84	63.73
17	Coal	600	Continuous	90	22.90	0.945	32.50	1.000	43.60	32.3	3.1	64.6	0.0	0.0	46.4	2.3	51.3	0.0	0.0
23	Oil	600	Continuous	50	23.57	0.899	57.25	0.980	19.18	0.0	0.0	60.0	38.0	7.0	0.0	0.0	60.0	20.0	20.0
30	Amalgam	700	Continuous	85	5.4	...	8.1	...	86.50	8.0	0.0	92.0	0.0	0.0	0.0	1.0	31.0	53.5	14.5
28	Coal	700	Continuous	80	7.4	0.910	24.3	0.960	68.30	22.2	2.3	75.5	0.0	0.0	13.7	4.5	42.2	30.3	9.3
22	Oil	700	Continuous	70	19.5	0.898	54.4	0.962	26.10	0.5	0.0	58.0	41.5	0.0	0.5	0.0	41.0	58.5	0.0
6	Amalgam	800	Continuous†	†	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
4	Amalgam	800	Batch	..	8.90	0.850	54.87	0.857	35.23	13.0	2.0	26.0	18.0	41.0	3.8	1.2	11.2	18.6	65.8
7	Coal	800	Continuous	..	4.5	...	28.9(C ₁₀ H ₈ 10.9%)	...	66.6	...	...	...	...	...	...	...	...	...	...
8	Oil	800	Continuous	†	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

* Boiling 200-300 deg. C.

† Tar consisted of heavy hydrocarbons and fixed carbon, regular analysis impractical.

the gradual heating to that temperature. By feeding the charge continuously in small increments, it was all heated almost instantaneously to the highest distillation temperature, and distillation took place, to borrow an expression from steam boiler technology, "from and at" that temperature.

Light oils absorbed by passing the gas through gas-mask charcoal consisted almost entirely of unsaturates

content. Its illuminant content was high, which fact partly accounts for its high heating value. Further, it contained more methane and less carbon monoxide than the calculated gas. Table IV gives average analyses of gases from all test runs of the series, together with an analysis of amalgam gas for each temperature calculated from the gas yields of oil and coal.

The total heating value of the amalgam gas is superior to that obtained from its constituents distilled alone, as the following approximate calculation shows:

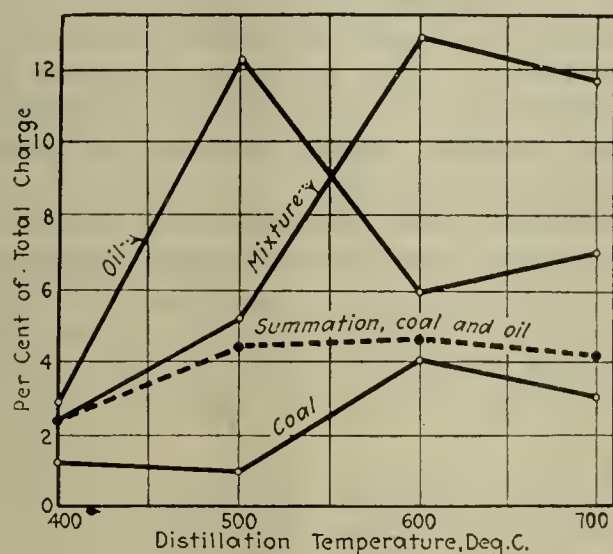


FIG. 6. TAR DISTILLATION RESIDUES

and aromatics, except where amalgams were distilled in batch and where the coal was distilled at 400 deg. C. Appreciable quantities of paraffines were here present. Eighty to 90 per cent of the oils extracted by the continuous distillation method were volatile under 100 deg. C., and practically all of them were completely volatile under 125 deg. C. The light oil from the coal distillation at 400 deg. C. was not completely distilled until a temperature of 200 deg. C. was reached, and then a tarry residue amounting to 5 per cent of the oil remained. The presence of condensable compounds, such as indene and cumarone, is thus indicated.

Several samples of gas were taken at corresponding time intervals during each distillation test, and the analyses of these grab samples were averaged. All samples were taken after the gas had passed the light oil scrubber, and their heating value was therefore lower than that of the raw gas.

For the most part, the gas yielded by the amalgams was better than that calculated for them from the gases obtained from the oil and coal; its volume also was greater. The weight per cent yield of amalgam gas was low (see Table II) chiefly owing to a low CO,

	Distillation Temp., Deg. C.	B.t.u. per Cu.Ft.	Cu.Ft. per Ton	B.t.u. in Gas From 1-Ton Charge
Amalgam.....	400	1,000	750	750,000
Calculated.....	400	739	866	640,000
Amalgam.....	500	937	4,470	4,188,000
Calculated.....	500	951	3,670	3,492,000
Amalgam.....	600	730	10,850	7,920,000
Calculated.....	600	717	9,570	6,860,000
Amalgam.....	700	832	10,100	8,408,000
Calculated.....	700	576	13,320	7,670,000
Amalgam.....	800	757	19,800	14,980,000
Calculated.....	800	560	12,630	7,070,000
Oil alone.....	800	710	20,050	14,450,000

Owing to the relatively small scale on which the experiments were made, and the consequent large experimental error, the above figures can not be considered as absolute; they do show, however, comparative gas

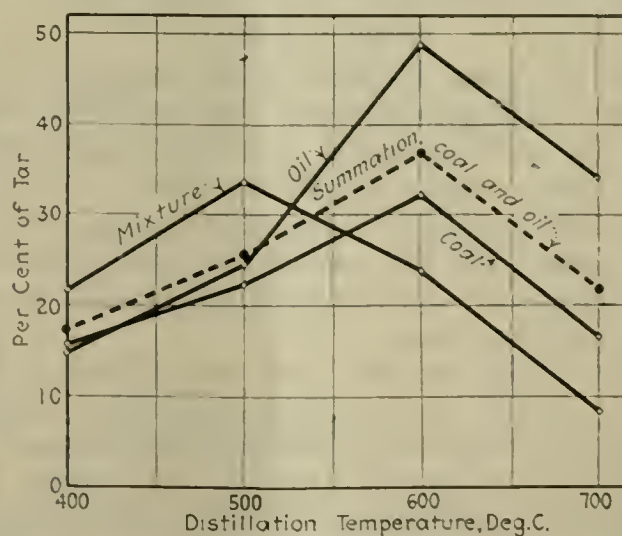


FIG. 7. PERCENTAGE OF TOTAL UNSATURATED BODIES IN TAR

values obtained in distilling oil and coal. At every temperature the advantage of amalgam gas is consistent. Apparently, a bituminous coal amalgam of such coal and oil as used here should be applicable

TABLE IV. ANALYSES OF GASES FROM TRENT AMALGAMS, COAL AND OIL

Charge	Temp., Deg. C.	CO ₂	C ₂ H ₄	O ₂	CO	CH ₄	C ₂ H ₆	H ₂	N ₂	B.t.u. per Cu. Ft. Calculated	Yield Cu. Ft. per Ton	Oil From Gas, Gal. per Ton	Remarks
Amalgam.....	400	9.8	23.4	0.6	4.0	29.1	17.3	8.9	6.9	1,000	750	0.38	Oil 30%; coal 70%.
Coal.....	400	17.9	0.5	0.4	11.7	46.7	0.0	17.4	5.4	550	980	1.5	
Oil.....	400	15.5	16.6	0.0	1.0	23.2	39.1	4.6	0.0	1,182	600	0.0	
Sum.....	...	16.7	5.5	0.3	8.6	33.7	11.8	13.6	3.8	739	866	...	
Amalgam.....	500	3.0	17.0	0.0	5.3	37.4	12.0	25.0	0.3	927	4,470	3.0	Oil 30%; coal 70%.
Coal.....	500	10.2	1.2	0.6	19.7	38.4	8.5	12.2	8.6	779	2,970	0.4	
Oil.....	500	0.6	39.6	0.4	0.5	29.3	24.1	2.9	2.6	1,353	5,300	3.1	
Sum.....	...	7.4	12.6	0.5	14.1	35.8	13.1	9.5	6.9	951	3,670	...	
Amalgam.....	600	3.0	8.8	0.6	8.7	50.8	0.0	25.3	2.8	730	10,850	7.2	Continuous feed oil 30%; coal 70%. Batch distillation.
Amalgam.....	600	3.3	13.6	0.6	7.5	48.4	0.0	23.9	1.7	794	5,650	3.7	
Coal.....	600	4.7	3.3	0.5	11.4	30.6	0.0	46.2	3.3	525	6,430	4.6	
Oil.....	600	1.8	31.0	0.5	1.8	46.3	10.8	5.0	2.8	1,167	16,900	11.1	
Sum.....	...	3.8	11.6	0.5	8.5	35.4	3.2	33.9	3.1	717	9,570	...	
Amalgam.....	700	2.6	13.9	0.1	6.9	46.9	3.2	25.3	0.3	832	10,100	6.7	Gas samples uncertain; oil 30%; coal 70%.
Coal.....	700	6.4	0.6	0.5	28.1	13.0	0.0	46.9	4.5	376	10,750	2.1	
Oil.....	700	0.4	23.2	0.5	0.5	63.6	2.0	8.3	1.5	1,056	19,320	7.0	
Sum.....	...	4.6	7.4	0.5	19.9	28.2	0.6	35.3	3.5	576	13,320	...	
Amalgam.....	800	4.9	8.9	0.7	6.7	35.3	8.1	31.5	3.9	757	19,800	4.1	Continuous feed; oil 25%; coal 75%. Batch distillation.
Amalgam.....	800	4.7	6.1	0.0	7.9	32.9	5.4	36.9	3.4	654	3,400	1.7	
Coal.....	800	4.2	3.0	0.4	16.5	26.6	0.0	45.4	3.9	496	10,000	0.55	
Oil.....	800	2.1	2.2	0.0	1.6	63.7	0.0	28.2	2.3	710	20,050	2.1	
Sum.....	...	3.5	2.8	0.3	12.0	37.7	0.0	40.3	3.4	560	12,630	...	

in the carburization of water gas, if a method were devised for handling the residues produced.

In no case where the continuous distillation method was employed was the residue coked. It was in the form of a fine powder, there being little tendency to

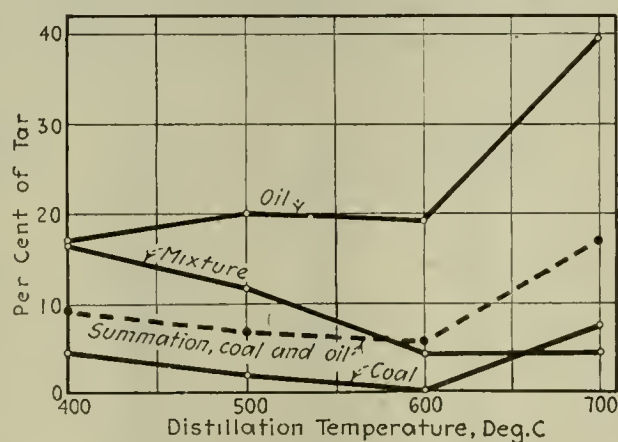


FIG. 8. TOTAL AROMATICS IN TAR

fusion, and contained at the higher temperatures a considerable quantity of finely divided carbon, a product of tar cracking reactions. Batch distillations of amalgams yielded a fairly coherent coke, but apparently no better than that from the coal alone.

CONCLUSIONS

Oil and coal were distilled under carefully controlled conditions at the temperatures 400, 500, 600, 700 and 800 deg. C., and amalgams of oil and coal were then distilled under similar conditions, and the distillation products were compared. For this purpose, the yields to be expected for the amalgams were calculated at each temperature from the yields obtained from the oil and coal distilled alone.

The distillation method used was unique in that it aimed at a rapid and complete destructive distillation of the materials within a narrow temperature range. The effect of this method was to bring about a more rapid thermal decomposition, and at lower apparent temperatures than is the rule in destructive distillation practice. The conditions of distillation were very similar to those prevailing in the carburization of water gas.

Comparison of the products shows in general that different results are obtained by distilling amalgams or mixtures of oil and coal from those obtained by distilling the constituents separately. Consistent differ-

ences appear in the quantity of residues obtained, and in the quantity and quality of the gases. Differences in the tar products are not so well defined. Light oils extracted vary in quantity and quality, but probably within the limits of experimental error. The results show that for this distillation method:

(1) Amalgams are more sensitive to temperature than their constituents. This is probably due to the fact that in the amalgams a part of the oil is held by surface tension forces in contact with the coal at temperatures above its boiling point.

(2) Amalgams yield a smaller distillation residue than their constituents, and a larger volume of gas.

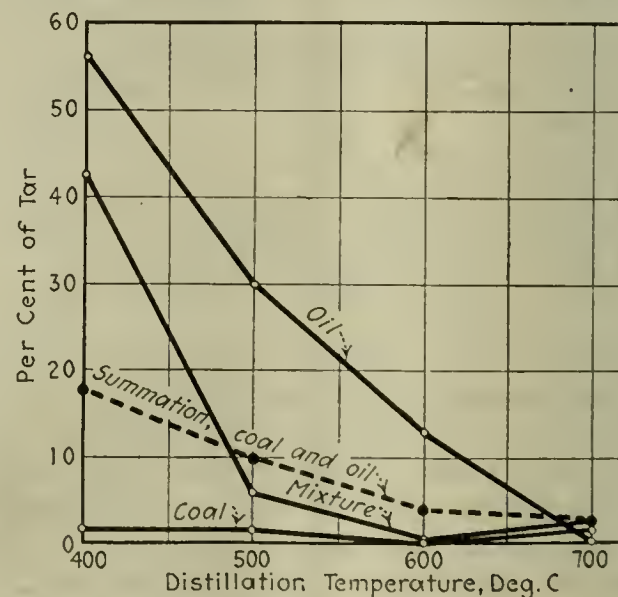


FIG. 9. TOTAL PARAFFINE CONTENT IN TAR

Further, the quality of this gas is better than the combined gases from coal and oil.

(3) Amalgams do not give a better light oil yield than their constituents, but they give a higher yield of tar, which is of poorer quality, containing excessive quantities of pitch.

ACKNOWLEDGMENTS

The authors wish to acknowledge their indebtedness to A. C. Fieldner, supervising chemist; G. St. J. Perrott, physical chemist; R. L. Brown, associate organic chemist, and E. W. Dean, petroleum chemist, of the U. S. Bureau of Mines, Pittsburgh Experiment Station, for many helpful suggestions in this work.

Boiling Point of Salt Solutions Under Varying Pressures*

Derivation of a General Law Which Greatly Simplifies the Accurate Determination of Important Data on the Boiling Points, Over the Usual Range of Pressure and Concentration, of Salt Solutions Commonly Evaporated in Vacuum Evaporators

BY E. M. BAKER AND V. H. WAITE

IN AN EARLIER paper¹ attention was called to the fact that in the design of an evaporator installation it is necessary to know the elevation of the boiling point of the solution being evaporated in each effect, at the temperature and pressure existing in that effect. It was further pointed out that while the literature shows a large number of determinations of the elevation of boiling points of aqueous solutions, many of these determinations were made at comparatively early dates with crude apparatus, and hence there frequently were wide variations in the values reported. This laboratory announced the intention of proceeding with the determination of the vapor pressure curves of such solutions as are used by the chemical industry and are commonly concentrated in vacuum evaporators. The Division of Chemistry and Chemical Technology of the National Research Council became interested in this work and made it one of its supported projects. The Council desired that the work be carried out to a greater degree of accuracy than was determined for technical purposes, in order that the data obtained might have a higher value for use in purely theoretical studies. To meet this condition, it was necessary to develop an apparatus in which the pressure could be maintained practically constant and in which other sources of error might be kept below a fixed maximum. The limit considered permissible for this work was placed at an absolute error of 0.1 deg. C.

DESCRIPTION OF APPARATUS

A sketch, partly diagrammatic, of the apparatus used is shown in Fig. 1. The solution whose vapor pressure was to be determined at different temperatures was placed in the glass tube *I* and then heated by an electric current passing through resistance coils in the heater *C*. The current was regulated by an external resistance and the current and voltage used were read on suitable meters. A modified Cottrell² pumping tube *D* was slipped down over the heater and used for pumping a mixture of the solution and vapor over the platinum resistance thermometer *B*. The tube *I* was jacketed with a second glass tube, *E*, to minimize the effect of air currents. The vapors coming from the boiling solution passed into a condenser *G*, to which is connected a large glass reservoir *H*. From *H* a line of glass tubing leads to a small catch bottle *J*, connected to a laboratory water-jet vacuum pump. This catch bottle was also connected to a vacuum regulator, consisting of two parts, a manometer *M* and a needle valve operated by the solenoid *K*. An increase in the vacuum over the

value desired would cause the mercury to rise in the manometer and in turn make a contact with the platinum tipped rod *F*, and complete a low-voltage circuit through the mercury and the relay *R*. This caused the relay to complete a 220-volt direct-current circuit through the solenoid *K*, thus pulling up its armature. The lower end of this armature constituted the plug of the needle valve.

It is necessary to be able to regulate the lift of the needle valve since different openings are required for

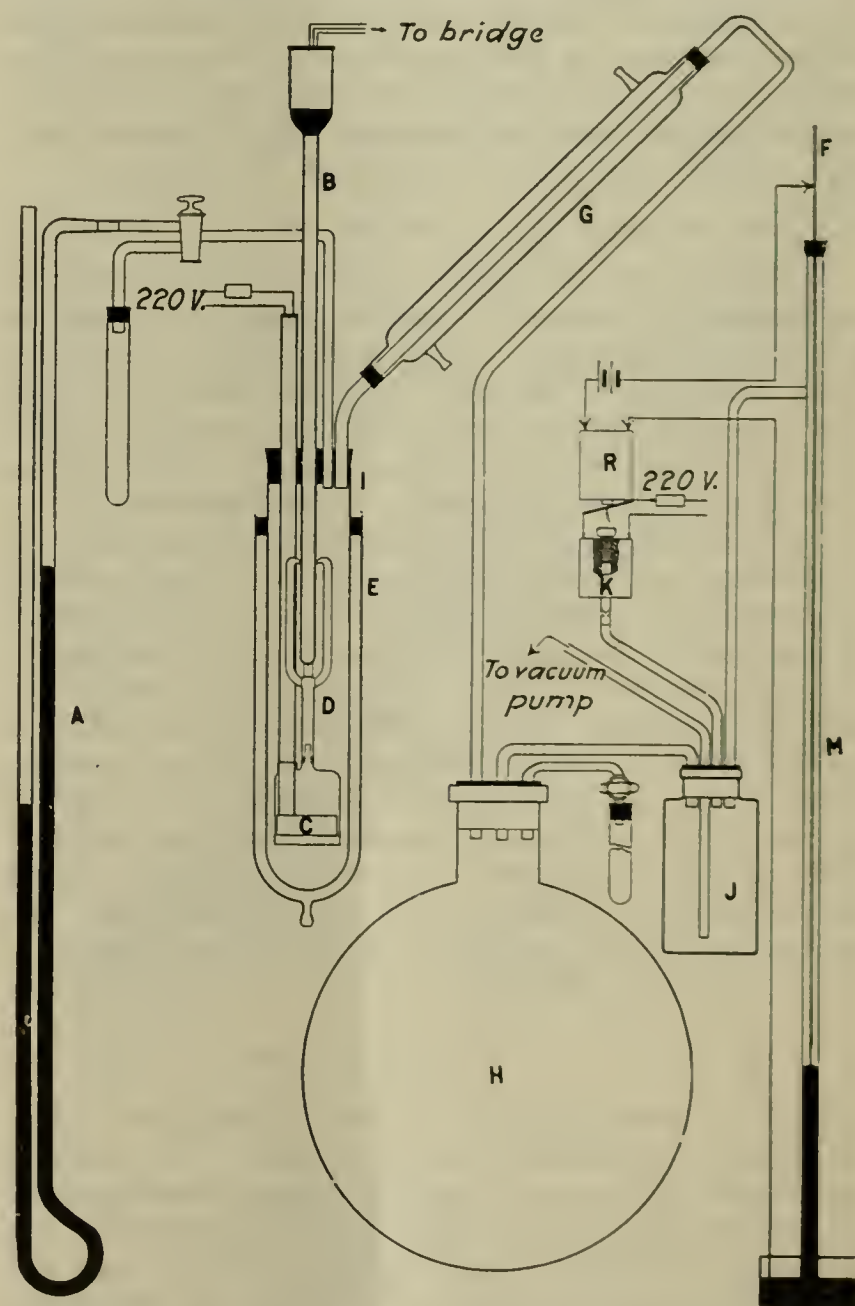


FIG. 1. SKETCH OF APPARATUS

best regulation at different absolute pressures. This regulation is obtained by screwing the upper end of the solenoid core up or down to the required position. By a proper setting of the pump the vacuum is regulated to a value slightly in excess of that wanted, and the "vacuum regulator" used to give the vacuum desired. The mercury in the regulating manometer oscil-

*Read before the thirteenth semi-annual meeting of the American Institute of Chemical Engineers, at Ann Arbor, Mich., June 21, 1921.

¹"The Boiling Point of Salt Solutions," by W. L. Badger and E. M. Baker, *Trans. Am. Inst. Chem. Engrs.*, 1920, also *CHEM. & MET. ENG.*, vol. 23, No. 12, pp. 569-574, Sept. 22, 1920.

²*J. Am. Chem. Soc.*, vol. 41, pp. 721-9 (1919).

lates regularly up and down, the magnitude of the oscillations being about 3 mm. The reservoir or vessel of large capacity *H* served to damp these oscillations, and to maintain the vacuum in the boiling point apparatus at a very constant value. This vacuum was measured by a manometer *A* connected directly into the boiling-point tube, thus insuring that the pressure read was the true pressure under which the liquid was boiling. The manometer was made of 10-mm. glass tubing in order to minimize the effect of capillary action. The variations in pressure in the boiling-point tube were so slight that the bottom of the mercury meniscus in the measuring manometer would show no perceptible movement over periods as long as a half hour, but the center of the meniscus would breathe or oscillate regularly up and down a distance of 0.1 to 0.3 mm. This measuring manometer was mounted against a mirror to aid in eliminating the parallax in reading. The value of the manometer reading was taken by a steel rule graduated in half millimeters and mounted so that it could be racked up and down over the manometer. In making a pressure reading, the rule was adjusted so that its bottom edge was just level with the center of the mercury meniscus in the low arm, and the graduated edge of the rule came to the center line of the mercury in the high arm. The reading of the center of the meniscus in the high arm was taken with the aid of a magnifying glass, care being used to avoid errors of parallax.

METHODS OF MEASURING TEMPERATURE AND PRESSURE

A 10-mm. tube filled with mercury was hung beside the measuring manometer, and its temperature read on a mercury thermometer whose bulb extended some distance down in this mercury. The temperature so read was taken as the temperature of the mercury in the measuring manometer. By this means the effect of lag with changing room temperatures was eliminated.

The temperature of the boiling solution was taken by a platinum resistance thermometer *B*. Except where otherwise noted, this thermometer was not immersed in the body of the liquid, but was in the vapor space. The thermometer tube was kept well wetted with solution for a distance about an inch above the platinum coil by means of the pumping tube *D*. The resistance thermometer was constructed according to the method as given by the Bureau of Standards,³ and was provided with compensating leads. The resistance was measured by means of a bridge with a wall galvanometer. In calibrating the thermometer and at all other times, the resistances corresponding to *A* and *B* in the formula

$$X = \frac{A}{B} R$$

were each 1,000 ohms, and the same re-

sistance coils were used for *A* and *B* throughout. For adjusting the resistance *R* to balance *X* a precision resistance was placed in parallel with the resistance *R* of the bridge proper. The precision resistance was adjusted to a value slightly greater than *X* and the final adjustment obtained by adjusting the resistance of the bridge. This latter resistance would always be large, at least 500 ohms, so that the accuracy of the bridge as a whole was determined by the galvanometer and the precision resistance. One of the three leads to the thermometer was connected in the battery circuit, and the two other leads were placed one in each of the arms *X* and *R*. These latter two leads were at no time

interchanged from the position they occupied at the time of calibration. A compensated aneroid barometer was used for measuring the barometric pressure. This barometer was compared at different times with the mercury barometer of the university observatory, and a calibration curve constructed.

DISCUSSION OF SOURCES OF ERROR

The general sources of error that may be experienced in boiling-point determinations have been so well discussed by Smith and Menzies⁴ and others that only those relating to this particular apparatus will be treated here.

Pressure and Temperature Control.—The vacuum regulator made it possible to maintain a constant mean difference between the barometric pressure and the pressure in the apparatus for as long a period as was desired. In some determinations the pressure in the apparatus actually oscillated as much as 0.3 mm. from the mean value, but as these oscillations were rapid and extremely regular, it may be safely assumed that their effect on the mean boiling point of the solution was nil. The temperature for all but the most concentrated and viscous solutions would be correspondingly equally constant. For the latter variations as much as 0.3 deg. C. were noted. In these cases the highest values obtained at a given pressure were taken as correct.

Temperature.—The platinum thermometer was calibrated against the temperature of melting ice, of steam above boiling water, and of the vapor above boiling naphthalene. From the resistance obtained at these three points the constants in the formula $R_t = R_0 (1 + \alpha t + \beta t^2)$ were determined. A calibration curve was then constructed using a scale such that 1 mm. corresponded to 0.1 deg. C. The values for temperature as read are calculated to be accurate to within less than 0.1 deg. C.

Pressure.—The pressures as measured by the mercury barometer and manometer were reduced to equivalent readings at 0 deg. C., 45 deg. latitude and sea level, and the values reported have all been so corrected. The steel rule used was compared with other standards and found to check to within less than 0.1 mm. at 25 deg. C. The height of the mercury column could be read as accurately as a mercury barometer. In taking these readings, the difference in height of the top of the meniscus in the two arms of the manometer was taken as the reading. It can be easily demonstrated that if the mercury column is oscillating regularly, the above reading is the true mean value. The mercury used had been purified by nitric acid, followed by a double distillation in vacuo.

Purity of Materials.—The materials used were sufficiently purified so that errors from this source could not cause an error of 0.1 deg. C. in the boiling point of any solution used. Dissolved gases, if any were present, would be completely swept out by the ebullistic method used, since about 20 minutes was allowed at each point for the system to come to equilibrium.

Superheat.—Superheating of the liquid was practically impossible, first, because the heat was conducted to the solution through metal, and second, because the solution that came in contact with the thermometer had been pumped by its own steam up the pumping tube onto the thermometer, thus giving time for the vapor and liquid to come into equilibrium with each other.

³Scientific Paper 107.

⁴"Studies in Vapor Pressure," *J. Am. Chem. Soc.*, vol. 32, p. 1412.

This also eliminated any possibility of the boiling point of the solution in which the thermometer was immersed being raised by the hydrostatic pressure of the liquid.

ACCURACY OF COMPLETE APPARATUS

To test the general accuracy of the complete apparatus determinations of the boiling point of water from 50 to 100 deg. C. were made, using the pumping tube exactly as in the case of a solution so that the thermometer was wet with the water pumped up. These results are presented in Table I. The fifth column of this table shows the corresponding values given by Peabody's Steam Tables,⁵ which are based on accepted standard values of Holborn and Henning.⁶ From these results, it would appear that the apparatus has an

TABLE I. COMPARISON OF BOILING POINT OF WATER AT DIFFERENT PRESSURES WITH VALUES OBTAINED BY HOLBORN AND HENNING

Corrected Barometer, Mm.	Corrected Manometer (Vacuum), Mm.	Corrected Absolute Pressure, Mm.	Temperature Observed, Deg. C.	Temperature From Steam Tables (H and H.), Deg. C.	Difference, Deg. C.
736.8	613.2	123.6	56.00	56.00	0.00
726.6	485.8	240.8	70.72	70.71	-0.01
740.8	249.9	490.9	88.22	88.20	-0.02
741.0	168.1	572.9	92.29	92.27	-0.02
741.0	127.5	613.5	94.12	94.11	-0.01
741.0	78.4	662.6	96.20	96.20	0.00

absolute accuracy within this range of better than 0.1 deg. C. The accuracy of pressure measurement is believed to be well within 0.3 mm. It is evident that if the mercurial barometer against which the aneroid barometer was calibrated were in error by 0.3 mm., this would have made the measurement of the boiling point of water, at 123.6 mm. pressure, in error by 0.05 deg. C.

CRITICAL STUDY OF DATA

The method of making a critical study of boiling point data described in a previous paper,⁷ while satisfactory for most technical work, is not sufficiently exact to preserve the accuracy of data which have a probable absolute error of less than 0.1 deg. C. Data of this sort could be obtained by the use of a series of empirical formulas, such as those of Bertrand, but the labor involved in such a method would be enormous. In searching for a simple yet accurate method for studying the data, it was found that if at a pressure p_1 the solution boiled at a temperature t_1 , and water boiled at a temperature θ_1 , and that at a pressure p_2 the corresponding boiling points were t_2 and θ_2 , then for p_n , t_n and θ_n , the following relationship would hold:

$$\frac{t_1 - t_2}{\theta_1 - \theta_2} = \frac{t_2 - t_3}{\theta_2 - \theta_3} = \frac{t_n - t_{n+1}}{\theta_n - \theta_{n+1}} = K,$$

where K is a constant. In other words, if a series of points were plotted on rectangular co-ordinate paper, showing for a given solution the temperatures at which the solution exerted certain vapor pressures plotted against the corresponding temperatures at which water would exert the same vapor pressure, then all the points so plotted would fall more nearly on a straight line than on any other smooth curve that could be drawn. This is essentially Dühring's rule. In 1878 Dühring⁸ advanced the theory that if t_1 and t_2 are the boiling points

of a substance at two pressures, p_1 and p_2 , and if θ_1 and θ_2 are the boiling points of another substance at the same pressures, then $(t_1 - t_2) = q (\theta_1 - \theta_2)$ where q is a constant. Curiously enough, while this rule has been largely used for comparing the boiling points of different pure substances with the boiling points of water, it has apparently not been applied to aqueous solutions where the solute exerted practically no vapor pressure. The same statement holds true for the more general law of Ramsay and Young.⁹

The accuracy with which Dühring's rule can be applied to aqueous solutions of any strength, provided always that these solutions are not saturated and provided that the solute does not exert an appreciable vapor pressure, has not been generally appreciated. The ap-

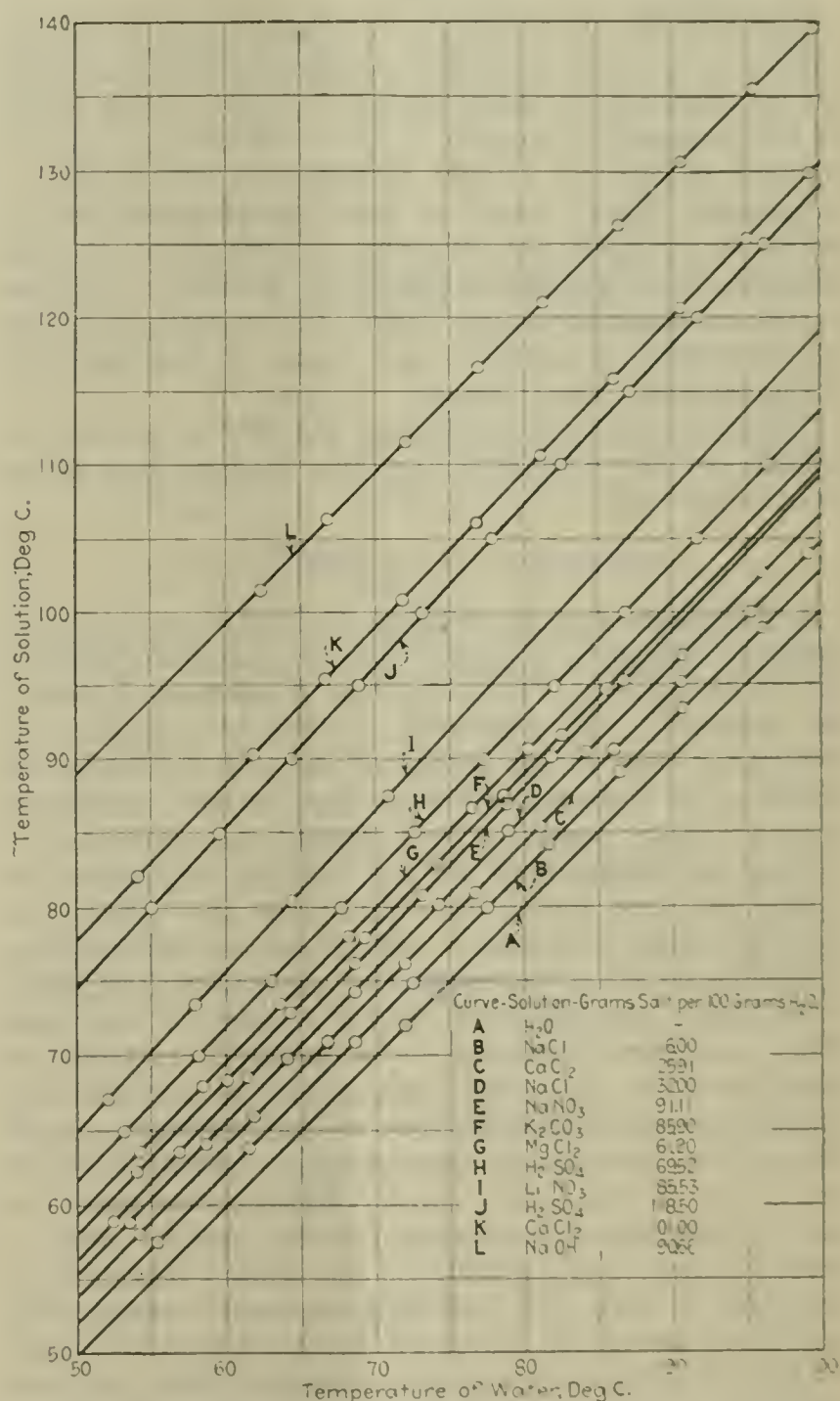


FIG. 2. BOILING POINTS OF CERTAIN SOLUTIONS PLOTTED AGAINST CORRESPONDING BOILING POINTS OF WATER UNDER THE SAME PRESSURE

plication of this rule to several solutions is shown by the curves in Fig. 2. This graph shows as ordinates the boiling points of certain solutions at various pressures, and as abscissas the corresponding boiling points of water under the same pressures. The boiling point data for this graph were selected rather at random both from the literature and from determinations by the authors. Some of the solutions represented ionize highly, others

⁵Eighth edition.

⁶Ann. Phys. (4), vol. 26, p. 833 (1908).

⁷W. L. Badger and E. M. Baker, *ibid.*

⁸Neue Grundgesetze sur nationale Physik und Chemie (erste folge: Leipzig 1878).

⁹Z. phys. Chem., vol. 1, p. 250.

to a less extent. Some of the solutes are not ordinarily considered to form a series of hydrated particles in solution, others are known to associate strongly. There is a great diversity of the chemical nature of the solutes considered. The actual data plotted are shown in each case by the circles. The curves as drawn are straight lines, and coincide with the data very closely. With few exceptions, the deviation is less than 0.1 deg. C., and in all cases the straight line more nearly represents the data than any other smooth curve that might be drawn. The variation of individual points from the straight line is presumably due to experimental error, and the general agreement of the data with Dühring's rule is most remarkable. That is to say, all these solutions obey

$$\text{the relationship } K = \frac{t_1 - t_2}{\theta_1 - \theta_2}$$

Accordingly, if Dühring's rule holds, as this study indicates, in order to define completely and accurately the relationship of vapor pressure to the boiling point of an unsaturated solution of any strength (an infinite number of data), it is only necessary to record two relationships—viz., a curve or table showing the boiling point of solutions of different concentrations at one pressure, for example, atmospheric pressure; and the curve or equation which shows the relation between concentration of solutions and slope of the lines for these varying concentrations.

From these two sets of data, the boiling point of a solution of any composition at any pressure may be at once calculated.

APPLICATION OF DÜHRING'S RULE

It is evident that in order to obtain the above information, instead of carrying out an indefinite number of determinations of boiling points of solutions at different strengths and pressures, it is only necessary to determine the boiling points of each of a number of solutions of different concentrations at two pressures. One of these pressures will usually be atmospheric. Thus, the establishing of the relation expressed by Dühring's rule has greatly decreased the number of determinations necessary to obtain the information and has simplified the method of recording these data.

To define completely the whole system for saturated and unsaturated solutions, it is necessary to know, in addition to the above, the boiling point of the saturated solution at different pressures, or else the solubility of the solute at different temperatures. With either of these sets of data, a line can be drawn on the chart for the system which will show, at the various solution temperatures, the solubility of the solute. The area to one side of this line will then represent unsaturated solutions for which Dühring's rule will hold; the area to the other side will represent supersaturated solutions and these should not exist under the given conditions; and the line itself will define the boiling points of the saturated solution at different pressures.

We desire to emphasize again that the relationships expressed by Dühring's rule appear to hold, for unsaturated aqueous solutions where the solute does not exert an appreciable vapor pressure, more accurately than data which have been determined, without regard to (1) whether the concentration is high or low, (2) whether or not the solute ionizes, and (3) whether or not the molecules or ions of the solute take up water of hydration or association. It is not at all necessary that the solution be "ideal," to conform rigorously to the law.

It should be pointed out that the curves in Fig. 2 are not parallel (in general) either to each other or to the curve for water, nor is there a definite relation between the slope of the curves and the elevation of the boiling point at any given pressure.

It is planned to use the apparatus and the method as described in this paper in a number of investigations. Two such investigations have already been completed, and are to be published in subsequent papers.¹⁰

The authors desire to acknowledge the assistance received from the National Research Council, which made possible this work, and of the active interest taken by Prof. W. L. Badger of this department.

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Increased Production of Rosin and Turpentine

The production of rosin rose 29 per cent, or 350,000 round barrels, and that of turpentine 33 per cent, or 122,000 casks, during the season 1920-21 over that of the previous season, according to a recent statement of the United States Bureau of Chemistry.

The following table, compiled from reports from individual producers, shows the production of rosin by states for the last three years:

ROSIN PRODUCTION IN ROUND BARRELS

State	1918-19	1919-20	1920-21
Alabama	136,180	141,410	150,310
Florida	414,150	495,660	548,880
Georgia	215,550	262,050	425,530
Louisiana	165,300	130,430	214,580
Mississippi	109,120	119,610	175,810
N. Carolina	2,920	4,090	1,740
S. Carolina	2,340	3,430	8,250
Texas	68,600	64,090	52,290
Total	1,114,160	1,220,770	1,577,390

The production of turpentine by states is given below:

TURPENTINE PRODUCTION IN CASKS

State	1918-19	1919-20	1920-21
Alabama	41,580	43,800	47,220
Florida	125,680	144,180	170,870
Georgia	65,470	82,420	133,070
Louisiana	52,850	38,950	65,520
Mississippi	31,920	36,080	53,430
N. Carolina	880	1,340	530
S. Carolina	690	1,110	2,540
Texas	21,200	18,690	15,410
Total	340,270	366,570	488,590

On the Heat-Treatment of Aluminum Bronze

In the article "On the Heat-Treatment of Aluminum Bronze," by A. A. Blue, in the Dec. 7 issue of CHEMICAL & METALLURGICAL ENGINEERING, an error due to a misunderstanding occurred in Table V on page 1048. The table as corrected should read as follows:

TABLE V. PROPERTIES OF FORGED ALUMINUM BRONZE

Treatment	Tensile Strength, Lb. per Sq. In.	Elastic Limit, Lb. per Sq. In.	Elongation, per Cent	Contraction in Area, per Cent
Forged, untreated	79,750	34,360	32.5	34.8
Forged, untreated	81,245	34,240	31.0	30.8
Forged, reheated to 1,650 deg. F. and quenched in brine	92,190	44,820	Broke outside gage marks.	
Forged, reheated to 1,650 deg. F., quenched in brine, drawn to 1,000 deg. F. and cooled in lime	81,345	43,820	Broke outside gage marks.	
Forged, reheated to 1,650 deg. F., quenched in brine, drawn to 1,000 deg. F. and cooled in lime	86,490	47,760	12.0	14.9

¹⁰"Vapor Pressure of the System Calcium Chloride-Water," by E. M. Baker and V. H. Waite (to appear in an early issue of CHEM. & MET. ENG.). "Vapor Pressure of the System Sodium Hydroxide-Water and of Sodium Hydroxide-Sodium Chloride-Water," by E. M. Baker and A. R. Carr.

Fatigue of Metals Under Repeated Stress

Professors Moore and Kommers Believe That Carbon Steels Will Not Fail by "Fatigue" if Stressed Below a Definite Amount, Quickly Determined by Measuring the Heat Generated in the Specimen During the Test

AS HAS been noted in these columns, Professors Moore and Kommers, of the University of Illinois, have been conducting an investigation upon fatigue failure under the joint auspices of the University Engineering Experiment Station, the Engineering Foundation and the General Electric Co. Bulletin 124 of the Experiment Station describes in considerable detail the results so far obtained.

Table I gives the chemical analysis of the steels tested; each of these was heat-treated to bring it in that condition often found in machine parts. (See Table II.) Usual physical tests were performed with the results listed in Table III. Fatigue tests were made on a battery of machines designed along lines proposed by F. M. Farmer.¹ Specimen A is rotated in swivel end bearings, and carries the load W at two places, C and D . These arrangements are designed to throw a uniform bending moment in a cylindrical specimen, but in order to localize the failure, the test-piece was reduced to a neck 0.30 in. in diameter by a fillet of 9.85 in. radius. Final polishing was done with No. 00 emery cloth.

In making the rotating-beam test on the first specimen a stress was applied which would cause failure in a short time. In successive specimens the stress was reduced until a stress was reached which the specimen could withstand for 100,000,000 cycles without failure.

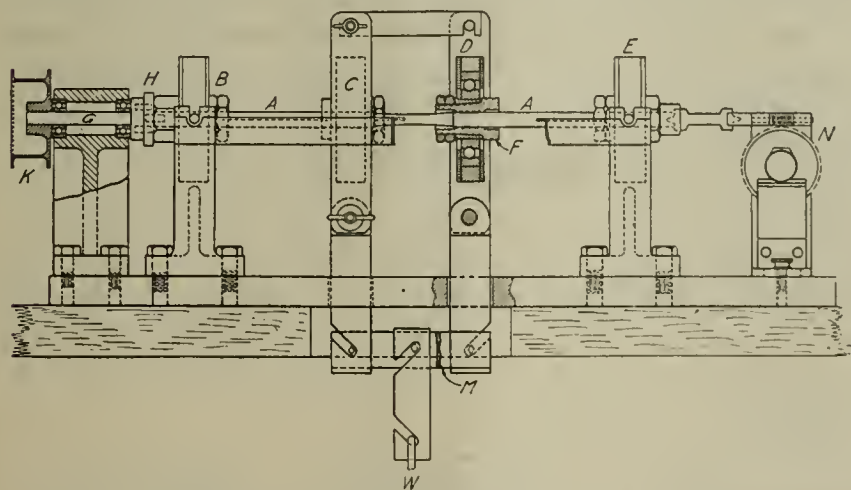


FIG. 1. SKETCH OF ROTATING BEAM MACHINE FOR MEASURING ENDURANCE OF METAL

Wherever possible these long-time tests without failure were run on from three to five specimens for each of the steels investigated. Altogether 963 reversed-stress tests were made.

Fig. 2 shows the results of fatigue tests on eutectoid steel No. 6. All the diagrams are plotted with logarithmic co-ordinates, stresses against number of cycles for rupture ($S-N$ diagrams). The authors have interpreted all their plots to indicate that up to some value of N the results of the reversed-stress tests may be well represented by a sloping straight line, where there is a decided break. For higher values of N a

horizontal straight line seems to represent the relation between S and N , up to a value of N of 100,000,000 cycles of stress, with no indication of a further break in the diagram. So far as they can see from their test results, the material would withstand an indefinite number of reversals of stress lower than the value corresponding to this break in the $S-N$ diagram. To this safe stress the name "endurance limit" has been given,

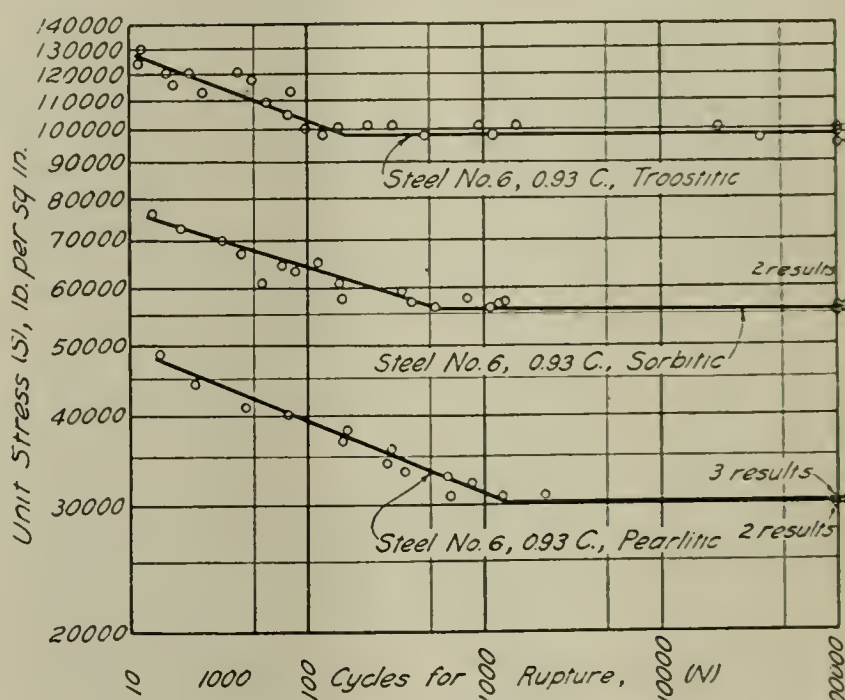


FIG. 2. TEST RESULTS ON ALTERNATIONS TO FAILURE OF EUTECTOID STEEL, VARIOUSLY HEAT-TREATED

and in all the steels tested it was developed at less than 10,000,000 reversals. In other words, a steel which will not break before 10,000,000 reversals can be expected to endure 100,000,000, and perhaps forever.

Searching for some short-time test for predicting fatigue resistance, this was found by measuring the rise of temperature² under a reversed stress applied for a few minutes or less.

The apparatus used in making the temperature test is shown in Fig. 3. The machine was designed to test the regular 13-in. rotating-beam specimen and to produce the same type of stress. Specimen S is held horizontally in V-notch grips A . The load is applied on a ball bearing B , at the end of the specimen, the bearing being heat-insulated from the specimen by a fiber collar $\frac{1}{8}$ in. thick. The machine is also heat-insulated from the base at points E and F , to prevent heat traveling from the bearings through the base to the specimen. The load on the specimen is measured by reading the deflection of the Ames dial C , a load-deflection curve

²The temperature test was suggested and to some extent used by C. E. Stromeyer of Manchester, England, as long ago as 1913. He did not, however, have the opportunity of carrying out a sufficient number of long-time tests to establish thoroughly the temperature limit as identical with the endurance limit under repeated stress. It should be stated that the credit of developing the temperature test in connection with the present investigation should be given to J. W. Harsch, a member of the test party of the present investigation, and to Prof. W. J. Putnam of the department of theoretical and applied mechanics of the University of Illinois.

¹American Society for Testing Materials, 1919.

for the specimen having been previously obtained by recording a set of loads and corresponding deflection readings. The load can be varied by an adjusting screw, *D*, in the head of the machine. A thermocouple cannot be readily attached to a rotating specimen, and it will be noted that the machine is so designed that the specimen does not turn, but that the head of the machine rotates. The left-hand end of the specimen is thus moved in a circle concentric with its axis, the radius of the circle being the deflection corresponding to the desired stress.

Differential copper-constantan thermocouples were used to measure the rise of temperature. One couple was attached at the section of greatest stress *K*, and was held directly against the specimen by means of tape. The other couple was at *L*, a section of zero stress, and was separated from the specimen by a

single layer of thin paper. The couples were connected in series, and the free wires lead to a D'Arsonval galvanometer. When the couples were at the same temperature no deflection of the galvanometer was shown, but when the temperature became different a corresponding deflection occurred.

The temperature test consists in running the machine at a speed of 1,000 r.p.m. for 30 seconds, using a known stress and recording the maximum deflection of the galvanometer. Then with a series of such readings, corresponding to a series of stresses, a curve like those of Fig. 4 is plotted to show the increase in temperature with increase of stress. The point at which the curve shows a sharp break corresponds to the endurance limit. In the cases of sorbitic structures in plain carbon steels and in that of alloy steels it was found necessary to increase the time of the run, at

TABLE I. CHEMICAL ANALYSIS OF STEELS TESTED

Steel No.	Furnished by	Material Furnished in	Content, Per Cent						
			Carbon	Chromium	Nickel	Silicon	Manganese	Phosphorus	Sulphur
1	Illinois Steel Co.	2 x 1 flats	1.20	.....	.....	0.19	0.25	0.021	0.021
3	John A. Roebling's Sons Co.	Billets, 4 in. square	0.52	.....	.....	0.24	0.56	0.037	0.029
4	John A. Roebling's Sons Co.	Billets, 4 in. square	0.37	.....	.....	0.16	0.58	0.032	0.035
5	Halcomb Steel Co.	2 x 1 flats	0.24	0.87	3.33	0.15	0.37	0.019	0.025
6	Carnegie Steel Co. through Standard Steel Co.	2 x 1 flats	0.93	.....	.....	0.03	0.38	0.017	0.045
7	Midvale Steel & Ord. Co. through General Electric Co.	1 in. squares	0.41	0.18	3.41	0.25	0.75	0.020	0.020
9	American Rolling Mill Co.	1 in. rounds	0.02	.....	.....	0.02	0.03	0.005	0.042
10	Inland Steel Co.	1 1/2 in. squares	0.49	.....	.....	0.12	0.46	0.017	0.029
50	J. T. Ryerson & Son, (cold-drawn screw stock)	1/2 in. rounds	0.20	.....	.....	0.03	0.67	0.025	0.090
51	University of Illinois stock (hot-rolled reinforcing rod)	1/2 in. rounds	0.18	.....	.....	0.06	0.37	0.013	0.039

TABLE II. HEAT-TREATMENTS OF STEELS TESTED

Steel No.	Structure	Heat-Treatment
No. 1—1.20 Carbon	Normalized	Heat to 1,460° F.; hold 15 min.; cool in furnace (this anneals the steel so that it can be machined); then heat to 1,580° F.; hold 15 min. Cool in furnace with door open.
No. 3—0.52 Carbon	Sorbitic	First anneal as above; then heat to 1,470° F.; quench in oil; reheat to 860° F.; hold 30 min.; cool in air.
	Normalized	Heat to 1,550° F.; hold 15 min.; cool in air.
No. 4—0.37 Carbon	Sorbitic	First normalize as above; then heat to 1,450° F.; hold 15 min.; quench in water; reheat to 1,200° F.; cool in air.
	Normalized	Heat to 1,495° F.; hold 15 min.; cool in furnace with door open.
	Sorbitic, Treatments A & B	This steel was not first normalized. Heat to 1,550° F.; hold 15 min.; quench in water; reheat to 1,050° F.; cool in air.
No. 5 Chromium-Nickel	Treatment A	Steel received annealed. Heat to 1,525° F.; quench in oil; reheat to 700° F.; quench in oil.
	Treatment B	Steel received annealed. Heat to 1,525° F.; hold for 1/2 hour, quench in oil. Reheat to 1,450° F.; quench in oil; reheat to 1,200° F.; hold for 1 hour, cool in furnace.
	Treatment C	Steel received annealed. Heat to 1,525° F.; hold for 1/2 hour, quench in oil; reheat to 1,450° F.; quench in oil; reheat to 1,200° F.; hold for 1 hour; quench in water.
No. 6—0.93 Carbon	Normalized	Heat to 1,600° F.; hold 15 min.; cool in air.
	Pearlitic	First normalize as above; then heat to 1,450° F.; hold 15 min., cool in furnace.
	Sorbitic	First normalize as above; then heat to 1,450° F.; hold 15 min., quench in oil; reheat to 1,200° F.; hold 30 min. cool in air.
	Troostitic	First normalize as above; then heat to 1,450° F.; hold 15 min., quench in oil; reheat to 850° F.; hold 30 min.; cool in air.
No. 7—Nickel	Treatment B	Normalize by heating to 1,525° F. and cooling in furnace; then heat to 1,525° F.; quench in oil; reheat to 1,210° F.; hold 2 hours; cool in furnace.
No. 9—0.02 Carbon	Ferrite	Tested as received.
No. 10—0.49 Carbon	Normalized	Heat to 1,700° F.; hold 20 min.; cool in air.
	Sorbitic	First normalize as above; then heat to 1,427° F.; quench in water; reheat to 1,200° F.; cool in furnace.
No. 50—Cold-drawn	As received	
	Annealed	Heated to 1,300° F.; hold for 15 min.; cool in furnace.
	Annealed	Heated to 1,550° F.; hold for 15 min.; cool in furnace.
No. 51—Hot-rolled	As received	
	Cold-stretched	Reduced to diameter of 0.44 in.; then heated to 500° F.; cool in furnace.
	Cold stretched	Reduced to diameter of 0.48 in.; then heated to 500° F.; cool in furnace.
	Cold bent	Bent to an angle of 45° at the middle, straightened cold.

TABLE III. RESULTS OF PHYSICAL TESTS

No.	Steel	Tension				Impact Bending		Impact Tension		Compression		Torsion	
		Proportional Elastic Limit	Ultimate	Per Cent of Elongation	Per Cent of Reduction of Area	Hardness Brinell	Energy of Rupture, Ft.Lb.	Per Cent of Elongation	Per Cent of Reduction of Area	Proportional Elastic Limit	Ultimate	Proportional Elastic Limit	Modulus of Elasticity
9	As received	16,100	42,400	48.3	76.2	69	19.3	84.9	27.0	72.7	19,200	31,200	12,500
51	As received	38,200	61,500	41.0	66.7	...	...	...	...	...	...	...	...
51	Reduced to 0.48 in.	60,000	67,600	22.3	63.3	...	...	...	...	...	...	...	...
51	Reduced to 0.44 in.	69,600	73,400	14.2	59.5	...	...	...	...	...	...	...	...
51	Bent cold and straightened	...	...	...	...	...	...	...	...	...	...	...	...
50	As received	55,200	86,800	13.8	49.3	...	...	...	...	...	...	...	...
50	Annealed at 1,300 deg. F.	26,700	56,600	41.3	65.5	...	...	...	...	...	...	...	...
50	Annealed at 1,550 deg. F.	28,000	57,700	40.8	63.2	...	...	...	...	...	...	...	...
4	Normalized	34,500	71,900	29.4	53.5	132	18	15.8	32.4	52.7	36,300	59,200	20,300
4	Sorbitic—Treatment A	80,600	102,600	23.3	65.1	209	26	53.2	163.2	24.0	62.8	75,800	102,800
4	Sorbitic—Treatment B	61,500	94,200	25.0	63.0	...	...	...	...	...	...	...	...
10	Sorbitic	67,700	96,900	23.5	57.8	197	23	22.5	152.3	24.0	55.1	55,900	76,500
3	Normalized	45,400	98,000	24.4	41.7	193	24	13.2	188.5	24.2	45.6	47,800	78,700
3	Sorbitic	80,300	111,400	21.9	56.6	227	30	21.4	172.0	22.2	55.1	84,400	97,800
6	Pearlitic	28,000	84,100	24.8	37.2	162	23	2.2	141.3	21.2	34.5	23,500	69,200
6	Sorbitic	60,300	115,000	23.0	39.6	227	31	3.3	193.2	21.6	43.9	64,800	97,100
6	Troostitic	97,200	188,300	9.9	29.3	380	51	4.4	186.8	15.0	41.3	106,500	75,200
1	Normalized	58,600	116,900	7.9	11.6	224	31	1.9	88.8	8.8	14.6	55,300	96,500
1	Sorbitic	120,400	179,900	9.0	15.2	369	45	2.0	109.1	6.3	11.0	102,700	149,200
7	Treatment B	82,400	111,800	23.6	60.2	242	28	41.0	179.9	22.8	57.4	86,400	95,100
5	Treatment A	115,500	138,700	18.2	61.8	291	36	45.4	173.8	17.0	61.7	122,600	133,000
5	Treatment B	191,700	113,300	24.2	68.7	247	28	53.8	175.3	22.2	63.2	97,800	100,300
5	Treatment C	86,200	114,200	23.2	69.3	246	29	56.0	187.6	23.4	67.0	91,500	99,900

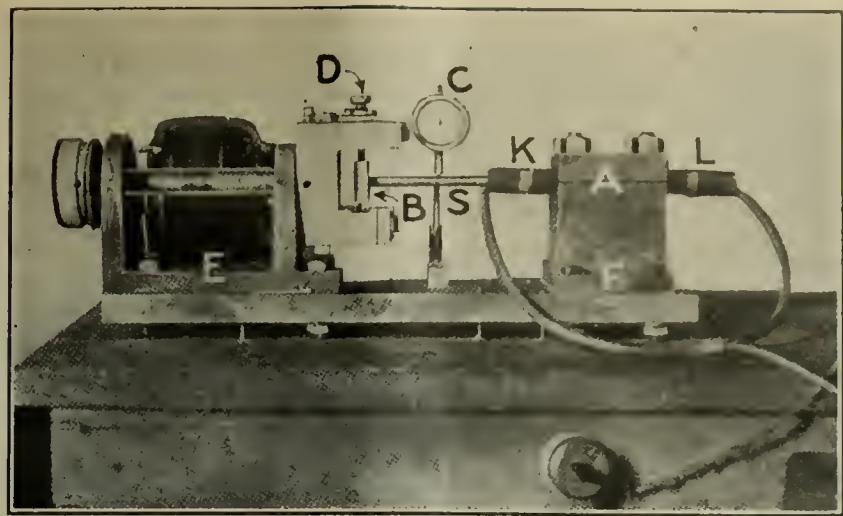


FIG. 3. BENDING MACHINE FOR MEASURING HEAT DEVELOPED DURING ALTERNATE STRESSING

each stress, from 30 seconds to 2 minutes, since these materials are slower in heating under stress.

A reference to Table IV and Fig. 5 shows a very good degree of coincidence between the values of endurance limit determined by the temperature test and those values determined by long-time rotating-beam tests.

Various physical properties of the steels used in this investigation are plotted in Figs. 5 and 6. It is apparent that the endurance limit (by rotating beam and logarithmic plot) corresponds most closely to the rise in temperature determinations. Fairly good parallelism exists between the curve for endurance limit and curves for Brinell hardness and ultimate tensile strength. Other properties vary widely. In none of the steels did the endurance limit under completely reversed stress fall below 36 per cent of the ultimate tensile strength; in only one metal did the endurance limit fall below 40 per cent of the ultimate tensile strength, while for several metals the endurance limit was more than 50 per cent of the ultimate tensile strength. In this connection it should be noted that the steels tested were to a high degree free from inclusions and other internal defects, that the specimens had no abrupt changes of outline, and that they had a good surface finish.

Effect of Shape of Specimens on Endurance Limit.—Previous investigators have shown that the shape of the specimen may exert a very great influence on the endurance strength of the material. Square shoulders and sharp notches are known to reduce the endurance limit as much as 50 per cent.

A study of this matter was first made in this investigation on a 0.49 carbon, sorbitic steel. It was found that specimens which had their diameter reduced by a fillet 1-in. radius were almost as strong as those in which a radius of 9.85 in. was used. A ½-in. radius reduced the strength about 8 per cent, square shoulders reduced the strength about 51 per cent, and a V-notch reduced the strength about 60 per cent. Square shoulders and a 1-in. radius showed about the same effect on a very soft 0.02 carbon as they did with the harder steel first mentioned.

Effect of Surface Finish on the Endurance Limit.—It has been known that the condition of the surface of a specimen may exert a marked influence on the fatigue strength of steel. A study of this matter was first

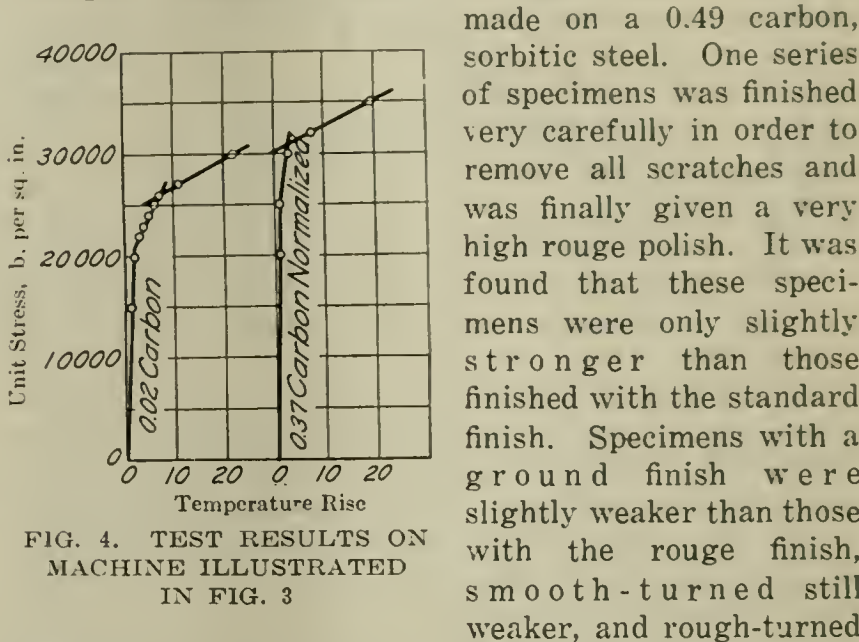


FIG. 4. TEST RESULTS ON MACHINE ILLUSTRATED IN FIG. 3

made on a 0.49 carbon, sorbitic steel. One series of specimens was finished very carefully in order to remove all scratches and was finally given a very high rouge polish. It was found that these specimens were only slightly stronger than those finished with the standard finish. Specimens with a ground finish were slightly weaker than those with the rouge finish, smooth-turned still weaker, and rough-turned

weaker even than the smooth-turned. The rough-turned specimens were about 18 per cent lower in endurance limit than those finished with the rouge polish. Similar results on the smooth-turned and rough-turned specimens were found with a very soft 0.02 carbon steel.

Effect of Overstress on Endurance Limit.—In order to determine whether stressing a specimen above its normal endurance limit would have a serious effect on the endurance limit under subsequent stresses, a number of different combinations of overstress and cycles of rupture were tried on a 0.49 carbon, sorbitic steel. For instance, one series of specimens was given 5,000 cycles of stress at a unit stress 10 per cent higher than its normal endurance limit. These specimens were then tested in the usual way to determine whether the over-

TABLE IV. ENDURANCE LIMITS						
No.	Steel	Endurance Limits			Francke Bending Fk Point in Francke Test	Repeated Impact Number of Double Blows
		Farmer Rotating Beam	Upton-Lewis Reversed Bending	Olsen-Foster Reversed Torsion		
9	0.02 Carbon, as received.....	26,000	23,000	12,500	.....	260
51	Hot-rolled—as received.....	28,000	.....	.....	.....	242
51	Hot-rolled—reduced to 0.48 in.....	35,000	.....	.....	.....	280
51	Hot-rolled—reduced to 0.44 in.....	41,000	.....	.....	.....	361
51	Hot-rolled—bent cold and straightened.....	30,000	.....	.....	.....	.....
50	Cold-drawn—as received.....	41,000	.....	.....	.....	316
50	Cold-drawn—annealed at 1,300 deg. F.....	29,000	.....	.....	.....	202
50	Cold-drawn—annealed at 1,550 deg. F.....	25,000	.....	.....	.....	223
4	0.37 Carbon normalized.....	33,000	30,000	16,000	33,000	183
4	0.37 Carbon sorbitic—treatment A.....	57,000	.....	32,500	.....	550
4	0.37 Carbon sorbitic—treatment B.....	45,000	.....	.....	44,000	503
10	0.49 Carbon sorbitic.....	48,000	39,000	26,000	.....	319
3	0.52 Carbon normalized.....	42,000	32,000	.....	39,500	275
3	0.52 Carbon sorbitic.....	55,000	44,000	.....	66,000	486
6	0.93 Carbon pearlitic.....	30,500	28,500	16,300	34,000	66
6	0.93 Carbon sorbitic.....	56,000	44,000	.....	.....	128
6	0.93 Carbon troostitic.....	98,000	.....	52,000	.....	227
1	1.20 Carbon normalized.....	50,000	45,000	.....	.....	39
1	1.20 Carbon sorbitic.....	92,000	.....	.....	.....	172
7	3½ Nickel—treatment B.....	63,000	.....	.....	.....	524
5	Chromium-nickel—treatment A.....	68,000	52,000	37,000	62,000	1,073
5	Chromium-nickel—treatment B.....	65,000	.....	31,500	.....	714
5	Chromium-nickel—treatment C.....	67,000	.....	.....	.....	722

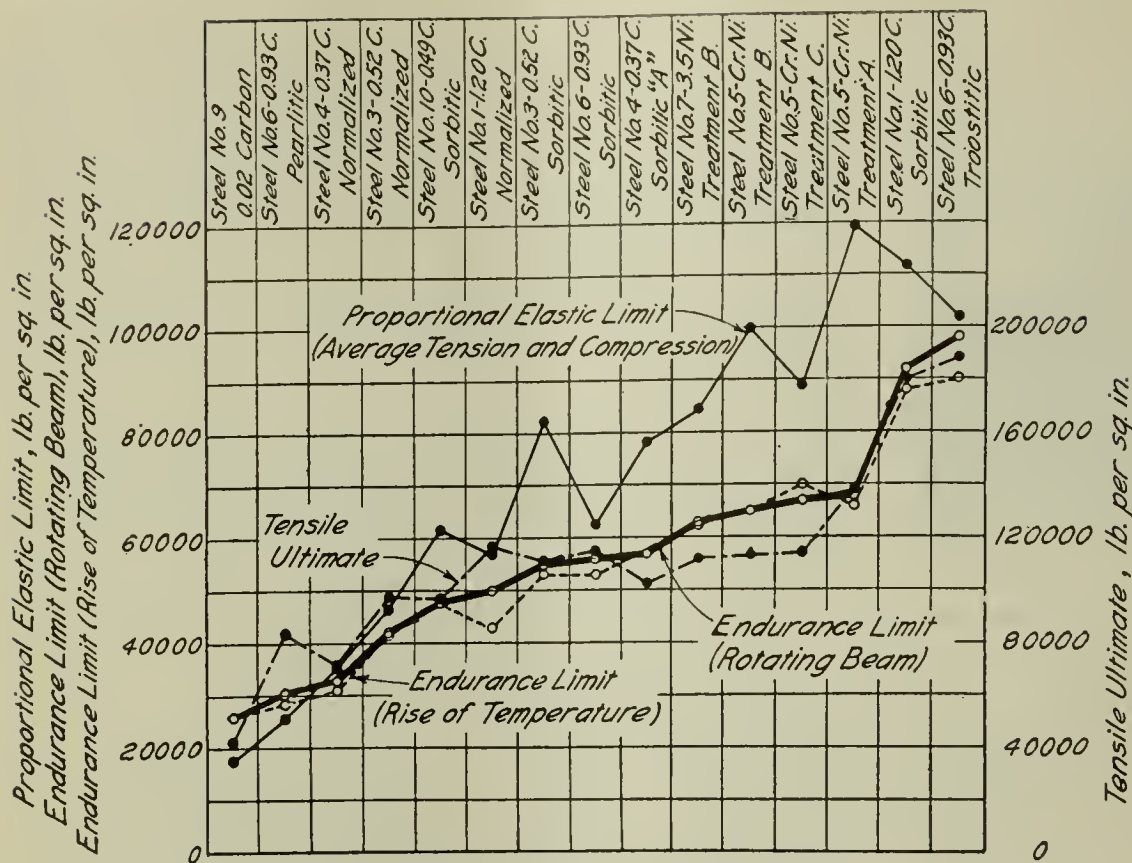


FIG. 5. COMPARATIVE PHYSICAL PROPERTIES OF STEELS UNDER TEST

stressing had changed the endurance limit. It was found that 10 per cent and 20 per cent of overstress applied 5,000 times, 29 per cent of overstress applied 1,000 times and 38 per cent of overstress applied 100 times did not reduce the endurance limit appreciably.

On the other hand, 35 per cent of overstress applied 1,000 times reduced the endurance limit about 4 per cent and 29 per cent of overstress applied 5,000 times reduced the endurance limit 11 per cent. It seems that a material may be able to withstand a considerable amount of overstress if the overstress is applied only a comparatively small number of times. Tests on a hard, high-carbon steel gave similar results to those above mentioned, the percentage of reduction being somewhat higher than for the soft steel.

Various Factors Influencing the Endurance Limit.

It is a well-known fact that the effect of subjecting steel to a tensile stress beyond the yield point is to raise the static elastic strength to a marked degree, as is illustrated by the strength of cold-drawn and cold-rolled steel. It was found in the case of a 0.18 carbon steel that the effect of such cold work was less marked on the endurance limit than on the static elastic strength, though some increase of the endurance limit was observed after cold working. Annealing of commercial cold-drawn screw stock was found to reduce its endurance limit.

Fig. 2 illustrates the effect of heat-treatment on the endurance limit. In the very soft condition of the pearl-

itic structure of the 0.93 carbon steel the material has an endurance limit of 30,500 lb. per sq.in. This can be increased by 84 per cent if the steel is given a sorbitic structure by heat-treatment, and by 221 per cent when it is given a troostitic structure. In general, a heat-treatment which raises the static elastic strength and the ultimate tensile strength raises the endurance limit also, but the increase in static strength is not a reliable indicator of the amount of increase in endurance limit.

In those cases in which the same steel was tested in a hard and a soft condition the results show that giving the material a sorbitic structure by heat-treatment may greatly increase the endurance limit without much sacrifice of ductility.

The results thus far obtained on eight different steels in reversed torsion indicate that the ratio of the endurance limit in torsion to the

endurance limit in bending is about 0.52.

With one very soft steel it was found that the computed stress at the endurance limit in bending was actually about 33 per cent higher than the proportional elastic limit in tension. This material was almost pure

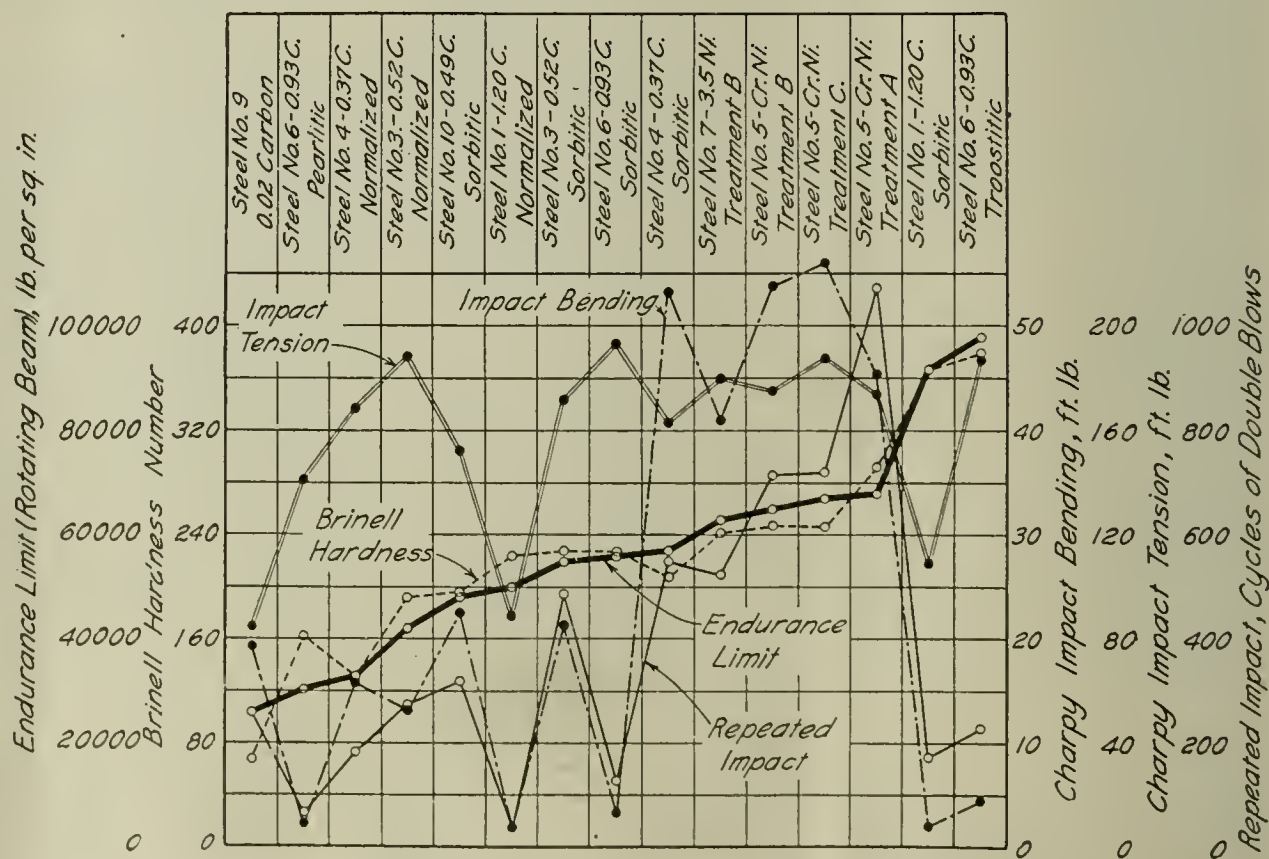


FIG. 6. COMPARATIVE PHYSICAL PROPERTIES OF STEELS UNDER TEST

ferrite and the result indicates that homogeneity of structure is a valuable factor in giving a high resistance against fatigue. Results indicate that thorough annealing also produces a high ratio of endurance limit to proportional elastic limit. It is quite possible to have a high ratio of endurance limit to proportional limit, when both are low.

Only one nickel and one chromium-nickel steel were investigated. The results indicate that the alloy steels have somewhat higher endurance limits for the same ductility, as compared with plain carbon steels.

Distillation Studies of Nitric Acid and Sulphuric-Nitric Acid Mixtures—II

Equilibria in the System Water:Nitric Acid:Sulphuric Acid During Distillation at Various Pressures
—Graphic Study of the Phenomena of Distillation—Application of the Experimental Data
to the Preconcentration and Superconcentration of Nitric Acid

By PAUL PASCAL

With the experimental assistance of Mr. Garnier

Study of the Ternaries: Water, Nitric Acid Sulphuric Acid

THE addition of sulphuric acid to a nitric acid modifies the volatility of the latter greatly. The phenomenon may be pictured by assuming that the sulphuric acid forms, with the water of the mixture, a non-volatile hydrate in an enriched nitric acid solution. The variation in the boiling point of the mixture with the first addition of sulphuric acid is determined principally by this "enrichment" in nitric acid, only later does the increase in the concentration of the sulphuric acid intervene, and the boiling temperature then rises in all cases.

It may thus be foreseen that the first addition of sulphuric acid will raise the boiling point of weak acids and lower that of strong acids.

But the most regular and most manifest effect of the addition of sulphuric acid is a rapid enrichment in nitric acid of the vapors emitted during boiling, and in a progressive effacement and displacement of the maximum toward acids of low nitric content.

In the zone of acids poor in water the boiling point varies very little as long as the sulphuric acid content remains below 60 to 70 per cent, but the nitric acid vapor emitted is then colored strongly red by the products of dissociation of the acid, and the true boiling point is distinctly lowered by this disturbing factor.

There are shown in Table IV the results of our experiments at various pressures, acids having about the same sulphuric acid content being grouped together. A final series comprehends mixtures which were almost anhydrous and which boiled with a partial dissociation of the vapor, at temperatures certainly too low; we have, however, included them because of the interest they present in practical operation.

The results of all these experiments may be reviewed by plotting in triangular co-ordinates the contours of the surface of boiling points, of which the altitude of the different points is a measure of the corresponding boiling point. Figs. 5, 6, 7 and 8 hold for the pressures 317, 458, 570 and 760 mm. respectively; the apexes of the reference triangles, *N*, *H* and *S*, represent 100 per cent nitric acid, water and 100 per cent sulphuric acid.

The contour lines have been plotted every 10 deg., and there has been added in dotted line the contour through the highest point of the maximum boiling point line, which, depending on the pressure, corresponds to 96, 104.5, 112.1 and 121.5 deg. C. respectively. For aqueous sulphuric acid the boiling point data of Bryce

Cudleigh Burt [*J. Chem. Soc.*, vol. 85, p. 1339 (1904)] have been used.

The momentary lowering of the maximum boiling point on the addition of sulphuric acid to a nitric acid of 65 to 68 per cent is noticeable, as well as the disappearance of this maximum in acid of this strength to which about twice its weight of sulphuric acid has been added and the rapid variation of the boiling point for mixtures containing three times as much sulphuric as nitric acid, for a water content of 15 to 20 per cent

But these acids of rapidly varying boiling point are just those employed in the manufacture of nitrocotton and it is known how strictly interdependent are the water content and the degree of nitration. It is thus possible to see in our results a justification of Saposchnikoff's contention that the degree of nitration of the cotton is directly influenced by the nitric acid vapor pressure of the bath. In the region which interests us, a small variation in water content displaces the boiling point considerably and in the same way affects the partial pressure of the nitric acid; it is thus comprehensible that it may cause the nitrogen content of the nitrocotton to vary rapidly.

COMPOSITION OF THE VAPORS EMITTED

The concentration in nitric acid, of the vapors emitted by mixed acids boiling under normal pressure is represented by the ternary diagram, Fig. 9, in which have been given, every 10 per cent, the boundaries of the mixtures giving vapors of the same composition. Lowering the pressure displaces the curves scarcely at all, in the direction of a higher acidity.

The distribution of the vapor composition curves shows besides, at least for mixtures not too rich in water nor too poor in nitric acid, that the composition of the vapor depends solely upon the water content of the boiling mixture. When there is less than 30 per cent of water in the liquid, the vapor contains less than 10 per cent water, with relatively little decomposition products, while for weaker acids the strength of the vapors rapidly decreases.

GRAPHIC STUDY OF THE PHENOMENA OF DISTILLATION

Let us designate by *n* the locus of the points representing the mixtures which on distillation yield a vapor of concentration *n* (Fig. 10). During this distillation the representative point *P* of the liquid, located at each instant upon a different curve *n*, is displaced continuously along the segment *nP* which joins *P* with the point *n* on the line *NH*, representing the vapor which passes over. The line *nP* is thus, at each instant, tangent to the trajectory at the point *P*, so that the line of the route passed over by the representative point of

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For Part I see *CHEM. & MET. ENG.*, vol. 25, No. 24, Dec. 14, 1921.

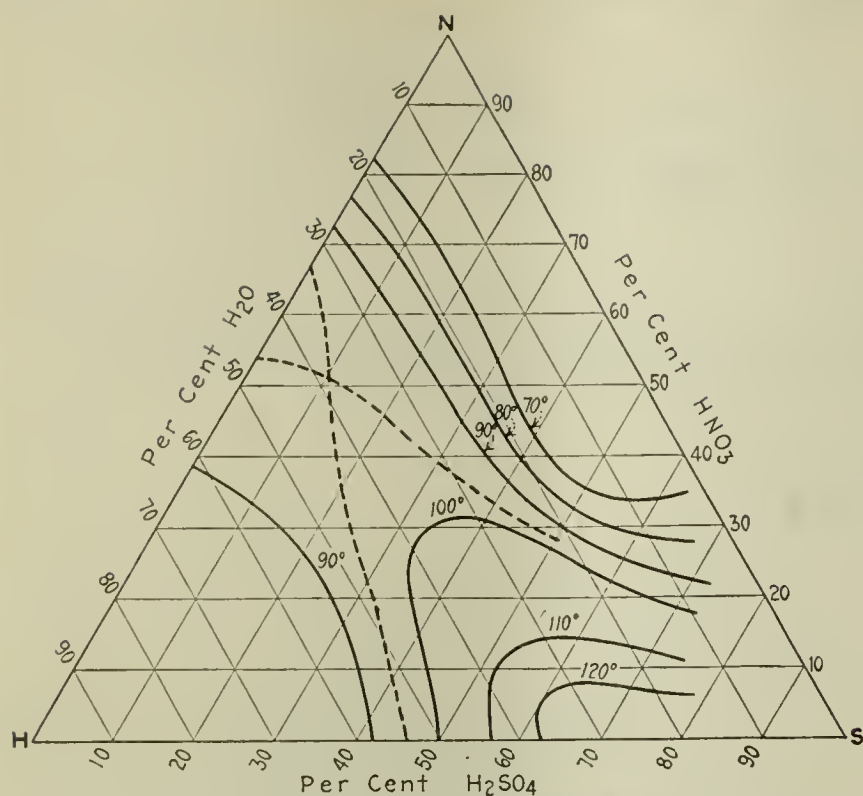


FIG. 5. BOILING POINTS OF H_2SO_4 : HNO_3 : H_2O MIXTURES AT 317 MM.

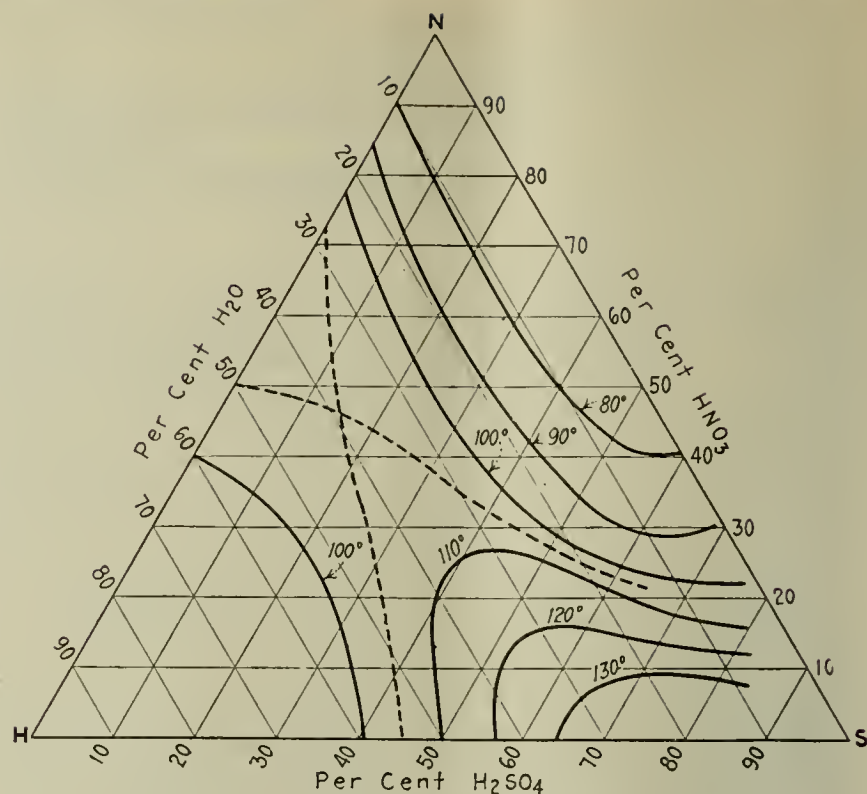


FIG. 6. BOILING POINTS OF H_2SO_4 : HNO_3 : H_2O MIXTURES AT 458 MM.

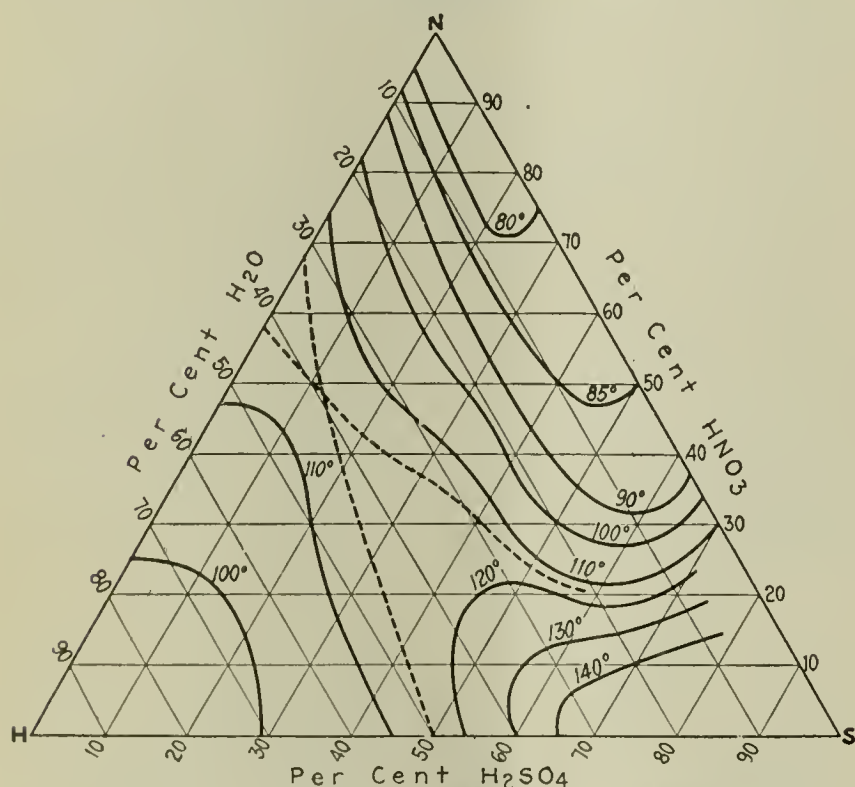


FIG. 7. BOILING POINTS OF H_2SO_4 : HNO_3 : H_2O MIXTURES AT 570 MM.

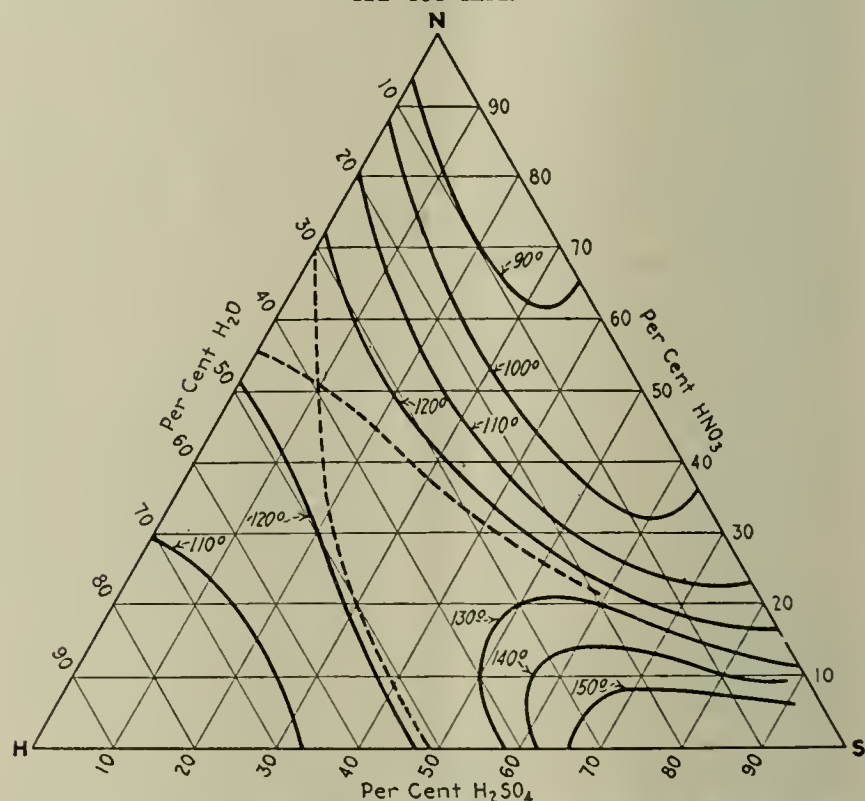


FIG. 8. BOILING POINTS OF H_2SO_4 : HNO_3 : H_2O MIXTURES AT 760 MM.

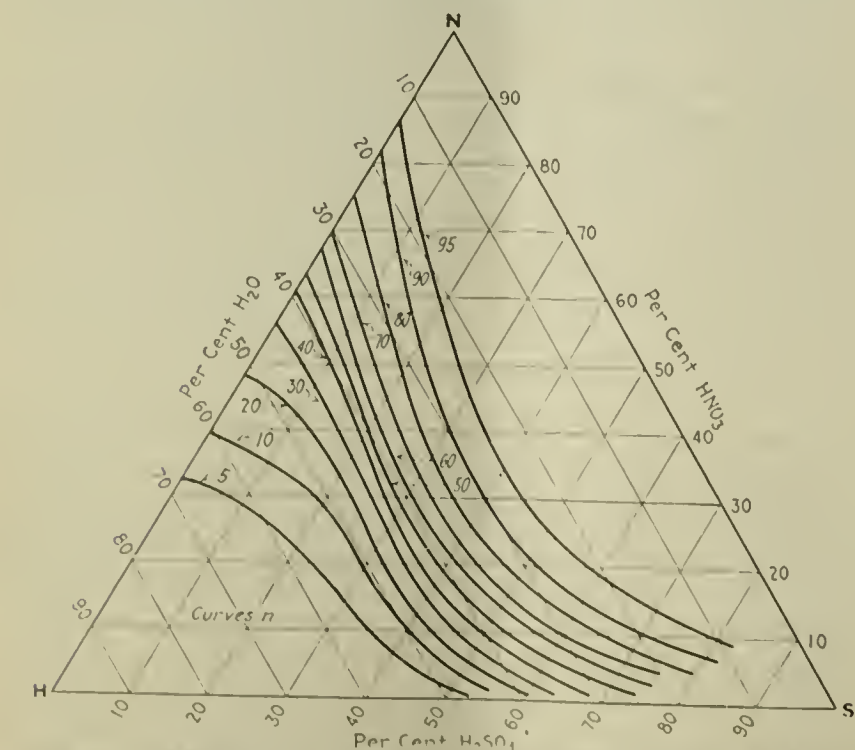


FIG. 9. COMPOSITION OF VAPORS IN EQUILIBRIUM WITH BOILING H_2SO_4 : HNO_3 : H_2O MIXTURES AT 760 MM.

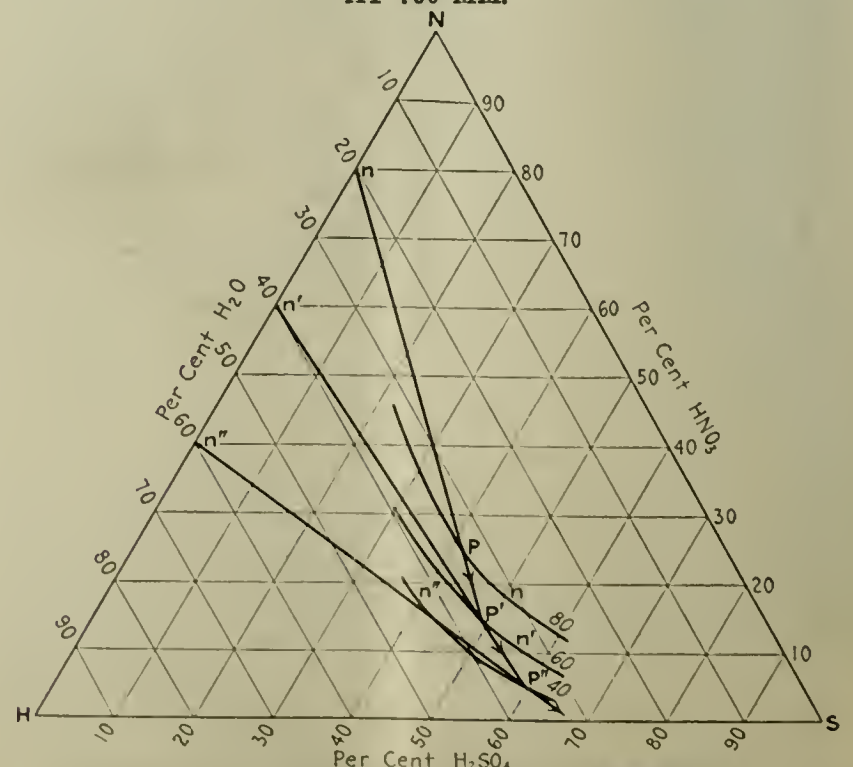


FIG. 10. CONSTRUCTION OF TRAJECTORY OF DISTILLATION

Note: The above curves were copied directly from the figures shown in the original article, which do not agree any too w' the numerical data. For very accurate work it will hence be necessary to redraw the curves.—F. C. Z.

the boiling liquid determines the series of rectilinear elements PP' , PP'' , $P''P'''$. . . , which join the successive points P , P' , P'' . . . to the points n , n' , n'' . . . corresponding to the curves n traversed at each instant by the trajectory of the point P . We pro-

TABLE IV. DISTILLATION EQUILIBRIA FOR THE SYSTEM
WATER : NITRIC ACID : SULPHURIC ACID
Acids of About 10 per Cent H_2SO_4

Pressure, Mm. Hg	Boiling Pt., Deg. C.	Liquid		Vapor, per Cent, HNO_3
		per Cent, HNO_3	per Cent, H_2SO_4	
300	87	23.75	10.20	5.92
440	95	25.20	10.31	4.25
570	102	25.30	9.90	4.05
760	110	25.30	9.98	4.10
300	92.0	37.11	9.91	23.0
440	103.0	40.10	10.20	20.1
550	107.5	39.53	10.01	16.25
760	117.0	40.02	9.91	15.52
760	121.0	46.70	10.70	36.0
760	121.2	48.00	10.0	38.5
300	97.0	49.00	10.0	38.5
440	104.5	49.23	10.30	45.0
570	112.5	50.00	10.10	50.5
760	121.5	50.25	10.18	50.17
300	96.0	52.11	10.00	57.02
400	103.0	50.88	10.20	50.19
440	104.0	50.88	10.20	50.2
760	121.0	50.69	10.10	56.0
300	95.0	57.10	10.0	79.0
400	102.5	56.23	9.98	76.0
440	103.5	56.23	9.98	76.23
550	110.0	57.0	10.1	75.28
760	120.5	58.0	10.8	75.0
300	89.0	64.0	12.8	95.15
440	102.0	60.80	9.0	92.50
550	97.5	69.10	10.0	92.15
760	117.5	62.0	8.20	95.60
300	78.5	72.27	10.38	98.98
440	89.0	71.27	10.08	98.18
550	92.5	73.23	10.40	97.20
760	102.0	72.50	11.00	96.51

Acids of About 20 per Cent H_2SO_4

Pressure, Mm. Hg	Boiling Pt., Deg. C.	Liquid per Cent, HNO_3	Liquid per Cent, H_2SO_4	Vapor, per Cent, HNO_3
300	85.0	20.01	20.18	3.2
440	97.5	20.22	20.71	3.2
550	103.0	20.31	21.22	3.3
760	113.0	20.10	21.37	3.1
300	93.5	30.15	21.20	9.8
440	103.0	31.33	21.31	10.0
550	110.0	30.05	20.21	9.7
760	119.5	30.01	19.98	10.0
300	96.0	34.5	20.18	30.0
440	106.0	35.20	20.27	29.7
550	112.0	35.10	21.02	28.9
760	122.0	35.02	20.07	28.5
300	97.0	41.22	21.00	68.0
440	106.0	39.29	20.90	67.5
550	112.0	40.07	20.37	66.0
760	122.0	41.01	20.01	64.2
300	94.0	50.11	20.65	83.0
440	104.5	50.53	20.50	82.0
550	110.0	50.17	19.98	82.8
760	120.0	50.50	20.18	82.0
300	71.5	64.29	20.17	97.2
440	84.5	64.10	21.02	96.5
550	91.5	64.17	19.97	96.5
760	102.5	64.13	20.29	96.2

Acids of About 30 per Cent H_2SO_4

Pressure, Mm. Hg	Boiling Pt., Deg. C.	Liquid per Cent, HNO_3	Liquid per Cent, H_2SO_4	Vapor, per Cent, HNO_3
300	89.0	11.23	32.15	4.1
440	100.0	11.05	32.16	3.0
550	107.5	10.95	31.18	2.4
760	116.0	11.28	32.00	2.0
300	94.5	21.02	32.15	14.0
440	104.5	20.15	31.17	13.0
550	111.5	21.02	31.23	12.4
760	121.5	19.05	32.10	10.0
300	98.0	32.18	32.17	67.6
440	108.0	31.19	32.25	65.0
550	114.5	30.98	32.18	62.0
760	124.0	32.0	31.05	63.0
300	97.6	39.35	31.23	92.7
440	102.5	39.75	31.19	92.5
550	110.0	39.66	32.30	92.0
760	120.0	40.01	32.09	91.50
300	71.0	56.23	31.75	99.80
440	82.5	55.14	32.20	99.55
550	83.0	54.98	31.23	99.50
760	99.0	55.25	30.10	99.14

Acids of About 40 per Cent H_2SO_4

Pressure, Mm. Hg	Boiling Pt., Deg. C.	Liquid per Cent, HNO_3	Liquid per Cent, H_2SO_4	Vapor, per Cent, HNO_3
300	98.0	10.01	40.05	23.21
440	106.0	12.25	42.38	24.15
550	114.0	10.05	41.25	22.18
760	124.0	10.01	41.15	21.42
300	102.0	15.76	42.92	34.18
440	111.0	15.95	42.86	35.06
550	117.5	16.40	42.08	35.20
760	127.0	15.23	40.07	35.49
300	105.0	20.18	41.15	73.25
440	112.0	20.05	41.03	73.17
550	118.0	19.75	42.53	71.0
760	128.0	18.08	46.31	70.80
300	100.0	29.85	39.85	92.0
440	105.5	29.75	40.25	91.82
550	110.0	30.18	40.10	91.18
760	119.5	31.50	41.05	90.50
300	71.5	34.18	41.57	99.27
440	82	35.06	40.57	98.36
550	102.5	35.20	40.39	96.02
760	110	34.49	41.05	98.54

Pressure, Mm. Hg	Boiling Pt., Deg. C.	Liquid		Vapor, per Cent, HNO_3
		per Cent, HNO_3	per Cent, H_2SO_4	
Acids of About 50 per Cent H_2SO_4				
300	104.0	11.21	47.46	33.0
440	114.5	10.13	47.60	32.5
550	120.5	10.29	48.22	32.5
760	130.0	10.05	49.81	42.0
300	106.5	14.97	51.17	61.5
440	116.0	15.17	49.98	61.5
550	122.5	15.21	49.15	60.0
760	133.5	15.07	49.93	60.0
300	106.0	19.28	51.07	91.7
440	116.0	19.36	52.18	91.6
550	122.0	19.52	51.99	91.0
760	133.0	19.49	52.06	90.0
300	80.0	30.18	51.20	98.00
440	89.0	29.19	51.03	98.02
550	100.0	29.89	51.15	97.08
760	110.0	30.28	50.05	97.50
300	66.5	41.05	51.22	99.70
440	80.0	40.35	50.15	99.80
550	86.5	40.10	49.95	99.60
760	97.5	41.50	50.10	99.15

Acids of About 60 per Cent H_2SO_4

Pressure, Mm. Hg	Boiling Pt., Deg. C.	Liquid per Cent, HNO_3	Liquid per Cent, H_2SO_4	Vapor, per Cent, HNO_3
300	116.0	6.10	61.01	51.17
440	127.5	5.21	59.95	51.10
550	135.0	4.99	59.98	49.20
760	145.0	5.13	60.21	48.00
300	116.5	10.01	59.95	68.51
440	127.5	10.28	59.98	68.10
550	135.0	10.17	60.17	67.75
760	145.0	10.01	60.18	67.00
300	103.0	21.05	59.99	99.93
440	110.0	19.95	60.21	98.99
550	120.0	19.99	60.67	98.77
760	120.0	19.99	60.67	98.77
300	71.00	31.93	61.00	99.94
440	82.50	32.19	59.93	99.93
550	89.00	33.0	59.61	99.0
760	99.00	32.0	59.0	98.91
300	105.0	19.07	59.99	98.27
440	116.0	18.16	60.15	98.0
550	124.0	18.21	61.01	98.10
760	134.0	18.01	60.23	97.5

Acids of About 65 per Cent H_2SO_4

Pressure, Mm. Hg	Boiling Pt., Deg. C.	Liquid per Cent, HNO_3	Liquid per Cent, H_2SO_4	Vapor, per Cent, HNO_3
300	121 (?)	9.95	65.17	90.20
440	132.0	10.17	67.0	89.75
550	137.5	11.0	66.11	89.0
760	147.0	10.07	65.15	89.55
300	95.0	21.02	64.33	99.60
440	106.0	20.53	64.49	99.60
550	112.5	19.98	65.57	99.60
760	118.0	20.10	64.90	99.15

Almost Anhydrous Mixed Acids

Pressure, Mm. Hg	Boiling Point, Deg. C.	Liquid			Vapor	
		HNO_3	H_2SO_4	NO_2	HNO_3	NO_2
300	66	59.27	38.62	0.75	93.45	4.0
440	79	57.29	40.10	0.75	92.63	4.54
550	87	57.12	40.0	0.95	92.86	4.10
760	91	57.28	40.12	0.74	92.55	4.13
300	54	73.95	23.0	1.19	93.84	3.93
440	73	73.45	22.5	1.19	93.70	4.00
760	87.5	73.48	23.5	1.17	92.89	4.15
300	75	30.62	66.63	0.63	96.31	1.27
440	86	30.40	66.90	0.64	94.08	2.15
550	95	31.14	66.93	0.63	92.78	3.17
760	104	28.73	68.05	0.63	90.49	4.15
300	67	39.22	44.60	0.50	97.47	1.11
440	79.5	39.58	44.0	0.60	97.40	1.10
550	87	39.09	44.2	0.80	97.26	1.20
760	97	39.32	44.5	0.50	97.23	1.21
300	73	35.18	47.28	0.60	97.62	1.00
440	85	34.80	47.16	0.80	97.55	1.01
550	90	35.12	47.20	0.60	97.39	1.07
760	100	34.58	48.0	0.60	97.50	1.02
300	66	38.73	54.0	0.2	97.86	1.00
440	78	38.09	54.2	0.3	97.57	1.17
550	88	38.19	54.0	0.3	97.56	1.20
760	98	38.47	58.9	0.9	97.43	1.22
300	66	47.45	45.6	0.4	97.78	1.00
440	78	48.19	45.2	0.3	97.33	1.22
550	84	48.43	45.1	0.2	97.32	1.15
760	94	47.98	45.0	0.6	96.80	1.31
300	88.5	67.18	27.0	0.6	95.91	1.79
440	84	87.73	9.0	0.2	95.05	2.23
760	92	57.33	35.4	0.8	96.47	1.49

pose to call this the trajectory of distillation. It is at once apparent that through one point on the plan passes one trajectory of distillation, but only one; the system of these curves is thus formed by a series of lines which nest into one another without crossing.

Three curves worthy of note then present themselves in the plan of this figure:

1. Let us draw from a point n on the line NH a horizontal which cuts the corresponding curve n at M_0 . The locus C_0 of the points M_0 (Fig. 11) represents the locus of the points where the trajectory of distillation possesses a horizontal tangent; or, in other words, the moment when the boiling liquid passes through a maximum concentration of nitric acid.

2. Let us draw the locus C_1 , the intersections of the

straight lines Sn with the corresponding curves n . All the trajectories of distillation cut C_1 in such a manner that at the point of coincidence the tangent passes through the point S representing sulphuric acid.

But if a mixed acid is regarded as a mixture of 100 per cent sulphuric acid and a dilute nitric acid which it is desired to concentrate, curve C_1 divides the plan into two noteworthy regions. All the points of curve C_1 represent those mixtures which at the instant the distillation begins give off vapors of the same composition as the nitric acid it was desired to concentrate. The left-hand region thus contains all the weak mixtures, which at the beginning of the distillation give off vapors less rich than the initial nitric acid; the

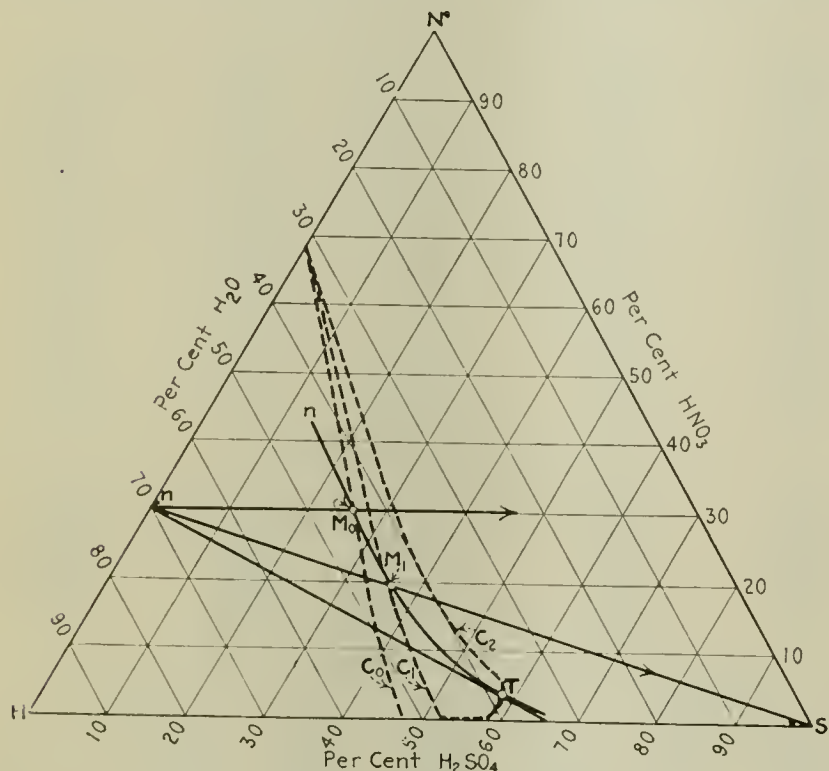


FIG. 11. CURVES DIVIDING PLAN INTO REGIONS HAVING SPECIAL PROPERTIES

right-hand region, on the contrary, corresponds to mixtures giving off stronger vapors. Actually curve C_1 is very near curve C_0 .

3. Finally, let us draw from each point n on the side NH a tangent nT to the corresponding curve n . The locus of the points of contact T will be a third noteworthy curve C_2 . From what has preceded, all the points of this curve belong to the trajectories of distillation which are tangent to the corresponding curve n at this point; and at this moment the liquid will emit a vapor of the concentration n . But the form and the position of the curves n is such that they are not cut by the trajectories that are exteriorly tangent to them. On both sides of the point T the trajectory thus passes through points corresponding to emitted vapors of a lower composition than n .

The curve C_2 is thus the locus of representative points through which the liquid passes at the moment when it is emitting a vapor of maximum concentration. But the extremity of the tangent which sweeps the line NH turns back at the moment when its point of contact falls upon the curve C_2 , just when the concentration of nitric acid in the vapor passes through a maximum. The curve C_2 is thus equally the locus of the points of inflection of the trajectories of distillation; their concave side, turned toward the bottom in the region of weak liquids, turns up toward the top of the triangle in the region of more concentrated liquids.

The curve C_2 , moreover, divides the plan into two remarkable regions:

1. The region adjacent to the apex H , containing points representing mixtures of which the vapors pass through a maximum of acidity during distillation.

2. The opposite region, containing points representing mixtures of which the vapors emitted during distillation have a constantly decreasing acidity.

Fig. 12 gives several examples of trajectories of distillation. It is easy to verify that if the system of trajectories is superimposed on the system of isotherms (Figs. 5, 6, 7 and 8) the point representing the liquid being distilled is displaced continually toward an increasing boiling point.

The relative location of the three curves C_0 , C_1 and C_2 shows also that the moment when the vapors emitted possess a maximum acidity does not in general correspond with the moment when the liquid passes through a maximum nitric acid acidity. This phenomenon does not occur except when the original mixtures are represented by points on C_2 or to the left of C_2 .

It is to be noted, finally, as follows from their definition, that the three curves C_0 , C_1 and C_2 run together at a point on the line HN corresponding to that of the maximum boiling point.

Application of the Preceding Study

The curves of Fig. 3 permit the operation of the apparatus used for preconcentrating weak nitric acid from the arc process to be accounted for.

Imagine that at the base of one of these apparatus a relatively weak acid is boiled, represented by the point L in Fig. 13. It will give off a vapor more

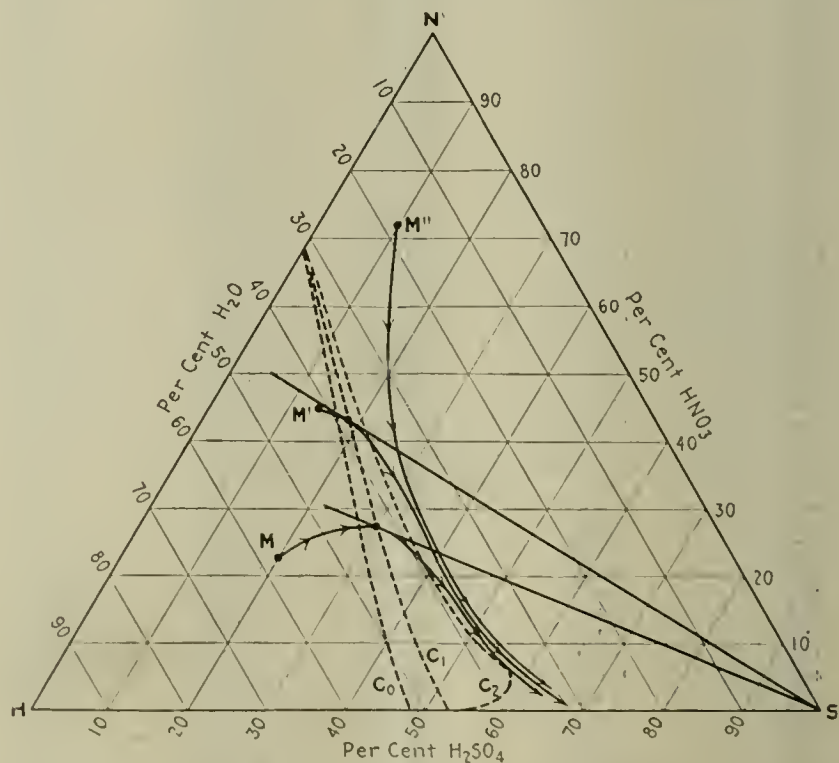


FIG. 12. TYPICAL TRAJECTORIES OF DISTILLATION

dilute, represented by V , and will consequently leave behind a residual liquid L_1 which is richer and boils at a higher temperature L_2 .

If the vapor emitted enters a plate column, it condenses on one of the plates to a liquid layer which boils at a lower temperature L' and which as a consequence emits a vapor still less acid. Thus, by the operation of the column the vapors circulating in the upper part of the column will become poorer and poorer in acid, the residual liquids more and more concentrated.

A time will come, however, where the composition of the boiling liquid approaches that of the maximum, the vapors condensed upon the different plates will be nearer and nearer the composition of the boiling

liquids; the column will become insufficient and 68 per cent HNO_3 will not be attained in the residual acid, at least without raising to an excessive point the strength of the weak liquors.

The very flattened shape of the dewpoint curve fortunately makes it possible to employ the usual columns for an already very extended preconcentration, and at the plants of Rossi, where the process has been carried out with success, acids of 60 per cent strength are easily obtained when starting with the very weak acids

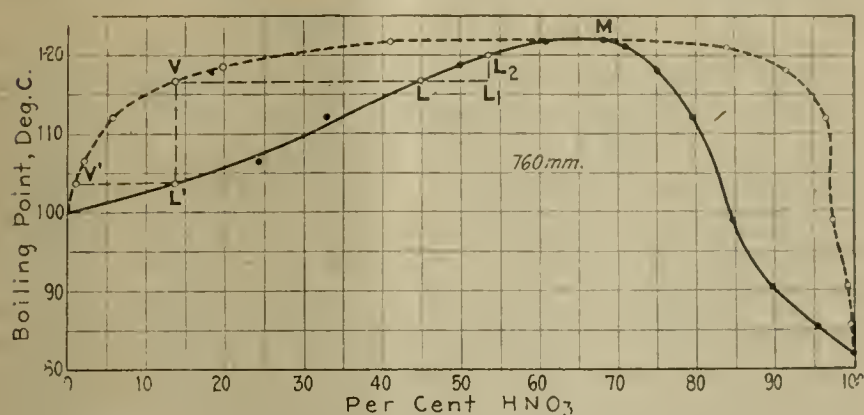


FIG. 13. DISTILLATION CURVE FOR NITRIC ACID

from the Pauling arc process. This fortunate circumstance gives a great interest to preconcentration, still too little extended, which offers great economy in fuel.

It is indeed of interest to evaporate an important part of the water contained in the weak acid, of which the heat of dilution is low; there is thus avoided the difficulty of making the same separation later from the dilute sulphuric acid which results from the final concentration of the nitric acid and which must return to the cycle after its strength is raised, at the expense of much coal used at much higher temperatures.

A weak nitric acid, strengthened, if need be, by preconcentration, may be transformed by distillation into concentrated and even anhydrous acid, if it is mixed beforehand with a sufficient amount of sulphuric acid.

As is known, the operation may be carried out in retorts, or better, in columns, made of towers filled with acid-proof material, down which runs the mixed acid, while superheated steam is injected at the base. We will examine in turn the theory of these two processes.

Let us treat this question in the most general way. To obtain a relatively concentrated nitric acid by distillation of any mixture of sulphuric and nitric acid whatever, the operation may be carried out in two different ways, depending upon the composition of the original mixture. (See Fig. 14.)

Let us suppose, first, that the point representing the original mixture is to the left of the curve C_2 ; there is collected, then, by the complete condensation of the vapor a nitric acid whose acidity (the original value given by the tangent m_0M_0 to the trajectory of distillation) constantly increases up to the end of the operation (total distillate). When, for example, the point representing the residual acid reaches the position M_1 , the condensed acid has the total composition m_1 , and the weight collected is the fraction $M_1M_0 \div M_1m_1$ of the original mixture.

At M_2 , situated on the curve C_2 , the distilling vapors have the maximum concentration, but the same is not yet true of the total condensed acid, represented by m_2 , for beyond this point the concentration of the vapors drops slowly enough to compensate for the initial dilution of the distillate. The concentration m_3 of the acid collected is not reached until the boiling liquid reaches

the point of contact M_2 on the trajectory of distillation. This is the time to stop the distillation, for from this moment the tailings will cause the concentration of the total distillate condensed to drop toward the limiting value M_3 , given by the intersection of NH and the straight line SM_0 .

When, on the contrary, the representative point M' , is to the right of the curve C_2 (and this is the case for the mixtures generally denitrated), the acid distilled, with an initial concentration m' , ($m'M'$, tangent to the trajectory of distillation at M') decreases constantly in strength to the minimum value m'' , determined by the straight line SM' .

For mixtures weak in nitric acid, as acids to be denitrated always are, the point m' , is always located very low; it is thus necessary to cut off before the end of the distillation. This is done the moment when the increase in the amount of acid collected appears to be neutralized by its progressive dilution. A good yield of concentrated acid is never obtained.

We will state to begin with that the system of curves n almost coincide at different pressures, with a mere tendency for the vapors to become richer when the pressure is lowered (and consequently when the temperature drops). It consequently results that, throughout their heating, the mixed acids emit a vapor which varies little in composition and becomes only a little less rich in nitric acid as boiling point is approached.

The mixtures of weak nitric acid and concentrated sulphuric acid, or better yet waste acids, which are

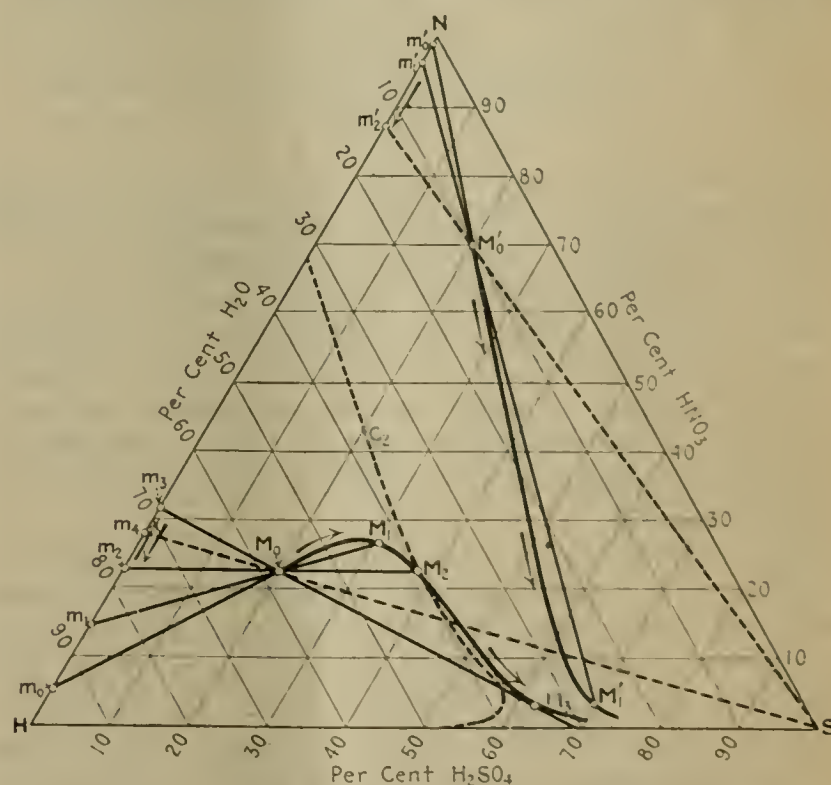


FIG. 14. CONCENTRATION AND DENITRATION IN RETORT

handled in towers, contain generally, roughly: HNO_3 , 15 per cent; H_2O , 15 per cent; H_2SO_4 , 70 per cent.

They are represented by the point A (Fig. 15). In its rapid descent over the packing or the plates of the tower, the liquid is but imperfectly in equilibrium with the surrounding vapors. Also, the concentrated vapors emitted by the distilling liquid are diluted by the weaker vapors from the lower part of the tower; instead of an acid C_0 , of more than 95 per cent, passing over, somewhat stronger even than the acid determined by the original tangent At to the trajectory at A, the apparatus gives in regular operation an acid whose strength corresponds only to the point C.

When the distillation is carried out in a kind of recti-

fying apparatus of silicon iron,³ heated externally, the "denitrated" acid depends upon the operating temperature T of the bottom of the column. If TBB' is the isotherm corresponding to the surface of boiling points, the acid run out at the base of the column is generally incompletely denitrated, and its representative point B , situated at the intersection of AC and the isotherm, permits a determination of the fraction $B'B_1 \div BB_1$ of nitric acid lost.

When, on the other hand, the distillation is made in towers into the base of which live steam is injected, a

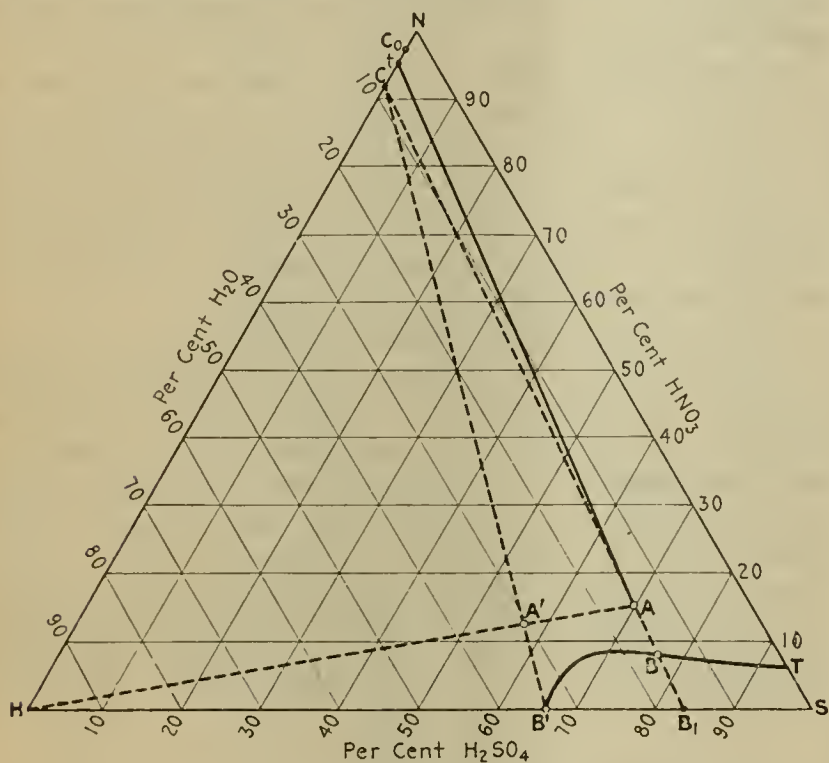


FIG. 15. CONCENTRATION AND DENITRATION IN A TOWER

much better denitration may be obtained, for the same heat consumption, without any appreciable diminution in the strength of the nitric acid separated.

The acid which distills is again represented by a point near the end of the tangent At , but this time there is introduced into the tower the acid A plus a certain amount of water vapor (in practice 10 to 12 per cent of the weight of original acid). The sum of the liquids treated is then represented by the point A' on the line AH .

But now, contrary to the progress of the "dry" distillation of a moment ago, the point B' of the denitrated acid can be brought to occupy the extremity B' of the isotherm of the base by a judicious choice of the temperature and amount of steam used. In this way a perfectly denitrated residue is obtained, without, however, diluting the recovered nitric acid. It is common practice to produce 92 per cent acid in this way, starting with the acid mentioned above and leaving as residue a sulphuric acid of 62 per cent H_2SO_4 .

This easy carrying over of nitric acid by steam, from sulphuric acid mixtures, is moreover a property well known to analysts who determine the nitric acid of mixed acids by the difference in acidity of the liquids, first of the original, then of the residue after this has been diluted with water and evaporated several times.

I will add in conclusion that all of the preceding study may be applied in all cases of distillation of ternary mixtures of which only two constituents are volatile under the conditions of the experiment.

Scientific Faculty of Lille.

³See Pascal, Synthèse et catalyses Industrielles, chez Janny, à Lille.

Various Methods for Hardening High-Speed Steel

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IN THIS paper I will state briefly the advantages and disadvantages of different hardening methods for high-speed steel, proposed in the 20 years which have intervened since Taylor and White made their recommendations.

SALT BATH HARDENING

Salt bath hardening was first introduced in this country in 1902. Ordinarily, barium chloride is the salt used and the operating temperature is from 2,000 to 2,100 deg. F. (1,093 to 1,149 deg. C.) Graphite crucibles are used for holding the salt, the life of these crucibles being from six to eight heats. The tools to be hardened are immersed in the hot liquid and the tools permitted to remain until the entire mass of the tool has attained the temperature of the bath. These tools are then usually oil-quenched, and drawn to from 400 to 600 deg. F. (204 to 316 deg. C.) in oil, depending upon the kind of tool.

No scaling takes place by this method, thus producing a cleaner tool than in muffle furnace hardening, but the method has the following disadvantages: (1) The quenching temperature is too low. (2) Soft scale is sometimes produced. (3) Blistering and pitting sometimes occurs. (4) Pots are very short lived.

It is a well-known fact that to obtain the highest degree of red-hardness, partial austenization must take place. This means quenching from a temperature of 2,200 deg. F. (1,204 deg. C.) and upward; indeed, the higher the quenching temperature above 2,200 deg. F. (1,204 deg. C.) up to about 2,350 deg. F. (1,288 deg. C.) the greater the effect called "secondary hardening"—the added hardness gained by tempering quenched steel. We have heated small test-pieces of high-speed steel 1½ hours in a barium chloride bath at 2,100 deg. F. (1,149 deg. C.), but the microstructure was the same as when left in the bath just long enough for the heat to soak through.

Blistering and pitting of tools heated in a barium chloride bath are said to be due to particles of the graphite crucible which have broken loose coming in contact with the tools and sticking to them. Sometimes these blisters or beads drop off, leaving pits. The longer service the bath has seen the more loss is suffered through this blistering and pitting.

A graphite pot lasts only from six to eight heats, making this method of hardening quite a costly one. A new salt is now being introduced for the hardening of high-speed steel, which can be maintained at a temperature of 2,200 deg. F. (1,204 deg. C.), thus being superior to the barium chloride bath. The container used is a graphite crucible with a cast-steel liner. In this way the steel pot is protected from the flame, and there is no danger of blistering or pitting from particles floating through the bath.

PACK HARDENING

Pack hardening consists of packing the high-speed tools with charcoal in a suitable container. The container is then luted carefully with clay, and the whole placed in a furnace, the temperature brought up to around 2,200 deg. F. (1,204 deg. C.) and held there a

considerable length of time. Tools are then removed, oil-quenched or air-cooled.

This method gives a tool free of scale, but has the following decided disadvantages: (1) Quenching temperature is too low, and (2) tools are carburized. We obtained the temperature of some test-pieces with an optical pyrometer just before they were removed from the pack, and found the temperature to be about 2,050 deg. F. (1,121 deg. C.), although the furnace temperature was 2,200 deg. F. (1,204 deg. C.), and they had remained 1½ hours at heat. Scleroscope tests and micrographs verified this temperature. Furthermore test-pieces showed a gain of 0.40 per cent carbon on the surface after being given the pack treatment.

I have been informed by two different men who attempted this method that at times the cutting edges of the tools melted, due either to the higher carbon content of the surface of the tools or to the tools coming in contact with each other. One other experimenter tried to use a cast-iron box for packing, but as cast iron melts at about 2,200 deg. F. the results can well be imagined. Carborundum powder has been suggested as a substitute for charcoal for a packing material, as the former would not carburize the steel. In the writer's opinion, however, high-speed tools treated in this way would be inferior to tools heated in the semi-muffle furnace, because the steel would have to remain at a high temperature for a long time when pack hardened, thus producing a coarse-grained structure.

LEAD BATH HARDENING

A lead bath was tried quite extensively about 10 years ago for heating high-speed tools, but the method did not prove a success. At 2,200 deg. F. the vapor pressure of lead is about 20 mm. of mercury, so that severe volatilization will inevitably ensue. It is also quite a problem to find pots to hold the same. Difficulty is also experienced in controlling the time of immersion, as lead is a very rapid heating medium. A metallurgist for one of the large tool steel mills in England told me recently that a large amount of high-speed steel was hardened in his country by the lead bath treatment. He stated that they were able to obtain a very pure grade of lead and could operate at a temperature of 2,300 deg. F. (1,260 deg. C.).¹ His method for hardening a 1-in. high-speed hand reamer would be to preheat to 1,500 deg. F. (816 deg. C.) in a muffle furnace, then transfer the tool to the lead bath whose temperature was 2,350 deg. F. (1,288 deg. C.), hold there 15 seconds and cool in an air blast.

SEMI-MUFFLE FURNACE HARDENING

Most of the high-speed steel hardened in this country is heated in semi-muffle furnaces, oil or gas fired. It is always advisable to have these furnaces equipped with pyrometers, using noble metal couples. The optical pyrometer is also satisfactory for controlling these high-temperature furnaces.

Work to be hardened should be preheated to 1,500 to 1,600 deg. F. (816 to 871 deg. C.), and when thoroughly heated through at this temperature, transferred to the high-temperature furnace, whose temperature is higher than the desired hardening heat. The tool is left in this furnace until the cutting edges have attained the proper temperature—about 2,300 deg. F. (1,260 deg. C.)—and the material then quenched. Soaking at the high tem-

perature is to be avoided, as it coarsens the grain and is likely to "burn" the steel. In such practice the time factor is evidently just as important as the temperature. Quenched tools are then drawn to the desired temperature. One great advantage of this method of hardening is the high temperature attainable, thus producing the greatest degree of red-hardness and almost complete solution of the carbides. The disadvantage is that the tool scales to a degree, which can be reduced to a minimum by a thorough preheating and the proper mixture of fuel and air in firing the high-temperature furnace. Large high-speed tools have been very successfully hardened by using two preheating furnaces; the first is maintained at a temperature of about 1,100 deg. F. (593 deg. C.) and is used as a stock furnace. The temperature of the second preheater is 1,700 to 1,800 deg. F. (927 to 982 deg. C.). The material will not scale in the first preheating furnace; while the steel will oxidize in the second preheater, it requires less time to bring it to heat, thus reducing scaling to the least possible amount.

Synopsis of Recent Chemical & Metallurgical Literature

Liberation of Ammonia From Coal and Coke.—At the recent annual meeting of the Institution of Gas Engineers of Great Britain, A. C. Monkhouse and Prof. J. W. Cobb reported the results of experiments undertaken by them to determine the influence of atmosphere upon the products of carbonization and its bearing upon the production of ammonia from coal. A complete report of the investigation appeared in the Oct. 21, 1921, issue of the *Iron and Coal Trades Review*. The work was especially directed toward the comparative behavior of nitrogen, hydrogen and steam in influencing the further yield of ammonia when carbonization at a low temperature (500 deg. C.) had been already effected. On carbonizing coal the authors found that the percentage of the total nitrogen of the coal obtained as ammonia is 10 to 25 per cent. The greater portion—40 to 80 per cent—is left in the coke; the remainder is found as free nitrogen and cyanogen in the gas, and a little in the tar. The liberation of ammonia in carbonization processes has been shown to be affected by various factors, such as: (1) *The Rate of Distillation.*—The slower the rate of distillation the more nitrogen is usually obtained as ammonia. (2) *The Nature of the Coal.*—Generally speaking, the older the formation of the coal geologically the smaller is the proportion of the total nitrogen obtained as ammonia. (3) *The Temperature of Distillation.*—The higher the temperature of distillation the less nitrogen is left in the coke. Temperatures above 500 deg. C. are necessary for a good yield of ammonia. In complete gasification with air and an excess of steam, as in the Mond process, the yield of ammonia is much higher than in carbonization—60 to 70 per cent. Our method was to take a particular coal and to coke it at three definite temperatures—500, 800 and 1,100 deg. C.—so preparing soft, medium and hard cokes. The action of hydrogen on these three cokes was then determined at three different temperatures—600, 800 and 1,000 deg. C. In order to differentiate between any specific action of hydrogen on the nitrogen compounds and the influence of an inactive gas, similar experiments were made using nitrogen instead of hydrogen. Comparison with steam followed.

A New Etching Agent for Chromium and Tungsten Steels.—Karl Daeves, in *Stahl und Eisen*, Sept. 8, 1921, p. 1,262, emphasizes the advantages of potassium ferricyanide as an etching reagent for Cr and W steels, first proposed by K. Honda and T. Murakami. According to the Japanese authors, there are three carbides in Cr steels—namely, α -carbide (Fe_3C), β -carbide (Fe_2C) and γ -carbide

¹At this temperature the vapor pressure of lead is nearly 50 mm. of mercury (see J. Johnston, *J. Ind. Eng. Chem.*, vol. 9, p. 873 (1917)).

FeC₂Cr₂C. A mixture of 10 g. potassium ferricyanide and 10 g. KOH in 100 cc. water acts as follows: α -carbide is attacked even in the cold, giving a brown to blue coloration; β -carbide is attacked only when hot, and γ -carbide is not attacked. High-speed steel with over 12 per cent tungsten contains the compound Fe₂W, which is easily attacked by the cold reagent, giving a brown to blue coloration.

Dr. Davies has also made further studies on the advantages of a potassium ferricyanide etching reagent and recommends the following solution: 20 g. potassium ferricyanide, 10 g. sodium hydroxide, 100 g. water. The following table summarizes the results found on various analyses:

Sample	Analysis, per Cent			Amount of the Etching Reagent	
	C	Cr	W	Cold Reagent	Hot Reagent
1	1.13	9.3		Coloration of the surface	Same as for cold reagent, but deeper (black) coloration
2	1.94	8.2		None	None
3	1.24	9.4		None	Grain boundaries slightly brown
4	0.3	3.00		Coloration of the surface	Same as for cold reagent but deeper
5	0.34	3.23		Traces of the surface colored	None
6	0.4	3.13		None	None
7	0.24	11.3		Coloration of the surface, small grains at the grain boundaries	None
8	1.76	1.1		None	Secondary cementite colored blue, pearlite light yellow
9	1.0	1.12		None	None
10	1.24		0.3	None	Cementite lamellae in the pearlite colored yellow to blue
11	1.13		1.2	None	None
12	0.3	4.1	12.2	Small and large carbide grains colored	Same as for cold reagent, but deeper coloration
13	0.2	4.0	14.0	None	None

This reagent is not satisfactory for pig iron, carbon and Ni-Cr steels.

Recent Chemical & Metallurgical Patents

American Patents

Complete specifications of any United States patent may be obtained by remitting 1 cc. to the Commissioner of Patents, Washington, D. C.

Electrical Heating Alloys.—An electrical heating element made of alloy steel containing iron, chromium, silicon and cobalt has been patented by Percy A. E. Armstrong, of Loudonville, N. Y. The chromium content of this alloy can be varied up to 30 per cent, the silicon to 7 per cent and the cobalt to 5 per cent. It is claimed that the alloy has considerable resistance to oxidation and to acids and similar corrosive agents. It therefore appears to be adapted for heating corrosive liquids. (1,383,740; July 26, 1921.)

Production of Ethyl Alcohol From Coke-Oven Gas.—Byproduct coke-oven gas or other gas containing ethylene and from which the tar, ammonia and light oils have been removed is treated to remove hydrogen sulphide, water and carbon dioxide, and is then scrubbed by causing it to bubble through hot concentrated sulphuric acid. The ethyl hydrogen sulphate resulting from the ethylene is withdrawn from the scrubbers, while the gas passes to the distribution mains for commercial use. By mixing the ethyl hydrogen sulphate with a definite quantity of water and subjecting the mixture to heat for a predetermined length of time, the requisite conditions are obtained for the formation of alcohol. The reaction yields its maximum production of alcohol when the mixture is heated in a closed vessel under a temperature ranging between 100 and 120 deg. C. The reaction develops rather slowly but is ordinarily completed in 50 to 60 minutes. It appears that the process has formerly been carried out without allowing the requisite time for completing the reaction and there has been no control or limitation of the volume of water or steam added. As a result of the latter practice, the relatively small quantity

of alcohol formed was usually greatly diluted, hence recovered with more difficulty. It is proposed to limit the volume of water to 50-70 per cent of the combined volume of acid and sulphate.

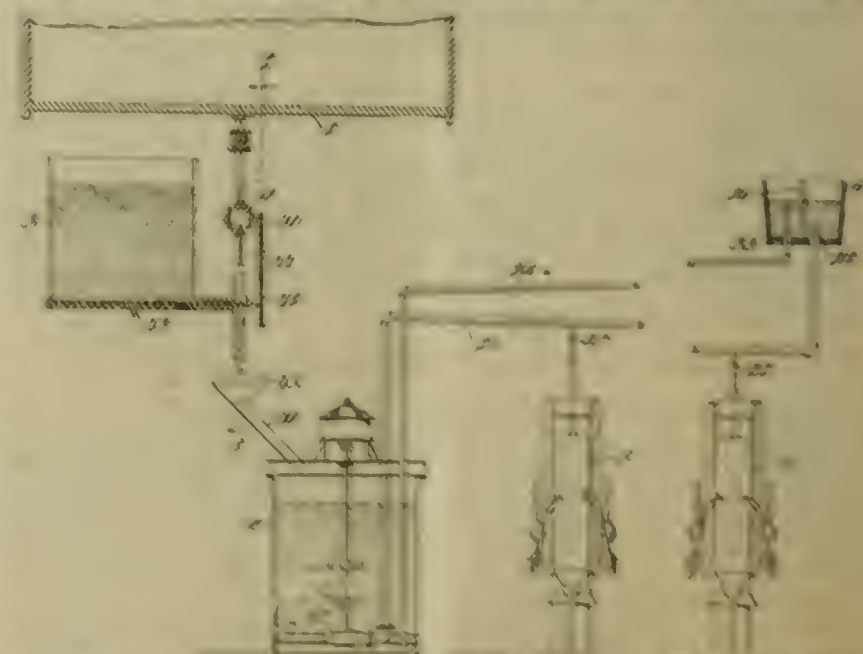
Another important factor bearing on the yield of alcohol is the concentration of the ethyl hydrogen sulphate in the scrubbers. In the process described in this patent, the acid is withdrawn when the ethyl hydrogen sulphate reaches a concentration between 10 per cent and 20 per cent by weight of the sulphuric acid. When this concentration exceeds 30 per cent, the subsequent dilution and treatment of the concentrated ethyl hydrogen sulphate produce ether in substantial quantity, which increases with the concentration of the ethyl hydrogen sulphate. (1,385,515; Chas. A. Basore, of Auburn, Ala., July 26, 1921.)

Process and Apparatus for Electrolysis of Sodium Chloride Solutions.—According to a recent invention of A. H. Hooker, an aqueous solution of sodium chloride carrying an excess of salt in the solid phase is introduced into the electrolytic cells in constant volume per unit of time. The quantity of salt thus supplied in solid phase is not quite sufficient to maintain the brine within the cell in a saturated condition at the operating temperature. In the past it has frequently been proposed to add an excess of solid salt, or to maintain a permanent supply of such salt within the cell, but it is well known that under such conditions the diaphragm will rapidly become clogged. In the present process the brine within the cell is kept safely below the saturation limit.

In the accompanying drawing 2 is the brine storage tank, 3 the salt hopper, 4 the mixing and agitating tank, 5 the electrolytic cells and 6 the level regulating device. The brine flowing through the power-driven metering device 8 is directed over the end of the worm conveyor 13, where it washes the salt out of the worm as fast as it is fed forward and carries it through the screen 15 and chute 16 into the mixing tank. There is, therefore, in the operation of this device a fixed relation between the displacement of the brine meter and the salt feed. This ratio may be adjusted by the proper choice of sprockets 10 and 12.

By means of the pump 17 and the pipes 21 and 24 a rapid circulation of the salt suspension is maintained. The mixture in the tank is therefore kept in violent agitation and the undissolved salt is maintained in suspension during its flow to the level regulating tank 6 through pipe 21 and its return through pipe 24.

Above each cell 5 is provided a feeding orifice or nozzle 27 of special design. The hydrostatic head upon this orifice



is determined by the level of the liquid in tank 6. This may be adjusted as desired by changing the effective height of the overflow pipe 23. As long as the level in the tank 6 is maintained constant, a uniform quantity of brine carrying with it any desired excess of suspended salt is fed into the cells. The circulating system and the means employed for maintaining the uniform feed are covered by patent 1,388,474 issued to Thomas L. R. Lyster and Kenneth E. Stuart of Niagara Falls, N. Y., assignors to Hooker Electrochemical Co. (1,388,496; Aug. 23, 1921.)

Book Reviews

METALLURGIE GENERALE. By *Léon Guillet*, 528 pp., with 335 illustrations. Paris, France: J. B. Baillière et Fils. Price 40 fr.; bound, 50 fr., 1921.

The publishing house of J. B. Baillière et Fils of Paris has undertaken to publish a technical encyclopedia which will be grouped into five classes—namely, Mining and Metallurgy, Electricity, Mechanics, Civil Engineering, and Chemistry, comprising respectively 43, 35, 30, 30 and 54 volumes, each volume to contain from 300 to 700 pages. This great work is to be carried out under the editorship of Léon Guillet for Mining and Metallurgy, André Blondel for Electricity, Léon Lecornu for Mechanics, A. Mesnager for Civil Engineering and Camille Matignon for Chemistry.

The collection of 192 volumes is to be published under the auspices of the Société d'Encouragement pour l'Industrie Nationale, the Society of Civil Engineers of France, the Union of the Mining and Metallurgical Industries, the Union of the Electrochemical Industry, the Society of Chemical Industry, the Hydrotechnic Society and other scientific and industrial institutions.

The fifty-four volumes devoted to chemistry are:

Thermochemistry	Metallurgical Analysis of Iron
Chemical Equilibrium	Combustibles and Their Distillation
Raw Materials in the Chemical Industry	Coal-Tar Distillates
Heating and Power in the Chemical Industry	Petroleum
Installation of Chemical Plants	Paints
Installation of Chemical Laboratories	Varnishes
Patents and Trade Marks	Powder and Explosives
Material Handling	Perfumes
Crushing, Pulverizing	Plastic Materials
Mixing and Agitating	Bleaching
Filtration	Fats
Concentration, Evaporation, Drying	Cellulose and Paper
Mineral Acids	Oenology
Industrial Bases	Brewing
Potash	Distillation
Sodium Nitrate	Sugar
Phosphates	Rubber
Electrochemistry	Tanning Extracts
Electrometallurgy	Tanning
Minor Chemical Industries	Resins
Precious Metals	Food Products (2 vols.)
Lime, Cement	Colloidal Chemistry
Glass	Pharmaceutical Products
Ceramics	Dyes
Porcelain	Waste Disposal
	Fertilizers
	Refrigerating
	Chemical Industry Hygiene

Of the forty-three volumes devoted to mining and metallurgy the following thirty-three volumes are devoted to metallurgy:

General Metallurgy	Chemical Analysis of Metallurgical Products
Fuels	Thermal and Chemical Treatments
Refractories	Welding and Soldering
Pig Iron	Electroplating
Bessemer Steel	Forging and Rolling of Steel
Open-hearth Steel	Forging and Rolling of Metals Other Than Steel
Crucible and Electric Steel	Casting
Ferro-Alloys	Drawing
Properties and Uses of Ordinary and Special Steels	Machining
Copper, Lead and Nickel	Foundry (2 vols.)
Zinc, Tin, Antimony and Mercury	Installation of Metallurgical Plants
Aluminum, Magnesium, Sodium and Calcium	Technical Organization of Metallurgical Plants
Gold and Silver	Commercial Function of the Metallurgical Industry
Platinum Group Metals	Economic Situation of the Metallurgical Industry
Radium	
Metallurgical Physics	
Metallurgical Chemistry	
Testing Metallurgical Products	

Métallurgie Générale, by Prof. *Léon Guillet*, is the first of the series on Metallurgy. This volume of 528 pages with 335 illustrations deals specifically with generalities on the extraction and refining of metals. It comprises twenty-one chapters, the following being a brief outline of the subject covered by each chapter:

In the chapter on classification of metallurgical operations (pp. 1-11) he defines the dry, wet and mixed processes and mentions their application to some of the most important ores.

Roasting and calcining are described under two main

classes—namely, those without and with chemical modification (pp. 12-32).

In the chapter on physicochemical laws in roasting and calcining (pp. 34-67) after enunciating Berthollet's eight laws on thermochemistry and the principle of maximum work, he dwells at length on Le Chatelier's thermodynamic laws as applied to metallurgy. The practical applications of these laws are described and are also diagrammatically illustrated.

After a brief description of the classification of the roasting and calcining apparatus, according to the fuel used (solid, pulverized, liquid and gaseous) and of the two main types—namely, direct heating and reverberatory (including electric heating)—(pp. 68-86) he describes and illustrates the most modern apparatus used under the two main classes of roasting and calcining without and with chemical modification (pp. 87-128) and concludes with a concise discussion on the selection of the appropriate apparatus (pp. 130-140).

Like roasting and calcining, fusion is described under the two main classes—namely, without and with chemical modification (pp. 141-200).

The chapter on the physicochemical laws applied to fusion (pp. 201-249) contains discussions and diagrammatic illustrations of fusion with the formation of two liquid layers and of fusion with one liquid and one solid layer. Classical equilibrium diagrams of alloys and reducing fusion with gaseous and solid reducing agents are also discussed.

Chapter VII contains a well-illustrated description of the different types of modern fusion apparatus and also concise outlines of charging and pouring for the different furnaces (pp. 250-313).

Vaporization is described under the two headings of vaporization without and with chemical modification (pp. 314-320). The physicochemical laws of vaporization are touched only briefly (pp. 321-322). The description of volatilization apparatus (pp. 323-335) is limited mostly to mercury and zinc furnaces, with brief mention of special furnaces for distilling alloys and amalgams.

The chapter on electrometallurgy (pp. 336-353) describes the principles of electrothermic operations without and with chemical modifications, giving also brief outlines of the applications to electric pig iron, alloys and aluminum.

In chapter XII he outlines and illustrates profusely the different types of modern electric furnaces and their adaptability for particular uses (pp. 354-384).

Chapters XIII (pp. 385-396) and XIV (pp. 397-416) deal with metallurgical wet method—namely, solution, precipitation and amalgamation—and with the apparatus used in these operations.

Chapters XV (pp. 417-430), XVI (pp. 431-443) and XVII (pp. 444-452) deal with electrolysis with insoluble and soluble anodes, with the physicochemical laws of electrolysis and with the electrolytic apparatus.

Chapter XVIII (pp. 453-468) summarizes the appropriate treatment for native metals and for the main groups of ores such as: oxides and carbonates, silicates, sulphides and arsenides.

Chapter XIX (pp. 469-489) describes pouring methods, faults of ingots and industrial methods used for improving the quality of the ingots.

Chapter XX (pp. 490-499) deals with the classification, properties and uses of metallurgical slags.

In the last chapter the author passes briefly in review the utilization of metallurgical gases, their purification, especially by the application of the Cottrell process, and the utilization of the precipitated dust.

Of special value are the chapters on the metallurgical apparatus, in which he dwells mainly on the most recent practice, and the chapters on the various physicochemical laws as applied to metallurgy, in which he has embodied the theories and practical conclusions of the past and present leading metallurgists.

The long experience of Mr. Guillet as professor of metallurgy and as editor of the *Revue de Métallurgie* has enabled him to give in this introductory volume a clear insight of the metallurgical art and of its present status.

J. S. NEGRU.

Current Events

in the Chemical and Metallurgical Industries

More Plants Increasing Operations

Rubber. The Kelly-Springfield Tire Co., Cumberland, Md., is arranging to place its local plant on a full-time operating basis at an early date, replacing a 4-day schedule operative for some time past. Employment is now being given to close to 1,000 workers as compared with a normal force of 1,165 men, and operatives now on furlough will be taken back gradually.

The Miller Rubber Co., Akron, Ohio, is increasing production at its plant, and since the first of the month about 2,000 employees have returned to the mills.

The Goodyear Tire & Rubber Co., Akron, Ohio, is planning for the resumption of a three-shift basis of production at its plant by Jan. 1. Night shift operations will be resumed at an early date.

The Stanwood Rubber Co., Newark Ave., Elizabeth, N. J., recently reorganized, is planning for the resumption of operations at the local plant on Jan. 15, following a shut-down of a number of months. Improvements will be made and machinery set up at once.

The Firestone Tire & Rubber Co., Akron, Ohio, is increasing operations and adding to its working force.

Ceramic. Practically every general ware pottery at Chester, W. Va., and vicinity is now being operated at capacity.

The McNicol Pottery Co., Clarksburg, W. Va., is increasing production to handle a volume of new orders.

The Briggs Co., Grand Ledge, Mich., manufacturer of facebrick, is developing record production at its plant, now averaging from 40,000 to 42,000 bricks per day. The company during the last month shipped more material than in any other similar period, totaling over 1,250,000 bricks. Advance orders are said to aggregate in excess of 800,000 bricks.

Glass. The Macbeth-Evans Glass Co., Marion, Ind., has resumed operations at its local plant, giving employment to about 500 operatives, or approximately 60 per cent of normal. The men will work in three 8-hour shifts. Additional employees will be added gradually to the force.

The Millville Bottle Works, Millville, N. J., is operating one plant at full capacity, and work will be commenced on a new factory for increased production at once.

The Mount Jewett Window Glass Co., Kane, Pa., controlled by the Interstate Window Glass Co., has been placed in operation, following a shut-down for almost a year past. Employment will be given to about 350 persons. The plant has been improved during the idle period. This is the seventh plant of the Interstate company to be placed in operation.

Iron and Steel. The Parryville (Pa.) Blast Furnace is arranging for immediate blowing in, following a shut-down for the past 6 months. More than 200 men will be employed.

The Lufkin Foundry & Machine Co., Lufkin, Tex., one of the largest industries in that section, will soon resume production on a full-time basis, following a curtailment for some time past.

The Midvale Steel & Ordnance Co., Philadelphia, Pa., is operating its different plants on an average of 50 per cent of normal, with bulk of activity at the Cambria mills.

The Harrisburg Pipe & Pipe Bending Works, Harrisburg, Pa., is operating at full capacity in the steel department at its works. In other branches production is now around 80 per cent, with prospects of early increase.

The Jones & Laughlin Steel Co., Pittsburgh, Pa., is now operating seventeen mills at its Woodlawn, Pa., works, for the first time in several months. A number of the mills resumed on Dec. 6.

Tin Plate. The American Sheet & Tinplate Co., Martins Ferry, Ohio, has placed four more mills in operation, making nineteen mills in service at the present time out of a

total of twenty-three. The company has placed every hot mill in operation at its New Castle, Pa., plants for the first time in more than a year, bringing the production up to a point of 100 per cent, or sixty mills. Several hundred additional men are being employed. This schedule of operation will be continued for an indefinite period.

Peat Gasoline Process Declared Fraud

In the case of Doolittle vs. Enricht, the trial of which was discussed at some length on p. 1109 of our Dec. 14 issue, the plaintiff was awarded the full amount invested in stock of the Enricht Peat Gasoline Co., Inc., plus interest.

In making his charge to the jury, Judge Lewis J. Smith stated that the main point in the case was whether or not Mr. Enricht could produce gasoline from peat by his process. To find for the plaintiff the jury would have to satisfy itself that representations were made, that they were fraudulent and that the defendant knew they were fraudulent. The measure of damage would be the amount paid by the plaintiff, \$1,000, less the present value of the stock, plus interest. Accordingly the verdict means that in the jury's opinion, the process was a fraud and that the stock is worthless.

During the latter part of the trial it was brought out that the suction-pressure pump was not produced in court with the rest of the apparatus but remained in Mr. Enricht's car until demanded by the experts. They noticed a piece of metal tubing on the piston rod of the pump which limited the stroke and demanded that the pump be taken apart. Mr. Enricht said that this was not possible. Then followed the peculiar actions noted last week which make it appear probable that gelatine capsules of some sort containing gasoline were concealed in the base of the pump, although this was denied by the defendant. In view of these facts at the conclusion of the trial, the attorney for the plaintiff moved that Mr. Enricht be held for perjury and contempt of court. This was denied because of a pending criminal action but the judge granted a motion by the District Attorney to increase the bail and fixed the sum at \$10,000, stating that Mr. Enricht had disobeyed the order of the court and that consequently he was not disposed to feel lenient. Mr. Enricht went to jail while the bail was being obtained.

New Oil Companies Organized

During the month of November, a total of seventy-one new companies was organized in different branches of the petroleum industry, with a capitalization of \$50,000 or larger. The total indicated investment was \$60,129,000, as compared with \$83,450,000 in the preceding month of October, and \$266,190,000 in the corresponding month of 1920. The aggregate indicated investment for the 11 months of the present year stands at \$1,190,042,600, divided among 878 companies, as against an amount of \$2,677,134,700 for the same period of 1920, representing the gross capitalization of 2,418 companies formed in this time.

Chemical Companies Organized

During the month of October thirty-five new companies were organized with a capital of \$50,000 or more, to engage in the chemical and affiliated industries, with indicated capitalization of \$6,300,000 for all organizations. This compares with the formation of twenty-six such companies in the preceding month of October, with a combined capitalization of \$6,675,000. In the same month of a year ago, the indicated capitalization of new companies was \$50,050,000. For the 11 months of the present year, the total indicated investment in new chemical companies stands at \$104,815,000, as against \$230,517,000 for the same period of 1920.

Marshal Foch Made Honorary Member of Engineering Societies

Extolled as a fellow engineer who has "directed a greater mass of human energy than any other man," Marshal Foch, at an elaborate ceremony Dec. 13, significant of the advancing movement to promote international peace through the furtherance of engineering ideals, was placed at the head of the honor roll of the organized engineering profession of the United States. In electing Marshal Foch to honorary membership in the four national engineering societies the engineers broke all precedent. The organizations whose governing boards unanimously conferred this distinction upon Marshal Foch were the American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, American Society of Mechanical Engineers and the American Institute of Electrical Engineers.

The ceremonies were held in the auditorium of the Engineering Societies Building. J. Vipond Davies, president of the United Engineering Society, presided and made a four-minute speech, after which Colonel William Barclay Parsons delivered an address in French. Formal presentation of the certificate of honorary membership was made by G. S. Webster. Marshal Foch responded in part as follows:

It was due largely to engineering and the engineering industry that the war was brought to a successful conclusion. To the engineering profession also we are indebted for many great lessons which will be vital to mankind in the future. The armies could not have done a great deal without the effort of the engineer. Success was made possible to a great extent by the industry of the people at home, but when it became a question of decision, when the decisive moments arrived, the engineer stood out as an essential factor in complete triumph. What would have become of the armies without the technical training, without the professional knowledge, which you have exercised for the Allies and which enabled us to lead our armies in the field, to feed them, to protect them, and to facilitate their advance quickly and decisively? It is for these reasons that I am pleased to find you here today, to receive from you so splendid a welcome and to express my gratitude and the gratitude of France, as well as the recognition of my countrymen for the tremendous sacrifices made by you and the men of your calling. I am grateful to you for including me in your ranks as a member of the four great engineering societies of the United States. Believe me, this honor which you have conferred upon me I indeed appreciate and I shall cherish this event with the happiest memories.

Safeguarding Fumigation With HCN

The great drawback to the use of hydrocyanic acid gas has been offset, it is believed, by an achievement of the chemists connected with the Chemical Warfare Service. Since hydrocyanic acid gas possesses the quality of killing the eggs of vermin, in addition to being a very powerful disinfectant, it is held by the United States Public Health Service to be the most effective disinfectant which can be used for a variety of purposes. It finds one of its chief uses in the disinfecting of ships. The chief objection of its use has been the fact that it has no smell or taste and produces no discomfort when breathed. As a result a person breathing it has no warning until he collapses. This has led to many casualties. The Chemical Warfare Service, however, has found that by adding tear gas to hydrocyanic acid gas ample warning is given of its presence. The effect of tear gas is felt instantly, whereas hydrocyanic acid gas must be breathed for several minutes before there are serious results. The experiments indicate that the admixture of tear gas will make possible an extended use of this valuable disinfectant.

Bureau of Mines Increases Chemical Staff

The Bureau of Mines has authorized the employment of a chemical engineer to assist in its non-metallic work. He will be stationed at Reno, Nev. Two chemical engineers are to be added to the staff of the ceramics station at Columbus to do work on cement.

Factory Waste Legislation Not Imminent

No legislation attempting to deal with the pollution of streams will be recommended by the House Committee on Rivers and Harbors until after a thorough study has been made of the question. The committee expects to recommend legislation after the holidays intended to meet the oil nuisance caused by the discharge of petroleum wastes by ships. The committee probably will recommend that the Department of Commerce and the Chief of Engineers make a special study of the alleged injurious effects of wastes from chemical and other manufacturing plants, before undertaking to suggest legislation.

This conclusion was influenced in no small degree by the testimony of Secretary Hoover and by that of John I. Tierney, secretary of the Manufacturing Chemists' Association. Mr. Hoover urged strongly that present legislation be confined to the petroleum nuisance. An excerpt from the argument which was presented by Mr. Tierney is as follows:

Any consideration of the question of factory waste must take into account local conditions. A manufacturing plant may be the sole or principal support of a community, but would Congress be justified in closing its doors because its effluent made an angler's holiday afternoon less thrilling? That question was put to the Supreme Court of Pennsylvania and the court decided that operation of the coal mines contributed more to the general welfare than did fish life in the rivers affected. Whenever the problem arises in the interior the community in which the factory is situated may be depended upon to work out a solution much more satisfactory than could Congress, and Congress would do well to leave to the city councils and to the state legislatures the framing of ordinances and statutes to control in the particular cases needing attention. Indeed, it is a serious question whether Congress has the power to include the streams of the interior in any legislation upon this subject. The Supreme Court has determined time and again that the federal government has no ownership of, or jurisdiction over, non-navigable streams of a state, and that it has only a negative power as to the navigable rivers, which may be exercised only to prevent obstruction to navigation.

If Congress, nevertheless, enacts a law to prohibit plants located on navigable rivers discharging their effluents into the waters, while it is powerless to enforce similar prohibition as to factories on non-navigable streams, there will result unequal conditions among competitors in the respective industries. The practical aspects of the question, as well as the provision of the Constitution and the rule of law, should convince Congress that the safest and wisest course is to leave to the city councils and to the state legislatures the solution of this industrial problem, at least to the extent that it exists in the interior. And as stated above, information concerning the relation of factory waste to the pollution of harbor waters is so meager and uncertain that the wiser plan would be for Congress to direct an investigation to be made of that phase of the problem before drafting a measure to deal with it.

Regulations for Transportation of Carboys

The regulations for the transportation of containers which have been used in the shipment of flammable or other dangerous articles have been amended by the Interstate Commerce Commission so as to read as follows:

Empty cylinders, barrels, kegs or drums, previously used for the shipment of an inflammable, poisonous, or corrosive gas or liquid, must have their filling and vent holes properly closed. They should be loaded in open or stock cars when practicable. Labels are not required on such packages and cars should not be placarded, but lighted lanterns or other open-flame lights should be kept away.

Carboys previously used for the shipment of corrosive liquids, when presented to carriers for transportation in carload and less-than-carload shipments as "empty carboys," must be thoroughly drained. Whenever practicable they should not be loaded in cars containing valuable or perishable freight.

Empty bottles previously used for the shipment of nitric acid or nitric acid mixtures should be securely stoppered.

November Meeting, Deutsche Chemische Gesellschaft

The November meeting of the Deutsche Chemische Gesellschaft took place as usual in the lecture hall of the society building, the well-known Hoffmann House, Berlin, on Monday, Nov. 14. It was promptly opened at 7.15 p.m. by President C. Harries, the synthetic rubber chemist.

The deaths of the following members were announced: Dr. Fr. Stockhausen, of the Deutsche Gold & Silberscheidanstalt, in Frankfurt a-Main. Dr. Erich Kunheim, of Kunheim & Co., Niedenschönweide-Berlin.

Prof. Gabriel, of the Chemische Institut of the University of Berlin, who was present at the meeting, was officially congratulated on his seventieth birthday by the president in the name of the society.

The first paper was read by Dr. Hermann Mark, who offered his work on penta-arylethyls in defence of trivalent carbon. Prof. Schlenk, the present head of the Chemische Institut of the University of Berlin and successor to the famous Emil Fischer, helped to support the theory, which was first announced in 1900 by the American chemist Gomborg, that carbon, although usually tetravalent, can also exist in a trivalent state. All compounds with trivalent carbon are very unstable and highly colored. While in the past only the tri-arylmethyls were known, W. Schlenk and the speaker succeeded in producing the homologs of penta-arylethyl. Hereby a new and interesting proof of the existence of trivalent carbon was brought to light. An interesting debate followed between the president and Dr. Mark.

The second paper was read by Dr. Hans Enders, on "The Effect of NO on Sodiumalkyls." This interesting substance NO, in which nitrogen must be considered bivalent, acts upon metallo-organic compounds in two stages. Through this reaction, addition products are formed which are of special interest, as they can be considered as substitution products of hyponitrous acid $\text{HN}_2\text{O}_2\text{R}$. W. Schlenk and the speaker succeeded in isolating three different reaction products, whereby three isomers were secured. These three isomers were demanded by the theory of structural valence and the experimental proof of their existence reinforces anew the stereochemistry of nitrogen. In the discussion which followed Prof. P. Jakobson, the author of the well-known "Lehrbuch der organischen Chemie," the president and the speaker took active part.

The third paper was delivered by Dr. E. Tiede on "Phosphorescent Magnesium Sulphide." Up to now the only sulphides of the alkaline earths which served in the production of luminous paints were those Ca, Sr and Ba. The speaker has now also succeeded in producing pure magnesium sulphide through the use of ingeniously devised apparatus and the exercise of extraordinary experimental care, and he has shown that this alkaline earth sulphide is very well adapted to the production of phosphorescent materials. These new phosphorescent substances are easily excited by ultraviolet light and they shine particularly long and brightly.

The three lectures were well illustrated with lantern slides and with experimental proofs and demonstrations. The latter could be performed to great advantage on the excellently equipped lecture table of the Hoffmann House. The demonstrations of the many variously excited phosphorescent materials by the last speaker met with most enthusiastic applause.

Bibliography on Refractories

The Refractory Division of the American Ceramic Society has issued a new bulletin in the form of a bibliography of magnesite and dolomite refractories. Organizing Secretary Ross Purdy, Columbus, Ohio, has collaborated with A. S. Greaves-Walker, chairman of the division.

This is but the first of the bibliographies to be issued by the society. The Refractory Division will shortly issue other bulletins on chromium, sillimanite, alumina, spinel, silicon carbide, zirconia, carbon, clay and special refractories including nitrides and oxides. The U. S. Bureau of Mines, in Columbus, is collaborating in the preparation.

Spread of War Gases Subject to Control

In view of recently published statements that gas should be outlawed as a weapon of warfare because it would drift away from the actual scene of conflict and endanger civilian communities at a distance from the battlefield, General Amos A. Fries, the head of the Chemical Warfare Service, has authorized the following statement:

Chemical warfare gases can be confined in war to the fighting forces practically to the same extent that the action of high explosives, shells and bombs can be confined. There is a widespread feeling that even a small quantity of gas loosened in a territory is dangerous for long distances. This is absolutely incorrect. The most powerful gases of today volatilize so slowly that their effects will be felt only a few hundred yards from where they are dropped.

The idea that gases would be dangerous to surrounding populations for long distances arose from the early cloud gas attacks. To produce a cloud that would drift, say, 6 miles, would require 20 lb. or more of liquid gas per foot of front (or about 53 tons per mile) 2 miles or more in extent. Such concentrations will never be attempted except in the face of the enemy where the chances of inflicting heavy losses among his soldiers are worthy of the attempt.

The use of gases against crossroads, railroad centers, camps and the like would be of the mustard gas variety, due to the lasting qualities of those gases. Thus a bombardment with shells every 2 to 5 days would make the place dangerous for every man working in the area bombarded unless continuously protected by masks and gasproof clothing. The danger area, however, would extend but very little beyond the immediate area at any time, and hence would affect the immediate area and that area only.

American Foundrymen's Association to Meet in Cleveland

The city of Cleveland has been selected as the place of the next convention and exhibit of the American Foundrymen's Association, to be held during the week of April 24, 1922. The association headquarters and exhibits will be in the new Cleveland Public Hall, at Lakeside Ave. and East Ninth St., which is rapidly nearing completion. The Institute of Metals Division of the American Institute of Mining and Metallurgical Engineers has announced that it will hold joint convention with the Foundrymen, as has been the custom in years past.

Of the cities considered, Cleveland is most centrally located for the membership, for the foundry industry and for the manufacturers of foundry equipment and supplies, who make annual exhibits, and its selection will conserve traveling and freight expense.

Following an interval of 18 months the next meeting promises to be of unusual interest and profit. The papers committee advises that manuscript copies are being received and that the first set of preprints of papers to be presented at the convention will be mailed out in January.

There never was a period when economy in production counted for so much as now. At the coming exhibit will be displayed all the latest improvements and inventions in foundry equipment.

Synthetic Camphor Factory May Resume Operations

Plans for the resumption of operations in the synthetic camphor factory of E. I. du Pont de Nemours & Co., Inc., at Deepwater Point, N. J., have been under discussion recently by large consumers of this product and officials of the du Pont company. The Deepwater plant has a capacity large enough to meet the requirements of the pyroxylin plastic manufacturers of the United States. These manufacturers were represented at the conference by N. M. Clark, vice-president of the Celluloid Company; H. R. Bemis, treasurer of the Fiberloid Corporation, and B. W. Doyle, treasurer of the Viscoloid Company.

Fire Caused by Sodium Peroxide

The analytical laboratory of the Central Scientific Co. of Chicago was recently badly damaged by fire started by a hundred pounds of sodium peroxide.

Plan to Avoid Duplication in Collecting Metal Statistics

The metal producers are having their interests made a matter of special consideration in connection with the biennial census of manufactures. Secretary of Commerce Hoover and Secretary of the Interior Fall have instructed Eugene F. Hartley, chief statistician of manufactures, and Dr. George Otis Smith, director of the U. S. Geological Survey, to recommend a plan to obviate duplication of government effort and to prevent unnecessary burdens on smelters and other sources of information required for the compilation of the statistics. The proposal which probably will be recommended to the two secretaries is that the Geological Survey, by reason of its constant touch with the mineral industry, act as the agent of the Bureau of the Census every two years and collect the special data desired at the time the figures of annual production are collected for the Survey's own use. It is the expressed desire of both Secretaries Fall and Hoover, each of whom knows the mining business from the inside, to make as few demands upon the accounting offices of the mining companies as is possible.

River Terminals Needed for Steel Shipments Into Cincinnati

Recent shipments of iron and steel from Pittsburgh and various cities along the Ohio River which have the necessary terminals have caused much comment among local business men, the products carried on these trips not being available to Cincinnati because of the difficulty of transferring them from barges to trucks or other vehicles. With proper terminal facilities much business that now goes to other cities would come to Cincinnati and at the same time local consumers would get the benefit of the lower space rates offered by the waterway carriers.

Several plans for terminals have already been worked out by engineers, and it is expected that early action will be taken to build river terminals at some advantageous point on the river front to take care of the ever-increasing shipments of heavy bulk freight into the city. The Chamber of Commerce is active in promoting a concerted effort to this end among the business interests.

Fertilizer Manufacturers Organize

Fertilizer manufacturers in the Del-Mar-Via Peninsula district, Maryland, are organizing an association to include all such interests throughout this section, to be known as the Peninsula Fertilizer Manufacturers' Association. Details of the new organization were perfected at an informal meeting at Salisbury, Md., Nov. 28, at which William B. Tilghman of the William B. Tilghman Co., Salisbury, was elected temporary chairman; E. Benson Dennis, of L. E. P. Dennis & Co., Crisfield, Md., vice-chairman; and William E. Valliant, Valliant Fertilizer Co., Georgetown, Del., temporary secretary. A meeting will be held soon to effect a permanent organization. Those represented in the new association include: William B. Tilghman Co. and the Farmers' & Planters' Co., both of Salisbury; L. E. P. Dennis & Co., Crisfield; Huston, Darby & Co., Seaford, Del.; Dorchester Fertilizer & Lime Co., Cambridge, Md.; W. H. Valliant & Bro., Bellevue, Md.; E. S. Valliant & Sons, Centerville, Md.; Worcester Fertilizer Co., Snow Hill, Md.; and the Valliant Fertilizer Co., Georgetown, Del.

Lehigh Valley Chemical Society Elects Officers

At a meeting of the Lehigh Valley Section of the American Chemical Society, held in Gayley Hall, Lafayette College, Easton, Pa., Dec. 1, the following officers were elected for the ensuing year: Chairman: P. R. Croll, New Jersey Zinc Co., Palmerton, Pa.; secretary and treasurer: H. A. Depew, New Jersey Zinc Co., Palmerton; first counselor: Dr. E. C. Bingham, Lafayette College; second counselor: Henry Wysor, Easton. The principal address of the evening was made by Dr. Charles L. Reese, research director, E. I. du Pont de Nemours & Co., Wilmington, Del., on the subject, "The Effect of Maintenance of the Dye Industry on Scientific Development in This Country."

Notes on Industrial Activities in Maine

Work on new construction for the Advance Bag & Paper Co. at Howland, Me., is progressing rapidly, about 200 men being employed at present. Crews of men have been working day and night on the coffer dam to enclose the site of the power house extension, which will increase the power production greatly. The new machine room will be 52 x 288 ft. New beater, Jordan and slusher rooms are also being built. Two 750-hp. boilers and a 400-ton overhead bunker are to be added to the power plant. The bag mill will be 150 x 65 ft., four stories high, and will house sixty modern bag machines. The new concrete dam, built last year in the Piscataquis River near its confluence with the Penobscot, will provide a supply of water for power for many years. The improvements will increase the paper production by about 48 tons daily and it is expected that there will be an output of over 2,000,000 bags daily.

The Bowdoin mill of the Pejepscot Paper Co., one of its six newsprint mills located at Topsham, Me., was shut down recently. This mill was formerly owned by the Cowles interests and it is believed that they are endeavoring to recover control of it.

Evidence on Dec. 1 indicates that the strike at the International Paper Co. mills at Livermore Falls is about at an end. The strike started May 1. Manager Murray states that eight of the machines at Livermore Falls are running. Eight machines of the same company at Palmer Falls and the sulphite mill at Chisholm are also in operation. The Webster mill of the International Paper Co., at Orono, Me., is now running on a normal production basis. The strikers have gradually returned or have been replaced.

The chemistry department of the University of Maine and the Maine Section of the American Chemical Society, under the direction of Dr. C. A. Brautlecht, have been showing moving pictures of chemical and metallurgical industries weekly. The films are those furnished by the Bureau of Mines and some of the leading industrial corporations.

Renewed activity in the building trades is causing an interest in the slate quarries near Brownville, Me. L. F. Johnson is temporary chairman of the newly organized board of trade of that town. Various concerns are investigating both the large masses of high-quality unquarried slate and the hills of accumulated waste near each quarry. The waste at practically all quarries will undoubtedly soon be crushed, screened and shipped to roofing paper mills as surfacing material and as filler in other industries. The Monson Slate Products Co., a Massachusetts corporation, has purchased one of the Blanchard quarries and is preparing to use some of this slate, after grinding, for coating asphalt shingles. Blanchard, Brownville and Monson quarries are being watched closely by parties interested in slate. The Monson Slate Products Co. has erected buildings for grinding and sieving waste slate.

Proposed Spanish Tax on the Export of Pyrites

The Huelva mine owners are beginning to protest against the proposed export duty of eight pesetas per ton on pyrites. They say that this duty will mean the ruin of the industry. The defenders of the future régime reply that the restrictions on exports will lead to the establishment in Spain of factories using this product, from which superphosphates, refined copper and sulphuric acid could be obtained.

Chemistry Building at University of Mississippi

The State Bond Improvement Commission, Jackson, Miss., has approved an award of contract to the Doullut & Williams Co., Hibernia Bldg., New Orleans, La., for the erection of a new fireproof chemistry building at the University of Mississippi, Oxford, to cost about \$160,000. Theodore C. Link, Director of Public Works, is in charge.

Colorado Clays Exploited

The U. S. Bureau of Standards will shortly analyze samples from clay deposits found in Grand Valley, Col. The local chambers of commerce at Grand Junction and Fruita are hoping to locate clays suitable for the making of brick, pottery and tiling.

Personal

R. L. AGASSIZ, Boston, Mass., has been elected president of the recently organized Copper and Brass Research Association.

WILLIAM T. ASHLEY has resigned as vice-president and general manager of the Hawk Nut Butter Co., Newark, N. J., to devote his time to the exploitation of his patents on a new process of margarine manufacture.

Dr. H. E. BARNARD, director of the American Institute of Baking, has moved his office from Minneapolis, Minn., to the new Institute home, 1135 Fullerton Ave., Chicago, Ill.

Prof. MARSTON T. BOGART, of Columbia University, addressed the Civic Club at Cleveland, Ohio, on Dec. 3, in defense of the proposed selective embargo on dyes. Dr. Bogart's address was in reply to one of the previous week, before the same audience, by a member of the editorial staff of *The Nation*, who attacked the embargo on the ground that it would foster monopoly.

WILLIAM M. BURTON, of the Standard Oil Co. of Indiana, will receive the Perkin Medal at the meeting of the Society of Chemical Industry at the Chemists' Club, New York, Jan. 13, 1922.

L. E. CALKINS, formerly superintendent of the Minneapolis plant of The Barrett Co., and F. SCHILLING, formerly superintendent of the St. Louis plant, are now members of the Chicago plant organization.

Dr. J. CAVALIER, recteur of the University of Toulouse, spoke before the Bureau of Standards scientific staff on Dec. 16 on the subject "Les Industries Chimiques en France pendant la Guerre."

FULLER CLARKSON left the Fixed Nitrogen Research Laboratory on Dec. 1 to become associated with the Procter & Gamble Co. He will study plant problems.

W. H. EISENMAN, national secretary of the American Society for Steel Treating, spoke before the Charleston, W. Va., chapter of the society on "Heat-Treating—Its Past, Present and Future."

H. S. GALE sailed on Dec. 13 for Colombia, where he will be engaged for three months in an oil investigation for an American company.

H. A. HAUPTLI, superintendent of Sears, Roebuck & Co.'s wallpaper mill, has just returned from an extended business trip through several European countries.

H. F. HERRICK, formerly of the National Aniline & Chemical Co., Buffalo, N. Y., has accepted a position as chemist with the American Aniline Products Co., Lock Haven, Conn.

HENRY JOSEPH, who received the degree of chemical engineer last June from Columbia University, has taken up work with the Consolidated Gas Co., as engineering assistant to Mr. Lunn, chief chemist.

Dr. ROBERT S. LANDAUER has accepted the position of research physicist with the Standard X-Ray Co. of Chicago.

W. LEE LEWIS, chemistry director at Northwestern University, is furnishing a new tear-gas bomb to the Chicago Police Department for combating dangerous criminals. It was used as an effective threat in the recent stockyard workers' strike in Chicago.

EDWARD S. LIEBSCHER has resigned as research chemist with the American Lead Pencil Co., Hoboken, N. J., and is now associated with the Far East Products Co., Inc., Brooklyn, N. Y. as president and chemical director.

Prof. A. S. LOEVENHART of the University of Wisconsin spoke on Nov. 17 on "The Relation Between Chemical Structure and Pharmacological Action." He also spoke at Northwestern University.

Prof. CHARLES MOUREU, of the College of France, president of the International Union of Pure and Applied Chemistry, and Prof. A. MAYER, of the University of Strasbourg, the two French chemical advisers at the Limitation of Arms Conference, spoke briefly before the Washington Section of the American Chemical Society on Dec. 8. They presented greetings of French chemists and spoke most encourag-

ingly of their interest in the international relations within the science.

A. PACYNA, formerly control chemist of production at the Chicago plant of The Barrett Co., is now a member of that company's research staff at Shadyside, N. J.

DON STEVENS, formerly with the technical division of the Goodyear Tire & Rubber Co., has accepted the managership of the Okonite Co., Passaic, N. J., manufacturer of insulated cable.

Prof. A. L. TATUM, of the department of pharmacology, University of Chicago, spoke to the Kent Chemical Society of the university on Nov. 10, on "The Equilibrium Between Stored and Circulatory Sugar in the Animal Organism."

MAURICE C. WALSH, who received the degree of chemical engineer from Columbia University last June, is now located at Mellon Institute, Pittsburgh. His work is in connection with the newer developments which are extending the uses of container board for packing cases.

Obituary

ARTHUR H. GALLUN, of A. F. Gallun & Sons, Milwaukee, died on Nov. 9, 1921, from an attack of pneumonia. He was associated with the leather industry all his life and worked constantly for a wider appreciation of the value of fundamental chemical research in this field.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, Dec. 19, 1921.

The general activity of the chemical market during the period under review has shown that business so far is better than in November, but there still remains a pronounced tendency of quietness, owing to the holiday season and the inventory period. It is commonly known that these two influences always work against any temporary activity. Contract business for deliveries to begin after the first of the year is progressing well under adverse conditions and with every indication that January business will be far ahead of recent months. A great deal of readjustment has been going on at chemical plants and it is asserted that prices of many items have been revised to meet the law of supply and demand. Export conditions are gradually improving, and this is fully reflected in the number of inquiries reaching the market from Italy, South American countries and the Orient. The recent rise in foreign exchange, together with efforts now on foot to stabilize money, will go a long way toward stimulating our foreign trade. Prices in second hands show a decided weakness, but producers seem to be firmer in their views. Additional sales of contracts went through in solid caustic soda and soda ash, but spot trading in these commodities remained quiet, with occasional sales noted for export. Prices on spot were a trifle easier owing to the limited extent of inquiries and keener competition existing among second hands. Caustic potash looked slightly weaker. Bichromate of soda held on at former levels, with sales of a small nature from regular consuming channels. Anhydrous ammonia was reduced 1c per lb. by manufacturers after nearly an entire year at the former quotation. Oxalic acid is holding steady, with former prices held by leading sellers. Imported bromides are being offered on spot at prices materially lower than those named by domestic producers. Cream of tartar showed a little more strength and the market closed slightly higher. Makers of cyanide of soda are very firm in their ideas before the announcement of contract prices. Arsenic is quoted lower. Prussiate of soda was practically the only item that furnished excitement in the otherwise quiet market. The reduced spot supplies and the advanced foreign

exchange rates and an active inquiry from the consuming industries all had a tendency to shoot prices upward and the market closed in an exceedingly firm position.

CHEMICALS

Dealers offered solid *caustic soda* at \$3.80@\$3.85 per 100 lb. on spot and quoted \$3.90 f.a.s. The strength in foreign exchange is bringing out more inquiry for export and although sales could not be termed plentiful, moderate orders were reported to Europe, South America and Japan. Producers report sales at \$2.75 per 100 lb. and upward for forward shipment, basis 60 per cent, f.o.b. works. There was a slightly firmer feeling noted in *nitrite of soda* on spot. Some dealers were still quoting former figures ranging from 6½@7c per lb. The inquiry is not showing any pronounced activity and consumers are merely buying actual necessities, which in most cases consist of small quantities. The continual absence of any important orders for additional quantities of caustic potash, 88-92 per cent, has caused a rather easy undertone. Imported material is offered at 5½@5¾c per lb. and it is admitted in some directions that a shade under this figure might be accepted on firm business. Forward shipments are quoted at \$5.35@\$5.40 per 100 lb. Quiet trading featured the market on *bichromate of soda* and prices have shown no tendency to advance. Sales are reported at 7½@8c. per lb., with most transactions going through at the lower figure. Contract quotations were held by leading interests at 7¾c per lb. Offerings were not too plentiful, but seemed to be sufficient to meet the current extent of inquiries. *Prussiate of soda* stood alone as the feature of the week's activities. Supplies of imported material have remained in a few scattered hands and with the strength in money rates and the sold up condition of domestic manufacturers, prices on spot were sharply advanced. Sales were reported toward the close of the week as high as 15½c. per lb., with the majority of sellers asking 15¾@16c per lb. for the remaining odd lots. Buyers have not responded as quickly as the rise in prices, but those in need of supplies have to purchase at the present market quotations. Domestic *bleaching powder* is holding firm on the basis of \$2.25 per 100 lb. for large containers, f.o.b. works, and at \$2.50 per 100 lb. for small drums. Spot offerings of large drums are limited and the market appears quite firm at 2½@2¾c per lb. Imported bleach is quoted at \$2.20 per 100 lb. ex-dock, with only scattered lots obtainable. Dealers offered spot *strontium nitrate* at 11@12c. per lb., depending upon the quantity. Some small-lot sales have been reported, but business in this chemical has shown very little activity. Imported U.S.P. *permanganate of potash* is offered as low as 15½c. per lb., against a manufacturers' price of 22c. per lb. Producers of *cyanide of soda* are firmer in their views. The 96-98 per cent grade is quoted at 30c per lb., although a slightly lower figure could be done on round-lot business. Leading factors in *arsenic* are quoting various prices on spot. Resale merchants want 5½c. per lb. and makers name 6c. per lb. as their lowest.

GENERAL CHEMICALS

CHICAGO, Dec. 16, 1921.

Quieter conditions prevailed in the general chemical market during the past two weeks. This state of affairs is nothing unusual at this time of the year and a pickup can scarcely be expected until after New Year's. There is some tendency on the part of dealers to shade prices on account of the approaching inventory season, but low prices do not appear to tempt the buyer at this time. One large firm has given its salesmen a two weeks' vacation starting on the 19th. This firm reports that it is useless to send out salesmen, as buyers are practically out of the market and will stay out until their inventories are cleared up. All factors seem optimistic over the prospects for next year and expect to enjoy a good volume.

GENERAL CHEMICALS

The situation on alkalis lacks new developments and the spot market is quiet. Ground *caustic soda*, 76 per cent, is quoted at \$4.75 per 100 lb. and the solid at \$4.10@\$4.25. *Soda ash* is moving only in small quantities and is unchanged at \$2.60 per 100 lb. in cooperage. *Caustic potash*

is quiet and supplies are available in the spot market at 6½@6¾c. per lb. *Potash alum* is firm and supplies are light. The lump is quoted at 5½@6c. per lb. and the powdered at 6½@7c. The demand for *ammonium carbonate* is limited and small spot stocks are offered at 9@10c. per lb. *Bleach* is moving in a routine way at 3@3¼c. per lb. for large drums. *Carbon bisulphide* is firm and lacks quotable change at 7@7½c. per lb. *Carbon tetrachloride* is in moderate demand and quotations are firm at 10½@11c. per lb. *Glycerine* was advanced again by refiners and is very firm at 15½c. per lb. for c.p. material in drums. *Epsom salts* are quiet, with supplies of the U.S.P. material offered at 2¾c. per lb. Single *nickel salts* are quoted lower by first hands, the new level being 11c. per lb.

Potassium bichromate is rather slow and supplies are available at 13@13½c. per lb. *Soda bichromate* is scarce, and 8½c. was the best offer noted. *Potassium chlorate* is firm and scarce. The small stocks on spot are quoted at 8¾@10c. for crystals and 8½@9c. for powdered. *Red prussiate of potash* has shown a firmer tendency and is offered at 28½@30c. per lb., according to seller and quantity. *Yellow prussiate* is also firm at 24@25c. per lb. *Sal ammoniac*, while very firm and scarce, is unchanged at 8@8½c. per lb. for the white granulated. *Bicarbonate of soda* is moving in a routine way at \$2.60 per 100 lb. *Sodium fluoride* is rather quiet at 11@12c. per lb. *Hyposulphite of soda* is not moving very well, although the photographic trade continues to purchase small lots. *Pea crystals* are unchanged at \$4.05 per 100 lb. in barrels.

The acid business is dull and prices are unchanged. *Acetic acid* is moving only in small lots and is quoted at 2¾c. per lb. for 28 per cent in barrels. *Glacial acetic acid* business is practically at a standstill, but prices remain the same. *Oxalic acid* is attracting but little attention and supplies are offered at 15@16c. per lb. *Phosphoric acid* is very quiet and the sirupy, 85 per cent, is quoted at 19@21c. per lb. The heavy acids are unchanged as to price and plentiful. *Sulphuric acid* is quoted in tank cars at the works at \$18@\$20 per ton.

PHARMACEUTICALS

There is a fair volume of business reported from this branch of the trade and practically all prices are firm. *Bismuth* metal advanced again to \$1.80 per lb. in 500-lb. lots. No announcement of a change in bismuth preparations came from manufacturers, but it is scarcely possible to maintain the present level in the face of the last three advances on the metal. *Mercurials* are very firm and are said to be moving in a satisfactory manner. Like bismuth, mercury metal has advanced rapidly of late with no corresponding advance in the preparations. *Iodine* and all iodides were advanced 30c. per lb. by manufacturers this week. This makes the new level for *potassium iodide* \$2.90 per lb. and for *iodine* \$3.80. Business on iodides was reported as very good by both first hands and dealers.

VEGETABLE OILS

There is only a routine demand for *linseed oil* and inquiries were reported as light. The boiled oil is quoted today at 69c. per gal. in 5-drum lots and the raw at 67c.

NAVAL STORES

The naval stores market is a rather quiet affair and only small business was reported. *Spirits of turpentine* was offered today at 80c. per gal. in 5-drum lots, but the movement was slow. *Rosins* are slightly lower in price.

The Iron and Steel Market

PITTSBURGH, Dec. 16, 1921.

Under date of Dec. 15 the National Tube Co., issued new price lists, increasing discounts on standard steel pipe, except ½-in., 2½ points or about \$5 per net ton, also on O.D. pipe, while oil country goods, which are quoted in net prices, were reduced approximately the same amount per ton. Line pipe discounts were increased 3 points. The action of the Steel Corporation subsidiary was taken on account of continued shading by independents, the shading beginning very shortly after the reduced prices of Sept. 16 were issued. Line pipe is usually shaded on large orders, but of late the shading has been very deep, and there have been

a few cases of deep shading in oil country goods. In standard steel pipe the shading was shallow, but had become almost universal. Possibly the shading would have been deeper had not the independents quite generally had price guarantees outstanding, providing a concession on all carload shipments made within 60 days of a general reduction. The shading was generally an extra 5 per cent instead of the 2½ per cent the independents frequently give from the leading interest's prices. Thus the official reduction goes quite beyond the shading.

The most interesting feature of the decline in tubular goods is the test it furnishes to the general rule that finished steel prices are practically stationary now because demand is light and orders are small individually, too small to provoke very active price competition. In tubular goods the demand has been heavier than demand for any other important finished steel product and has represented 70 or 80 per cent of the pipe mill capacity, conservatively estimated. Other steel products show no noteworthy price change in the past week or indeed for several weeks.

Shading in tin plate has spread somewhat and the market is quotable now at \$4.65@\$.4.75 against \$.4.75 flat formerly quoted. Sheets, on the other hand, are the most rigidly held of any finished steel product, buyers finding it quite impossible to shade 3c on black or 4c on galvanized. The condition is the more remarkable on account of the recent great irregularities in sheet prices.

Bars, shapes and plates remain quotable at a range of 1.50@1.60c., but the lower price is more common. Wire products in general are at prices ruling before the advance of Sept. 12, which proves to have been largely on paper, and there is occasional shading at that.

PITTSBURGH BASING

The long-established custom of Pittsburgh basing, or "Pittsburgh plus," the practice complained of months ago before the Federal Trade Commission and on which hearings are to begin next month, is less and less in evidence. The departure is of course due chiefly to the strongly competitive conditions existing when demand is far below productive capacity, but is no doubt encouraged by the high freight rates now ruling. The Pittsburgh basis obtains in sheets and tin plates, but in practically all other commodities there are some cases of departures, by Eastern, Buffalo, Southern and Western mills. Usually the Pittsburgh and valley mills do not meet the special prices thus made, but occasionally they do, thus accepting lower prices f.o.b. their mills than they would receive when selling in nearby territory.

PRODUCTION

Production is fairly well maintained by the Steel Corporation, while independent mill operations have decreased considerably since the high point early in November, when ingot output was at the rate of about 25,000,000 tons per annum, or 48 per cent of capacity, while the rate now is about 21,000,000 tons or 40 per cent. Unless there is a phenomenal increase in steel demand in the not distant future the present practice of speaking of steel production in terms of percentage of capacity will yield to a style of referring to production in terms of actual tons, the estimated capacity coming to have only theoretical interest. The tonnage concept is much more cheering. Thus the recent rate of about 25,000,000 tons was equal to the production in 1910, when the mills operated substantially at their capacity.

PIG IRON

Foundry pig iron, quotable for weeks past at \$20.50 valley, the price gradually becoming nominal, has sold in a few small lots at \$19.50, making a more substantial quotation and putting foundry between bessemer, at \$20, and basic, at \$19, a position that seems more natural. The whole pig iron market remains decidedly stagnant and consumptive requirements are evidently decreased, for a mere "waiting policy" on the part of buyers would not account for the long-continued apathy.

Connellsville furnace coke for spot shipment is quotable nominally at \$3 per net ton f.o.b. ovens, a price that would probably be shaded if there were any important inquiry. Spot foundry ranges from \$3.75 to \$4.50 according to brand.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots		Less Carlots	
Acetic anhydride.....lb.			\$0 40 - \$0 45	
Acetone.....lb.	\$0 12½ - \$0 12½		.13 - .13½	
Acid, acetic, 28 per cent.....100 lbs.	2.75 - 3 00		3.25 - 3 50	
Acetic, 56 per cent.....100 lbs.	5.00 - 5 25		5.30 - 5 50	
Acetic, glacial, 99½ per cent, carboys, 100 lbs.	10.00 - 10 50		10.75 - 11 00	
Boric, crystals.....lb.	.12½ - .12½		.13 - .13½	
Boric, powder.....lb.	.13 - .13½		.14 - .14½	
Citric.....lb.			.44½ - .46	
Hydrochloric.....100 lb.	1.25 - 1 50		1.60 - 1 75	
Hydrofluoric, 52 per cent.....lb.	.12 - .12½		.12½ - .13	
Lactic, 44 per cent tech.....lb.	.09½ - .10		.10½ - .12	
Lactic, 22 per cent tech.....lb.	.04 - .04½		.04½ - .05	
Molybdic, C.P.....lb.	3.00 - 3 25		3.30 - 3 75	
Muriatic, 20 deg. (see hydrochloric).....lb.				
Nitric, 40 deg.....lb.	.06½ - .06½		.06½ - .07	
Nitric, 42 deg.....lb.	.06½ - .07		.07½ - .07½	
Oxalic, crys. tals.....lb.	.14½ - .15		.15½ - .16	
Phosphoric, 50 per cent solution.....lb.	.13 - .13½		.14 - .18	
Picric.....lb.	.20 - .25		.27 - .35	
Pyrogallol, resublimed.....lb.			1 75 - 1 90	
Sulphuric, 60 deg., tank cars.....ton			11 00 - 12 00	
Sulphuric, 60 deg., drums.....ton			13.00 - 15 00	
Sulphuric, 66 deg., tank cars.....ton	17 00 - 18 00			
Sulphuric, 66 deg., drums.....ton	21.00 - 22.00		22.50 - 23 00	
Sulphuric, 66 deg., carboys.....ton				
Sulphuric, fuming, 20 per cent(oleum) tank cars.....ton	21.00 - 22.00			
Sulphuric, fuming, 20 per cent(oleum) drums.....ton	23.00 - 23.50		24.00 - 24 50	
Sulphuric, fuming, 20 per cent(oleum) carboys.....ton	31.00 - 32.00		33.00 - 34 00	
Tannic, U. S. P.....lb.			.75 - .85	
Tannic (tech.).....lb.	.55 - .60		.61 - .65	
Tartaric, imported crystals.....lb.			.26 - .26½	
Tartaric acid, imported, powdered.....lb.			.27 - .28	
Tartaric acid, domestic.....lb.				.32
Tungstic, per lb. of WO.....lb.			1 10 - 1 20	
Alcohol, Ethyl.....gal.			4 65 - 5 00	
Alcohol, Methyl (see methanol).....gal.				
Alcohol, denatured, 188 proof.....gal.			.42 - .43	
Alcohol, denatured, 190 proof.....gal.			.43 - .44	
Alum, ammonia, lump.....lb.	.03½ - .03½		.04 - .04½	
Alum, potash, lump.....lb.	.03½ - .04		.04½ - .04½	
Alum, chrome lump.....lb.	.07½ - .08		.08½ - .08½	
Aluminum sulphate, commercial.....lb.	.01½ - .02		.02½ - .02½	
Aluminum sulphate, iron free.....lb.	.02½ - .02½		.03 - .03½	
Aqua ammonia, 26 deg., drums(750 lb.) lb.	.07½ - .07½		.08 - .08½	
Ammonia, anhydrous, cyl.(100-150 lb.) lb.	.30 - .30½		.31 - .33	
Ammonium carbonate, powder.....lb.	.07 - .07½		.08 - .09	
Ammonium chloride, granular (white sal ammoniac).....lb.	.06½ - .07		.07½ - .07½	
Ammonium chloride, granular (gray sal ammoniac).....lb.	.06½ - .07		.07½ - .07½	
Ammonium nitrate.....lb.	.07½ - .07½		.07½ - .08½	
Amylacetate tech.....gal.			2 40 - 2 65	
Arsenic oxide, (white arsenic) powdered lb.	.05½ - .05½		.06 - .06½	
Arsenic, sulphide, powdered (red arsenic) lb.	.12 - .12½		.12½ - .13	
Barium chloride.....ton	48.00 - 49.00		50.00 - 55.00	
Barium dioxide (peroxide).....lb.	.20 - .21		.22 - .23	
Barium nitrate.....lb.	.06½ - .07		.07½ - .08	
Barium sulphate (precip.) (blanc fixe) lb.	.04 - .04½		.04½ - .05	
Bleaching powder (see calc. hypochlorite).....lb.				
Blue vitriol (see copper sulphate).....lb.				
Borax (see sodium borate).....lb.				
Brimstone (see sulphur, roll).....lb.				
Bromine.....lb.	.23 - .24		.25 - .28	
Calcium acetate.....100 lbs.	1.75 - 2.00			
Calcium carbide.....lb.	.04½ - .04½		.05 - .05½	
Calcium chloride, fused, lump.....ton	23.00 - 24.00		24 50 - 28 00	
Calcium chloride, granulated.....lb.	.01½ - .02		.02½ - .02½	
Calcium hypochloride(bleach'g powder) 100 lb.	2.50 - 2 60		2 65 - 3 25	
Calcium peroxide.....lb.			1 40 - 1 50	
Calcium phosphate, tribasic.....lb.			.15 - .16	
Camphor.....lb.			.91 - .95	
Carbon bisulphide.....lb.	.06½ - .06½		.07 - .07½	
Carbon tetrachloride, drums.....lb.	.10½ - .10½		.11 - .12	
Carbonyl chloride, (phosgene).....lb.			.60 - .75	
Caustic potash (see potassium hydroxide).....lb.				
Caustic soda (see sodium hydroxide).....lb.				
Chlorine, gas, liquid-cylinders(100 lb.) lb.	.08 - .09		.09½ - .10	
Chloroform.....lb.			.40 - .43	
Cobalt oxide.....lb.			2.00 - 2 10	
Copperas (see iron sulphate).....lb.				
Copper carbonate, green precipitate.....lb.	.19 - .19½		.20 - .21	
Copper cyanide.....lb.			.50 - .62	
Copper sulphate, crystals.....100 lb.	5.65 - 5 70		5 75 - 6 25	
Cream of tartar(see potassium bitartrate).....lb.				
Epsom salt (see magnesium sulphate).....lb.				
Ethyl Acetate Com. 85%.....gal.			.70 - .80	
Ethyl Acetate pure (acetic ether, 98% to 100%).....gal.			.95 - .95	
Formaldehyde, 40 per cent.....lb.	.10½ - .11		.11½ - .12	
Fusel oil, ref.....gal.			2 50 - 3 00	
Fusel oil, crude.....gal.			1 50 - 1 75	
Glauber's salt (see sodium sulphate).....lb.				
Glycerine, C. P. drums extra.....lb.			.15 - .16	
Iodine, resublimed.....lb.			3 50 - 3 60	
Iron oxide, red.....lb.			.12 - .18	
Iron sulphate (copperas).....ton	15 00 - 16 00		17 00 - 20 00	
Lead acetate.....lb.			.10½ - .12½	
Lead arsenate, powd.....lb.	.15 - .15½		.15½ - .16½	
Lead nitrate.....lb.			.15 - .20	
Litharge.....lb.	.08 - .08½		.08½ - .09	
Lithium carbonate.....lb.			1 40 - 1 50	
Magnesium carbonate, technical.....lb.	.07½ - .07½		.08 - .09	
Magnesium sulphate, U. S. P.....100 lb.	2 65 - 2 70		2 75 - 3 00	
Magnesium sulphate, technical.....100 lb.			1 10 - 1 75	
Methanol, 95%.....gal.			.62 - .63	
Methanol, 97%.....gal.			.64 - .65	
Nickel Salt, double.....lb.			.12 - .12½	
Nickel salt, single.....lb.			.14 - .14½	
Phosgene (see carbonyl chloride).....lb.				
Phosphorus, red.....lb.	.45 - .46		.47 - .50	
Phosphorus, yellow.....lb.			.32 - .35	
Potassium bichromate.....lb.	.10½ - .11		.11½ - .11½	

		Carlots	Less Carlots
Potassium bitartrate (cream of tartar).....	lb.	\$.25 - \$.27	\$0.25 - \$0.27
Potassium bromide, granular.....	lb.	.15 - .20	.15 - .20
Potassium carbonate, U. S. P.....	lb.	.15 - .16	.17 - .20
Potassium carbonate, 80-85%.....	lb.	.04 - .04	.05 - .06
Potassium chlorate, crystals.....	lb.	.05 - .06	.06 - .12
Potassium cyanide.....	lb.	.35 - .40	.35 - .40
Potassium hydroxide (caustic potash).....	lb.	.05 - .05	.06 - .08
Potassium iodide.....	lb.	2.60 - 2.75	2.60 - 2.75
Potassium nitrate.....	lb.	.07 - .07	.08 - .09
Potassium permanganate.....	lb.	.15 - .16	.17 - .22
Potassium prussiate, red.....	lb.	.28 - .29	.29 - .30
Potassium prussiate, yellow.....	lb.	.22 - .22	.22 - .23
Rochelle salts (see sodium potas tartrate).....			
Salammoniac (see ammonium chloride).....			
Salt soda (see sodium carbonate).....			
Salt cake (bulk).....	ton	17.00 - 20.00	17.00 - 20.00
Silver cyanide.....	oz.	1.10 - 1.20	1.10 - 1.20
Silver nitrate.....	oz.	.45 - .46	.45 - .46
Soda ash, light.....	100 lb.	1.75 - 2.10	2.15 - 2.50
Soda ash, dense.....	100 lb.	2.15 - 2.20	2.25 - 2.50
Sodium acetate.....	lb.	.04 - .04	.04 - .05
Sodium bicarbonate.....	100 lb.	2.30 - 2.35	2.40 - 2.75
Sodium bichromate.....	lb.	.07 - .08	.08 - .08
Sodium bisulphate (nitre cake).....	ton	5.00 - 5.25	5.50 - 6.50
Sodium bisulphite powdered, U.S.P.....	lb.	.04 - .05	.05 - .06
Sodium borate (borax).....	lb.	.05 - .06	.06 - .07
Sodium carbonate (salt soda).....	100 lb.	1.75 - 1.80	1.85 - 2.10
Sodium chloride.....	lb.	.06 - .07	.07 - .08
Sodium cyanide.....	lb.	.27 - .27	.28 - .30
Sodium fluoride.....	lb.	.11 - .12	.12 - .14
Sodium hydroxide (caustic soda).....	100 lb.	3.80 - 3.85	3.90 - 4.30
Sodium hyposulphite.....	lb.	.03 - .03	.03 - .03
Sodium nitrite.....	lb.	.06 - .07	.07 - .07
Sodium peroxide, powdered.....	lb.	.25 - .26	.27 - .30
Sodium phosphate, dibasic.....	lb.	.04 - .04	.04 - .05
Sodium potassium tartrate (Rochelle salts).....	lb.	.16 - .16	.16 - .17
Sodium prussiate, yellow.....	lb.	1.00 - 1.05	1.10 - 1.30
Sodium silicate, solution (40 deg.).....	100 lb.	2.30 - 2.40	2.45 - 3.00
Sodium silicate, solution (60 deg.).....	100 lb.	1.30 - 1.50	1.60 - 2.00
Sodium sulphate, crystals (Glauber's salt).....	100 lbs.	.04 - .04	.04 - .05
Sodium sulphide, fused, 60-62 per cent (conc.).....	lb.	.03 - .03	.04 - .04
Sodium sulphite, crystals.....	lb.	.11 - .12	.12 - .15
Strontium nitrate, powdered.....	lb.	.05 - .06	.06 - .06
Sulphur, crude.....	ton	20.00 - 22.00	.09 - .10
Sulphur dioxide, liquid, cylinders extra.....	lb.	.08 - .08	2.25 - 3.10
Sulphur (sublimed), flour.....	100 lb.	.09 - .09	2.00 - 2.75
Sulphur, roll (brimstone).....	100 lb.	.09 - .09	.09 - .10
Tin bichloride.....	lb.	.14 - .14	.15 - .16
Tin oxide.....	lb.	.09 - .09	.09 - .10
Zinc carbonate.....	lb.	.42 - .44	.45 - .47
Zinc chloride, gran.....	lb.	.11 - .11	.11 - .12
Zinc cyanide.....	lb.	.07 - .07	.08 - .09
Zinc dust.....	lb.	3.00 - 3.25	3.30 - 3.50
Zinc oxide, XX.....	100 lb.		
Zinc sulphate.....	100 lb.		

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude.....	lb.	\$1.10 - \$1.15
Alpha-naphthol, refined.....	lb.	1.25 - 1.30
Alpha-naphthylamine.....	lb.	.30 - .32
Aniline oil, drums extra.....	lb.	.17 - .19
Aniline salts.....	lb.	.24 - .26
Anthracene, 80% in drums (100 lb.).....	lb.	.75 - 1.00
Benzaldehyde U.S.P.....	lb.	1.35 - 1.45
Benzidine, base.....	lb.	.90 - 1.00
Benzidine sulphate.....	lb.	.75 - .85
Benzoic acid, U.S.P.....	lb.	.60 - .65
Benzoate of soda, U.S.P.....	lb.	.52 - .55
Benzene, pure, water-white, in drums (100 gal.).....	gal.	.27 - .32
Benzene, 90%, in drums (100 gal.).....	gal.	.25 - .28
Benzyl chloride, 95-97%, refined.....	lb.	.25 - .27
Benzyl chloride, tech.....	lb.	.20 - .23
Beta-naphthol benzoate.....	lb.	3.75 - 4.00
Beta-naphthol, sublimed.....	lb.	.70 - .75
Beta-naphthol, tech.....	lb.	.30 - .34
Beta-naphthylamine, sublimed.....	lb.	1.75 - 1.85
Cresol, U. S. P., in drums (100 lb.).....	lb.	.15 - .16
Ortho-cresol, in drums (100 lb.).....	lb.	.24 - .26
Cresylic acid, 7-9% straw color, in drums.....	gal.	.70 - .80
Cresylic acid, 35-97%, dark, in drums.....	gal.	.65 - .70
Cresylic acid, 50%, first quality, drums.....	gal.	.45 - .50
Dichlorobenzene.....	lb.	.06 - .09
Diethylaniline.....	lb.	.95 - 1.10
Dimethylaniline.....	lb.	.40 - .45
Dinitrobenzene.....	lb.	.23 - .27
Dinitrochlorobenzene.....	lb.	.20 - .25
Dinitronaphthalene.....	lb.	.30 - .35
Dinitrophenol.....	lb.	.35 - .40
Dinitrotoluene.....	lb.	.25 - .30
Dip oil, 25%, car lots, in drums.....	gal.	.30 - .35
Diphenylamine.....	lb.	.60 - .70
H-acid.....	lb.	1.00 - 1.10
Meta-phenylenediamine.....	lb.	1.10 - 1.15
Monochlorobenzene.....	lb.	.12 - .14
Monoethylaniline.....	lb.	1.65 - 1.70
Naphthalene crushed, in bbls.....	lb.	.07 - .08
Naphthalene, flake.....	lb.	.07 - .08
Naphthalene, balls.....	lb.	.08 - .09
Naphthionic acid, crude.....	lb.	.70 - .75
Nitrobenzene.....	lb.	.12 - .15
Nitro-naphthalene.....	lb.	.30 - .35
Nitro-toluene.....	lb.	.15 - .17
Ortho-amidophenol.....	lb.	3.00 - 3.10
Ortho-dichlor-benzene.....	lb.	.15 - .20
Ortho-nitro-phenol.....	lb.	.77 - .80
Ortho-nitro-toluene.....	lb.	.15 - .20
Ortho-toluidine.....	lb.	.20 - .25
Para-amidophenol, base.....	lb.	1.40 - 1.45
Para-amidophenol, HCl.....	lb.	1.70 - 1.80
Para-dichlorobenzene.....	lb.	.12 - .15
Paranitroaniline.....	lb.	.77 - .80
Para-nitrotoluene.....	lb.	.80 - .85
Para-phenylenediamine.....	lb.	1.70 - 1.75
Para-toluidine.....	lb.	1.25 - 1.40
Phthalic anhydride.....	lb.	.37 - .40

Phenol, U. S. P., drums.....	lb.	.11 - .15
Pyridine.....	gal.	2.00 - 3.50
Resorcinol, technical.....	lb.	1.50 - 1.60
Resorcinol, pure.....	lb.	2.00 - 2.25
Salicylic acid, tech., in bbls.....	lb.	.20 - .21
Salicylic acid, U. S. P.....	lb.	.22 - .23
Salol.....	lb.	.70 - .72
Solvent naphtha, water-white, in drums, 100 gal.....	gal.	.25 - .28
Solvent naphtha, crude, heavy, in drums, 100 gal.....	gal.	.14 - .16
Sulphanilic acid, crude.....	lb.	.27 - .30
Tolidine.....	lb.	1.30 - 1.35
Toluidine, mixed.....	lb.	.43 - .45
Toluene, in tank cars.....	gal.	.25 - .28
Toluene, in drums.....	gal.	.28 - .31
Xylidines, drums, 100 gal.....	lb.	.40 - .45
Xylene, pure, in drums.....	gal.	.40 - .45
Xylene, pure, in tank cars.....	gal.	.45 - .45
Xylene, commercial, in drums, 100 gal.....	gal.	.33 - .35
Xylene, commercial, in tank cars.....	gal.	.30 - .30

Waxes

Prices based on original packages in large quantities.

Bayberry Wax.....	lb.	\$0.21 - \$0.22
Beeswax, refined, dark.....	lb.	.24 - .25
Beeswax, refined, light.....	lb.	.28 - .30
Beeswax, white pure.....	lb.	.34 - .38
Cardellina wax.....	lb.	.24 - .24
Carnauba, No. 1.....	lb.	.45 - .46
Carnauba, No. 2, North Country.....	lb.	.23 - .24
Carnauba, No. 3, North Country.....	lb.	.13 - .14
Japan.....	lb.	.21 - .21
Montan, crude.....	lb.	.04 - .04
Paraffine waxes, crude match wax (white) 105-110 m.p.....	lb.	.04 - .04
Paraffine waxes, crude, scale 124-126 m.p.....	lb.	.03 - .03
Paraffine waxes, refined, 118-120 m.p.....	lb.	.03 - .04
Paraffine waxes, refined, 125 m.p.....	lb.	.04 - .04
Paraffine waxes, refined, 128-130 m.p.....	lb.	.04 - .04
Paraffine waxes, refined, 133-135 m.p.....	lb.	.05 - .05
Paraffine waxes, refined, 135-137 m.p.....	lb.	.05 - .05
Stearic acid, single pressed.....	lb.	.09 - .09
Stearic acid, double pressed.....	lb.	.09 - .09
Stearic acid, triple pressed.....	lb.	.10 - .10

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on earload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl.....	280 lb.	\$5.30 - 5.35
Rosin E-I.....	280 lb.	5.40 - 5.50
Rosin K-N.....	280 lb.	6.05 - 6.75
Rosin W. G. W. W.....	280 lb.	7.00 - 7.25
Wood rosin, bbl.....	280 lb.	6.25 - .
Spirits of turpentine.....	gal.	.82 - .
Wood turpentine, steam dist.....	gal.	.80 - .
Wood turpentine, dest. dist.....	gal.	.78 - .
Pine tar pitch, bbl.....	200 lb.	. - 6.00
Tar, kiln burned, bbl. (500 lb.).....	bbl.	. - 9.50
Retort tar, bbl.....	500 lb.	. - 9.50
Rosin oil, first run.....	gal.	.36 - .
Rosin oil, second run.....	gal.	.39 - .
Rosin oil, third run.....	gal.	.46 - .
Pine oil, steam dist., sp.gr. 0.930-0.940.....	gal.	\$1.90 - .
Pine oil, pure, dest. dist.....	gal.	1.50 - .
Pine tar oil, ref., sp.gr. 1.025-1.035.....	gal.	.46 - .
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.....	gal.	.35 - .
Pine tar oil, double ref., sp.gr. 0.965-0.990.....	gal.	.75 - .
Pine tar, ref., thin, sp.gr. 1.080-1.960.....	gal.	.35 - .
Turpentine, crude, sp. gr. 0.900-0.970.....	gal.	1.25 - .
Hardwood oil, f.o.b. Mich., sp.gr. 0.960-0.990.....	gal.	.35 - .
Pinewood creosote, ref.....	gal.	.52 - .

Solvents

73-76 deg., steel bbls. (85 lb.).....	gal.	\$0.37 - .
70-72 deg., steel bbls. (85 lb.).....	gal.	.35 - .
68-70 deg., steel bbls. (85 lb.).....	gal.	.34 - .
V. M. and P. naphtha, steel bbls. (85 lb.).....	gal.	.23 - .

Fertilizers

Ammonium sulphate, bulk and d. bags.....	100 lb.	\$2.30 - 2.90
Blood, dried, f.o.b., N. Y.....	unit	4.00 - .
Bone, 3 and 50, ground, raw.....	ton	30.00 - 32.00
Fish scrap, dom., dried, f.o.b. works.....	unit	2.90 - 3.00
Nitrate soda.....	100 lb.	2.30 - 2.35
Tankage, high grade, f.o.b. Chicago.....	unit	2.75 - 3.00
Phosphate rock, f.o.b. mines, Florida pebble, 68-72 p.c.....	ton	4.50 - 6.50
Tennessee, 78-80 p.c.....	ton	8.50 - 9.00
Potassium muriate, 80 p.c.....	ton	34.00 - 35.00
Potassium sulphate.....	unit	.90 - 1.00

Crude Rubber

Para-Upriver fine.....	lb.	\$0.23 - .23
Upriver coarse.....	lb.	.13 - .14
Upriver cauchoball.....	lb.	.13 - .13
Plantation—First latex crepe.....	lb.	.18 - .18
Ribbed smoked sheets.....	lb.	.18 - .19
Brown crepe, thin, clean.....	lb.	.15 - .
Amber crepe No. 1.....	lb.	.17 - .

Oils

VEGETABLE

The following prices are f.o.b. New York for earload lots.

Castor oil, No. 3, in bbls.....	lb.	\$0.10 - \$0.10
Castor oil, AA, in bbls.....	lb.	.11 - .12
China wood oil, in bbls. (f.o.b. Pac. coast).....	lb.	.13 - .13
Cocoonut oil, Ceylon grade, in bbls.....	lb.	.09 - .09
Cocoonut oil, Cochinchina grade, in bbls.....	lb.	.10 - .10
Corn oil, crude, in bbls.....	lb.	.08 - .08
Cottonseed oil, crude (f. o. b. mill).....	lb.	.07 - .07
Cottonseed oil, summer yellow.....	lb.	.08 - .09
Cottonseed oil, winter yellow.....	lb.	.09 - .09

Linseed oil, raw, ear lots (domestic).....	gal.	.67	—	.68
Linseed oil, raw, tank cars (domestic).....	gal.	.62	—	.63
Linseed oil, in 5-bbl lots (domestic).....	gal.	.70	—	.71
Olive oil, Denatured.....	gal.	\$1.15	—	\$1.20
Palm, Lagos.....	lb.	.07 ³ / ₄	—	.08
Palm, Niger.....	lb.	.06 ¹ / ₂	—	.06 ¹ / ₂
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.08 ¹ / ₄	—	.08 ¹ / ₄
Peanut oil, refined, in bbls.....	lb.	.11	—	.11 ¹ / ₄
Rapeseed oil, refined in bbls.....	gal.	.84	—	.85
Rapeseed oil, blown, in bbls.....	gal.	.88	—	.90
Soya bean oil (Manchurian), in bbls, N. Y.....	lb.	.08 ³ / ₄	—	.....
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.07 ³ / ₄	—	.....

FISH

Light pressed menhaden.....	gal.	\$0.40	—	.....
Yellow bleached menhaden.....	gal.	.42	—	.....
White bleached menhaden.....	gal.	.45	—	.....
Blown menhaden.....	gal.	.48	—	.....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$23.00	—	23.50
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	15.00	—	17.00
Barytes, crude, 88% @ 94% ba., Kings Creek.....	net ton	10.00	—	12.00
Barytes, floated, f.o.b. St. Louis.....	net ton	23.00	—	24.00
Barytes, crude, first grade, Missouri.....	net ton	6.00	—	7.00
Blanc fixe, dry.....	lb.	.04	—	.04 ¹ / ₂
Blanc fixe, pulp.....	net ton	45.00	—	55.00
Casein.....	lb.	.15	—	.16
Chalk, Precipitated, domestic, extra light.....	lb.	.04 ¹ / ₂	—	.05
Chalk, Precipitated, domestic, light.....	lb.	.04	—	.04 ¹ / ₂
Chalk, Precipitated, domestic, heavy.....	lb.	.03 ¹ / ₂	—	.04
Chalk, Precipitated, English, extra light.....	lb.	.04 ¹ / ₂	—	.05
Chalk, Precipitated, English, light.....	lb.	.04 ¹ / ₂	—	.05
Chalk, Precipitated, English, dense.....	lb.	.04	—	.04 ¹ / ₂
China clay (kaolin) crude, f.o.b. mines, Georgia.....	net ton	6.50	—	8.50
China clay (kaolin) washed, f.o.b. Georgia.....	net ton	9.00	—	10.00
China clay (kaolin) powdered, f.o.b. Georgia.....	net ton	13.00	—	20.00
China clay (kaolin) crude f.o.b. Virginia points.....	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points.....	net ton	13.00	—	20.00
China clay (kaolin), imported, lump.....	net ton	12.00	—	20.00
China clay (kaolin), imported, powdered.....	net ton	25.00	—	30.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	net ton	5.00	—	7.50
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27.00	—	30.00
Fullers earth, f.o.b. Mines.....	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Ia.....	net ton	15.00	—	18.00
Fullers earth, powdered, f.o.b. Fla.....	net ton	18.00	—	.....
Fullers earth, imported, powdered.....	net ton	24.00	—	27.00
Graphite, Ceylon lump, first quality.....	lb.	.05 ¹ / ₂	—	.06 ¹ / ₂
Graphite, Ceylon chip.....	lb.	.04	—	.05
Graphite, high grade amorphous crude.....	lb.	.00 ³ / ₄	—	.02 ¹ / ₂
Kieselguhr, f.o.b. mines, Cal.....	per ton	40.00	—	.....
Kieselguhr, f.o.b. N. Y.....	per ton	55.00	—	60.00
Magnesi.e, calcined.....	per ton	50.00	—	65.00
Pumice stone, imported.....	lb.	.03	—	.40
Pumice stone, domestic, lump.....	lb.	.05	—	.05 ¹ / ₂
Pumice stone, domestic, ground.....	lb.	.06	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore.....	net ton	.....	—	10.00
Quartz (acid tower) 1 ¹ / ₂ @ 2 in., f.o.b. Baltimore.....	net ton	.....	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	.....	—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange fine.....	lb.	.68	—	.70
Shellac, orange superfine.....	lb.	.78	—	.80
Shellac, A. C. garnet.....	lb.	.58	—	.60
Shellac, T. N.....	lb.	.68	—	.70
Soapstone.....	ton	12.00	—	15.00
Sodium chloride.....	long ton	12.50	—	13.00
Talc, paper-making grades, f.o.b. Vermont.....	ton	11.00	—	18.00
Talc, roofing grades, f.o.b. Vermont.....	ton	8.25	—	13.00
Talc, rubber grades, f.o.b. Vermont.....	ton	11.00	—	18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	7.50	—	11.00
Talc, imported.....	ton	30.00	—	40.00
Talc, California talcum powder grade.....	ton	18.00	—	25.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	per ton	\$50.00	.....	.....
Carborundum refractory brick, 9-in.	1,000	1250.00	.....	.....
Chrome brick, f.o.b. Eastern shipping points.....	net ton	52- 55	.....	.....
Chrome cement, 40-45% Cr ₂ O ₃	net ton	30- 32	.....	.....
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in ear lots, f.o.b. Eastern shipping points.....	net ton	33- 35	.....	.....
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	35- 40	.....	.....
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	30- 35	.....	.....
Magnesite brick, 9-in. straight.....	net ton	65- 70	.....	.....
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	77	.....	.....
Magnesite brick, soaps and splits.....	net ton	98	.....	.....
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	40- 42	.....	.....
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	42- 45	.....	.....
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	35- 38	.....	.....

Ferro-Alloys

All f.o.b. Works

Ferrocobalt-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00	—	\$225.00
Ferrochrome per lb. of Cr. contained, 6-8% carbon, earlots.....	lb.	.12	—	.....
Ferrochrome, per lb. of Cr. contained, 4-6% carbon, earlots.....	lb.	.13	—	.....
Ferromanganese, 76-80% Mn, domestic.....	gross ton	58.00	—	60.00
Ferromanganese, 76-80% Mn, Foreign, C. I. F. Atlantic Seaport.....	gross ton	54.00	—	58.35
Spiegeleisen, 18-22% Mn.....	gross ton	25.00	—	27.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.25	—	.....
Ferrosilicon, 10-15%.....	gross ton	38.00	—	40.00
Ferrosilicon, 50%.....	gross ton	57.00	—	59.00
Ferrosilicon, 75%.....	gross ton	120.00	—	125.00
Ferrotungsten, 70-80%, per lb. of contained W.....	lb.	.40	—	.45
Ferroumium, 35-50% of U, per lb. of U content.....	lb.	6.00	—	.....
Ferrovandium, 30-40% per lb. of contained V.....	lb.	4.25	—	4.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content.....	net ton	\$8.00	—	\$10.00
Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃	ton	22.00	—	23.00
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard.....	ton	22.00	—	23.00
Coke, foundry, f.o.b. ovens.....	net ton	4.25	—	4.50
Coke, furnace, f.o.b. ovens.....	net ton	3.25	—	3.50
Fluorspar, gravel, f.o.b. mines, New Mexico.....	net ton	12.00	—	.....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	20.00	—	22.00
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01 ¹ / ₂	—	.01 ¹ / ₂
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	.23	—	.24
Manganese ore, chemical (MnO ₂).....	net ton	55.00	—	60.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.45	—	.50
Monazite, per unit of ThO ₂ , c.i.f. Atlantic seaport.....	unit	30.00	—	.....
Pyrites, Spanish, fines, c.i.f. Atlantic seaport.....	unit	.12	—	.12
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.13	—	.13
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.11	—	.12
Rutile, 95% TiO ₂ per lb. ore.....	lb.	.15	—	.....
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	2.50	—	2.75
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	2.75	—	3.00
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	1.25	—	1.75
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.25	—	2.50
Vanadium pentoxide, 99%.....	lb.	12.00	—	14.00
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1.00	—	.....
Zircon, washed, iron free, f.o.b. Pablo, Florida.....	lb.	.04 ¹ / ₂	—	.13

Non-Ferrous Metals

New York Markets

Cents per Lb.

Copper, electrolytic.....	13.75
Aluminum, 98 to 99 per cent.....	19.00
Antimony, wholesale lots, Chinese and Japanese.....	4.50
Nickel, ordinary (ingot).....	41.00
Nickel, electrolytic.....	44.00
Monel metal, shot and blocks.....	35.00
Monel metal, ingots.....	38.00
Monel metal, sheet bars.....	40.00
Tin, 5-ton lots, Straits.....	33.00
Lead, New York, spot.....	4.70
Lead, E. St. Louis, spot.....	4.35 @ 4.40
Zinc, spot, New York.....	5.25 @ 5.30
Zinc, spot, E. St. Louis.....	4.80 @ 4.85

OTHER METALS

Silver (commercial).....	oz.	\$0.65 ¹ / ₂
Cadmium.....	lb.	1.00-1.25
Bismuth (500 lb. lots).....	lb.	1.50 @ 1.55
Cobalt.....	lb.	3.00 @ 3.25
Magnesium (f.o.b. Philadelphia).....	lb.	1.25
Platinum.....	oz.	75.00-78.00
Iridium.....	oz.	150.00 @ 170.00
Palladium.....	oz.	55.00-60.00
Mercury.....	.75 lb.	48.00-49.00

FINISHED METAL PRODUCTS

Warehouse Price
Cents per Lb.

Copper sheets, hot rolled.....	21.25
Copper bottoms.....	28.75
Copper rods.....	19.75
High brass wire.....	17.25
High brass rods.....	14.75
Low brass wire.....	18.75
Low brass rods.....	19.25
Brazed brass tubing.....	25.50
Brazed bronze tubing.....	30.50
Seamless copper tubing.....	21.25
Seamless high brass tubing.....	18.50

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current	Cleveland	Chicago
Copper, heavy and crucible.....	9.75 @ 10.25	9.25	9.50
Copper, heavy and wire.....	9.25 @ 9.50	8.50	8.50
Copper, light and bottoms.....	7.50 @ 8.00	7.50	7.25
Lead, heavy.....	3.50 @ 3.75	3.25	3.25
Lead, tea.....	2.25 @ 2.35	2.25	2.25
Brass, heavy.....	4.25 @ 4.50	4.50	5.00
Brass, light.....	3.25 @ 3.50	3.25	3.50
No. 1 yellow brass turnings.....	4.00 @ 4.25	4.25	4.50
Zinc.....	2.00 @ 2.25	2.00	2.25

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by 1/2 in. and larger, and plates 1/2 in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes.....	\$2.78	\$2.88	\$2.78
Soft steel bars.....	2.68	2.78	2.68
Soft steel bar shapes.....	2.68	2.78	2.68
Soft steel bands.....	3.28	3.48	3.28
Plates, 1/2 to 1 in. thick.....	2.78	2.88	2.78

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Arkansas

LITTLE ROCK—A. B. Banks, Little Rock, and Burton B. Tuttle, Cincinnati, O., are organizing a new company for the operation of a plant for the manufacture of fertilizer, whitening and kindred products on property recently acquired at White Cliffs on the Little River, between Nashville and Ashdown, Ark. The site totals over 2,500 acres of land and was obtained for a consideration said to be about \$500,000. A chalk works will also be established in connection with the project. The new company will operate with a capital of \$1,000,000.

FORT SMITH—The Crystal Glass Co., Ninth and O Sts., is planning for the remodeling of its plant, with extensions and improvements estimated to cost about \$75,000. C. P. Zenor heads the company.

California

CHICO—The Shell Oil Co., 343 Sansome St., San Francisco, has plans under way for the construction of a new distributing plant on a 2-acre plot of ground, known as the Thompson property, Chico, estimated to cost about \$60,000, including equipment.

Colorado

GRAND JUNCTION—The Grand Junction Gas Co. plans an expenditure of \$25,000 for the enlargement of its plant. J. Stewart is general superintendent.

Connecticut

BRIDGEPORT—The D. & C. Oil Co., Lindley St., has completed plans for the erection of a new 1-story plant, 25 x 80 ft., on Colonial Ave., estimated to cost about \$25,000.

Indiana

MICHIGAN CITY—A 1-story foundry addition, with power plant, estimated to cost about \$500,000, including machinery, will be erected at the plant of the Haskell & Barker Car Co. Bids have been taken. Frank D. Chase, Inc., 545 North Michigan Ave., Chicago, Ill., is architect and engineer.

Kentucky

CORBIN—The Corbin Brick Co. is planning for extensions in its plant to increase the capacity from about 15,000 to 30,000 bricks per day. Two new kilns will be constructed, drier equipment and other apparatus installed. The company has recently increased its capital from \$50,000 to \$100,000 for expansion. Benn Goodwin is manager.

Louisiana

KENNER—The National Petroleum Co., Hibernia Bank Bldg., New Orleans, La., is planning for the erection of a new oil-refining plant in the vicinity of Kenner, La. P. A. Leslie is manager.

GRETNNA—The United States Flour Mills Co., 606 Common St., New Orleans, is perfecting plans for the erection of a new flour mill at Gretna, with initial capacity of about 6,000 bbl. of flour per day. An extensive laboratory will be established in connection with the works. W. L. O'Daniel is president.

ALEXANDRIA—The Alexandria Refining Co., recently organized, has construction under way on a new local oil refinery for the production of gasoline, kerosene and petroleum byproducts. It is proposed to have the plant ready for service at an early date. E. M. Talley is general manager.

Maryland

BALTIMORE—The Bethlehem Steel Co., Bethlehem, Pa., has preliminary plans under way for extensions and improvements in its local plant, estimated to cost close to \$50,000,000. The plans are being developed and will provide, it is said, for about twice the present output. The present plant, known as the Sparrow Point

Works, represents an investment of more than \$70,000,000.

BALTIMORE—The Central Chemical Co. has acquired the plant of the D. B. Marton Co., 1630 Clinton St., and will use the property for a new chemical manufacturing works. Possession will be taken at once.

BALTIMORE—The National Wall Paper Co., 1009 East Baltimore St., has had plans prepared for the erection of an addition, 40 x 100 ft., to its 3-story building at 706 East Baltimore St.

BALTIMORE—The new oil refinery now being constructed by the Standard Oil Co. is estimated to represent a total investment of \$7,000,000, and will rank as the second largest plant of its kind in the world. It will be placed in operation as soon as completed. The company will build a new tankage department at First Ave. and Fourteenth St., to cost about \$30,000.

Massachusetts

WALTHAM—The Elastoid Fiber Co., Norman and Marshall Sts., has construction under way on a new 1-story plant, 72 x 180 ft., in the vicinity of Pond St. It is expected to be ready for occupancy at an early date. A 1-story power house will also be constructed. The H. P. Cummings Construction Co., Ware, Mass., has the erection contract.

Michigan

BAY CITY—The Aetna Portland Cement Co., Union Trust Bldg., Detroit, has acquired property at Bay City, totaling about 30 acres, as a site for the erection of a large cement-manufacturing plant. Preliminary plans are under way for the first plant unit, designed in the form of an inverted U, with total area 375 x 900 ft. It will consist of a grinding department, 60 x 60 ft.; cooling department; 3 kilns; machine repair shop; coating department; and power plant. Docks and other transportation facilities will be constructed. The plant unit will have an initial minimum output of about 300 bbl. per day, and is estimated to cost close to \$750,000. It is proposed to commence erection early in the spring. The plant will be operated in conjunction with the present works of the company at Fenton, Mich. Franklin R. Robinson is president; and O. J. Lingeman, secretary.

Missouri

MARSTON—The East St. Louis Cotton Oil Co., is planning for the rebuilding of the portion of its local plant, recently destroyed by fire with loss of about \$30,000.

ST. LOUIS—The Red Spot Paint & Varnish Co., 1534 North Eighth St., is perfecting plans for the immediate remodeling and improving of the 3-story factory, 40 x 125 ft., recently acquired, for the establishment of a new plant for the manufacture of paints and varnishes for industrial and other service. P. C. Fryaser is general manager.

New Jersey

JERSEY CITY—The Ault & Wiborg Chemical Co., 432 New St., Cincinnati, O., manufacturer of printing inks, etc., has acquired the property of the Cockburn Corp., Monmouth and Twelfth Sts., Jersey City, including land and buildings, and will occupy the premises for a plant.

EAST ROCHESTER—The Merchants' Dispatch Transportation Co., has completed plans and will soon commence the erection of a 1-story addition to its steel-fabricating plant, 60 x 80 ft. L. F. West is head.

CUYLERVILLE—The Sterling Salt Co., 29 Broadway, New York, has awarded a contract to Dwight P. Robinson & Co., 126 East Forty-Sixth St., for the erection of a new building at Cuylerville.

Ohio

AKRON—The National Sulphur Co., 80 Maiden Lane, New York, has completed plans and will take bids at once for the construction of a new sulphur plant on Talmadge Road, Akron, to consist of four 1-story buildings, estimated to cost about

\$300,000, including machinery. C. S. Clark, 212 Ohio Bldg., Akron, is engineer.

AKRON—The Seiberling Rubber Co., recently organized under Delaware laws, is arranging for a stock issue of \$2,000,000, the proceeds to be used for general operations, expansion, etc. The company proposes to develop a capacity of about 5,000 automobile tires and 6,000 tubes daily at its two plants at New Castle, Pa., and Barberton, Ohio, the latter comprising the former works of the Portage Rubber Co., lately purchased. Cord tires, also, will be manufactured at the plants. F. A. Seiberling, formerly president of the Goodyear Tire & Rubber Co., is president; and C. W. Seiberling, vice-president.

Oklahoma

MUSKOGEE—The Muskogee Vitrified Brick Co. is planning for the rebuilding of the portion of its plant recently destroyed by fire with loss estimated at about \$50,000, including equipment.

Pennsylvania

BRACKENBRIDGE—The Atlantic Bottling Co. has construction in progress for a new 2-story plant, 100 x 250 ft., estimated to cost about \$35,000. Allan & Kestner, Tarentum, Tarentum, Pa., are architects.

PITTSBURGH—The Neely Oil & Production Co., Pittsburgh, is planning for the establishment of a new oil-refining plant on a site in Allen County, Ky. It is said that work will be inaugurated at an early date.

DERRY—The Pittsburgh High Voltage Insulator Co., is considering tentative plans for the erection of an addition to its plant.

Tennessee

NASHVILLE—Mercer Reynolds, Chattanooga, Tenn., is perfecting plans for the organization of a new company, to construct and operate a plant at Nashville, where a site has been acquired. The new plant will manufacture paper products from cotton linters, under a special process. A specialty will be made of fine bond papers.

Texas

WACO—William Sacks, Tulsa, Okla., is planning for extensions and improvements in the local refinery of the Waco Refining Co., recently acquired. The present capacity of 5,000 bbl. per day will be increased. A new pipeline will be constructed from Mexia to Waco. The entire project is estimated to cost in excess of \$750,000, including equipment.

PORT ARTHUR—Fire, Dec. 5, destroyed a portion of the local oil refinery of the Texas Co., Dallas, Tex. The loss, official estimate of which has not been made, included high pressure stills and other equipment.

Virginia

RICHMOND—George Gibson, Richmond Trust Co. Bldg. Seventh and Main Sts., operating the Industrial Realty Corp., has awarded a contract to John T. Wilson & Co., Inc., Mutual Bldg., for the erection of a new 1-story and basement plant, 102 x 202 ft., at Seventh and Everett Sts., to be equipped for the manufacture of paper products. It is estimated to cost about \$75,000. Carneal & Johnston, Chamber of Commerce Bldg., are architects.

West Virginia

SALEM—The Salem Flint Glass Co., recently organized, will install considerable glass-manufacturing equipment in an existing building, for the manufacture of shades, globes and kindred glass specialties. R. F. Davis is president, and J. O. Burkhard, general manager.

WHEELING—The Wheeling Mold & Foundry Co. has extensive improvement work under way at its plant, including the remodeling of certain departments and equipment. The plant will be placed in operation, it is said, at an early date.

Wisconsin

GREEN BAY—The Fort Howard Paper Co. has active construction under way on a new 3-story paper mill, 100 x 120 ft., in the East Side section, estimated to cost about \$85,000. The plant will be occupied as soon as completed.

Ontario

LONDON—The Board of Education asks for bids on complete equipment for chemistry and physics laboratories for a new high school, estimated cost \$15,000. L. E. Carrothers is the engineer.

New Companies

THE WAXTWELL PAPER Co., Grand Rapids, Mich., has been incorporated with a capital of \$10,000, to manufacture waxed, plain and other papers. The incorporators are Archibald I. McCall, Grand Rapids; John F. Hastings, Jr., and George J. Putt, Kalamazoo, Mich.

THE AMERICAN ALUMINUM CASTING Co., Newark, N. J., has been incorporated with a capital of \$25,000, to manufacture aluminum and other metal castings. The incorporators are John Rohn, Frank T. Schmuhl and Henry Brucker, 324 Colt St., Newark.

THE METROPOLITAN POTTERY Co., Woodhaven, L. I., has been incorporated with a capital of \$50,000, to manufacture pottery products of various kinds. The incorporators are A. and H. Ratner, and N. McCoy. The company is represented by W. Augenmeyer, Woodhaven.

THE SALUTARAS DRUG & CHEMICAL Co., 1707 South Halsted St., Chicago, Ill., has been incorporated with a capital of \$5,000, to manufacture chemicals, drugs, etc. The incorporators are M. K. Wood, Stanley Darguzis and William Picktorman.

THE GARDNER-HART CHEMICAL CORP., Wilmington, Del., has been incorporated under state laws with capital of \$1,000,000, to manufacture chemicals and chemical by-products. The company is represented by the Delaware Registration Trust Co., 900 Market St., Wilmington.

THE GLO-RITE Co., Camden, N. J., has been incorporated with a capital of \$100,000, to manufacture polishes and kindred specialties. The incorporators are Edward S. Gille, James D. Eastnick and Harold W. Bennett, 45 North Third St., Camden.

THE SAGAMORE OIL CORP., Grandfield, Okla., has been incorporated with a capital of \$100,000, to manufacture petroleum products. The incorporators are Homer D. Cris, and W. S. Hamilton, both of Grandfield; and H. P. Downs, Tulsa, Okla.

THE SOUTHBRIDGE FOUNDRY Co., Southbridge, Mass., has been incorporated with a capital of \$30,000, to manufacture iron, steel and other metal castings. Frank S. Mills is president; and Arthur A. Allard, Southbridge, treasurer.

THE M-S POLAR-PROOF Co., Room 623, 53 West Jackson St., Chicago, Ill., has been incorporated with a capital of \$10,000, to manufacture varnishes, polishes, carbon removers, etc. The incorporators are John F. Ashworth, Judson G. Hancock and Robert M. Sherritt.

RESPRO, INC., Cranston, R. I., has been incorporated with a capital of \$100,000 to manufacture rubber products. The incorporators are Eugene A. Kingman, Walter A. Edwards and Kenneth J. Tanner, all of Providence, R. I.

H. MURDOCH & Co., Wilmington, Del., has been incorporated under state laws with a capital of \$100,000, to operate a metal smelting and refining plant; converting ores, etc. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington.

THE HEINEMANN & MOSCH GLASS & MIRROR Co., Newark, N. J., has been incorporated with a capital of \$50,000, to manufacture glass products, mirrors, etc. The incorporators are Otto Heinemann, Joseph Mosch and Frank Prasch. The company is represented by Howard Ishewood, 738 Broad St., Newark.

THE HERCULES CHEMICAL Co., Wilmington, Del., has been incorporated with a capital of \$100,000 under state laws, to manufacture chemicals and affiliated products. The company is represented by Franklin L. Mettler, 832 Market St., Wilmington.

THE FAIRMONT OIL Co., Woonsocket, R. I., has been incorporated with a capital of \$25,000, to manufacture oil products. The incorporators are A. E., R. A., and Lumina D. Bonin, all of Woonsocket.

THE ARTCHAFT PAPER BOX Co., 154 Whiting St., Chicago, Ill., has been incorporated with a capital of 250 shares of stock, no par value, to manufacture paper boxes and containers. The incorporators are James H. Cartwright, Jr.; Harold Beacon and R. S. Tuthill.

THE NEW JERSEY LEATHER GOODS Co., Jersey City, N. J., has been incorporated with a capital of \$100,000, to manufacture leather products. The incorporators are Herbert W. Royal, Edwin G. Adams and Herman B. Welch, 542 Palisade Ave., Jersey City.

THE RELIANCE OIL Co., Los Angeles, Cal., has been incorporated with a capital of \$1,000,000, to manufacture petroleum products. The incorporators are F. G.

Howland, L. Volk and G. J. Knight, all of Los Angeles. The company is represented by Carnahan & Clark, 756 South Broadway, Los Angeles.

THE RIO GRANDE PAINT Co., Laredo, Tex., has been incorporated with a capital of \$15,000, to manufacture paints, varnishes, etc. The incorporators are W. L. Guyler and E. H. Buenz, both of Laredo.

THE GREAT SOUTHERN STEEL Co., Chicago, Ill., has been incorporated under Delaware laws with capital of \$105,000,000, to manufacture steel products. The company is represented by Charles E. Pain, First National Bank Bldg., Chicago.

GEORGE J. YOUNG, INC., Brooklyn, N. Y., has been incorporated with a capital of \$100,000, to manufacture chemicals and chemical byproducts, drugs, etc. The incorporators are George J. and R. Young. The company is represented by I. Cook, 189 Montague St., Brooklyn.

Capital Increases, Etc.

THE OCCIDENTAL OIL Co., Mexia, Tex., has been incorporated with a capital of \$500,000, to manufacture petroleum products. The incorporators are Frank Smith, S. E. Colgin and A. E. Wilder, all of Mexia.

THE POLO CHEMICAL Co., 2824 West Chicago Ave., Chicago, Ill., has been incorporated with a capital of \$25,000, to manufacture chemicals and chemical byproducts. The incorporators are Michael Schwetz and Leon Segel.

THE EASTERN ALUMINUM Co., Pittsburgh, Pa., has been incorporated with a capital of \$300,000, under Delaware laws, to manufacture aluminum and other metal products. The incorporators are George V. Brooke, Pittsburgh; John J. Hughes, New Florence, Pa.; and J. V. Hughes, Johnstown, Pa.

THE TRINITY OIL CORP., Dallas, Tex., has been incorporated with a capital of \$400,000, to manufacture petroleum products. The incorporators are Harry Pennington, Frank D. Halm and J. W. Ricker, all of Dallas.

THE COMMERCIAL CHEMICAL Co., 23-25 Light St. Baltimore, Md., has been incorporated with a capital of \$10,000, to manufacture chemicals and chemical byproducts. The incorporators are Edward S. Tyler, Charles E. Callis and William F. Hammond.

THE WEST BRANCH TANNING Co., Philadelphia, Pa., has been incorporated with a capital of \$5,000, to manufacture leather products. W. S. Anderson, 2241 North 53d Street, is treasurer.

THE CAFICO CHEMICAL Co., Pittsburgh, Pa., has been incorporated under Delaware laws with capital of \$50,000, to manufacture chemicals and chemical byproducts. The company is represented by the Capital Trust Co., Dover, Del.

THE OIL DESULPHURIZING CORP., New York, N. Y., has been incorporated with a capital of \$1,500,000, under Delaware laws, to manufacture refined oil products. The company is represented by the United States Corporation Co., 65 Cedar St., New York.

THE MUTUAL PETROLEUM CORP., Adrian, Mich., has filed notice of increase in capital from \$25,000 to \$100,000.

THE CLAY-GODSON CORP., 2413 Third Ave., New York, N. Y., has filed notice of dissolution under state laws.

THE PURE OIL Co., 74 Broadway, New York, N. Y., has arranged for a preferred stock issue to total \$4,300,000, for general operations, financing, etc.

THE WARNER SUGAR REFINING Co., 79 Wall St., New York, N. Y., has disposed of a bond issue of \$6,000,000, the proceeds to be used for general operations, financing, etc.

THE NATIONAL LEATHER Co., 161 South St., Boston, Mass., has been reorganized with a capital of \$7,500,000, a reduction of \$22,500,000 from the former capitalization. Stockholders have approved plans for a preferred stock issue to total \$15,000,000.

THE PIERCE OIL CORP., 25 Broad St., New York, N. Y., has arranged for a bond issue of \$2,000,000, the proceeds to be used for general operations, financing, etc.

THE ELECTRIC ALLOY STEEL Co., Charlevoix, Pa., has perfected arrangements for a preferred stock issue to total \$750,000, the proceeds to be used for additional working capital, plant extensions and improvements, etc.

Following the acquisition of the APSLEY RUBBER Co., Marlboro, Mass., by the Firestone Tire & Rubber Co., Akron, O., notice has been filed of change of name to the Firestone-Apsley Rubber Co.

Industrial Notes

W. F. LEGGET, former advertising manager of the Webster Manufacturing Co., Chicago, has become associated with the Chemical Catalog Co. as Western sales manager, with headquarters in Chicago.

THE UNION SULPHUR Co.'s New York office is now located in the Frasci Bldg., 32 Rector St., a new 15-story building named in honor of the founder of the Union Sulphur Co.

J. DOL & CIE., 30 Rue Pertinax, Nice, France, inform us that they hold options on large deposits of bauxite in southern France.

THE INSULATION & SPECIALTY CORP. OF AMERICA, du Pont Bldg., Wilmington, Del., has been incorporated for the manufacture of insulating material known as fiber granite. The material will be produced in sheets, tubes and rods.

THE W. A. JONES FOUNDRY & MACHINE Co., manufacturer of power transmitting machinery, announces the appointment of Fred E. Holtz as its Milwaukee district representative. He will assume his new duties immediately, making headquarters in the First National Bank Bldg.

THE COMBUSTION ENGINEERING CORP., New York, announces the recent opening of two branch offices: One at 216 Latta Arcade, Charlotte, N. C., in charge of T. E. Nott; the other at Seattle, Wash., where it is represented by the Fryer-Barker Co., 1133 Henry Bldg.

THE CHLORINE PRODUCTS Co., Chicago, Ill., announces that it is now ready to market its line of electrolytic cells, gas compressors, gas controllers, condensers, etc., for the production of chlorine gas, caustic alkalis, hydrogen gas and liquid chlorine. W. M. Jewell is secretary of the company.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its seventy-fourth meeting at Toronto, Canada, Dec. 26 to 31, 1921.

AMERICAN CERAMIC SOCIETY will hold its twenty-fourth annual meeting at St. Louis, Feb. 27 to March 2, 1922.

AMERICAN CHEMICAL SOCIETY will hold its spring meeting at Birmingham, Ala., April 4 to 7, 1922.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting in Baltimore, April 27, 28 and 29, 1922.

AMERICAN ENGINEERING COUNCIL will hold its next meeting in Washington, Jan. 5-6.

AMERICAN FOUNDRYMEN'S ASSOCIATION will hold its next convention and exhibit at Cleveland, O., during the week of April 24, 1922. Meetings will be held in the spring instead of in the fall as heretofore.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its spring meeting in New York the week of Feb. 20, 1922.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

PERKIN MEDAL will be presented to William M. Burton by the Society of Chemical Industry at its meeting Jan. 13 at the Chemists' Club, New York.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

The following meetings are scheduled to be held in Rumford Hall, the Chemists' Club, New York: Jan. 6—American Chemical Society, regular meeting; Jan. 13—Society of Chemical Industry, Perkin Medal; Feb. 10—American Electrochemical Society (in charge), Society of Chemical Industry, Société de Chimie Industrielle, American Chemical Society, joint meeting; March 10—American Chemical Society, Nichols Medal; March 24—Society of Chemical Industry, regular meeting; April 21—Society of Chemical Industry (in charge), American Electrochemical Society, Société de Chimie Industrielle, American Chemical Society, joint meeting; May 5—American Chemical Society, regular meeting; May 12—Société de Chimie Industrielle (in charge), American Chemical Society, Society of Chemical Industry, American Electrochemical Society, joint meeting; May 19—Society of Chemical Industry, regular meeting; June 9—American Chemical Society, regular meeting.

CHEMICAL & METALLURGICAL ENGINEERING

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R. S. McBRIDE
CHARLES N. HULBURT
Assistant Editors
CHESTER H. JONES
Industrial Editor
J. S. NEGRU
Managing Editor

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Number 26

Unemployment and The Cost of Production

AN EXCEPTIONALLY prominent chemical manufacturer made a statement a few days ago that bears repeating, for it directs our thought along some of the less frequented byways of industry. The theme of the discussion was the inefficiency of present-day labor, and to carry his point this manufacturer related an incident that occurred a year ago in one of his chemical plants. During the month of December that plant produced a certain chemical at a cost of, say, \$10 per ton. In the following month, with the same workmen receiving the same wages and working the same number of hours, the plant had an increased output of this chemical and the cost of production had dropped to \$7.50 per ton. The only new factor entering into the situation was that all during the month of January there had been an ever-increasing crowd outside the factory gate, whereas in the preceding month the plant's employment bureau had been forced to take the initiative in obtaining even a few necessary replacements. In other words, the potential competition of those men outside the gate and the fear of being replaced by lower-priced men had the effect of stimulating the workers to increased production and greater efficiency.

But not long ago a famous British manufacturer, who is also a large employer, visited this country and, among other things, outlined a program of suggested reforms in relations between employer and employee. These he maintained were essential to material progress and represented the only real solution to the problem of industrial unrest. Prominent among his recommendations was the appeal to remove the menace of unemployment and the feeling of economic insecurity which is widely prevalent among the workers.

At first blush it would appear that the actual demonstration in the American factory disproved this part of the Englishman's theory. But is this the case after all? The possibility of unemployment served as a temporary stimulus to increased efficiency in this chemical plant, but are there not other more constructive ways by which this could have been accomplished? For instance, one of the outstanding features in the British manufacturer's program was the suggestion that the worker should have some tangible interest in the results of his labor and that where practicable he should share directly in the profits of the business. Another arrangement which has worked out satisfactorily in some plants is the periodical bonus based on production. In fact anything which tends to promote a closer understanding and a more intimate relation between the men inside the gate and their employer is in the interest of greater output and increased efficiency.

There will always be shirkers and inefficient workmen to retard progress and slow up production, but the

future holds much in store for the far-sighted manufacturer who succeeds in convincing the men inside the gate that all are working toward a common goal and that their mutual success or failure is entirely dependent on the combined efforts of the employer and the employed.

Are Colleges Over-Supplying Chemists?

OF ALL the laws of economics the dabbler in the subject usually unversed in business is most familiar with that governing the supply and demand of commodities. Having as a rule only a hazy idea of modern industry and no comprehension of how this law is dependent on many others, he proceeds glibly to generalize on "supply and demand" in relation to professional knowledge also. This forces him to consider the chemist or engineer as an inanimate thing without free choice, without "time-binding" or even "space-binding" characteristics, and immediately leads to a discussion of unionism, licensing or other methods of tampering with these laws.

The man of brains and technical training must in his very soul resent being classed as one of a number. If he's worth his salt he sincerely desires to be different and better, to remain the individual—not one of a class. He abhors the idea of unionizing and licensing.

Now, if we are to discuss an over-supply of chemists, thinking of the chemist purely as a laboratory worker, which unfortunately is the popular conception, such an over-supply does exist and always will exist. For the laboratory worker is merely on the first rung of the ladder. He parallels the draftsman in the engineering field and the test-shop man in the electrical field. Men are turned out of our technical courses and naturally are forced to crowd around the first step.

But industry needs these apprentices badly, and the chemical industry above all others requires more men with chemical training who can be absorbed in the many departments outside the laboratory. As these chemists become operating men, engineers, salesmen and executives, the industry is bettered and the economic return to the individual is, therefore, greatly increased.

Industry will accept them as theorists, but demands of them the ability to grasp the business side. There is no time in a four-year course to make business men of chemists, and it should therefore not be attempted. However, our teaching staffs may help the situation by putting the student in the proper frame of mind to see this aspect and talk less of fundamental research.

The electrical, mining and metallurgical industries have progressed rapidly because of their absorption of highly trained men in every branch of the work. Many hundreds of men are received from the colleges and turned to fit their places in these industries every year. Electrical teaching staffs do not prattle of research. No

more need the chemistry professors. The process industries are fearfully short of the type of technically trained man willing to seize opportunity in all branches.

Wouldn't it be better if our colleges held out a vision of science applied to industry, leaving research to the occasional brilliant mind that shows special adaptability? Industry can still absorb a large number of chemists of varied abilities.

Limiting the Activities Of Trade Associations

"**N**OW watch for the trade associations to fade away into nothing," was the comment offered by a close observer after the United States Supreme Court had rendered its decision on Dec. 19 in the case of the American Hardwood Manufacturers Association. In effect this association is told that the maintenance of open-price information is practically a restraint of trade and an effort to stifle competition and fix prices. On this ground the Supreme Court ruled that such practices must be discontinued.

For some time there has been little doubt in the minds of close students of association affairs that the open-price agreement would sooner or later be condemned; now the condemnation comes from the highest tribunal of the land and in no uncertain language. The decision will, of course, not at all affect scientific and technical societies that deal with matters of research and investigation or with matters of resource or manufacturing procedure. However, it will vitally affect those industrial groups that attempt to influence trade or commercial practices. In fact it should prove of considerable importance in guiding the activities of the newly organized Synthetic Organic Chemical Manufacturers Association.

Two association activities now distinctly in disrepute in Washington are "lobbying" and "open-price" agreements. There is much splendid work that can be done without dangerous intrusion upon these two fields of endeavor, and there is no doubt that the newly formed chemical organization can accomplish many helpful results. The chemical industry, because of its rapid growth and unnatural development, has failed to lay the proper stress on modern methods of cost finding, merchandising and other business problems on which a trade association might be expected to offer constructive criticism and advice. The study of foreign competition and of market possibilities at home and abroad is also a legitimate activity for co-operative work. Furthermore, there is a definite need for a unified organization to represent the chemical industry in its contact with the Department of Commerce, the Tariff Commission and other governmental agencies. The Bureau of Foreign and Domestic Commerce, under Mr. HOOVER'S guidance, is offering valuable assistance to industries that are willing to pledge whole-hearted co-operation. Can the chemical industry afford to stand aloof?

These are but a few of the many activities that are open to an association in the chemical industry. However, it is not unseemly, perhaps, to sound warning that the decision just rendered by the Supreme Court has placed one very definite limitation on the co-operative work which industry may legitimately undertake through the medium of the trade association. To ignore this decision will not only embarrass the association but will also damage any cause, however worthy it may be, which the industry hopes to serve.

Coke Byproduct Output Misinterpreted

THE GREAT decrease in output of coke during the past twelve months as compared with the large production of 1917, 1918 and 1920 has given rise to some confusion as to the effect upon production of byproducts. The cause for this confusion is easily understood; for those who have examined only totals of coke production have apparently forgotten that these totals do not indicate at all clearly the byproduct part of the business. In fact they are very misleading with respect to byproducts such as ammonia, tar and light oil, for the greater part of the fluctuation in coke totals is caused by the variation in beehive output, which, of course, does not at all affect the byproduct part of the business.

The peak of coke production was reached in 1918, when an average of slightly over 4,700,000 net tons of byproduct and beehive coke was made per month. Following the close of the war, there was a distinct falling off in the total, so that in 1919 the monthly average was over a million tons less than during the previous year, but most of this decrease was on beehive coke, the decrease on byproduct coke output being less than 4 per cent. The following year there was an increase in both beehive and byproduct output, but it was only slight for beehive and very marked in the case of byproduct. As a consequence of this, in 1920 the monthly average beehive coke production was less than two-thirds that of 1917, whereas the byproduct coke production for the same year was the greatest in the history of the industry.

During the present calendar year there have been, of course, large decreases of output of both kinds of coke, and only during the last few months has there been a tendency to increase again toward "normal." However, in no case has the byproduct coke output fallen below 50 per cent of the monthly average production for the previous year, which, as mentioned above, was the greatest ever recorded. The latest figures, those for November, 1921, show about 70 per cent of the monthly average production of 1920. During the same period, however, the output of beehive coke was less than 30 per cent of the 1920 monthly average and less than 20 per cent of the 1917 monthly average.

It is inconceivable that coke ovens should be operated without production of byproducts in more or less fixed ratio to the coke produced. In other words, for every million tons of coke made we can expect substantially uniform output of tar, ammonium sulphate and light oil. Whether this million tons of coke be made during a season of great activity or during a period of slack operation. The ratio, of course, is not exactly the same, for different coking periods affect the output of each of the byproducts somewhat; but the ratio for practical purposes is nearly enough uniform to permit us safely to draw conclusions as to these secondary products. It is clear, therefore, that no one is justified in assuming that the byproduct output—tar, light oil and ammonium sulphate—will fall in the neighborhood of 25 or 30 per cent of last year's production, as some seem to think would be the case. The output probably will be in the neighborhood of 65 or 70 per cent of the 1920 totals, for the byproduct coke output of the period will probably be of this order of magnitude. The proper interpretation of these facts is of great importance to the industries which depend upon the coke-oven operations of the country for their raw materials.

Work and

Employment in 1920

EXAMPLES of "how not to do it" are generally considered very useful. They are informing, while they do not circumscribe initiative as do examples of how to do it. We have already learned much from the year 1920 as to how not to do it, and now comes the preliminary report of the Bureau of the Census on gainful employment in 1920 to add to this knowledge.

We find from this report that we have some things to unlearn. A very popular idea has been that in 1920 a great many persons were receiving emoluments, including salaries and something called by the undignified and almost opprobrious title of wages, and that the chief thing wrong was that a great many were not working hard for the emolument received. Even that, however, was not the case, for the census report shows that a smaller percentage of the population was engaged in gainful occupation in 1920 than in 1910. There had been an increase in the proportion in each census up to and including that of 1910, but the 1920 proportion is almost precisely the same as that for 1900. The proportion is figured not against the total population but against the population ten years and more of age. The percentages have been: 1880, 47.3; 1890, 49.2; 1900, 50.2; 1910, 53.3; 1920, 50.3. So there is another good story gone wrong. Not as many were holding jobs, not to speak of working.

The Bureau of the Census in its preliminary report intimates that a considerable part of the apparent decrease in the proportion may arise from the 1910 census having been on April 15 while the 1920 census was of January 1, whereby the shown decrease in farm laborers might be accounted for. The common talk, however, was that men had gone away from the farm and got jobs in town, and furthermore it is to be noted that the larger decrease from 1910 to 1920 was in females.

The matter of females in employment is another thing suggesting we have something to unlearn. Most of us have heard so much about females replacing males in employment right along, and particularly on account of the war, that it has been difficult to avoid concluding that the contention must be correct. Not so, according to the census figures. Of the females ten years of age and over 23.4 per cent were gainfully employed in 1910 and 21.1 per cent in 1920, while of the males of the same age the proportions were 81.3 per cent in 1910 and 78.2 per cent in 1920. Thus the female proportion decreased 10 per cent and the male proportion only 4 per cent.

There was nothing particularly startling about industrial conditions on April 15, 1910, when the previous census was taken. We were going along and tending to business. We were not extremely or abnormally active, and 53.3 per cent of the male population ten years of age and over was gainfully employed. January 1, 1920, the proportion was only 50.3 per cent. In addition to a great many who were "gainfully employed" but were loafing more or less in this gainful employment (the census did not attempt to report how much real work they were doing), it now appears that there were a good many who ought to have been working and who did not even have jobs, presumably because they did not want to have jobs. The total number gainfully employed was 8,549,399 females and 33,059,793 males, or 41,609,192 altogether. Now and then there is a little talk—fortunately it shows a tendency to increase in

volume—about the "rights of the public" in labor disputes, the unions having a total membership of say 5,000,000 or less. When "the public" is mentioned in this connection it does not mean simply those who do not work, but includes the more than 35,000,000 persons who are gainfully employed but do not seek to get the gain by striking and threatening to strike.

Wildcats in

Western Texas

ONE of the outstanding national problems is the gradual impoverishment of the soil. Continuing our present agricultural practices will be to court serious economic difficulties; the problem of fertilization must be solved. Continued impoverishment of the soil will cause us to depend for our exports more and more upon the irreplaceable mineral resources available in limited quantities and less and less upon those food-stuffs which are annually renewed.

It is of more than passing interest, therefore, to study the possibilities of development in this country of natural potash supplies of all types. In every case where there appears reasonable ground for belief that potash deposits occur no time should be lost in exploration to determine their presence, their extent and their workability. Until some commanding percentage of our annual need can be supplied from domestic sources, we can never feel entirely safe against excessive charges by the producers who control the German and Alsatian supplies.

In this issue Professor UDDEN gives illuminating information regarding the possibilities of potash in Texas. He urges, and quite properly, exploration to determine the thickness and the extent of potash-bearing beds which are known to exist at least in small areas and in thin layers at widely separated regions in his state.

In Professor UDDEN's recommendation, the U. S. Geological Survey also heartily concurs. But the Survey also issues a warning that should be carefully heeded. In a recent announcement given wide circulation, it said:

To protect the public from misrepresentation and fraud by unscrupulous promoters and sellers of stocks based on potash deposits in western Texas the United States Geological Survey, Department of the Interior, states that the potash deposits there, instead of being 1,100 or even 300 ft. thick, as represented by the promoters, have not yet been proved to be of workable thickness or of commercial value. Rich potash salts, comprising the mineral polyhalite, which were deposited in association with great thicknesses of rock salt and gypsum in "red beds," as in Germany, and, in fact, at the same time as the German deposits, have been discovered by representatives of the United States Geological Survey and the Texas University Bureau of Geology and Technology in a co-operative search, but though this discovery, which was made public early in June, is encouraging and interesting, the practical question whether the deposits are thick enough to mine—that is, whether they are worth anything—is yet to be answered.

There is ample ground for optimism and certain need for exploration to give us exact information. But this is no time for the typical broadcast promotion of stock such as that which has been undertaken by certain persons obviously serving their own interest, not that of the general public. It should be the effort of technical men upon every appropriate occasion to encourage these scientific projects recommended by state and federal authorities; but they will also do a public service if they will repeat the warning which the Geological Survey has issued.

Hardness of High-Speed Steel

Hardness of High-Speed Tool Steel at Moderate Temperatures, Hardness in the Cold After Various Heat-Treatments, and Cutting Efficiency Determined in an Effort to Predetermine the Usefulness of a Modern Machine Tool

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IT IS interesting to read the hardening recommendations for high-speed steel given in the different tool steel catalogs. Some manufacturers recommend an extremely high quenching temperature, with no subsequent tempering; others advocate a high quenching temperature with 400 to 600 deg. F. (204 to 316 deg. C.) drawing heat; a few recommend drawing to 1,050 to 1,100 deg. F. (566 to 593 deg. C.) after quenching from a high temperature; still others advise a lower quenching temperature; one or two recommend pack hardening or salt bath hardening; while one catalog states that drawing to 900 deg. F. (482 deg. C.) in an oil bath produces beneficial results.

In tests just completed by the writer on the best-known brands of high-speed steel made in this country and abroad, the analyses of which are shown in Table I, every brand of tungsten high-speed steel responded in the highest degree to a high quenching temperature followed by a draw at 1,100 deg. F. (593 deg. C.). The treatment recommended by Taylor and White in 1900 was to quench from a temperature close to the fusing point of the steel into a lead bath at 1,150 deg. F. (621 deg. C.), from there into oil or air quench, then drawing to 1,150 deg. F. (621 deg. C.). In the last 20 years the barium chloride process has been proposed, but is now little used, pack hardening was tried and still finds extensive use, especially abroad, and lead-bath hardening was tried and found wanting. Today, therefore, the majority of high-speed steel is being hardened in practically the same manner as recommended by Taylor and White in the beginning.

I have already stated briefly the advantages and disadvantages of the different hardening methods in an article entitled "Various Methods for Hardening High-Speed Steel". This contribution will attempt to show, by micrographs, hardness data, physical tests and cutting tests, the results produced by different hardening treatments on crucible and electric furnace high-speed steels of various compositions.

Fifteen bars (4½ in. rounds) listed in Table I were available. Steels numbered 1, 2, 5, 6, 7, 10, 12, 14 and 15 were selected for microscopic examinations, scleroscope tests, cutting tests, etc. As indicated in this table, some of these brands were the product of the crucible furnace, the remainder being electric furnace melted. Brinell hardness varied from 217 to 286; as a matter of fact, high-speed rounds of this size should be annealed to a Brinell hardness not greater than 240, but it seems to be the practice of some mills to conduct this final annealing operation in the shortest time possible, in consequence sending out a product not fully annealed. The majority of American tool steel mills rough turn their larger sized rounds, which is of considerable advantage to the consumer, since a smaller machining

tolerance may be used after the scale and decarburized surface have been removed. It also insures bars free from surface defects, for seams or laps are easily detected after turning. Not a bar of several received from abroad was rough turned.

Figs. 1 to 4 show the micrographs of this material as received in the annealed condition. Longitudinal sections were examined in order to reveal carbide segregations, envelope structure, etc. The only specimen showing complete freedom from these defects was No. 14, shown in Fig. 2. It was cut from a disk forged from No. 15 bar. The segregations and large carbide areas shown in Fig. 1 were completely broken up by this added working. Cutters made from hammered disks have greater cutting efficiency than cutters machined from the bar from which these disks were forged, as will be shown later. Bar 5 shows the worst segregation. Massive carbide areas and envelope structures cannot be broken up to any extent whatsoever by hardening; in fact, the only possible way to eliminate this undesirable structure is by further mechanical working.

Each of the bars of high-speed steel was machined into 4 x ½ x 1 in. hole, side-milling cutters. Blanks ½ in. thick were also cut from these bars; these blanks were then cut into disks, twelve of which were given the semi-muffle furnace treatment, twelve more the barium chloride treatment and the remaining twelve were hardened by the pack process.² These pieces were then drawn to different temperatures, carefully ground to remove

²For details of this treatment see "Various Methods for Hardening High-Speed Steel," by A. H. d'Arcambal, CHEM. & MET. ENG., vol. 25, No. 25, p. 1150, Dec. 21, 1921.

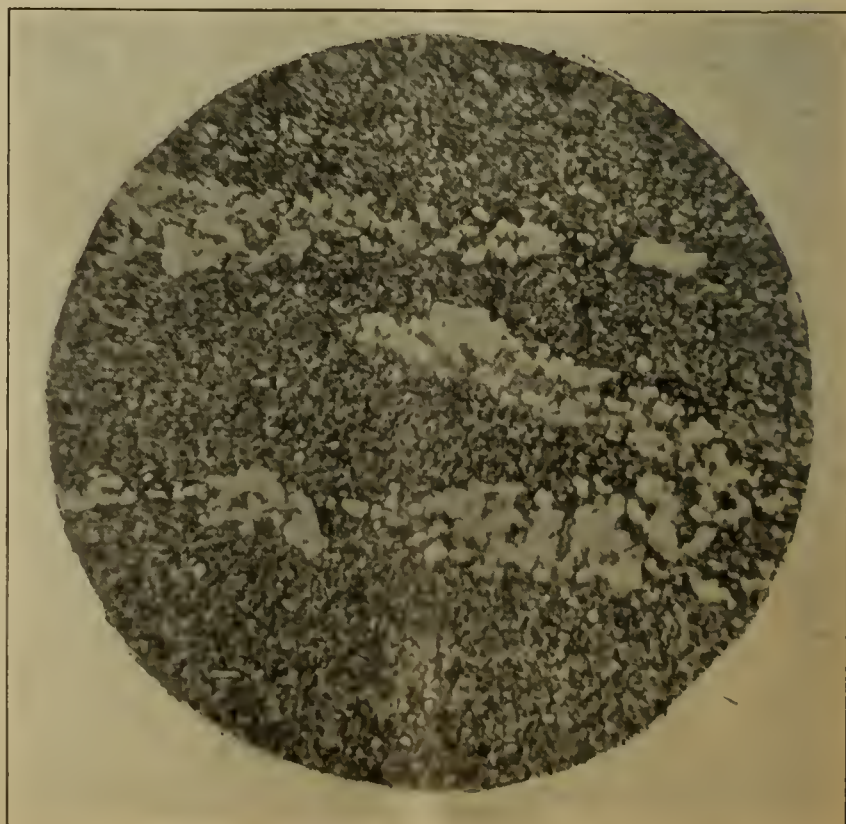


FIG. 1. STEEL NO. 15; LONGITUDINAL SECTION; × 500

TABLE I. HIGH-SPEED STEELS USED IN EST

No.	C	Mn	P	S	Si	Cr	V	W	Co	Mo	Brinell Hardness	Method of Mfg.
* 1	0.70	0.18	0.017	0.025	0.13	3.53	0.68	17.56	...	...	286	Cruc. melted
* 2	0.67	0.30	0.016	0.009	0.11	3.66	0.95	17.39	...	...	241	Cruc. melted
3	0.65	0.16	0.022	0.025	0.24	4.70	1.02	18.45	...	...	228	Elec. fee. melted
* 4	0.64	0.24	0.017	0.025	0.16	3.33	1.01	18.44	...	...	228	Cruc. melted
5	0.70	0.18	0.026	0.024	0.41	4.43	...	...	5.25	4.90	255	Cruc. melted
* 6	0.68	0.30	0.014	0.010	0.22	3.68	0.97	17.51	3.27	...	286	Elec. fee. melted
7	0.70	0.21	0.020	0.025	0.31	4.45	1.18	12.65	...	...	241	Elec. fee. melted
8	0.67	0.14	0.020	0.020	0.23	3.37	0.97	19.05	...	...	217	Cruc. melted
10	0.62	0.22	0.017	0.009	0.14	4.14	0.26	17.84	...	...	269	Elec. fee. melted
11	0.63	0.34	0.024	0.022	0.15	3.89	0.85	18.60	...	...	241	Cruc. melted
*12	0.80	0.25	0.024	0.014	0.14	3.57	1.75	14.70	...	...	228	Cruc. melted
14	0.62	0.34	0.014	0.023	0.09	3.74	0.55	17.87	...	...	217	Cruc. melted, blank forged
*15	0.62	0.34	0.014	0.023	0.09	3.74	0.55	17.87	...	...	217	Cruc. melted
16	1.07	0.32	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

* Indicates that bars are rough turned.

scale and decarburized material. A type "D" (dial reading) Shore scleroscope was used to determine the hardness of each sample, the scleroscope readings shown in Table II being the average of not less than ten readings. These results give the following information:

1. The three different methods of hardening all give about the same initial scleroscope hardness.

2. The majority of the samples quenched from the highest temperature (that is, Quenching A, the semi-muffle furnace treatment) showed a lower scleroscope reading after drawing to temperatures ranging from 600 to 1,000 deg. F. (316 to 538 deg. C.), but the samples drawn from 1,050 to 1,150 deg. F. (566 to 621 deg. C.) and in some cases as high as 1,200 deg. F. (649 deg. C.) showed the same or greater scleroscope hardness than in the undrawn condition.

3. Samples given the barium chloride and pack hardening treatments (B and C) also showed a lower scleroscope reading when drawn from 600 to 1,000 deg. F. (316 to 538 deg. C.) than in the undrawn condition. In a few cases the same scleroscope hardness as when quenched was obtained on samples drawn to 1,050 or 1,100 deg. F. (566 or 593 deg. C.). The falling off in scleroscope hardness after this temperature was passed was much greater in every case than found on samples treated in the semi-muffle furnace (Quenching A). The highest degree of secondary hardness was therefore obtained in test specimens quenched from the highest temperature.



FIG. 2. STEEL NO. 14; FORGED DISK, HAMMERED FROM BAR NO. 15 AND ANNEALED. LONGITUDINAL SECTION; X 500

TABLE II. SCLEROSCOPE HARDNESS OF 1/4-IN. DISKS OF 4 1/4-IN. HIGH-SPEED STEEL BARS AFTER VARIOUS HEAT-TREATMENTS

Bar	Quenching (See Note)	Drawing Temperature, Deg. F.											
		None	400	600	800	900	1,000	1,050	1,100	1,150	1,200	1,250	1,300
1	A	90	90	84	85	84	83	86	90	...	92	87	79
1	B	92	92	87	82	82	83	86	87	83	82	82	72
1	C	90	92	83	84	84	80	86	82	77	77	72	66
2	A	93	92	...	85	86	89	88	92	92	89	86	79
2	B	92	91	85	84	84	84	86	91	85	82	76	72
2	C	90	91	82	80	82	85	82	82	80	77	72	59
2	D	92	...	92	93	...	92	...	93	92	...	...	...
5	A	85	88	85	86	87	90	95	96	99	97	94	...
5	B	87	86	85	81	82	86	86	93	93	93	86	72
5	C	91	91	84	85	86	88	90	95	82	82	74	60
6	A	92	93	86	85	90	91	91	92	92	91	86	77
6	B	92	90	84	83	83	83	87	92	85	83	77	71
6	C	87	85	84	85	79	79	85	76	76	74	72	61
10	A	91	91	83	85	83	85	87	89	89	...	78	72
10	B	90	90	85	83	82	80	83	88	82	75	70	64
10	C	93	90	82	86	80	80	80	83	79	85	67	62
12	A	93	92	86	86	86	89	89	91	94	92	88	83
12	B	91	91	82	84	83	80	85	88	87	78	75	70
12	C	89	91	83	83	83	84	83	88	78	76	73	63

NOTE.—Heat-treatment A: Heated to 2,300 deg. F. (1,260 deg. C.) in open fire and quenched in oil at 100 deg. F. (38 deg. C.).
Heat-Treatment B: Heated in barium chloride bath for twelve minutes at 2,100 deg. F. (1,150 deg. C.), and quenched in oil at 100 deg. F. (38 deg. C.).
Heat-Treatment C: Heated two hours in charcoal pack at 2,050 deg. F. (1,120 deg. C.)—requiring 3 hours to come to heat—and quenched in oil at 100 deg. F. (38 deg. C.).
Heat-Treatment D: Heated to 2,300 deg. F. (1,260 deg. C.) in open fire; quenched; drawn to 1,150 deg.; redrawn to various temperatures.

One of the samples that had been quenched from 2,300 deg. F. (1,260 deg. C.) and drawn to 1,150 deg. F. (621 deg. C.) was redrawn to temperatures up to 1,150 deg. F. (621 deg. C.), giving the results shown in Table II, Quenching 2-D. This shows that the scleroscope hardness obtained on redrawing a piece of hardened high-speed steel, which had been drawn to 1,150 deg. F. (621 deg. C.), would be a straight line, instead of showing a softened range from 600 deg. F. (316 deg. C.) to 1,000 deg. F. (538 deg. C.). Greater stability is thus produced by the high drawing treatment.

Microscopic sections were then cut from quenched specimens A, not drawn as well as after drawing to 1,100 deg. F. (593 deg. C.). These micrographs after etching for 2 minutes in a 5 per cent nital solution were then compared with micro-specimens of the corresponding pieces that had received the barium chloride treatment B. Fig. 4 shows these micrographs. A close study brings out the following points:

1. A high quenching temperature dissolves nearly all the carbides and tungstides³ which are not in massive or

³Honda and Murakami, "Notes on the Structural Constitution, Hardening and Tempering of High-Speed Steel Containing Chromium and Tungsten" (*Journal of Iron and Steel Institute*, No. 1, 1920), think that the fine white globules visible in high-speed steel under the microscope are a tungstide (Fe₂W) instead of a carbide for the following reasons: 1. The globules have the same behavior with chemical reagents as the tungstide found in carbonless iron-tungsten alloys. 2. Steels containing a definite quantity of carbon and chromium show an increase in these fine globules as the tungsten content is increased. 3. In steels containing a definite quantity of tungsten and chromium the globules do not increase with increasing carbon.

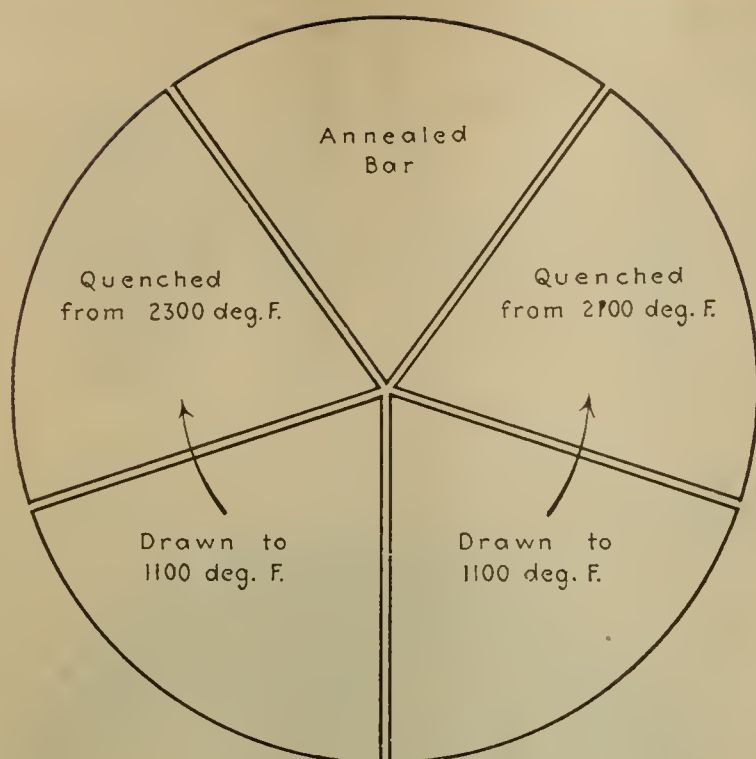


FIG. 3. KEY TO FIG. 4

envelope formation, producing a polyhedral structure; the resulting microconstituents are austenite, martensite and free carbides and tungstides.

2. Drawing to 1,100 deg. F. (593 deg. C.) produces a full martensitic structure and in general with suppression of the polyhedral crystals boundary markings.

3. High-speed steel quenched from 2,100 deg. F. (1,149 deg. C.) or lower does not possess the polyhedral structure of austenite (steel No. 5 being the exception), but reveals considerable quantity of free carbides and tungstides embedded in a martensitic matrix. Drawing

to 1,100 deg. F. (593 deg. C.) produces a slight amount of troostite.

4. Severe carbide segregations present in the annealed condition are not dissolved by the hardening treatment.

A comparison of the scleroscope data in Table II with these microstructures indicates that the greatest degree of secondary hardness is attained when the quenched material is partially austenitic. In other words, the higher the quenching temperature the greater the secondary hardening effect. The resistance to tempering is also dependent on the quantity of dissolved carbides.

Quenching high-speed steel from 2,300 deg. F. (1,260 deg. C.) apparently preserves austenite to only a slight degree, for the scleroscope hardness is about the same as for high-speed steel quenched from lower temperatures, which in turn produces a full martensitic structure. Hardened high-speed steel in the so-called "austenitic condition" is also quite strongly magnetic showing that the structure is by no means exclusively austenite. A sample of Mushet steel previously described,⁴ quenched from 2,200 deg. F. (1,204 deg. C.) was almost entirely austenitic, for the specimen was non-magnetic and possessed a scleroscope hardness of only 53.

HARDNESS AT HIGH TEMPERATURES

One often hears the question asked "How hard is high-speed steel at a dull red heat?"

In order to determine the hardness of hardened high-speed steels at temperatures from 400 to 1,200 deg. F. (204 to 649 deg. C.), tests were conducted as follows: Disks $\frac{5}{8}$ in. thick were cut from the 4 $\frac{1}{4}$ -in. round bars of high-speed steel as well as from a bar of carbon tool

⁴See CHEM. & MET. ENG., vol 25, No. 23, p. 1055, Dec. 7, 1921.

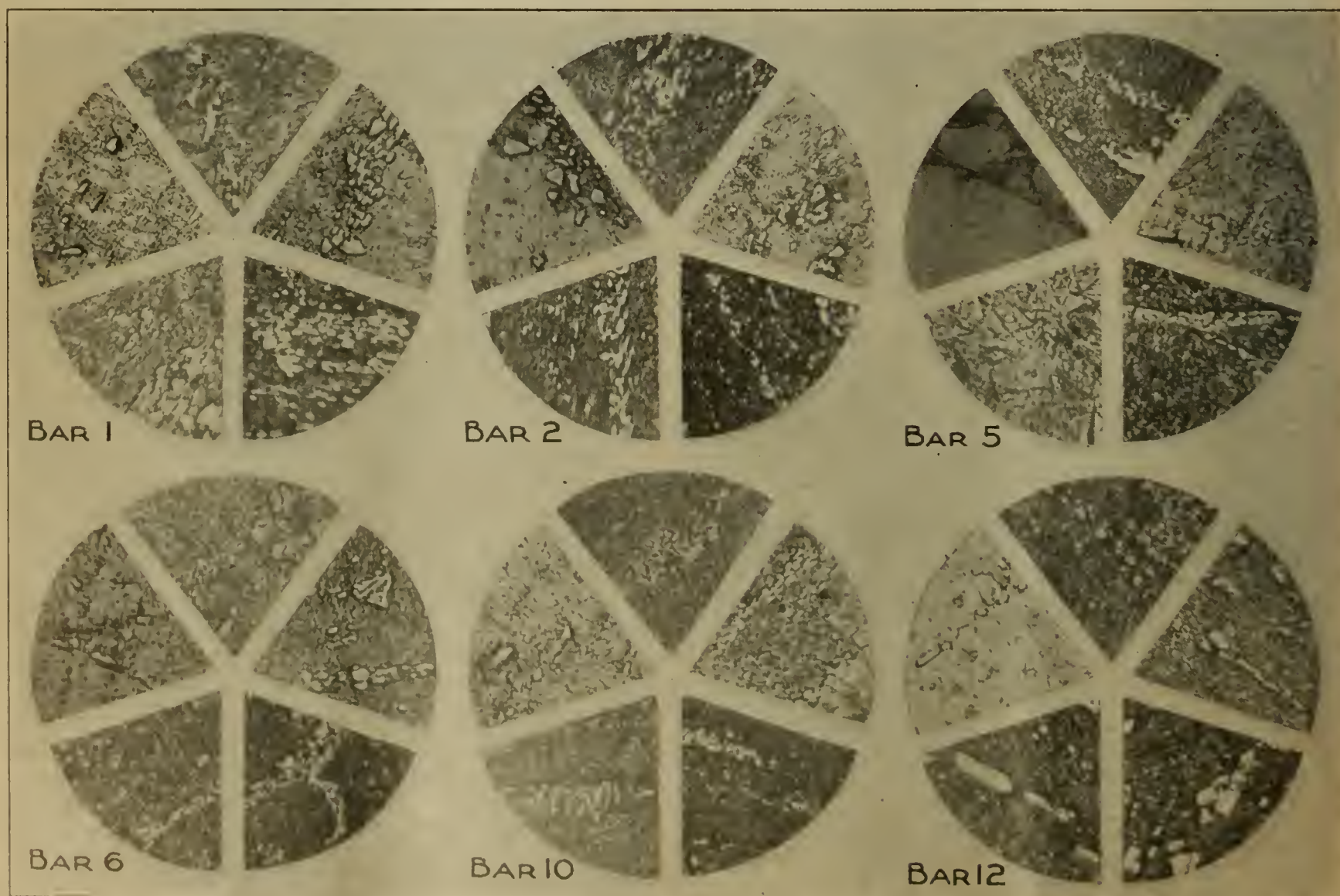


FIG. 4. MICROSTRUCTURE OF VARIOUS HIGH-SPEED STEELS AS RECEIVED AND AFTER VARIOUS HEAT-TREATMENTS. ETCHED 2 MIN. IN NITAL. $\times 350$.

steel, the disks then being halved. These disks were given the hardening treatments shown in Table III and tested for Brinell hardness at room temperature. They were then heated in a small electric muffle furnace, two at a time, with a pyrometer between the disks and touching them. The pieces were held at the desired temperature for a sufficient length of time to insure thorough soaking, removed from the furnace, placed at once on a steel block at the same temperature, and the Brinell hardness taken. The Brinell impressions were scaled immediately and the disk again placed in the furnace for the next higher temperature. After the test at 1,200 deg. F. (649 deg. C.) was taken, the pieces were cooled to room temperature and again tested.

It is necessary to use a ball after each test at 800 deg. F. (427 deg. C.) and higher as the ball was softened

the Brinell hardness of carbon tool steel at a dull red heat; see line 16-*I*.

6. High-speed steel disks given the high quench (treatment *E*), drawn to 1,200 deg. F. (649 deg. C.) and cooled gave the same Brinell readings as obtained before drawing. The disks given the pack treatment (*F*), and then drawn to 1,200 deg. F. (649 deg. C.), cooled and tested showed a softening of up to one hundred points. These results would be expected after studying the scleroscope data in Table II.

These Brinell tests at high temperature were a little disappointing in the results obtained, as the steel which showed the greatest cutting efficiency (No. 12) did not show a higher Brinell hardness at the different temperatures than some of the other brands. The steel which showed the poorest cutting qualities (No. 5), however, did show lower hardness at elevated temperatures.

CUTTER TESTS

It was decided to use heat-treated chromium-nickel steel, S.A.E. No. 3140, for testing these cutters. This alloy steel was given the same heat-treatment as this grade of material usually receives when used for airplane and automobile parts, and the resultant Brinell hardness varied from 262 to 277, the majority of the bars testing 269.

Chemical and physical properties follow:

Analysis	Per Cent	Physical Tests (Standard 0.505-In. Test-Piece)
Carbon.....	0.46	Elastic limit, 112,000 lb. per sq.in.
Manganese...	0.60	Tensile strength, 126,000 lb. per sq.in.
Chromium....	0.69	Elongation, 20 per cent.
Nickel.....	1.16	Reduction of area, 54 per cent.
		Brinell hardness, 269.

These 16 x 2½ x 1½-in slabs were ground on all sides after heat-treating to remove scale.

When milling material of this analysis and hardness, it was not necessary to run at such high speeds, feeds and depths of cut to break the tool down as when milling ordinary machinery steel or cast iron. Therefore the following was used: Speed, 130 ft. per minute; feed, 3½ in. per minute; cut, ½ in. deep; coolant, oil. An examination of each of these cutters showed that the cutting edges were worn, not burned down after being tested.

Referring to Table IV, it will be noted that all of these cutters were quenched from the semi-muffle furnace when they had attained a temperature of 2,300 deg. F. (1,260 deg. C.). They were carefully preheated at 1,600 deg. F. (871 deg. C.) before being placed in the high-speed furnace. The proper time to be given these cutters in the furnaces was obtained by independent experiments, then all the cutters were hardened in exactly the same manner.

Cutters tempered at 450 deg. F. (232 deg. C.) were drawn in an oil bath while cutters given the high drawing treatment (1,100 to 593 deg. C.) were first drawn in the oil bath to 600 deg. F. (316 deg. C.), then transferred to the niter bath at 650 deg. F. (343 deg. C.), and the temperature increased to 1,100 deg. F. (593 deg. C.). The cutters were permitted to remain for 10 minutes at this temperature, then were oil quenched. Cutters quenched from 2,300 deg. F. (1,260 deg. C.) into the niter bath at 1,100 deg. F. (593 deg. C.) were held in the bath for about 4 minutes, then oil quenched. As niter at this temperature attacks high-speed steel when quenched into the same and held for a considerable length of time, a lead bath is more suitable for the quenching medium.

Referring again to Table IV, it will be noted that

TABLE III. BRINELL HARDNESS OF A HIGH-SPEED TOOL AT ELEVATED TEMPERATURES

Bar	Quenching (See Note)	After Quenching	Brinell Hardness								After Cooling From 1,200 Deg. F.
			At 400 Deg. F.	At 600 Deg. F.	At 800 Deg. F.	At 900 Deg. F.	At 1,000 Deg. F.	At 1,100 Deg. F.	At 1,200 Deg. F.		
1	E	652	652	600	532	477	444	418	387	652	
1	F	652	652	578	512	460	444	387	321	555	
2	G	652	652	555	512	495	477	418	...	...	
2	H	652	652	600	555	555	477	418	...	...	
5	E	600	512	495	444	444	460	418	340	652	
5	F	627	512	477	444	444	418	387	340	652	
6	E	652	627	600	532	512	512	444	387	652	
6	F	652	600	555	512	477	444	418	321	555	
7	E	652	600	555	495	477	444	418	364	652	
7	F	652	600	532	460	444	418	375	302	555	
12	E	652	652	555	512	512	477	418	418	652	
12	F	652	600	512	512	477	444	340	332	578	
16	I	713	600	477	302	241	179	...	...	...	

NOTE.—Heat-Treatment *E*: Heated to 2,350 deg. F. (1,290 deg. C.) in open fire; quenched in oil at 100 deg. F. (38 deg. C.).

Heat-Treatment *F*: Heated 1½ hours in charcoal pack at 2,050 deg. F. (1,120 deg. C.), (requiring 4 hours to come to heat), and quenched in oil at 100 deg. F. (38 deg. C.).

Heat-Treatment *G*: Same as *E*, except quenching followed by draw to 450 deg. F. (232 deg. C.).

Heat-Treatment *H*: Same as *E*, except quenching followed by draw to 1,100 deg. F. (593 deg. C.).

Heat-Treatment *I*: Heated to 1,480 deg. F. (805 deg. C.) for 10 minutes in lead bath and quenched into brine.

to a slight extent at the contact surface. In no case, however, did the balls flatten when in contact with the hot metal.

The following information is obtained from the data in Table III:

1. The higher the quenching temperature given the different brands of high-speed steel the greater the hardness at temperatures from 600 to 1,200 deg. F. (316 to 649 deg. C.).

2. The cobalt-molybdenum steel No. 5 shows considerably lower hardness at 600 to 900 deg. F. (316 to 482 deg. C.) than do the tungsten steels.

3. High-speed steel quenched and drawn to 1,100 deg. F. (593 deg. C.) (heat-treatment *H*) shows a greater Brinell hardness at temperatures from 600 to 900 deg. F. (316 to 482 deg. C.) than when quenched from the same temperature but only drawn to 450 deg. F. (232 deg. C.) (heat-treatment *G*).

4. All the high-speed steels given heat-treatment *E* (quenched from 2,300 deg. F.) have the same Brinell hardness, with one exception, at 1,100 deg. F. (593 deg. C.).

5. Hardened high-speed steel, while not as hard as hardened carbon tool steel, possesses almost three times

TABLE IV. CUTTER TESTS

Steel No.	Heat-Treatment	Inches of Metal Cut
12	2,300 deg. F. muffle furnace, oil quenched, 450 deg. F. draw....	132
12	2,300 deg. F. muffle furnace, oil quenched, 1,100 deg. F. draw..	214
12	Average.....	173
6	2,300 deg. F. muffle furnace, oil quenched, 450 deg. F. draw....	107
6	2,300 deg. F. muffle furnace, oil quenched, 1,100 deg. F. draw..	183
6	Average.....	145
10	2,300 deg. F. muffle furnace, oil quenched, 450 deg. F. draw....	67
10	2,300 deg. F. muffle furnace, oil quenched, 1,100 deg. F. draw..	216
10	Average.....	142
7	2,300 deg. F. muffle furnace, oil quenched, 450 deg. F. draw....	88
7	2,300 deg. F. muffle furnace, oil quenched, 1,100 deg. F. draw..	155
7	Average.....	122
1	2,300 deg. F. muffle furnace, oil quenched, 450 deg. F. draw....	60
1	2,300 deg. F. muffle furnace, oil quenched, 1,100 deg. F. draw..	140
1	Average.....	100
5	2,300 deg. F. muffle furnace, oil quenched, 450 deg. F. draw....	12
5	2,300 deg. F. muffle furnace, oil quenched, 1,100 deg. F. draw..	65
5	Average.....	39
14*	2,300 deg. F. muffle furnace, oil quenched, 450 deg. F. draw....	88
14	2,300 deg. F. muffle furnace, oil quenched, 1,100 deg. F. draw..	168
14	Average.....	128
15	2,300 deg. F. muffle furnace, oil quenched, 450 deg. F. draw....	48
15	2,300 deg. F. muffle furnace, oil quenched, 1,100 deg. F. draw..	155
15	Average.....	102
2	2,300 deg. F. muffle furnace, oil quenched, 450 deg. F. draw....	59
2	2,300 deg. F. muffle furnace, oil quenched, 1,100 deg. F. draw..	182
2	Average.....	121
2	2,300 deg. F. muffle furnace, oil quenched, 800 deg. F. draw....	...
	Average.....	54
2	2,300 deg. F. muffle furnace, quenched in niter at 1,100 deg. F., not drawn.....	...
	Average.....	iii

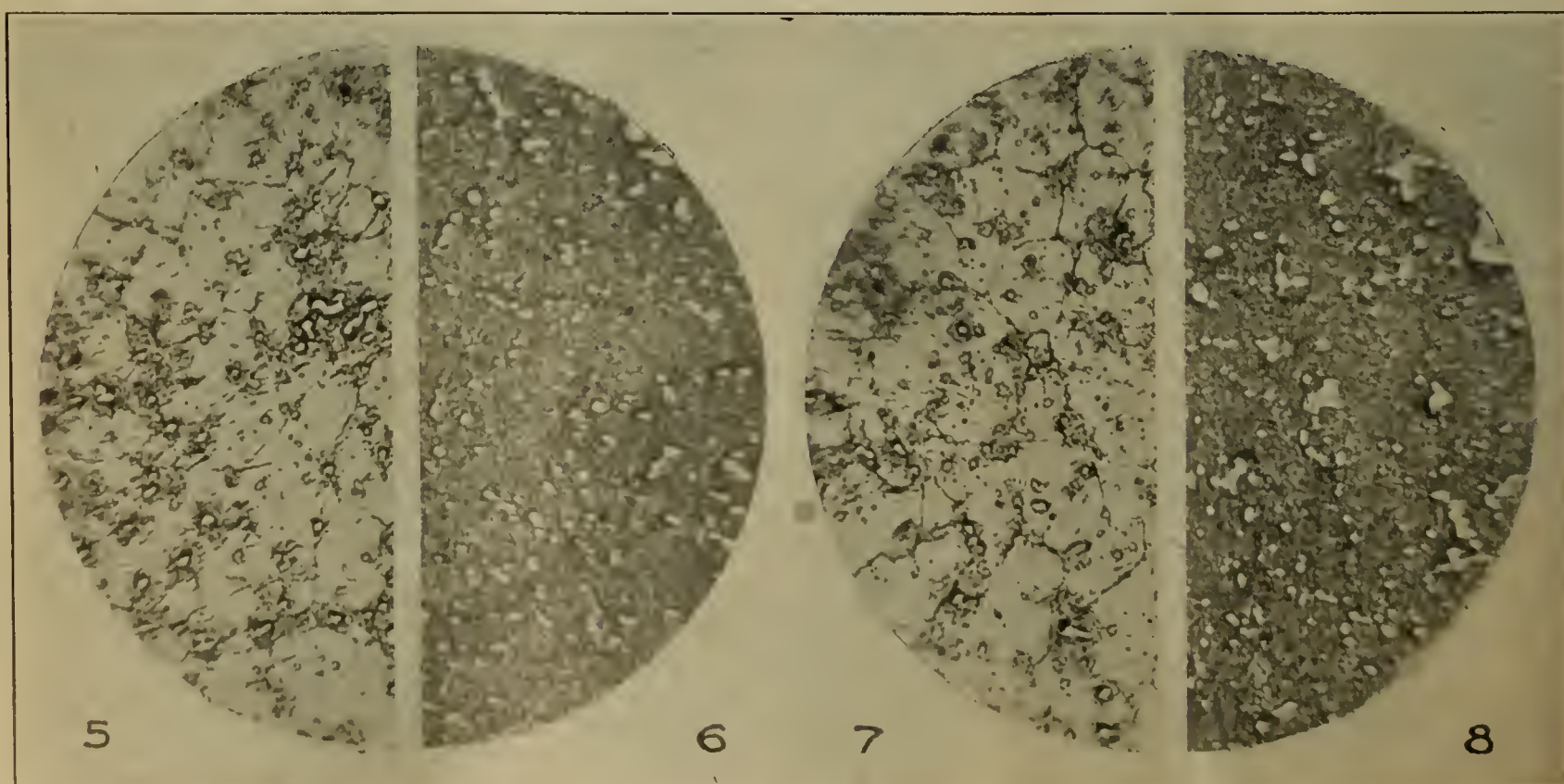
*Cutters made from forged blanks using No. 15 bar.

cutters containing somewhat higher vanadium (No. 12) showed the greatest cutting efficiency. The corners on these cutters were in good condition after the test, failure being due to the dullness. In passing it should be noted that each figure in the table represents the average length of cut made by two tools. In nearly all of the other cutters, the corners failed as well as the cutting edges. Steel No. 6, containing 3 per cent cobalt, ranked second, while the cobalt-molybdenum steel No. 5 showed the poorest cutting qualities. Cutters made from this brand of steel were given a higher quenching

temperature than recommended by the manufacturer, but it was decided to harden all of these cutters in exactly the same manner. Cutters No. 14, made from forged disks, showed about 25 per cent greater cutting efficiency than those machined from bar No. 15, from which the former were forged. Cutters No. 2, drawn to 800 deg. F. (427 deg. C.), which is in a soft range, as shown by Table II, showed less cutting ability than those made from the same bar, quenched from the same temperature but drawn only to 450 deg. F. (232 deg. C.). Other No. 2 cutters quenched into a niter bath at 1,100 deg. F. (593 deg. C.) performed about twice as well as those drawn to 450 deg. F. (232 deg. C.), but only a little more than half as well as when given the 1,100 deg. F. (593 deg. C.) draw.

One of the important points brought out by these cutter tests was the great increase in cutting properties produced by the high drawing temperature. The results obtained from cutters made of forged blanks, as compared with those machined from the hammered bar, verified the well-known fact that high-speed steel which has received sufficient working to break up carbide segregations and massive carbide areas will produce better tools than material containing them. As stated previously, these crystals will not go into solution on heating for hardening, and as the red-hardness and cutting efficiency are dependent on the dispersion of these carbides and tungstides, the greater cutting efficiency obtained from materials free from these segregations is accounted for.

Another interesting point brought out was the result obtained from cutters No. 2, quenched into a bath at 1,100 deg. F. (593 deg. C.) cooled from that temperature to room temperature and not drawn. The writer has been informed by two or three persons that quenching high-speed steel into a bath of 1,100 to 1,200 deg. F. (593 to 649 deg. C.) produces the same effect as oil quenching and drawing back to 1,100 to 1,200 deg. F. (593 to 649 deg. C.). As the results obtained in the cutter tests showed this was not true, we com-



FIGS. 5 TO 8. OIL VERSUS LEAD BATH QUENCHING. $\times 500$. ETCHED 3 MIN. IN 5 PER CENT NITAL SOLUTION
 Fig. 5—Oil quenched from 2,300 deg. F. Fig. 6—Fig. 5 after drawing to 1,100 deg. F.
 Fig. 7—Quenched from 2,300 deg. F. into lead at 1,100 deg. F.; held 30 min. and air cooled. Fig. 8—Fig. 7 after drawing to 1,100 deg. F.

pared the microstructure of $\frac{3}{4}$ -in. specimens of a high-speed steel⁵ after heat-treatments. The results obtained are shown in Figs. 5 to 8.

The specimen quenched into the lead bath at 1,100 deg. F. (593 deg. C.) and not drawn (Fig. 7) has exactly the same structure as the piece from the same bar quenched into oil and not drawn (Fig. 5). Drawing each of these pieces to 1,100 deg. F. (593 deg. C.) produced a full martensitic structure. It would seem that a temperature lower than 750 deg. F. (400 deg. C.), where a head evolution occurs on slow cooling curves of high-speed steel, must be attained before one can successfully obtain secondary hardening properties by reheating.

Hardness results were:

	Scleroscope Hardness	Brinell Hardness
Specimen oil quenched, but not drawn.....	93	652
Specimen oil quenched and drawn to 1,100 deg. F. (593 deg. C.).....	94	652
Specimen lead quenched and not drawn.....	93	652
Specimen lead quenched and drawn to 1,100 deg. F. (593 deg. C.).....	94	652

PHYSICAL TESTS

A $\frac{3}{4}$ -in. round bar of high-speed steel was cut into 7-in. lengths, the pieces centered and turned to $\frac{1}{2}$ in. round. These specimens were then quenched from 2,300 deg. F. (1,260 deg. C.) into an oil bath. Three of these test specimens were then drawn to 450 deg. F. (232 deg. C.) in oil, the remaining three pieces being drawn to 1,100 deg. F. (593 deg. C.). All of these bars were then ground to 0.656 in. and transverse tests⁶ conducted on the same, the results running as follows:

	Fiber Stress at Fracture, According to Formula, $p = \frac{eM}{I}$ Lb. per Sq. In.	Deflection, In.
Average of three specimens given the 450 deg. F. (232 deg. C.) draw.....	221,000	0.08
Average of three specimens, given the 1,100 deg. F. (593 deg. C.) draw.....	550,000	0.20

As can be seen from these results, the bars given the 1,100 deg. F. (593 deg. C.) drawing temperature required two and a half times the load to fracture them, although the hardness was identical (92). Under the microscope, the polyhedral structure was found to be still present in the material given the lower drawing temperature but the specimen drawn to 1,100 deg. F. (593 deg. C.) shows a martensitic ground mass with carbide globules. The results obtained from these transverse tests show that much greater toughness, with no sacrifice of hardness, is produced by the high draw. This greater toughness accounts to some extent for the increase in cutting efficiency obtained.

SUMMARY

A careful study of the data on hardness, micrographs, cutting tests and physical properties leads to the following conclusions:

1. The greatest degree of secondary hardness and the highest actual red-hardness is obtained in specimens given the highest quenching temperature (2,300 deg. F. or 1,260 deg. C.). The micrographs of the

quenched samples show that partial austenization has taken place in the steel given this high quenching temperature, with almost complete solution of the carbides and tungstides not in massive or envelope formation.

2. High-speed steel, quenched from a high temperature (2,300 deg. F. or 1,260 deg. C.) and drawn to 1,100 to 1,150 deg. F. (593 to 621 deg. C.), shows as great scleroscope hardness as in the undrawn condition, sometimes greater. Micrographs show that the small amount of austenite present in the undrawn material has changed to martensite.

Toughness and cutting efficiency have been increased from 100 to 200 per cent by the 1,100 deg. F. (593 deg. C.) draw. Cutters given a high quenching temperature, and drawn to 800 deg. F. (427 deg. C.) fail quicker than when given the 450 deg. F. (232 deg. C.) draw. One is led to expect that quenching from a temperature higher than 2,300 deg. F. (1,260 deg. C.) would give a lower initial hardness because of the formation of a larger amount of austenite. Drawing this material to 1,150 to 1,200 deg. F. (621 to 649 deg. C.) should develop the full martensitic structure with a considerable increase in hardness over that obtained in the undrawn condition. The drawing temperature at which this maximum hardness is reached would be higher than when quenched from the lower temperature, principally due to the greater resistance to tempering brought about by the larger amount of dissolved carbides.

3. High-speed steel quenched into a bath whose temperature is about 1,100 deg. F. (593 deg. C.), then cooled from that temperature to room temperature and not drawn, does not possess the same good properties as when drawn back to 1,100 deg. F. (593 deg. C.) after quenching. In other words, high-speed steel cannot be quenched and drawn in one operation. Taylor, in his experiments conducted 20 years ago at the Bethlehem Steel Co., found that it was necessary to draw his tools to 1,100 to 1,150 deg. F. (593 to 621 deg. C.) after they had been quenched in a bath at about the same temperature.

4. High-speed steel, in the larger size rounds, is very seldom free from segregations of massive carbide. As shown in a previous part of this article, these will not go into solution upon hardening. Tools made of material of this nature are of inferior quality, due to brittleness and deficient red-hardness caused by the large amount of undissolved carbides. Forged cutter blanks, which receive a large amount of working in all directions, are free from these segregations and thus produce better tools.

5. The scleroscope or Brinell hardness of a high-speed steel tool is no indication of its cutting qualities. Some of the cutters which showed the greatest cutting efficiency and some of the cutters which produced very little work showed exactly the same hardness readings. The file test is also a misleading one. A high-speed steel tool may be quite easily filed with a good file, but still do just as good work as a similar tool which is file hard.

In closing, the writer wishes to emphasize the fact that using material of the proper chemical analysis does not insure a good tool. If the steel is not fabricated correctly or if the tools are improperly hardened or ground, a poor product will result. However, a close control of all of these factors does insure a uniformly good product.

Hartford, Conn.

⁵Analysis: C 0.63, Cr 3.42, V 0.79, W 17.98.

⁶A Tinius Olsen universal machine was used testing bars 7 in. long, resting on V-blocks, 6 in. centers. After a load of 50 lb. was imposed, an Ames indicator was so placed to measure deflection and the dial set at zero. The ordinary beam formula was used for computing fiber stresses, and gives comparable results in such hard materials. The analysis of the bar from which these transverse test-pieces were cut follows:

	Per Cent		Per Cent
Carbon.....	0.62	Vanadium.....	1.08
Chromium.....	3.57	Tungsten.....	17.82

Vapor Pressure of the System Calcium Chloride-Water*

The Application of Dühring's General Law in an Investigation of the Boiling Points of Aqueous Calcium Chloride Solutions of Various Concentrations and Under Reduced Pressures Affords a Graphic Solution of Some Practical Problems in Vacuum Evaporation

BY E. M. BAKER AND V. H. WAITE

THIS paper is a report of an investigation of the boiling points of calcium chloride solutions at atmospheric and reduced pressures. The apparatus used for the determinations and the method of making the critical study are those described in a previous paper by the same authors.¹

Five solutions of the following concentrations were investigated:

- (1) 141.3 g. CaCl_2 per 100 g. H_2O .
- (2) 101.0 g. CaCl_2 per 100 g. H_2O .
- (3) 68.86 g. CaCl_2 per 100 g. H_2O .
- (4) 25.91 g. CaCl_2 per 100 g. H_2O .
- (5) Saturated solution.

The range of pressures over which the boiling points of the system were studied was from 100 mm. to 760 mm. absolute pressure.

Chemically pure calcium chloride was used for these determinations. Solutions were made up of about the concentrations desired, and the boiling-point curves were determined by the method described. In the case of the more dilute solution a sample of this liquor was then poured into a glass-stoppered sample bottle, which was then sealed with paraffin and held for analysis. In the case of the more concentrated solutions this method could not be used, since on cooling the CaCl_2 would partly or completely crystallize, often breaking the containing bottle. For these solutions the sample was taken by pouring a portion of the solution, while still hot, into a tared weighing bottle containing a weighed amount of water. The bottle was then weighed, sealed and saved for analysis. The results of the analysis were calculated back to the original concentration of solution. The standard gravimetric method for chlorine, using AgNO_3 , was used for determining the concentration of the various solutions. The solutions were tested to determine if any HCl had resulted from hydrolysis and had been given off with the vapor. Hydrolysis was found to be negligible. To make an error of 0.1 deg. in the boiling point the concentration as determined would have to be in error by 0.25 g. of calcium chloride per 100 g. of water, at the range where the boiling point changes most rapidly with a given change of concentration.

PROCEDURE FOR CONCENTRATED SOLUTIONS

Work on unsaturated solutions would have been carried to even higher concentrations than was done, if these solutions were not so viscous that there could be no assurance that at higher concentrations they would be of uniform concentration throughout.

In determining the boiling-point curve for the

saturated solution it was necessary to immerse the platinum resistance thermometer directly into the solution, as the solution was so extremely viscous that the pumping tube could not be made to work. Except for immersing the bulb of the thermometer in the solution, the method used was the same as for the unsaturated solution. Temperatures were taken both for ascending and descending pressures with an excess of solid CaCl_2 in the boiling-point tube in order to eliminate the possibility of supersaturation or undersaturation. The experimental values thus obtained for both the saturated and unsaturated solutions are shown in Table I.

EXPERIMENTAL VALUES AND THOSE IN LITERATURE

Most of the data given in the literature on the boiling points of CaCl_2 solutions can be classified into two groups:

- (a) The boiling temperature of solutions of a given strength at various pressures.
- (b) The boiling temperature at atmospheric pressure of solutions of different concentrations.

Fig. 1 shows the data of group *a* plotted by the method referred to in the previous article—i.e., for each solution of a given concentration, the temperatures at which the solution has certain vapor pressures are plotted as ordinates, against the corresponding temperatures at which water has the same vapor pressures, as abscissas. It is noticeable that the data given in the literature for boiling points of calcium chloride solutions at reduced pressures do not include solutions more strongly concentrated than 43 g. of CaCl_2 per 100 g. of H_2O .

Data taken from the literature are indicated by separate symbols for each worker. It will be noted that many of these values as plotted are erratic and do not fall on the curve. However, this is presumably due to experimental errors, as they do fall more nearly on the straight line curves than on any other smooth curve that could be drawn.

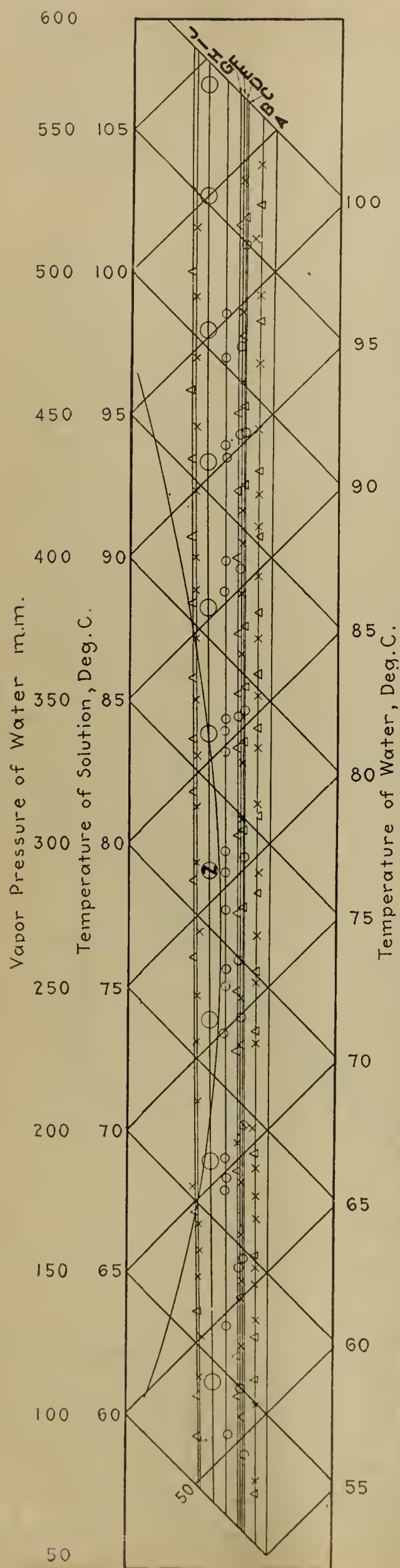
In Fig. 1 are also shown experimental data for the solutions investigated by the authors. The curves are lettered to indicate the concentration of each solution. The values for individual determinations are given in Table I and are shown in the graph by the large open circles. In the discussion of the apparatus in the previous paper it was stated that an absolute accuracy of 0.1 deg. C. could be expected in these determinations. The maximum variation of any of the above points from the straight lines as drawn is 0.1 deg. C., while most of the points do not lie more than 0.02 or 0.03 deg. C. from the respective straight lines.

For each concentration of solution represented in Fig. 1 the boiling temperatures of the solutions corresponding to the pressures at which water would boil at 100 deg. C. and 50 deg. C., were read off—i.e., at

*Read before the Thirteenth Semi-Annual Meeting of the American Institute of Chemical Engineers at Ann Arbor, Mich., on June 21, 1921.

¹"Boiling Point of Salt Solutions Under Varying Pressures," by E. M. Baker and V. H. Waite, CHEM. & MET. ENG., vol. 25, No. 26, p. 1137, Dec. 21, 1921.

²See Bibliography, page 1178.



1A. BOILING POINTS OF CALCIUM CHLORIDE SOLUTIONS PLOTTED AGAINST THE CORRESPONDING BOILING POINTS OF WATER UNDER THE SAME PRESSURE. Curves A to J from Fig. 1 are here reproduced on a greatly enlarged scale. Explanation of the symbols and data regarding concentration are given in the legend on Fig. 1

TABLE II. RELATION OF CONCENTRATION OF CaCl_2 SOLUTIONS TO SLOPE OF CURVES IN FIG. 1, AND TO BOILING POINT AT 760 MM. PRESSURE. VALUES READ FROM FIG. 1

Concentration, in per Cent	Concentration, (Grams CaCl_2 per 100 G. H_2O)	$K = \frac{t_1 - t_2}{\theta_1 - \theta_2}$	Bp. at 760 Mm.
20.58	25.91	1.020	104.78
40.78	68.86	1.047	120.18
50.25	101.00	1.058	130.70
58.56	141.30	1.092	141.90

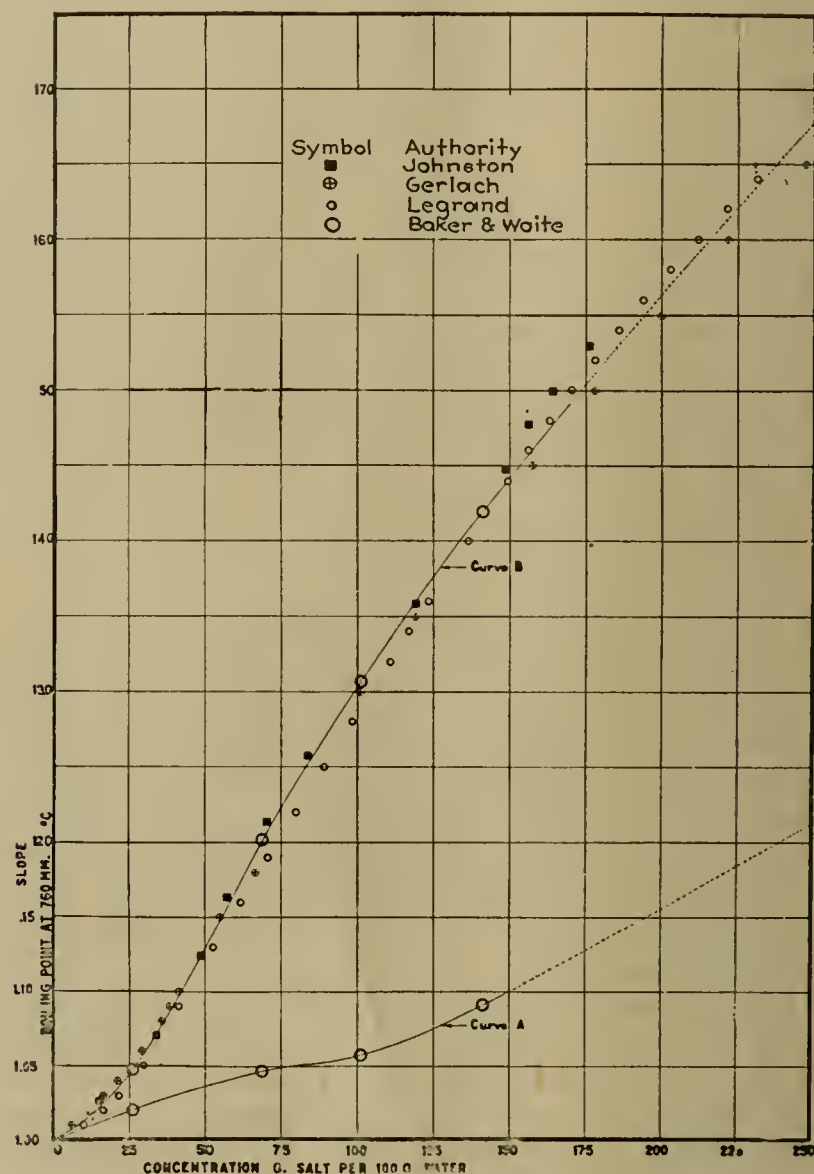


FIG. 2.

Curve A. Concentration of solution plotted against slope of lines in Fig. 1. Curve B. Concentration of solutions plotted against boiling points of solutions at 760 mm.

the latter data being tabulated in Table III. The ordinates of Fig. 3 show the temperature at which the solutions would boil under some given pressure, plotted against the temperature at which water would boil under the corresponding pressure, as abscissas. For each of the solutions shown, the boiling points at 760 mm. and 92.3 mm. (boiling points of water 100 deg. C. and 50 deg. C.) were plotted, and straight lines were drawn between the two intermediate points. The corresponding curve for the saturated calcium chloride solution was also plotted directly from the experimental data. As here reproduced the scale is too small to permit Fig. 3 being directly used as a source of data, but it may be easily reconstructed on a large scale from the data of Table III. However, numerous values were read from this figure, and these are reproduced in Table IV, which shows the temperature at which calcium chloride solutions of various concentrations would have certain vapor pressures, between the limits of 100 mm. and 760 mm. pressure.

Since the curves A and B of Fig. 2 are based on comparatively few values determined by us, the same

TABLE III. RELATION OF CONCENTRATION OF CaCl_2 SOLUTIONS TO BOILING POINT AT 760 MM. PRESSURE AND TO THE SLOPE K. VALUES READ FROM FIG. 2

Concentration (Grams CaCl_2 per 100g. H_2O)	Slope $K = \frac{t_1 - t_2}{\theta_1 - \theta_2}$	Boiling Point at 760 Mm. (Bp. of H_2O = 100 Deg.)	Boiling Point at 92.3 Mm. (Bp. of H_2O = 50 Deg.)
10	1.008	101.30	50.90
20	1.016	103.20	52.40
30	1.023	105.85	54.69
40	1.030	109.25	57.75
50	1.0365	112.90	61.07
60	1.043	116.70	64.55
70	1.0475	120.60	68.22
80	1.0505	124.00	71.47
90	1.053	127.25	74.60
100	1.057	130.35	77.50
110	1.063	133.35	80.20
120	1.0705	136.20	82.67
130	1.080	139.05	85.05
140	1.0905	141.65	87.12
150	1.101	144.20	89.15

accuracy is not claimed for the data on the system as a whole, as tabulated in Table IV, as for an individual determination. The probable maximum error of the latter is 0.1 deg. C., while the corresponding error of values in Table IV may reach 0.2 or 0.3 deg. in extreme cases. An absolute accuracy of this order is quite sufficient for practically all technical purposes.

It will be noticed that the vapor pressure curve of water (data from Peabody's Steam Tables, 1910) is also plotted in Fig. 3. This curve may be used to give directly the vapor pressure under which a given solution will boil at a given temperature and *vice versa*. For instance, to find the vapor pressure corresponding to the boiling point at 90 deg. C. of solution of 100 g. CaCl_2 per 100 g. of water, extend across horizontally from 90 deg. on the temperature ordinate to the curve for the given concentration. Then, extending down vertically from this intersection, the temperature at which water would boil at the same pressure is found to be 61.85 deg. C. Or, if the pressure is read corresponding to the intersection of this abscissa with the curve for the vapor pressure of water, this pressure is found to be 162.3 mm. and is the pressure sought.

SOLVING SOME EVAPORATOR PROBLEMS

As a second simple illustration of the use of Fig. 3, assume that a calcium chloride solution is being concentrated in a single effect evaporator. Exhaust steam is available at a pressure corresponding to 105 deg. C. The minimum permissible temperature drop across the

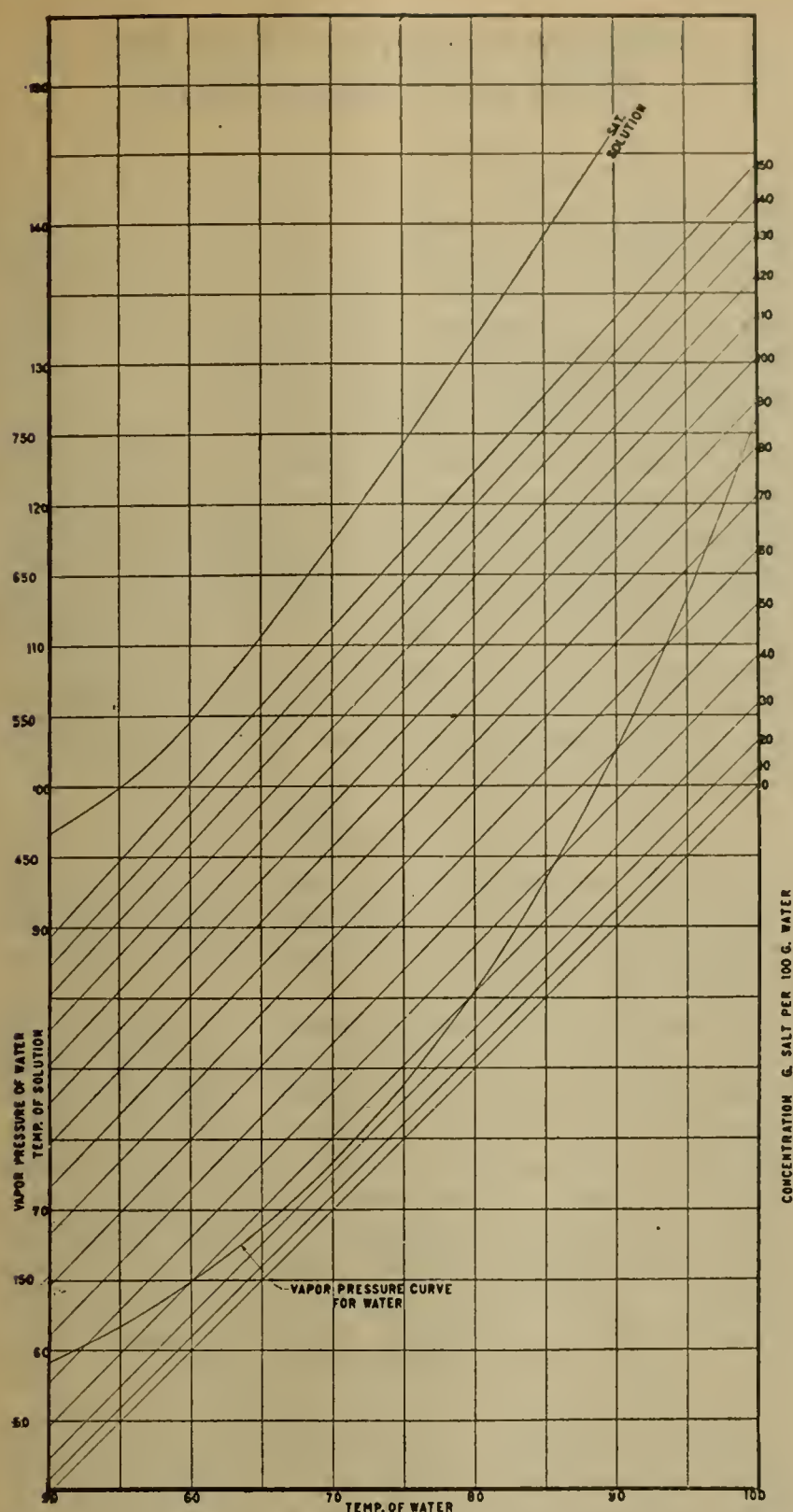


FIG. 3.

Boiling points of calcium chloride solutions plotted against corresponding boiling points of water under the same pressure.

TABLE IV. VAPOR PRESSURE OF CaCl_2 SOLUTIONS AT VARIOUS TEMPERATURES. VALUES FROM FIG. 3
Temperature of Solutions Containing G Grams CaCl_2 per 100 G. H_2O

Vapor Pressure of Solution at tempera- ture T.	G = 0	G = 10	G = 20	G = 30	G = 40	G = 50	G = 60	G = 70	G = 80	G = 90	G = 100	G = 110	G = 120	G = 130	G = 140	G = 150	Saturated Solution
760	100.00	101.30	103.20	105.85	109.25	112.90	116.70	120.60	124.00	127.25	130.35	133.35	136.20	139.05	141.65	144.20	179.5
720	98.50	99.80	101.70	104.32	107.70	111.35	115.12	119.00	122.42	125.69	128.75	131.74	134.60	137.40	140.00	142.51	168.9
680	96.90	98.15	100.05	102.70	106.05	109.70	113.45	117.32	120.75	124.00	127.05	130.00	132.89	135.70	138.29	140.75	162.1
640	95.30	96.50	98.40	101.00	104.38	108.00	111.75	115.60	119.02	122.28	125.35	128.28	131.12	133.92	136.50	138.95	156.6
600	93.50	94.80	96.65	99.25	102.60	106.20	110.00	113.80	117.20	120.50	123.55	126.45	129.30	132.10	134.60	137.10	152.8
560	91.70	92.92	94.78	97.35	100.70	104.30	108.10	111.85	115.30	118.50	121.60	124.50	127.30	130.05	132.60	135.05	149.8
520	89.70	90.98	92.80	95.35	98.70	102.30	106.00	109.82	113.25	116.45	119.52	122.45	125.20	128.00	130.48	132.99	146.3
480	87.60	88.82	90.63	93.20	96.55	100.10	103.80	107.60	111.00	114.20	117.28	120.20	122.95	125.70	128.18	130.60	143.0
440	85.40	86.61	88.40	90.90	94.20	97.75	101.50	105.25	108.65	111.88	114.90	117.80	120.55	123.30	125.75	128.10	139.5
400	83.00	84.15	85.90	88.45	91.70	95.25	98.95	102.75	106.10	109.30	112.35	115.25	117.95	120.65	123.10	125.45	136.0
360	80.30	81.50	83.25	85.75	89.00	92.55	96.20	100.00	103.40	106.55	109.60	112.45	115.15	117.85	120.25	122.60	132.0
320	77.50	78.75	80.30	82.75	86.05	89.55	93.20	96.95	100.35	103.50	106.50	109.35	112.05	114.70	117.10	119.40	127.9
300	75.92	76.95	78.68	81.15	84.40	87.90	91.50	95.30	98.65	101.85	104.85	107.70	110.35	113.00	115.35	117.65	125.6
280	74.35	75.40	77.10	79.55	82.80	86.25	89.90	93.65	97.00	100.20	103.20	106.00	108.65	111.30	113.60	115.90	123.2
260	72.55	73.60	75.28	77.70	81.00	84.40	88.00	91.80	95.10	98.30	101.30	104.10	106.75	109.40	111.65	113.90	120.6
240	70.60	71.70	73.35	75.75	79.00	82.43	86.00	89.80	93.10	96.30	99.30	102.10	104.70	107.30	109.60	111.85	118.1
220	68.60	69.65	71.30	73.70	76.90	80.35	83.95	87.70	91.00	94.20	97.20	100.00	102.60	105.20	107.45	109.65	115.5
200	66.55	67.55	69.20	71.60	74.75	78.15	81.75	85.50	88.80	92.00	95.00	97.75	100.35	102.90	105.15	107.35	112.5
180	64.15	65.15	66.75	69.10	72.30	75.70	79.30	83.00	86.30	89.45	92.40	95.20	97.80	100.35	102.50	104.70	109.5
160	61.60	62.55	64.15	66.50	69.70	73.05	76.65	80.30	83.65	86.75	89.70	92.45	95.05	97.55	99.75	101.90	106.2
140	58.60	59.65	61.20	63.60	66.75	70.05	73.60	77.30	80.60	83.75	86.70	89.45	92.00	94.45	96.60	98.70	103.1
120	55.45	56.35	57.90	60.25	63.35	66.70	70.25	73.90	77.20	80.35	83.35	86.00	88.55	91.00	93.10	95.15	100.2
110	53.65	54.60	56.10	58.40	61.50	64.85	68.35	72.00	75.30	78.45	81.35	84.10	86.60	89.05	91.15	93.15	99.0
1	51.65	52.60	54.10	56.35	59.50	62.80	66.30	70.00	73.25	76.40	79.30	82.00	84.50	86.95	89.00	91.00	97.6

heating surface to give the desired evaporator capacity is 20 deg. C. The evaporator is operated at an absolute pressure of 160 mm. What is the maximum degree to which the concentration of the CaCl_2 solution can be carried, and satisfy the above conditions?

From the ordinate of 160 mm. pressure, extend across horizontally to the vapor pressure curve for water, finding that water would boil under this pressure at 61.6 deg. C. Then extending up vertically on this abscissa (61.6 deg. C.) to the ordinate 85 deg. C., the concentration of the solution that would boil at 85 deg. C. under 160 mm. pressure is found by interpolation to be 85.2 g. CaCl_2 per 100 g. of H_2O . This is the concentration sought. The actual temperature drop is 105 deg. — 85 deg. = 20 deg. C., while the temperature drop for evaporating water under the given pressures would be 105 deg. — 61.6 deg. = 43.4 deg. C.

Or again, suppose it were desired to carry the concentration to 150 g. of CaCl_2 per 100 g. of water, in the above case, what would be the necessary temperature of the steam to have a minimum effective temperature drop of 20 deg. C. across the heating surface when the solution reached this concentration? The absolute pressure in the evaporator is 160 mm. Extending across horizontally from this pressure ordinate to the vapor pressure curve for water, it is found that water will boil at 61.6 deg. C. under this pressure. Extending up vertically from this abscissa of 61.6 deg. C. to the curve for a solution of 150 g. of CaCl_2 per 100 g. of water, it is found that this solution would boil under this pressure at 101.9 deg. C. Then to give an effective temperature drop of 20 deg. C., the temperature of the steam would have to be 101.9 deg. + 20 deg. = 121.9 deg. C., or 1580.8 mm. absolute pressure; whereas for evaporating water under like conditions, the steam would have to be under an absolute pressure of only 378.8 mm.

A bibliography of references on the vapor pressure of calcium chloride solutions is appended.

Acknowledgment is made of the financial assistance received from the National Research Council, which made possible this investigation.

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Favorable African Market for American Products

Vice-Consul John R. Minter of Johannesburg reports in the Nov. 21, 1921, issue of *Commerce Reports* that not more than 3 to 5 per cent of the paints and varnishes consumed in South Africa are manufactured locally. Americans have been holding their own in the South African markets. Imports from the United States in 1914 constituted 28 per cent of the total imports of paints and varnishes, 40 per cent in 1919, and 40 per cent in 1920.

Copper-Cadmium Wire for Electrical Transmission

BY W. C. SMITH

Metallurgist, U. S. Metals Refining Co.

COPPER is the metal generally employed for electrical conductors. It combines several very desirable properties—for example, high electrical conductivity (second only to silver), fairly high tensile strength, resistance to corrosion and reasonable cost. It can readily be cast, rolled and drawn.

Copper wire of good quality should have a resistivity of less than 0.15535 ohm per meter gram at 20 deg. C. or a conductivity greater than 98.5 per cent, Matthiessen standard, annealed. The tensile strength of hard-drawn copper wire should be greater than 49,000 lb. per sq.in. for a wire 0.46 in. in diameter, and 67,000 lb. per sq.in. for a wire 0.040 in. in diameter. Wrought copper is completely softened (annealed) by being heated to a temperature of 175 deg. C. (350 deg. F.) for 72 hours, or in a few seconds when heated to a temperature of 310 deg. C. (600 deg. F.).

PROBLEMS FOR THE ELECTRICAL ENGINEER

Electrical engineers are constantly being confronted with problems, the solution of which requires the use of metallic conductors possessing properties not inherent to hard-drawn copper wire.

As examples, the tensile strength of copper wire limits the distance between supports; the low annealing temperature of hard-drawn copper wire limits the temperature to which the wire may be heated either by intention or by accident, and in many places where abrasion of wear is particularly heavy, copper is too soft to give satisfactory service. A large number of brasses and bronzes are on the market and are used more or less as electrical conductors because of some special property each one possesses. All of the special alloys have one great disadvantage—they are all of very much lower electrical conductivity than hard-drawn copper.

An alloy of rather unusual properties, and one unknown to the average engineer, is copper-cadmium. Wire drawn from copper containing a small amount of cadmium has a much greater tensile strength, is considerably harder, has a higher annealing temperature than a pure copper wire of the same size, and its electrical conductivity has been reduced to a lesser degree than for any other known alloy of equivalent tensile strength.

RESULTS OF LABORATORY TESTS

The results of some laboratory experiments made by the writer during 1918 and 1919 are shown in the accompanying curves of Fig. 1. In every case the wire tested was a No. 12 B. & S. gage (approximately 0.081 in. in diameter). The tensile strength tests were made on hard-drawn wire, and the conductivity tests were made on annealed samples.

Annealing was done by passing 150 amp. through each sample for 65 seconds. Preliminary experiments indicated that a complete anneal could be made under these conditions. A series of laboratory experiments on the annealing temperatures of copper-cadmium wire as compared with pure copper wire indicated that the annealing temperature of the copper-cadmium increased as the cadmium content was increased, and that a wire containing 1.10 per cent cadmium withstood a temperature

of 260 deg. C. (500 deg. F.) for $\frac{1}{2}$ hour, with only slight evidence of softening, while the pure copper wire was *dead soft* after the same treatment.

A hardness test made on a cast alloy containing 1.10 per cent cadmium indicated that the alloy was about 20 to 22 Brinell numbers harder than cast copper. No Brinell tests were made on wire, but it was observed that the alloy wires were somewhat stiffer and harder to file than wires of pure copper.

Mill tests indicated that wirebars containing up to 1.20 per cent cadmium could be hot-rolled, but when the cadmium content of the alloy was further increased the bars cracked in passing through the breaking down rolls.

The melting point of copper is approximately 1,083 deg. C. (1,980 deg. F.), of cadmium 321 deg. C. (609 deg. F.) and the boiling point of cadmium is approximately 778 deg. C. (1,332 deg. F.) This explains the

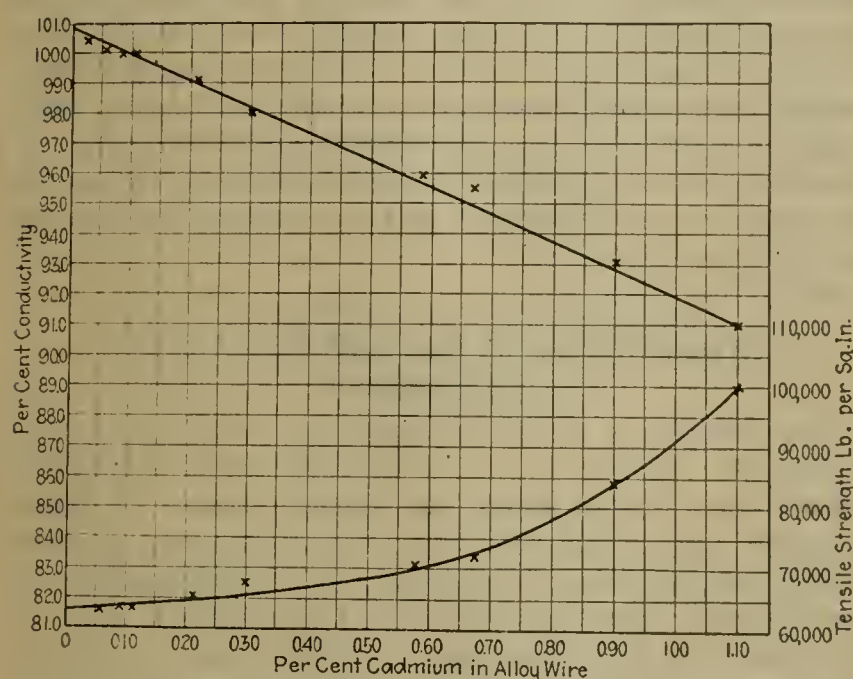


FIG. 1. STRENGTH AND ELECTRICAL CONDUCTIVITY OF COPPER-CADMIUM WIRE

failure of our first attempts to produce an alloy of uniform composition by the direct addition of cadmium to molten copper. Experimental work developed the fact that a uniform alloy could be produced by introducing the cadmium into the molten copper in the form of an alloy of copper and cadmium rich in cadmium. For this work alloys containing from 30 to 75 per cent cadmium have been used. The base alloy generally employed contains about 50 per cent cadmium. It was found that the base alloy could be produced from molten copper and solid cadmium with the loss of very small amounts of cadmium if the temperature were accurately controlled.¹

A number of lots of copper-cadmium wirebar were made by adding calculated amounts of copper-cadmium base alloy to known quantities of molten refined copper in a large ladle, and then casting the metal into wirebar molds. The wires drawn from the several wirebars of each cast were tested for tensile strength and conductivity. These tests indicated that uniform results could be expected.

Copper-cadmium wire has been successfully used for wireless aërials, long-span transmission wire and trolley wire.

Chrome, N. J.

¹The method of production of the base alloy and its use to produce copper-cadmium alloy of the desired composition is covered by U. S. Pat. 1,307,642 (June 24, 1919).

On the Discovery of Potash in West Texas

BY J. A. UDDEN

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FOR some time it has been regarded as quite likely that potash may exist in association with the extensive salt beds underlying the west part of the state of Texas. In 1912 S. M. Swenson & Co. were drilling a deep well at Spur, in Dickens County, and this work seemed to offer an opportunity for making observations bearing on this question. Accordingly it was arranged that the Bureau of Economic Geology and Technology of the University of Texas should be permitted to collect and to make analyses of several samples of brines from this boring. These samples carried evidence of a more than normal amount of potash in the brine only from 2,100 to 2,200 ft. below the surface. An account of this was published on pages 82 to 90 in Bulletin 363 of the University of Texas.

In 1914 an opportunity was likewise presented to secure samples of salt from two borings in Potter County. These showed the presence of a potash-bearing red mineral at several depths. A report on these results was prepared and published in 1915. This was our Bulletin 17, entitled "Potash in the Texas Permian." Largely on the strength of the evidence in these observations, the U. S. Geological Survey undertook to drill a hole at Cliffside in Potter County, to obtain more definite information on the occurrence of potash in the salt beds in that vicinity. Very slight evidence of potash was found also in this exploration, the results of which were published in the potash report of the Survey for 1917. Later co-operation was arranged between our bureau and the U. S. Geological Survey and a man was engaged to get all information possible in the field on the occurrence of potash in association with salt in such wells as were being drilled for oil in the western part of the state. We have now had a co-operative man in the field for 3 years. Lately D. D. Christner, the joint representative of the two Surveys, has found potash in five new places in the Llano Estacado about 200 miles south of the first occurrences noted.

EXTENT OF THE POTASH-BEARING STRATA

The potash-bearing mineral is, in almost every case noted, a red salt, which is now believed to be polyhalite, at least in part. This mineral contains about 18 or 19 per cent of potash. The occurrence of this mineral in sufficient quantity in the drillings taken at considerable depths makes it appear desirable to investigate the size of the deposits. This can be done only by coring the salt beds. As the salt and potash are both soluble in water, the taking of cores through such beds requires special and expensive processes, and to obtain the results desired it should be done under competent scientific and technical direction. The latest five places where potash has been found are about 60 miles apart. It seems possible that the potash-bearing strata may extend the entire distance between these places and possibly up to the Panhandle. From a recent study by N. H. Darton, of the United States Geological Survey, it appears that conditions that may be considered favorable for the natural concentration of salt and also potash in the formations of the Permian, in which these salt beds occur may have been widespread, reaching possibly from western Oklahoma southwestward to the

Pecos River. The largest part of this area lies in our own state.

To summarize the evidence obtained showing the existence of potash in this state the following brief statements can be made:

In 1912 S. M. Swenson's boring at Spur, in Dickens County, gave a brine at 2,200 ft. below the surface, which contained 5.4 per cent of potassium, calculated as chloride.

In 1915 a boring at Boden, in Potter County, furnished some red salt, probably polyhalite, occurring somewhere between 875 and 925 ft. below the surface, and this red salt contained 9.2 per cent of potash, calculated as oxide.

In the same year the Miller boring in Potter County furnished at somewhere between 1,500 and 1,700 ft. below the surface some red salt that contained 6.1 per cent of potash calculated as oxide, and at some level below 1,700 ft. it had some colorless salt associated with anhydrite. This salt contained 10.5 per cent of potash, calculated as oxide.

Within the last 12 months, we have found in the Bryant boring in Midland County, in cuttings accumulated while boring from 2,405 to 2,425 ft. below the surface, a mixture of colorless and red salt, shale and anhydrite yielding 6.9 per cent of potash, calculated as oxide.

We have found in the early part of last spring in the La Mesa Oil & Gas Co.'s Burns No. 1 boring in Dawson County, at a depth of from 1,864 to 1,865 ft. below the surface a red salt which yields 10.8 per cent of potassium oxide.

In the Means well, in Loving County, about 40 miles north of Pecos, samples show 15.5 per cent of potassium oxide, coming from a depth of 1,000 ft., and there is 8 per cent of potassium oxide in samples from between 1,855 and 1,860 ft.

In the River well of the A. Pitts Oil Co., about 8 miles east of Barstow, in Ward County near the Pecos River, showings of 14.4 per cent of potassium oxide were obtained from samples taken at 1,600 ft. In a sample taken at a depth of 1,875 ft. in the same boring there was found 10.5 per cent of potassium oxide.

In the G. A. Jones et al. Long well, in the southeast part of Borden County, an analysis shows the presence of 22.9 per cent of potassium oxide in a picked sample from between 1,070 and 1,075 ft., and a picked sample from cutting between 1,075 and 1,083 ft. showed 17.68 per cent of potassium oxide. The sample from 1,115 ft., similarly picked, shows 6.59 per cent.

NEED OF SYSTEMATIC EXPLORATION

It is generally known that the salt beds of our Permian on the High Plains have resulted from concentration of water in the arms of the sea during a long period of time in the Permian age. The desiccation of these waters caused the potash salts of the brines to be precipitated last, whenever the points of saturation for these salts was reached. Evidently desiccation did not go far enough in many cases to precipitate the potash. We can scarcely expect that evaporation of such arms of the sea should continue through a long period of time, resulting in the laying down of a considerable number of salt beds and that desiccation should in every case have stopped short of precipitating the potash. In the many cases of partial or total desiccation indicated by the number of salt beds found in the Permian, it is more likely that the waters were in some

cases completely evaporated. Reasoning in this way, there is good ground for the belief that potash should exist in separate beds in that part of our Permian basin where most salt was precipitated. Our finding of potash salts in no less than seven wells, two of which are located in the Panhandle and five in the Llano Estacado, strongly tends to prove the correctness of the conclusion that widespread beds of potash exist in this region; but the observations that have so far been made give absolutely no information on the thickness of the potash-bearing beds. All we know is that there are such beds. To determine the thickness of the beds in order to find whether these deposits will prove of commercial importance, it will, as already stated, be necessary to drill special holes for that purpose and to take out cores of the beds, to be carefully examined. As I look at it, the time is now at hand when our information justifies such explorations. It is scarcely conceivable that potash-bearing beds should occur for 300 miles and that they should not at some place be of sufficient thickness to be profitably mined. Such explorations will require large capital, so that a number of holes, a half hundred if necessary, can be made in different parts of the area indicated by the observations now made, before the location for operations and the method of mining are to be determined.

Austin, Tex.

Strengthening of Zinc and Zinc Alloys by Compression

The dearth of copper during the war forced the Continental Powers to try to discover total or partial substitutes for this metal, and several papers on these attempts and researches have recently been brought before the Deutsche Gesellschaft für Metallkunde. In one of these communications Dr. Ing. Hanszel, of Berlin, deals with the improvement of brass and of zinc by compression. Various brasses containing from 57 to 61 per cent of copper, about 1 per cent of lead and about 3.5 per cent of total impurities were improved by compression after reheating; but they were not sufficiently uniform to be quite reliable. Zinc containing about 1 per cent of lead, with traces of iron and cadmium, was so much strengthened by high compression that it appeared almost a different metal with its grainy, partly fibrous structure. Compression of zinc had been in use in the Hohenlohenhütte, Silesia, before the war. The ingots should be perfect, the tops and pipe must be discarded, and the ingot remelted before compression; cracks in the ingot are not really welded up by compression. When objects like stoppers with threaded bolts are pressed in the molds, sharp corners should be avoided, and the profile rounded off first and finished on the lathe; the zinc flows, and the lines of flow are diverted at sharp corners. The superior qualities of this compressed zinc are, moreover, confined to the temperature range 0 deg. to 50 deg. C., but the metal seems to bear the winter cold well. Storage for several years did not deteriorate several of the alloys of zinc with copper and aluminum, which also passed the repeated gage tests. Among these the alloy of zinc with 6 per cent of copper and 5 per cent of aluminum found favor in Austria and was, later, with only 2.5 per cent of aluminum, manufactured also at Spandau. Zinc alloys with up to 30 per cent of Al were also tried, and the alloys were tested in large quantities, both mechanically and metallographically. These metals and alloys were mainly utilized in ammunition works.

The Electrolytically Produced Calcium-Barium-Lead Alloys Comprising Frary Metal*

Equilibrium Diagram and Microstructure of Barium-Lead and Calcium-Lead Alloys—Ternary Alloy Hardens and Strengthens on Aging; Is Hard at Moderate Temperature; Can Be Melted Without Change in Analysis, and Is a Very Fine Bearing Metal

By WILLIAM A. COWAN, L. D. SIMPKINS AND G. O. HIERS
National Lead Co. Research Laboratories

DURING the early part of the World War when, on account of the large amount of shrapnel bullets being made from antimonial lead, there was a shortage of this material and of antimony, a substitute was eagerly sought. It was following this that Drs. F. C. Frary and S. N. Temple procured patents¹ covering alloys of lead with barium, calcium and other elements. The calcium-barium-lead alloy was found to have remarkable qualities as a bearing metal, showing the characteristic structure and necessary properties required for such service. The Bureau of Standards² made a report of physical and service tests on a submitted sample of the alloy showing better results than with genuine babbitt and stating that it possessed all the requisites of a good bearing metal. The alloy has been manufactured on an extensive scale for this and other uses by the United Lead Co.

METHOD OF PRODUCTION

The method of production can be classified as electrodeposition from fused salts, since the process consists in electrolyzing the fused chlorides of barium and calcium over a bath of molten lead as cathode. In the preparation of alloys of barium and calcium by this method the electrodeposited metals are taken up by the lead, and the resulting alloy is obtained as the desired product.

There has been previous mention made in the literature³ of similar methods of preparing either pure metals or alloys by electrolysis of fused salts. Such elements as sodium, calcium, magnesium, zinc and aluminum have been prepared as pure metals in this way, the principle involved being essentially the same in all cases, but differing in difficulties encountered. These are owing to differences in melting points and dissociation phenomena of the salts, as well as to differences in the properties of the pure metals produced.

Preparation of metallic calcium from fused calcium chloride has been accomplished only after overcoming numerous difficulties. It was prepared on a fairly large scale during the war, and has also been made experimentally both by the Westinghouse Manufacturing & Electric Co.⁴ and by the General Electric Co. However,

owing to the difficulties in producing pure metallic calcium free from chlorides, carbides and other impurities, it is not economical to produce an alloy by first preparing the calcium separately and adding it to molten lead. There would also be trouble in commercial manufacture of an alloy by mixing the pure metals in this way owing to the difficulty of obtaining complete solution of the calcium in the lead without loss by oxidation of the calcium. In attempting to produce metallic barium electrolytically it has been found that the resulting barium gathers around the cathode in droplets which fail to coalesce, and therefore it is not economical to attempt to obtain the barium in a pure metallic state. However, with the use of a bath of molten lead as a cathode, this difficulty is not encountered, since the barium alloys readily with the lead as it is produced.

MANUFACTURE

Calcium-barium-lead alloys suitable for bearing metals and other purposes, together with the process of manufacture, are described in United States patents.⁵



FIG. 1. BATTERY OF ELECTROLYTIC POTS FOR MANUFACTURING FRARY METAL; UNITED LEAD CO., KEOKUK, IOWA

The process of manufacture, as carried out by the United Lead Co. operating under these patents, consists in the use of a series of iron pots of about 2 tons capacity each. These are partly filled with pig lead of high quality. As shown in Fig. 1, each pot of the series is set in brickwork containing a hearth which is fired with coal. After the pots have been filled with pig lead all the hearths are fired until the lead is melted. On top

*A paper read before the fortieth meeting of the American Electrochemical Society, Lake Placid, Sept. 29, 1921 (slightly condensed).

¹U. S. Patents 1,158,671-5.

²Bureau of Standards, "Report on Tests of Ulco Hard Metal" to National Lead Co., May 6, 1918.

³Trans. Am. Electrochem. Soc., vol. 9, p. 123 (1906); vol. 17, p. 249 (1910); vol. 18, p. 117 (1910); vol. 10, p. 63 (1906); vol. 16, p. 185 (1909). MET. & CHEM. ENG., vol. 8, p. 253 (1910). Z. Elektrochem., vol. 8, p. 817, p. 697 (1902). Electrochemical Industry (now CHEM. & MET. ENG.), vol. 3, p. 63 (1905); vol. 4, p. 152 (1905). Transactions Faraday Society, vol. 2, p. 56 (1906).

⁴"The Electrolytic Production of Calcium," P. H. Brace, Trans. Am. Electrochem. Soc., vol. 37, p. 465; CHEM. & MET. ENG., vol. 25, p. 105, July 20, 1921.

⁵U. S. Patents 1,360,339 (T. F. Wettstein); 1,360,348 (G. H. Worrall); 1,360,272 (E. A. de Camp).



FIG. 2. INTERIOR VIEW, UNITED LEAD CO.'S PLANT FOR FRARY METAL

of the molten lead is placed a layer of the mixed salts of calcium and barium chlorides of high purity, in such proportions as to give a low melting point. This layer of chlorides is usually about 3 or 4 in. thick. Each pot is equipped with a graphite anode at the center which can be raised or lowered by a chainblock.

In starting, the anodes are inserted in the chlorides and a direct current thrown in. There is sufficient resistance in the salts to produce enough heat to fuse the mixed chlorides. The temperatures in the pots are controlled by raising or lowering the anodes. Under the influence of the electrolytic action, the fused salts are decomposed and the resulting calcium and barium are absorbed by the molten lead. There is a tendency toward fogging and arcing, and considerable amounts of the calcium and barium form carbides which reduce the efficiency of the process, therefore requiring approximately 3 days of electrolysis to produce a lead alloy containing 2 per cent of the alkaline earth metals. The fused chlorides and carbides tend to freeze at the surface, forming a hard crust, particularly around the periphery of the interior of the pots. If this forms too near the anode, it may need to be broken down in order to give proper conditions; otherwise it is advantageous, acting as an insulator and thus preventing loss of current which might pass through the fused electrolyte from the anode directly to the iron pot instead of to the molten lead. Absorption of the calcium and barium by the lead appears to follow a logarithmic curve—that is, it requires much longer than 3 days to produce an equal increment of absorption of the alkaline earth metals. This is probably due to an equilibrium set up between the lead and the alkaline earth metal on the one hand, and in the decomposition of and reactions in the fused electrolyte on the other hand.

After the electrodeposition has been under way for some time, samples of the molten metal are removed, and the barium and calcium contents determined, additional samples being taken from time to time until the desired composition is obtained. When the proper amounts of calcium and barium have been absorbed by the lead, the current is shut off and the molten alloy is run out from the bottom of each pot into a carrying ladle of equal capacity, which is conveyed by an overhead crane. By this means the metal from the whole series of pots is emptied into a large mixing kettle shown in Fig. 2, where it is thoroughly agitated and

further alloying ingredients are added. The resulting alloy is then sampled and cast in water-cooled ingot molds.

FRARY METAL

The alloy thus produced by the United Lead Co. has been termed "Frary metal." As disclosed by the patents, it is essentially a ternary alloy of lead, barium and calcium, with the addition of small amounts of other elements. It contains up to 2 per cent barium and up to 1 per cent calcium, the remainder consisting almost entirely of lead. As much as 0.25 per cent mercury and smaller amounts of other elements may be added.

METALLOGRAPHY

In studying the metallography of the alloy it is most profitable first to consider the binary alloys, barium-lead and calcium-lead. The constitution of the latter series of alloys has been investigated by N. Baar⁶ and L. Donski,⁷ and a portion of the thermal equilibrium diagram, adjacent to the lead side, as published in Landolt,⁸ is reproduced in Fig. 3.

Several points in the curves have been checked very closely by determinations made at this laboratory. It appears from the complete diagram that additions of

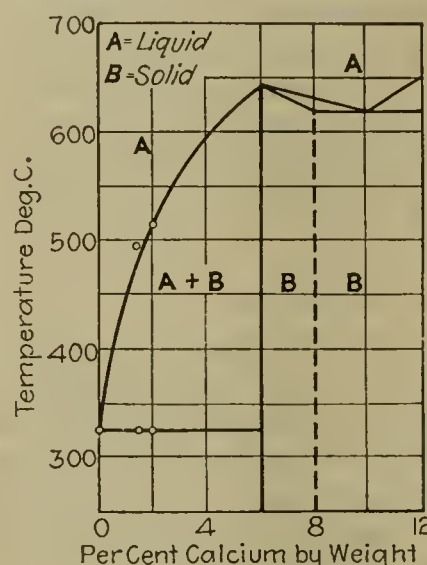


FIG. 3

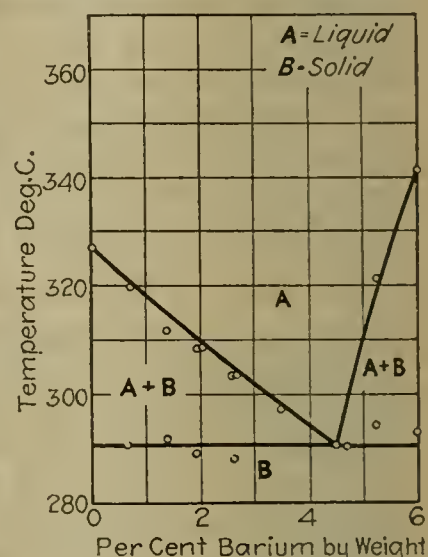


FIG. 4

FIGS. 3 AND 4

Fig. 3—Calcium:lead equilibrium diagram, according to Baar and Donski.

Fig. 4—Barium:lead equilibrium diagram, according to Cowan, Simpkins and Hiers.

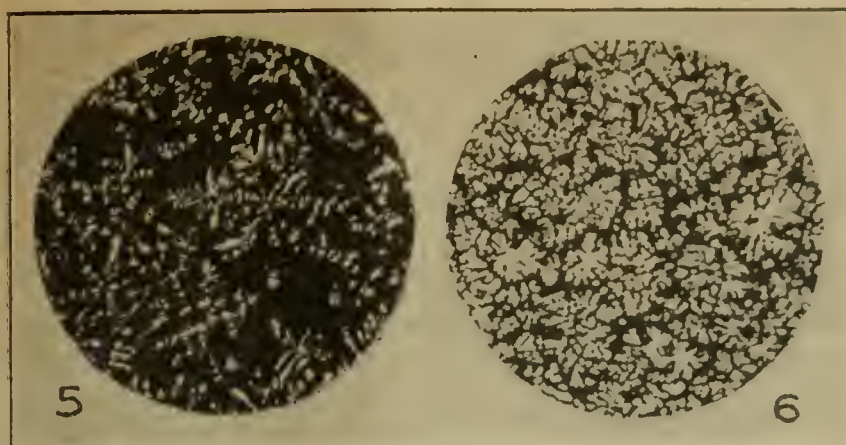
calcium up to 6 per cent, where the compound Pb_3Ca is formed, raise the melting point rapidly. Other compounds are formed beyond this and the melting point is increased to 1,100 deg. C. The photomicrographs, Figs. 5 and 6, are in accord with this equilibrium diagram. They show crystals of lead-calcium compound Pb_3Ca in a ground-mass of lead. The crystals appear to be rod- or needle-shaped, and at higher magnification the rods are shown to be built up of cubical crystals. (Fig. 10.)

Calcium-lead alloys for experimental purposes were made at this laboratory from pure lead and metallic calcium. The lead is melted in a ladle and heated to about 500 deg. C. A piece of calcium is then held under the molten lead, being scraped meanwhile to remove oxide, etc., and to permit the lead to come in contact with clean metallic calcium. When the calcium dissolves, there is a decided exothermic reaction and more lead in bar form is quickly inserted in the molten metal to cool the alloy and prevent oxidation. In this way alloys containing up to 6 per cent calcium were made up

⁶Z. anorg. Chem., vol. 70, p. 375 (1911).

⁷Z. anorg. Chem., vol. 57, p. 217 (1908).

⁸"Tabellen," Landolt, Börnstein and Roth; 1912 edition, p. 664.



FIGS. 5 AND 6. MICROSTRUCTURE OF CAST Ca:Pb ALLOYS. NOT ETCHED. $\times 50$. COMPOUND (Pb_3Ca) IN RELIEF IN GROUND MASS OF LEAD

Fig. 5—Ca 1.52 per cent, Pb remainder.
Fig. 6—Ca 3.2 per cent, Pb remainder.

to be used as base metals in preparing other alloys for further investigations.

In studying the constitution of barium-lead alloys no published data could be found.⁹ An alloy was produced for us at the plant of the United Lead Co. at Keokuk,

TABLE I. COMPOSITION OF CALCIUM USED AND ALLOYS STUDIED

	Electrolytic Calcium from General Electric Co. Per Cent	Calcium-Lead Alloy	Barium-Lead Alloy
		Made by Authors, Per Cent	from United Lead Co., Per Cent
Lead.....	none	96.43	93.17
Barium.....	none	.....	6.05
Calcium.....	86.42	3.20	none
Tin.....	.....	.....	trace
Antimony.....	.....	.....	0.0017
Copper.....	0.16	.....	0.0032
Zinc.....	none	.....	trace
Aluminum }.....	3.55	.....	none
Iron..... }	.....	.....	0.0006
Bismuth.....	.....	.....	0.055
Mercury.....	.....	.....	none
Magnesium.....	0.29	.....	0.0008
Sodium.....	0.55	.....	.....
Carbon (by diff.).....	9.03	.....	.....

Ia., by the electrolytic process from fused barium chloride, using molten lead as cathode. (Table I.) By diluting this with pure lead, alloys of varying compositions were produced for our investigations. Cooling curves were determined both by the differential and the inverse

⁹After our work was completed an abstract appeared in *Chemical Abstracts*, vol. 15, p. 662, describing an investigation of barium-lead alloys first published in *Zeitschrift für Metallkunde*, Oct. 1, 1920 ("The Constitution Diagram of the Alloys of Lead and Barium," by J. Czochralski and E. Rassow). Our work was in fact practically completed before that date, and is corroborated by the results reported in the article.

rate methods. From the results obtained the equilibrium diagram shown in Fig. 4 was derived.

Photomicrographs are in accord with the thermal equilibrium diagram and show a eutectic of lead with a lead-barium compound (presumably Pb_3Ba). From the diagram published in the article referred to,⁹ it appears that an examination was made of an alloy containing as little as 0.14 per cent barium, and that presence of eutectic was found therein. Judging from this, no solid solutions are formed unless with smaller amounts of barium. In the work carried out at this laboratory microscopic examination indicates the presence of eutectic in the alloys containing barium down to at least 0.50 per cent (Figs. 7 and 8). In the thermal study the alloy lowest in barium of which cooling curve was made—namely, 0.70 per cent barium—plainly shows the presence of eutectic. Its structure is not the completely homogeneous solid solution, rather being composed of homogeneous crystallites (either pure lead or solid solution with a very small amount of barium) surrounded at their boundaries by another component, a eutectic. In the alloys containing above $4\frac{1}{2}$ per cent barium and up to 6 per cent barium, coarse rod-like crystals make their appearance in the micrographs, which presumably consist of the compound Pb_3Ba (Fig. 9).

In the ternary calcium-barium-lead alloy, containing slight amounts of other elements (Frary metal), the eutectic forms at a slightly lower temperature than is the case with the binary barium-lead eutectic. That is, from study of the photomicrographs and thermal equilibrium of Frary metal the eutectic is found to be at a temperature of 284 deg. C. instead of 291 deg. C.; otherwise, however, the structure is such as would be expected from a combination of the binary alloys calcium-lead and barium-lead. There are, however, some indications of solid solutions being formed in the alloy up to about 0.2 per cent calcium and 0.4 per cent barium. The structure consists of homogeneous grains of lead, probably containing some calcium and barium in solid solution, surrounded by eutectic of this solid solution with lead-barium compound (Pb_3Ba), together with crystals of lead-calcium compound (Pb_3Ca) embedded in this ground mass of solid solution and eutectic (Fig. 10). The critical points found in thermal study of some of these alloys are given in Table II.

As indicated by Table II, there is a range of tempera-



FIGS. 7, 8, 9. MICROSTRUCTURE OF Ba:Pb ALLOYS

Etched with 2 per cent $AgNO_3$ in alcohol. $\times 50$.

Fig. 7—Ba 0.50 per cent. Small amount of eutectic in cast specimen. Fig. 8—Ba 1.39 per cent. Dendrites of lead in cast specimen. Fig. 9—Ba 5.5 per cent. Plates of Pb_3Ba in eutectic ground mass. (Slowly cooled specimen.)

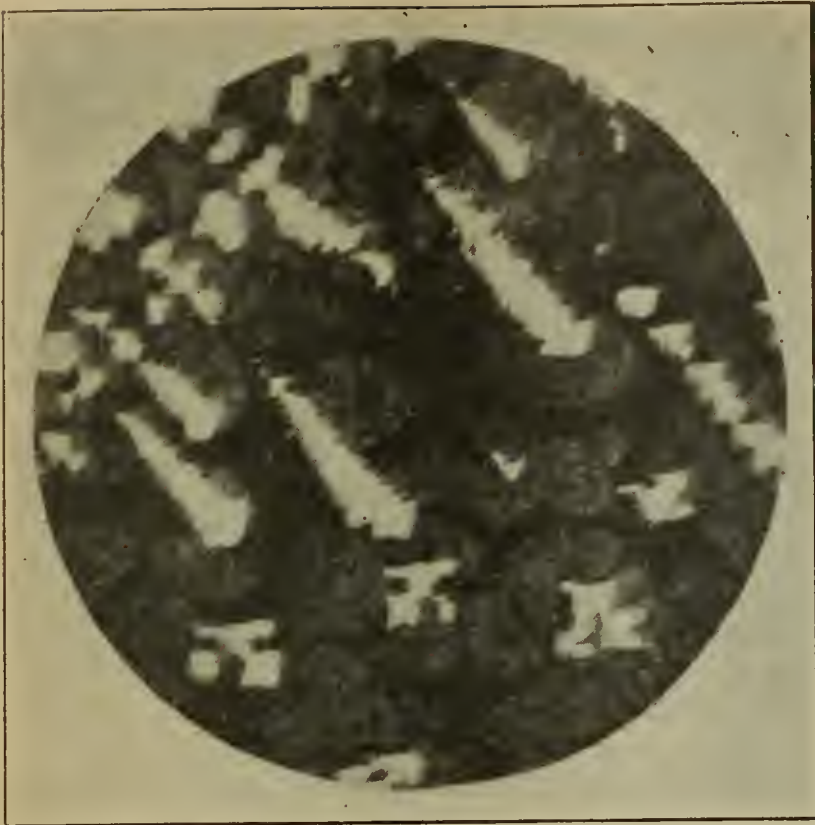


FIG. 10. TOP OF SLOWLY COOLED SPECIMEN OF FRARY METAL. $\times 250$
Etched with HNO_3 and picric acid. White crystals of Pb_3Ca and gray areas of lead (or lead containing a little calcium and barium in solid solution), surrounded by dark areas of eutectic.

ture in cooling such an alloy from a molten state, through which freezing of some of its components continues until complete solidification is reached. The binary barium-lead alloys, in the range studied, melt at a lower temperature and have greater apparent fluidity than pure lead. In the binary calcium-lead alloys, the complete solidification point is at the melting point of lead, but the presence of lead-calcium compound gives a somewhat higher complete liquefaction point. In the ternary alloy the latter point is above the melting point of lead, while the solidification point is lower than that of lead. This range of temperature through which solidification takes place in Frary metal is no greater, however, than the range of temperature through which most tin base bearing metals are partly fluid and partly solid.

The practical pouring temperature of any metal should, of course, be well above its complete liquefaction point, the best temperature logically depending upon the size, shape and temperature of the mold into which it is

TABLE II. THERMAL ANALYSIS OF ALLOYS						
Alloy				Complete Liquefaction Point	Point at Which Most of the Metal Freezes	Complete Solidification Point
Barium Per Cent	Calcium Per Cent	Mercury Per Cent	Lead	Deg. C.	Deg. C.	Deg. C.
1.20	0.80	0.25	Remainder	317	317	291
1.20	0.80	0.25	"	440	327	327
1.20	0.80	0.25	"	446	316	284
1.20	0.80	0.25	"	445	314	280

TABLE III. AGING EFFECT EXHIBITED BY Ca:Ba:Pb ALLOYS.								
No.	Alloy Composition in Per Cent				Lead	Brinell Hardness Numbers		
	Barium	Calcium	Mercury	Age of Specimen		1 Hr.	7 Days	28 Days
155	2.00	0.77		Remainder	25.7	29.2	31.5	
157	1.20	0.77		"	17.6	26.1	28.4	
159	0.40	0.77		"	13.8	21.8	24.5	
219	1.00	0.50		"	18.7	22.2	23.5	
218	1.00	0.50	0.2	"	22.6	24.4	24.7	

TABLE IV. HARDENING Ca:Ba:Pb ALLOYS BY HEAT-TREATMENT			
Specimen		Brinell Hardness Before Heat-Treatment	Brinell Hardness After Heat-Treatment
$\frac{1}{2}$ in. extruded rod		15.0	29.6
$\frac{1}{8}$ in. O. D., $\frac{1}{8}$ in. I. D. extruded pipe		11.2	25.0
Sheet		14.4	25.3
Swaged metal		12.3	23.5

to be cast. Other lead base alloys of the class of bearing metals and type metals melt at a comparatively low temperature, corresponding closely to the melting point of antimony-lead eutectic, and there is in most of these alloys only a short range of temperature between their complete solidification and liquefaction points; whereas Frary metal begins to melt at a temperature closer to the melting point of lead itself and corresponds in its comparatively wide melting range of temperature more nearly to tin base babbitt metals. In remelting and pouring into castings, therefore, it is necessary to use a higher temperature than with lead base alloys containing antimony.

Combination with oxygen in general takes place the more readily the higher the temperature. Frary metal does not oxidize or form dross to any greater extent than lead itself or other similar alloys at the temperature in question. In remelting ingots or other cast shapes of any metal or alloy, to avoid oxidation or drossing, the crucible, pot or ladle should, when practicable, be first heated to a temperature above the melting point of the metal, a small part of it first melted, and then the remainder added a little at a time at the rate at which it melts. With some alloys there may be



FIGS. 11, 12 AND 13. HARD CRYSTALS IN RELIEF ON POLISHED BEARING METALS. $\times 50$

Fig. 11—Ba 4.65 per cent; Pb remain-der; slowly cooled; a few plates of Pb_3Ba . Fig. 12—Cast Frary metal; Pb_3Ca crystals in relief. Fig. 13—Cast babbitt (Sn 83.9; Sb 7.4; Cu 3.7); etched with 2 per cent HNO_3 in alcohol. CuSn in relief.

a tendency under certain conditions for one element to oxidize more readily than another. However, Frary metal, as now produced, shows no tendency toward loss of its constituent elements by oxidation, when remelted by ordinary good practice. Alloys containing only barium and lead, on remelting, lose barium by oxidation. The calcium-lead alloys as made in this laboratory with the purchased metallic calcium, analysis of which is shown in Table II, do not act in this way, although calcium itself oxidizes very readily in the atmosphere. The surface of the molten metal has a very bright silvery appearance, free from oxide. The cause for this may be in the presence, as an impurity in the metallic calcium used, of a very slight amount of some other element. The absence of any tendency in Frary metal to lose its constituent elements by oxidation is probably due to a similar protective or deoxidizing action. The addition of small amounts of some metallic elements has proved beneficial, whereas the presence of slight amounts of other elements is harmful and must be avoided.

PECULIAR PROPERTIES

Cast specimens of some of the alloys have shown a remarkable increase in hardness and strength upon aging. The cause of this change which takes place in the solid metal may be similar to the theory advanced for a somewhat like hardening which takes place in duralumin.¹⁰ This is more pronounced with the alloys containing the lower percentages of calcium and barium. The period over which the change in hardness takes place is shortened by the addition of some other elements.

The hardness of the alloy, when in certain forms, can be increased by heat-treatment. In this respect also its behavior is similar to that of duralumin.

Pure lead, as is well known, emits a very dull sound when struck, while these alloys are quite remarkably resonant. This appears to be largely due to the presence of barium, since we have shown that cast lead containing only 0.08 per cent barium is quite highly sonorous, emitting a clear bell-like sound on being struck.

REQUISITES OF BEARING METAL

Frary metal, as described above, has a very large field of usefulness, especially as an excellent bearing metal. It has been found valuable for many purposes where strength and hardness is required, and can be readily cast in brass or iron molds, or made into die castings. It has also found use in the form of extruded pipe, tubing and rod; rolled sheets; and in swaged forms. As a bearing metal it has strength without brittleness, and also remarkable anti-frictional properties, while retaining largely the characteristics of lead in respect to plasticity (malleability, unctuousness).

It is generally recognized that the structure which renders an alloy suitable for use as a bearing metal consists of a crystalline component embedded in a plastic ground mass. The purpose of this desired structure is to give sufficient hardness to the bearing metal to enable it to resist the required pressure and at the same time impart to it the quality of plasticity, so that the bearing will adapt itself to any irregularities in fit and alignment. The metal should have the greatest hardness

compatible with the necessary plasticity; this hardness, however, being much less than the hardness of the shaft so that in case of injury the latter will not be scored, but the bearing metal itself will suffer. A metal having these properties of hardness combined with plasticity will have good anti-frictional qualities, since, as generally thought of, this term probably involves a low coefficient of friction and also so-called unctuousness. The former is actually the lower with the greater hardness, and the latter, used in this connection, may be simply the property of plasticity.

It appears from photomicrographs and from the working qualities of Frary metal that its structural components have all of these characteristics in a marked degree. Figs. 12 and 13 show photomicrographs of

TABLE V. HARDNESS OF VARIOUS BEARING METALS AT MODERATE TEMPERATURES

Alloys	Per Cent Lead	Per Cent Tin	Per Cent Antimony	Per Cent Copper	Brinell Hardness Numbers			
					20 Deg. C.	50 Deg. C.	100 Deg. C.	150 Deg. C.
1.....	..	91	4.5	4.5	24	..	12	..
2.....	..	88.9	7.4	3.7	28	..	14.5	..
3.....	..	85	7.5	7.5	31	..	16	..
4.....	10	75	12	3.	29.5	..	13	..
5.....	48	40	10	2.	21.	..	9	..
6.....	77	10	12.5	0.5	25	..	13	..
7.....	80	5	15	..	22.5	..	10.5	..
Genuine babbitt.....	..	88.9	7.4	3.7	28.3*	23.5	13.8	9.0
Frary metal.....	97.5	..	..	..	29.6*	27.2	20.9	14.0

*At 25 deg. C.

Frary metal, and a tin base babbitt metal prepared under the same conditions. These indicate that the structure of Frary metal is very similar to that of high-grade tin base bearing metals, and the similarity is even more notable when compared with the somewhat different structure of other lead base bearing metals. In Frary metal the presence of lead (or solid solution of lead with small amounts of calcium and barium) in the ground mass is undoubtedly partly the cause of the high degree of plasticity which is characteristic of the metal, and it is evidently distributed throughout the alloy in such a way as to result in no sacrifice of hardness.

In actual service bearings attain a temperature above normal, in many cases due to faulty lubrication or other causes. Their value in service then depends upon their properties at such temperature. Metals in general decrease in hardness and strength with rise in temperature to zero at the melting points. The decrease appears in general to be approximately a linear function with change of temperature; therefore, at elevated temperatures, metals having low initial solidification points are at a disadvantage in this respect, as shown by the figures in Table V.

Discovery of New Nitrate Lands in Chile

The Chilean Government has sent a mining engineer to Iquique to investigate a report of the discovery of a new nitrate zone, reports Consul Brett in *Commerce Reports*. A prospector claims he has found nitrate beds underlying a district of about 2,000 sq.km., where no nitrate was previously known to exist. The region is in the Province of Tarapaca, and it is said that the results of forty blasts, put in at distances of from 3 to 4 km. apart, show that beds of caliche from 2 to 3 ft. thick containing from 20 to 40 per cent of nitrate of soda underlie the region at a depth of 11 ft. below the surface.

¹⁰"The Heat-Treatment of Duralumin," by P. D. Merica, R. C. Waltenberg and H. Scott. A. I. M. E., June 1919. See also "Slip Interference Theory of the Hardening of Metals," by Zay Jeffries and R. S. Archer, CHEM. & MET. ENG., vol. 24, p. 1057 (June 15, 1921).

Solvents for Cellulose Esters*

Review of the Principal Solvents for Nitrocellulose and Cellulose Acetate—Development of a Pure Anhydrous Ethyl Acetate Which Is Known Commercially as Acetic Ether and Which Appears to Possess Unusual Solvent Properties

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THERE are two general types of solvents for cellulose esters. The first type are the solid solvents, which act upon the nitrocellulose whereby it loses all structural form and together with the solvent passes into a homogeneous plastic mass. The combination of such a solvent with the cellulose ester is brought about through the application of heat or pressure, by the addition of a liquid solvent, or by a combination of these methods. The homogeneous plastic mass once formed may be worked under influence of heat and pressure into any desired shape. Examples of this class of solvents, which are also known as latent solvents, are camphor, acetanilide and triphenyl phosphate.

The second general class of solvents are the direct or liquid solvents, which dissolve directly without such aid as heat or pressure. These solvents first act upon the cellulose esters to form a colloidal mass, which, upon the addition of further solvent, becomes a free flowing solution which may be indefinitely diluted with the same solvent. These solvents produce solutions which evaporate to leave clear films of the cellulose esters. The solutions are used as lacquers and protective coatings for wood, metal and other products; as a covering for cloth in the manufacture of artificial leather, and in the production of photographic films. When once dry these films can be redissolved by a direct solvent, but cannot be molded under the influence of heat or pressure unless a latent solvent such as camphor be present. Consequently for many purposes combinations of direct and latent solvents are used. Some of the more generally known direct solvents are amyl acetate, acetone and ethyl and methyl acetates.

Because of the relative high cost of high-grade solvents such as amyl acetate it is desirable to dilute them with non-solvents or with other cheaper solvents which alone would not give satisfactory results. These diluents may add some useful property to the mixture or may merely act as thinners. Examples of non-solvents which often impart valuable properties to solutions are the alcohols (ethyl, methyl, propyl), fusel oil, benzine and benzene. Included with the direct solvents are the mixtures of solvents with thinners and other solvent mixtures made of combinations of two liquids which separately are non-solvents but together from a solvent, such as alcohol and ether.

EFFECTS OF WATER IN SOLVENT MIXTURES

To the list of non-solvents should be added water. This non-solvent has given rise to a great deal of trouble in the development of the cellulose-ester industry, especially from the solvent standpoint. It is a precipitant of cellulose ester, and a solution of a cel-

lulose ester in a hygroscopic solvent will take up moisture to the point of precipitation. A solution of a cellulose ester in a mixture containing a solvent and non-solvent will not evaporate to form a clear film, but will precipitate whenever during the course of evaporation of the solvent the unevaporated portion is no longer a mixture in which the cellulose ester is soluble. This rule, of course, applies to water. Consequently, the use of a hygroscopic solvent with a boiling point below 100 deg. C. will often result in precipitation, or film blushing, as it is known, unless great precaution is exerted to prevent absorption of water.

A solution in any solvent which evaporates rapidly enough to cause an appreciable lowering of the temperature of the surrounding atmosphere and thereby resulting in a precipitation of moisture upon the evaporating solution is apt to suffer from this same trouble, especially if the solvent is also hygroscopic. Because of this difficulty a high boiling point, at least above 100 deg. C., has been considered one of the prime requisites of a good solvent. The quality of a lacquer, imitation leather or photographic film depends first of all upon the use of a solvent or solvent mixture which will evaporate in such a manner as to eliminate water and thereby leave a clear strong homogeneous film free from precipitation or blush.

SOME PROPERTIES OF AMYL ACETATE

Since 1882 amyl acetate has been the most important solvent for cellulose nitrate and has enjoyed extreme popularity due to its many important properties, among which are its high boiling point, low solubility in water, absence of hygroscopicity, its ability to stand high dilution with non-solvents (especially with benzene in the preparation of lacquers) and its property of producing smooth films of luster and high tensile strength. On the other hand, amyl acetate has low solvent power in comparison with acetone and ethyl acetate. Its variability of composition and, above all, its rapidly increasing scarcity, which has been accompanied by a corresponding rise in price, are factors which have tended to limit its use as a solvent for cellulose esters.

In the past few years there has been a tremendous growth of the industries based upon cellulose-ester solutions. The almost universal use of automobiles has increased the demand for artificial leather, the airplane has brought in an increased demand for dopes or lacquers, and the motion picture industry consumes tremendous quantities of films. Together with increased use of these products has come the rapidly decreasing supply of the industry's most dependable solvent and the necessity of, and demand for, new solvents or solvent mixtures. Out of this need first came greater dilution of the amyl-acetate solvents with non-solvents—the introduction of varying quantities of methyl ace-

*A paper read before the Section of Cellulose Chemistry at New York City on Sept. 7, 1921, and published by permission of the American Chemical Society.

tate, which could be obtained in an anhydrous condition but which soon became prohibitive in price—and later the rather general introduction of ethyl-acetate mixtures consisting of ethyl acetate and alcohol and ethyl acetate and benzene, with varying amounts of water dependent upon the source and method of manufacture of the ethyl acetate. These solvent mixtures are used together with a quantity of high boiling solvent, such as amyl acetate, sufficient to produce a solution which will evaporate without fogging. However, these solvent mixtures do not and cannot take the place of amyl acetate, and the demand for such a solvent is not satisfied by them.

PRODUCTION OF ANHYDROUS ETHYL ACETATE

This unsatisfied demand has led to experimentation with ethyl acetate, which has long been known to be a powerful solvent for nitrocellulose, but with which great difficulties had been encountered in attempting to produce it as an anhydrous product. However, this work has resulted in the development of successful and economical processes for the production of anhydrous ethyl acetate free from both alcohol and water and of many other anhydrous esters and solvents.

Heretofore but little has been known regarding ethyl acetate which is free from water and alcohol. However, acetic ether,¹ as this product is designated in this paper, promises to take the place to a great extent of amyl acetate and to extend greatly the field of cellulose ester solutions. Since acetic ether is produced from acetic acid and alcohol, the possible supply is practically unlimited. Furthermore, it should not increase materially in price, but naturally it should decrease as its manufacture on a large scale becomes justified through its increased use.

Acetic ether has suffered and still suffers from adverse criticism, due to information based on experiments with impure products and lack of knowledge of the behavior of the pure anhydrous preparation. References have been made repeatedly in the literature to the tendency of acetic ether to take on a strong acid reaction on standing.² Pure acetic ether as such or pure acetic ether diluted with 95 per cent alcohol does not show any indication of this objectionable property. Samples of acetic ether, and acetic ether and alcohol, after standing for 1 to 2 years have shown only a slight trace of acidity or even complete freedom from the same. After eighteen months' time four representative samples showed: 0.009 per cent, 0.024 per cent, 0.017 per cent and 0.009 per cent of free acetic acid. Acetic ether is stable even when treated with hot water.

Iron drums in which acetic ether had been stored for months have shown no evidence of corrosion, nor was the ester itself discolored. Chemical tests of acetic ether show that the supposed acid-developing tendency cannot be too strongly denied.

Another objection raised to acetic ether and which is found frequently in the literature is its alleged hygroscopicity.³ It is known, however, that acetic ether is not hygroscopic, but on the other hand takes up moisture very slowly. High-grade acetic ether such as produced by the process previously referred to, after standing in a storage tank with a loose cover for a month, showed no action on metallic sodium when the latter was placed

in it. Acetic ether stored in drums for 6 months gave the same result.

A third commonly repeated objection to acetic ether is its volatility or low boiling point (77 deg. C.).

Having discussed briefly the more common objections to acetic ether, some of its properties will now be considered. It is a colorless, limpid, pleasant smelling fluid, entirely free from disagreeable and poisonous fumes. It evaporates without a visible or detectable residue. Being a pure compound, it evaporates at a uniform rate. Acetic ether is unaffected by light or air. Samples stored for months in bottles or exposed to the air in storage tanks have shown no signs of deterioration. It is a powerful solvent for nitrocellulose and is a good solvent for the more soluble forms of cellulose acetate.

TESTS WITH NITROCELLULOSE

In this connection the description of a series of experiments which were carried on to determine the nature of acetic ether and acetic ether-ethyl alcohol mixtures as solvents for nitrocellulose might be of interest. Samples of nitrocellulose were obtained from the Hercules Powder Co. and showed the analyses given in Table I.

TABLE I. PROXIMATE ANALYSES OF NITROCELLULOSE SAMPLES

Description	Nitrogen	(In per cent)		Ash	Moisture
		Insoluble in Ether and Alcohol	Insoluble in Acetone		
"L," low viscosity.....	12.00	0.40	0.15	0.14	27.9
"P,"	11.14	3.25	0.26	0.12	38.1
"M," medium viscosity..	12.13	0.08	0.15	0.13	29.2
"H," high viscosity.....	12.06	0.10	0.08	0.14	28.0
"V.H.," very high viscosity.....	12.18	2.15	0.30	0.20	32.3

These samples were wet with alcohol when received and were all dried at about 50 deg. C. before using. They are designated by the letters "L" "P" "M" "H" and "V.H." respectively.

The alcohol used was 95 per cent ethyl alcohol containing $\frac{1}{2}$ per cent of benzene. The acetic ether and alcohol were mixed so as to give mixtures containing 10 per cent of acetic ether and 90 per cent of alcohol, 20 per cent of acetic ether and 80 per cent alcohol and so on, advancing by tens to the pure acetic ether. These mixtures are designated as "10 per cent," "20 per cent," "30 per cent," . . . "100 per cent" acetic ether.

To weighed samples of the nitrocellulose in large test-tubes were added measured amounts of the different ester mixtures; a separate tube was set up for each solvent with each sample of nitrocellulose. In each case slightly less of the ester mixture was added than had been found necessary for complete gelatinization of the nitrocellulose.

The tubes were well stoppered and were allowed to stand for 24 hours, when more ester was added in each case. This was repeated until just enough solvent had been used in each case to dissolve the nitrocellulose, while the addition of more solvent merely rendered the mixture fluid.

The solubilities expressed as ounces of nitrocellulose per gallon of solvent were found to be as shown in Table II and the curves prepared from these data are shown in Fig. 1.

From these experiments it will be seen that acetic ether has a high solvent power for the various samples of nitrocellulose, dissolving from 11.2 to 30 oz. per gallon of solvent. Further, it may be noted that the high dilutions possible with 95 per cent alcohol is accom-

¹It is appreciated that this does not conform with exact chemical nomenclature, but the term is used here because of its commercial significance. In the trade "ethyl acetate" refers to the 85 per cent material, and "acetic ether" is used to designate the 99 to 100 per cent ethyl acetate.

²"Nitro-Cellulose Industry," by E. C. Worden, vol. 1, pp. 230 and 434.

³"Nitro-Cellulose Industry," by E. C. Worden, vol. 1, p. 434.

TABLE II. SOLUBILITIES OF NITROCELLULOSE SAMPLES IN VARIOUS MIXTURES OF ACETIC ETHER AND ALCOHOL.

Solvent	Nitrocellulose Samples				
	L	P	M	H	V.H.
10 per cent acetic ether.....	30.6	27.8	26.5	23.6	11.7
20 per cent acetic ether.....	36.7	28.7	29.0	24.5	12.2
30 per cent acetic ether.....	37.2	29.4	29.7	25.7	13.0
40 per cent acetic ether.....	38.0	30.0	30.0	25.7	13.5
50 per cent acetic ether.....	37.7	29.4	28.7	25.7	13.2
60 per cent acetic ether.....	37.2	28.9	28.4	25.3	13.0
70 per cent acetic ether.....	35.8	28.5	28.1	24.6	12.8
80 per cent acetic ether.....	33.5	26.8	27.3	24.0	12.2
90 per cent acetic ether.....	29.7	23.4	23.5	23.0	11.2
100 per cent acetic ether.....					

panied by an increase rather than decrease in the solvent power of the mixture.

A similar set of experiments showed the possibility of diluting the acetic ether with benzene to the point of a mixture of 70 per cent of benzene and 30 per cent of acetic ether. Although solvent for the various nitrocelluloses, the dilution with benzene beyond a 50-50 mixture reduced the solvent power appreciably.

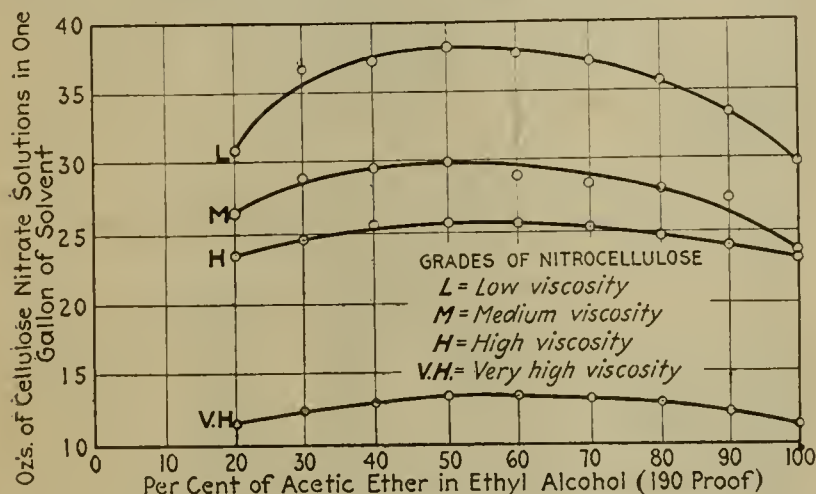


FIG. 1. SOLUBILITY OF NITROCELLULOSE IN ACETIC ETHER-ETHYL ALCOHOL MIXTURES

Curves showing the relative viscosities of 5- and 10-oz. solutions of nitrocellulose in these solvent mixtures are shown in Figs. 2 and 3.

The solvent properties of acetic ether for cellulose acetate were shown by experiments with three different lots of cellulose acetate obtained from the Eastman Kodak Co. over a period of 3 years. All dissolved in anhydrous acetic ether to the extent of about 25 oz. to 1 gal. of solvent and gave good workable solutions of 10-oz. strength from which films were produced. Another sample of cellulose acetate was found to be soluble to the extent of 20 oz. per gallon. Later a sample of salvage cellulose acetate proved to be insoluble in acetic ether, but experiments demonstrated that this sample was also insoluble in other cellulose acetate solvents.

Besides being a powerful solvent for the cellulose esters, acetic ether, alone and together with small percentages of alcohol or water, or diluted by with as much as 50 per cent of chemically pure benzene, will produce solutions leaving satisfactory films upon evaporation.

Clear, strong films were produced by permitting the following solutions to evaporate under the ordinary atmospheric conditions of the laboratory: Solutions of various samples of nitrocellulose in acetic ether, acetic ether diluted with 5 per cent of 95 per cent alcohol, acetic ether wet with 2 per cent water, and acetic ether diluted with an equal volume of c.p. benzene; a solution of cellulose acetate in acetic ether, and one of half cellulose acetate and half cellulose nitrate in acetic ether.

Acetic ether is an example of a low boiling solvent

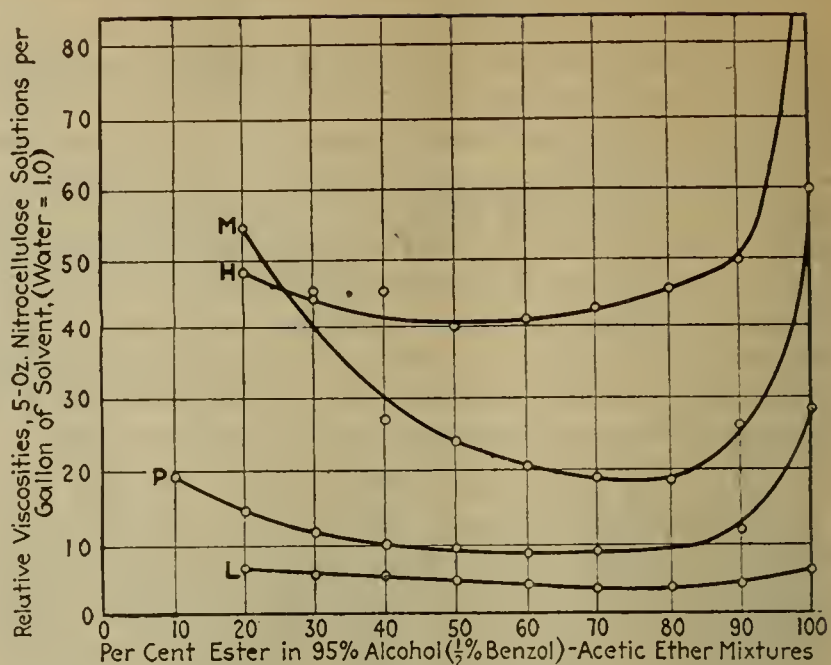


FIG. 2. RELATIVE VISCOSITIES OF 5-OZ. NITROCELLULOSE SOLUTIONS

(b.p. 77 deg. C.) giving a result which in the past has been considered possible only from a non-hydrosopic solvent boiling above 100 deg. C., such as amyl acetate. The effect of water upon the low boiling solvents and upon hydrosopic solvents has already been discussed.

The explanation of this unusual and important behavior of acetic ether depends chiefly upon its characteristic property of forming constant boiling mixtures with water. Among the constant boiling mixtures of acetic ether with other liquids are the following:

With Water. Acetic ether 91.4 per cent, water 8.6 per cent. Boiling point, 70.45 deg. C.

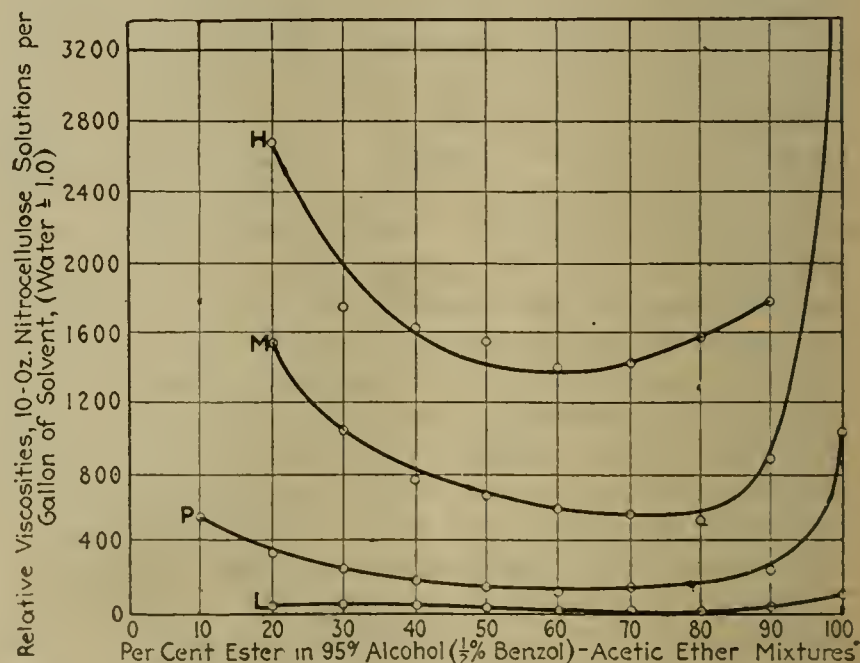


FIG. 3. RELATIVE VISCOSITIES OF 10-OZ. NITROCELLULOSE SOLUTIONS

With Alcohol. Acetic ether 69.4 per cent, alcohol 30.6 per cent. Boiling point, 71.8 deg. C.

With Alcohol and Water. Acetic ether 83.2 per cent, alcohol 9.0 per cent, water 7.8 per cent. Boiling point, 70.3 deg. C.

The relative low boiling point of acetic ether becomes a decided advantage. It makes possible rapid work. Further, by control of the temperature of evaporation and other atmospheric conditions such as concentration of evaporating solvent any desired rate of evaporation may be maintained.

Baltimore, Md.

*Ryland, *Am. Chem. J.*, vol. 22 (1899).

German Chemical Industries

FROM OUR SPECIAL CORRESPONDENT

ESSEN, Nov. 28, 1921.

JUDGING from the commercial reports of the principal German newspapers, opinion as to the prospects and future of the German chemical industries is still divided. Pessimists still reckon on the possibility of France demanding that the greater part of the chemical works be dismantled, on the ground that in case of a new war they could be able to manufacture war gases. On the other hand, the stock exchange, which at all times is a better barometer for the course of future events, does not seem to share such a gloomy view.

While in normal times, and even until recently, the market for industrial debentures varied generally only between 95 and 100 per cent, the recent rush to invest money caused the price for these debentures to reach a figure never known before, this increase varying in proportion with the confidence the public has in the future prospects of each individual undertaking. The $4\frac{1}{2}$ per cent debentures of the undertakings united in the great dye trust have beaten all previous records. The obligations of the Badische Anilin und Soda-Fabrik and the Elberfelder Farbenfabriken vorm. Friedr. Bayer (yielding $4\frac{1}{2}$ per cent interest in paper marks) reached their highest bid at 180 per cent, a price which has never previously been known to be paid in Germany for industrial debentures of any kind.

CHEMICAL MARKETS

The situation in all branches can be considered favorable, although the intensity of buying has somewhat relaxed this month, but everything offered is readily sold. Prices are increasing continually and in consequence contracts cannot be placed at fixed prices. As the prices have, however, reached an exceptional and one is very much inclined to say a phantastic level, buyers are somewhat more careful, with the result that the situation has begun to ease a little. In consequence the available quantities of chemicals offered in the open market were much smaller than usual and were readily disposed of. As examples may be mentioned borax, which had reached the exorbitant figure of 45 marks per kilogram and has since dropped to 37, with the result that it has disappeared from the market entirely; mercury is much in demand, but only very small quantities are to be had, these changing hands at 300 marks per kilogram exclusive of bottles; sulphur in lumps reached 6.50 to 6.75 marks per kilogram; sulphuric acid as supplied through the German ammonia syndicate to the byproduct coking plants has also been increased in price—to 83 marks per 100 kg. from Nov. 1.

TAR PRODUCTS

The market in anthracene is very quiet due to the fact that the large dye works accumulated thousands of tons during the war when it was very cheap and are thus fully supplied with this material for a number of years to come. The comparatively cheap price paid for anthracene during the war is explained by the fact that the manufacture of oils for fuel and lubricating purposes was of primary importance and anthracene was then considered merely a byproduct.

Benzene, toluene and xylene have been increased in price during October, but in spite of these increases these products are still sold at a figure much below the rates prevailing on the world markets. The rapidly

jumping prices for imported gasoline have again increased, with the result that the demand for benzene exceeds the available quantities by far.

To relieve the acute shortage of liquid fuel the benzene syndicate, which is under government control, has recently introduced a new standard motor fuel called "tetralitbenzol." It consists of two parts by weight of motor benzene, one part motor tetraline and one part of 95 per cent alcohol. This fuel is introduced and distributed now on a considerable scale and has proved very serviceable for motor cars or any other internal combustion motors. A great number of mixing plants have been erected all over Germany so as to insure an even distribution all over the country. The new fuel has been well received by the consumers and by its use the amount of benzene available for home consumption is increased by 4,000 tons per month through this addition of tetraline and alcohol, so that Germany is practically independent of foreign supplies of motor fuel.

DYES

The turnover in dyes is somewhat quieter and in the export trade the Swiss competition is keenly felt. The American and English competition is also a disturbing factor. Trade with Italy is much impaired by the peace treaty with that country which makes compulsory the supply by Germany of certain quantities of dyes and chemicals.

On the whole the chemical industry is suffering acutely from the general scarcity and inferior quality of fuel. Apart from this impediment in production, the works are sold out for several months to come, so that today only goods for supply in January or February can be promised. Owing to the shortage of railway cars, even wholesale dealers cannot supply promptly and for many chemicals no offer at all can be had.

Surface Defects on Brass Sheet

H. A. Hays read a paper on "The Rolling of 70:30 Brass" before the Birmingham (England) Metallurgical Society in November, 1921. As reported by the *Iron and Coal Trades Review*, he noted that the surface defects chiefly met with in brass strip and sheet could be divided into three main classes: (1) Spilly areas, (2) scratches, rolled-in mill scale or dirt, (3) stains. The first named was the most serious and was too frequently met with. Spilly areas were due to bad pouring, which caused splashing of partly solidified metal on the surface of the ingot mold, cracks and serious porosity of the ingot mold and fragments of sand, metal, etc., mixed in with the mold facing. The steelworks practice of machining blooms all over before rolling into strips could be advantageously adopted.

Mechanical defects were altogether too frequent. The rolling-in of mill scale and dirt could be avoided by adopting closed muffles for all heating operations and the keeping the floor of the rolling mill clean, and, as far as possible, keeping the material off the floor. Continental manufacturers are able to produce excellent finish by the use of steel rolls, the use of which in England is limited.

Recent work by the Non-Ferrous Research Association indicated that the removal of grease from the material before annealing greatly helped in preventing staining. Insufficient cleaning and pickling or the presence of chlorides in the wash water resulted in the material becoming badly stained after being left standing for some time.

Synopsis of Recent Chemical & Metallurgical Literature

British Steel-Works Practice.—R. H. Archer Coulson, president of the Cleveland (England) Institution of Engineers, delivered an address¹ before that body in which he outlined the changes in their industry which might possibly be used to offset high cost of labor and fuel. Given a well-designed plant, built with the idea of saving fuel, the main determining factor of success is *reliability* of the various independent operating units. Material handling should be simple and continuous; avoid intricate machines which will require heavy attendance and upkeep costs. Again, material may get into a department efficiently, but get out wastefully. The speaker feels that storage battery locomotives will be a great time and money saver. Low-ash coke, pure limestone and high-grade ore should be insisted upon; poor chemical and physical properties of coke are especially expensive at any price. Much yet remains to be known about the factors which promote combustibility—that prime requisite of coke as a blast-furnace fuel. Irregularities in practice should be avoided if at all possible—a furnace running well on fine ore will show distress if given several charges of lumpy ore. Pure fluxes are of great importance in the open-hearth furnace, not so much from the increased tonnage, but the loss of iron in the slag. Silica and magnesite brick are not so good as before the war. Gas houses should operate, not to make the richest gas, but the gas which burns with the highest temperature. Waste-heat boilers are to be recommended. After all, the most important factor is the weight of ingot required to produce a ton of finished material. Given sound ingots, good heating practice is of great importance, in keeping this weight down and in reducing power and repair bills. Continuous operation is essential to economy in every department, even though workmen are paid by tonnage rates. Reliable, simple, stout, and if possible automatic electrical equipment will cut down incidental and exasperating delays remarkably. Cleanliness and order will work to the same ends. Finally, but perhaps most important, every member of the staff and every workman should have a desire to do his best, to have “the pride of craft.”

Water Japan Installations.—The November issue of the *General Electric Review* contains an article by Wheeler P. Davey and P. Dunning describing several installations at the General Electric Co.'s plants using the water japan developed in the research laboratories of the company. This water japan is an emulsion of an asphalt oil base in water. It may be applied by two methods: the electric dip, in which the articles to be coated are charged positively; the hot dip, in which the articles are preheated before dipping in the japan. (See CHEM. & MET. ENG., May 19, 1920.)

Two small installations at the Schenectady works are described briefly, followed by a discussion the installation at the Sprague works, which is the first to use water japan on a large scale. The latter consists of three electrically heated conveyor ovens of the vertical intermittent type. Two of these have a maximum capacity of 2 tons per charge; the third, 3 tons per charge. The dip tanks, placed in a pit below the floor level, are provided with cooling coils and air jets so arranged that the temperature of the japan is always below 70 deg. F., even without the use of a circulating pump. Each tank holds about 900 gal. of japan. This provides enough heat capacity in the japan itself to prevent undue temperature rise during dipping.

Articles to be japanned are hung from hooks on the bars of the conveyor, if large, or placed in baskets, if small. After preheating to about 500 deg. F., the articles pass through the dip tanks at a speed of not less than 6 in. per second, and then back to the oven, where the japan is baked for 20 to 30 minutes. When operating on a load

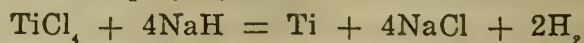
of 4,000 lb., the efficiency of the 2-ton ovens for preheating plus baking is 11 lb. per kw.-hr. With smaller loads the efficiency is, of course, less. For instance, if the load is decreased to 1,800 lb., the efficiency is only 6 lb. per kw.-hr. The 3-ton oven has never been loaded to its maximum capacity, so that actual data are not available, but it is estimated that if it were so loaded its efficiency would be 14 lb. per kw.-hr. These figures compare favorably with those obtained with box-type or other intermittent ovens.

The relative freedom from drip, which is a characteristic of water japan, prevents material on one bar from being marred by japan dropping from the next higher bar and also prevents prohibitive scarring of the work which is dipped in baskets. Data taken on metal totaling several thousand square feet in area show a coverage of a little more than 200 sq.ft. per gal. of water japan. In spite of the large amount of metal that is japanned daily by the ovens at the Sprague works, it is not necessary to measure the concentration of the japan oftener than once a week. Since the solvent (water) is relatively non-volatile, there is no need for the daily addition of “thinner,” so that the low initial cost of water japan is further supplemented by the saving in the cost of thinner. These advantages are nevertheless of but supplementary importance compared with the main purpose for which the water japan was developed—the absolute elimination of fire risk.

Contribution to the Study of Titanium.—The July-August, 1921, issue of *Annales de Chimie* contains the results of the research work on titanium made by Maurice Billy at the Institut de Chimie Appliquée (pp. 5 to 54). His study consisted in obtaining the raw materials for the preparation of pure metallic titanium, gaseous and solid hydrates, oxides (TiO , Ti_2O_3 , Ti_2O_4 , Ti_2O_5), crystallized persalts, complex double sulphates and the determination of the degree of oxidation of the compounds obtained in acid solution in the presence of hydrogen peroxide.

He obtained the raw material used in his study by mixing 1 part of commercial titanium anhydride with 6 parts of sugar and transforming this into chloride by calcining, pulverizing, heating to 1,000-1,200 deg. C. in a current of dry chlorine in a porcelain tube. The impurities of the resulting chloride were separated by an agitation with sodium amalgam and a fractional distillation at 135-137 deg. C. under normal pressure.

After passing in review the different methods employed in the preparation of metallic titanium he describes in detail the method he employed, based on the reaction



and gives the schematic arrangement of the apparatus used (p.14). Qualitative and quantitative tests have shown no trace of impurities.

Nascent titanium absorbs hydrogen, giving a black mass, which is titanium hydride. He describes the method of preparation and the apparatus used (p. 21).

The only titanium oxide which can be obtained easily in a perfectly pure state is TiO_2 and this served for the preparation of the other oxides by reduction with hydrogen or by the action of metals having a greater affinity for oxygen. After describing in detail the preparation of pure TiO_2 he passes in review the methods formerly used for the reduction by hydrogen and then gives his method with the schematic arrangement of the apparatus used (p. 27). Similarly he passes in review the methods formerly used for the reduction of TiO_2 , especially by magnesium and zinc, and gives his procedure and came to the result that the most convenient metal is titanium and that the mixture TiO_2 -Ti heated in a specially constructed furnace shown schematically on pp. 39 and 41 he was able to obtain all the oxides according to the degree of heating. Thus:

Between 700–800 deg. C. he obtained a blue oxide, Ti_2O_3 .
Between 900–1,000 deg. C. he obtained a violet oxide, Ti_2O_3 .
Between 1,100–1,200 deg. C. he obtained a black oxide, Ti_2O_3 .
Between 1,400–1,500 deg. C. he obtained a brown oxide, TiO .

He then studied the preparation of persalts and states that he has succeeded in preparing crystallized sulphates of titanium peroxide. He concludes with the statement that all the salts of titanium are not salts of TiO_2 , as given by previous authors, but salts of $\text{Ti}_2\text{O}_3 \cdot \text{H}_2\text{O}$.

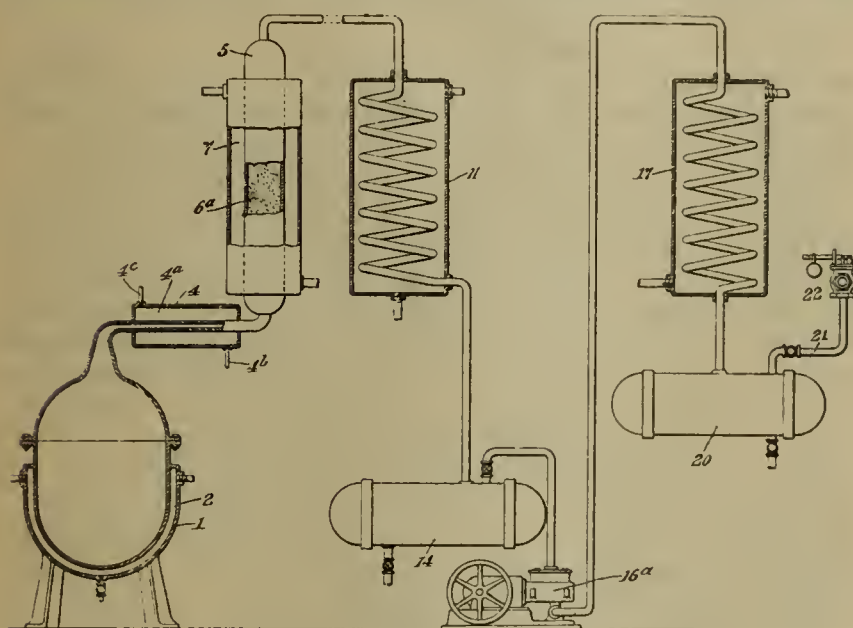
¹Reported in *Iron and Coal Review*, Nov. 11, 1921.

Recent Chemical & Metallurgical Patents

American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Production of Acetaldehyde.—A process for the catalytic production of aldehydes, with particular reference to the manufacture of acetaldehyde from ethyl alcohol, is the subject of a patent granted to Arthur A. Backhaus of Baltimore and Fred B. Arentz of Curtis Bay, Md., assignors to the U. S. Industrial Alcohol Co. To carry out the process, the alcohol is introduced in the still 1 (see figure), which is heated by the steam jacket 2. The alcohol vapors are conveyed to the preheater 4, where they are heated to about 300 deg. C. by means of the oil jacket 4a. The vapors enter the catalyzer 5, which is filled with pumice stone, unglazed porcelain, charcoal or a similar granular porous



material upon which has been deposited the finely divided catalyzer metal. The catalyst used is copper, nickel, chromium or iron. The oil jacket 7 maintains the vapors in the catalyzer at approximately 300 deg. C. throughout the length of the tube, and a large percentage of the alcohol is decomposed to form acetaldehyde and hydrogen. The vapors passing out of the catalyzer are conducted through the condenser 11, maintained at a temperature of 20 to 30 deg. C., where any alcohol vapors present are condensed and are collected in the receiver 14. The acetaldehyde and the hydrogen pass out of the receiver and are conducted to the compressor 16a, where the gases are compressed to approximately 60 lb. per sq.in. The compressed gases then pass through the condenser 17, maintained at a temperature of 10 to 20 deg. C., where the acetaldehyde is condensed and collected in the receiver 20. In case the compressor 16a is not used, the temperature in the condenser 17 is kept at about 0 deg. C. by means of a brine bath. The hydrogen is conveyed away from the receiver 20 by the pipe 21, through the relief valve 22. The hydrogen may be collected in any suitable manner. (1,388,841; Aug. 30, 1921.)

Purifying Fuel Gases.—Charles J. Ramsburg of Pittsburgh, Pa., assignor to the Koppers Co., has obtained a patent for purifying fuel gases by a process in which the obnoxious constituents such as the sulphur compounds are removed from the gas through absorption in a water solution of sodium carbonate or a similar alkaline salt. It is common practice to pass the gases through boxes filled with iron oxide, but these boxes have to be cleaned frequently and replenished and consequently are expensive to maintain. This invention claims to reduce the quantity of iron oxide to a minimum inasmuch as the purification removes substantially all of the sulphur compounds from the

gas before it passes into the iron-oxide boxes on its way to the mains. An efficient aeration process for regenerating the sodium carbonate solution after it has absorbed the hydrogen disulphide is also provided. This causes the purifying agent to give up its sulphur, thereby permitting a constant reflux of the sodium carbonate solution back to the process. The features of the process which relate to the principle of absorption by the alkaline solution and its regeneration are the invention of David L. Jacobson of Jersey City, N. J., and are covered by patent 1,390,037, which is also assigned to the Koppers Co. (1,389,980; Sept. 6, 1921.)

A New Detonator.—When finely pulverized cyanure chloride is introduced into an aqueous solution of sodium azide, there is obtained a new organic compound, cyanure triazide, which corresponds to the formula C_3N_{12} . Pure cyanure triazide consists of colorless crystals melting at 94 deg. C., is not volatile, but is saponified slowly by hot water, and explodes when subjected to concussion or when heated to 170 deg. C. It is particularly adapted for use as a priming agent as a substitute for mercury fulminate, lead azide or silver azide. In comparison with these priming agents, its inventor claims the following advantages:

(1) It is not poisonous in contradistinction to fulminating mercury and lead azide.

(2) It is not sensitive—that is to say not affected by moisture in contradistinction to fulminating mercury.

(3) It is resistant to and not changed by light in contradistinction to lead azide and to silver azide.

(4) There is no danger of reaction with a metal of the material of the detonator casing or capsule shell, as is the case with lead azide.

(5) It is fusible and its fusion point (94 deg. C.) is so low that the product, melted by a single heating on water or steam bath, can be poured without danger in the capsule shell. It solidifies therein after cooling and shows the density (specific weight) of 1.5.

(1,390,378; Erwin Ott of Basel, Switzerland, assignor to Dr. Edwin Hanton Faust of Basel, Switzerland, Sept. 13, 1921.)

Catalytic Oxidation With Silica Gel.—A patent has been granted to Dr. Ralph H. McKee of New York for the process of oxidizing certain gases in which hydrated silica gel is used as a catalyst. The method is shown to be particularly applicable to the oxidation of nitric oxide to nitrogen peroxide such as is required in the production of nitric acid. In one form of the process the gas stream flows through a series of chambers in which it is alternately exposed first to the action of silica gel and then to the action of water or dilute nitric acid. (1,391,332; Sept. 20, 1921.)

Book Reviews

ORGANIC COMPOUNDS OF MERCURY. by Prof. Frank C. Whitmore of the Northwestern University. 394 pp. New York: The Chemical Catalogue Co. Price, \$4.50.

Probably very few organic chemists, whose chief interests lie in other fields, realize the rich variety and volume of work which has been done in the investigation of the organic compounds of mercury. This monograph by Prof. Whitmore has been "arranged to serve both the general chemist, who wishes to get a conception of what has been done in the field as a whole, and the specialist, who wishes to find out quickly what has been done in any particular portion of the field."

The reviewer is of the former class and from his point of view Prof. Whitmore has succeeded in achieving his purpose. The subject matter is well condensed, but nevertheless has a readable quality which is frequently lacking in mechanically compiled volumes. The omission of practically all detailed experimental material contributes to the readability of the volume. A very large number of literature references are given throughout the text and a bibliographical appendix includes a special list of patents on

organic mercury compounds. The subject index is unusually complete and has evidently been compiled with great care. A monograph which shows such evidence of careful preparation as the present volume naturally inspires the reader with a feeling of confidence. Prof. Whitmore's own experience in this field has enabled him to treat certain subjects very critically, and the present volume is happily not such as are more or less mechanically compiled by persons who have not been actively engaged in original research in the subjects of which they write.

The monograph is confined almost entirely to the true organic mercury compounds in which mercury is attached directly to carbon. No attempt has been made to include biological and pharmacological studies, on account of lack of space and "because of the unsatisfactory condition of the literature of this phase of the subject." The reviewer particularly welcomes the absence of erroneous theories and the results of faulty work of earlier investigators, which sort of material is often included by authors in a historical treatment of the subject. The book is remarkably free from typographical errors. Those whose interests lie in industrial fields might desire a fuller discussion of the rôle of mercury salts in the conversion of acetylene to acetaldehyde and also the mercury compounds of ethylene, since the latter also promise to be of industrial interest. Also the very fact that the biological and pharmacological literature is in such unsatisfactory condition, as noted by Dr. Whitmore, suggests that the same critical treatment of this phase of the subject by him would add greatly to the value of the book, at least for a certain class of readers. Nevertheless, the care which Prof. Whitmore has obviously given the preparation of this volume is a service which should be appreciated by all organic chemists. It has seldom been the privilege of the reviewer to read a monograph on any subject of chemistry which he could commend so unservedly.

BENJAMIN T. BROOKS.

* * *

WASTE IN INDUSTRY. By the *Committee on Elimination of Waste in Industry* of the Federated American Engineering Societies. Published by Federated American Engineering Societies, Washington, D. C., and sold by the McGraw-Hill Book Co., Inc., New York. 410 pages, illustrated. Price \$4.

This is a report of the Committee on Elimination of Waste in Industry of the Federated American Engineering Societies, appointed by Herbert Hoover, the first president of that organization. It represents an intensive study of six typical branches of American industry undertaken for the purpose of gathering quickly data and information that would permit of a comparison of average practice with the best-known practice. Such a study, it was expected, would disclose the nature, cause and extent of preventable waste. The analysis was based on a questionnaire which had been devised for obtaining such quantitative data as the industries possessed. The work was completed in 5 months. On studying the report one is impressed with the fact that American industry is marked by preventable waste of great magnitude which if properly brought to the attention of those responsible for the financial support and commercial success of our industries would stimulate them to keener introspection and consequent improvement of their processes of production and distribution. From this point of view the report merits the careful study of financiers, business leaders, labor leaders, industrial engineers, economists and others in positions of authority and responsibility.

The sources and causes of waste in industry are attributed by the committee to: 1, low production; 2, interrupted production; 3, restricted production; 4, lost production. In seeking to place responsibility for these wastes the committee came to the conclusion that "over 50 per cent of the responsibility for these wastes can be placed at the door of the management and less than 25 per cent at the door of labor, while the amount chargeable to outside contacts is least of all. It must be recognized that if management is to meet this responsibility fully it must have the co-operation of labor."

Low production is to be ascribed mainly to faulty control of material, design and production; lack of knowledge of costs and lack of cost control; lack of research; faulty labor and sales policies. Interrupted production is a consequence of idle men whose unemployment is due to seasonal occupation, industrial depression or labor disturbances. The committee dispels a popular notion that the waste due to unemployment on account of labor disturbances is high. As a matter of fact, the amount of waste from strikes and lockouts in general is much less than is popularly supposed. Seasonal unemployment, however, is a factor of great importance in such industries as building, shoemaking and bituminous coal mining. In 1919, a year of exceptionally regular employment, the percentage of full time worked in the brick, chemical and glass industries was 85, 84 and 87 respectively. The margin of unemployment in all industry in our best years has never been less than one million men.

In restricted production due to rules and regulations of labor unions the committee finds a serious cause of waste. To the average reader many of these restrictions will appear inconceivable, affronting the intelligence of reasonable men. Lost production due to ill health and accidents is found to run into figures that are beyond comprehension, but which, nevertheless, measure the great waste arising from disease and accidents.

A chapter is devoted to the committee's recommendations for eliminating waste. Having placed a large share of the responsibility upon management, it outlines a way in which this responsibility can be met. It is largely through improvement in organization and executive control, applying sound and modern principles to production, costs, sales, purchase and personnel. Simplification and standardization of processes, equipment and products will do much to eliminate waste. Labor is held responsible for co-operation in increasing production by changing its rules that restrict output unreasonably. It is also held accountable for co-operation in the plans of management for standardization and improvement of industrial relations. The public is called upon to contribute to waste elimination by being less exacting in its demand for changes in style. The public can also assist in stabilizing industry by distributing demand in certain seasonal industries throughout the year, as in the building industry.

The committee sees an opportunity for governmental assistance through the establishment and maintenance of a national industrial information service and a national statistical service. These are functions which the Secretary of Commerce is now trying to exercise in co-operation with various industries by issuing monthly figures on production, consumption and stocks.

The industries that were investigated and on which detailed reports are made in Chapter V are building, men's clothing, shoemaking, printing, textile manufacturing and metal trades. The separate reports in these industries are accompanied by a questionnaire and the field report evaluation. While they are of particular value to the industries studied, they are suggestive to all industries and to all establishments, large or small. It is inconceivable that any manager, for example, can spend a period of serious reflection on the questionnaire, with respect to his own establishment, without having his attention directed to wasteful practices that can be changed. Indeed, this is the principal value to be gained from the widespread reading of the book.

Part III is concerned with some reports on unemployment, strikes and lockouts, legal machinery for adjusting disputes, industrial accidents, health of industrial workers, eye conservation, purchasing and sales policies. These are general summaries of available information compiled by competent critics. They have a supplementary value by emphasizing some of the causes of waste disclosed by the committee and by focusing attention on further means for solving the problem. On the whole the book represents a useful study that will be productive of further investigations and of a more critical attitude toward waste on the part of all who read it.

H. C. PARMELEE.

Current Events

in the Chemical and Metallurgical Industries

Senate Sub-Committee Appointed to Investigate Dye Industry and Practices of Dye Importers

The Senate's investigation of the legislative activities of the domestic dye industry and of the practices of dye importers will be conducted by a sub-committee of the Judiciary Committee to be composed of Senator Shortridge of California, Senator Borah of Idaho and Senator Reed of Missouri. No date has been set for the hearings.

Dates Set for Rate Reduction Arguments Before Interstate Commerce Commission

Representatives of the fertilizer, sulphuric acid and phosphate rock industries will make their arguments in the rate reduction case now before the Interstate Commerce Commission on Jan. 28. Representatives of the vegetable oil and soap industries will appear on Feb. 8.

"Open Competition" Plan of Hardwood Manufacturers Association Declared Illegal

In a decision made public Dec. 19 the United States Supreme Court declared the "open competition" plan of the American Hardwood Manufacturers Association a restraint upon trade in violation of the Sherman anti-trust law. The association, consisting of 603 individuals and corporations, was charged, in the suit brought by the government, with enhancement of prices through exchange of bulletins and reports on stocks, prices and production.

Gas Leaves No Permanent Injury, Survey by C. W. S. Shows

The Chemical Warfare Service has completed its survey of chemical plants and finds that the manufacturers of chlorine, heavy chemicals and other materials that produce gases similar to those used in war have no record of any permanent disability which followed the gassing of an employee.

In the research, proving development and care of the various chemicals and war gases at Edgewood Arsenal there has not been a fatal accident or permanent injury from gas since the armistice, but no week passes without one or more men being gassed to the extent of causing temporary inconvenience.

Anti-Chemical Propaganda Rife—Measures Suggested to Combat It

A country-wide propaganda apparently is on foot, which, while striking mainly at chemical warfare, shows signs of being hostile to American chemical development in general. Some profess to see behind this movement the encouragement of German dye interests, but regardless of the real source of the movement, there is evidence to show that it is being carried on in a systematic and active manner. Very material assistance is being given this effort by persons of good standing who have not taken the trouble to inquire into both sides of the chemical question. To meet this organized effort, leaders among chemists are of the opinion that it can be offset best if individual chemists throughout the country will make an effort to disseminate in their own locality the truth as to chemical warfare and to the current situation which confronts the chemical industry. There is a feeling that the domestic chemical industry has confined its attention too largely to the erection of a superstructure in Washington for which there is an insufficient base, formed by public opinion.

The whole anti-chemical movement has received great impetus from the action of the advisory committee to the

American delegation at the Conference on Limitation of Armament. This report has not been made public, but it is no longer a secret that the advisory committee has recommended that chemical warfare be prohibited by international agreement. A reaction has set up in the advisory committee itself in regard to that report, it is understood. Some members of the committee now are said to feel that this report was forwarded to the commission without due consideration and it is altogether probable that it will be recalled for modification, at least.

Claims are being made widely that public opinion in the United States demands the abolition of chemical warfare. It is admitted by the friends of chemical warfare that the public has been apathetic in its attitude, but they claim that among those who have gone into the merits of the subject only an insignificant proportion believes that chemical warfare can be abolished by agreement any more than war itself can be abolished by agreement. Writers of editorials in newspapers throughout the country seem to be well advised on the subject and the overwhelming percentage not only expresses the opinion that gas has come to stay as a military weapon, but is inclined to the belief that it may be more humane than the weapons now more largely used. In that connection it may be mentioned that the controversy about gas was threshed over extensively before committees of Congress and that a deliberate conclusion in favor of gas was reached.

National Research Council's Information Service to Advise "Where to Buy"

As a part of the service to investigators generally, the Research Information Service of the National Research Council is preparing itself to supply information regarding research instruments, apparatus and supplies. This service is apparently a much needed one, for the Council is frequently receiving requests now as to where special types of apparatus or special research facilities may be procured.

It will be the effort of the information service to have available sufficient information from all sources of such equipment and supplies that it may promptly advise investigators where things needed may be quickly obtained. Some of the recent queries asked where the inquirer may purchase such things as a human skull, a selenium cell, lantern slides on European geography, a Lummer-Brodhun photometric cube, inexpensive photomicrographic apparatus, recording gages which indicate fractions of an ounce, apparatus for the study of the sensitiveness of photographic plates, and a multitude of other "specials."

In general the queries represent needs of investigators who cannot well have on hand complete files of catalogs because it is only occasionally that such special facilities are required in most small laboratories. It is hoped by the Council, therefore, that research workers generally when in doubt can be materially assisted through the complete files which it will be worth while for the Council to maintain as a part of this service. Anyone desiring information and those wishing to make sure that the facilities which they offer for sale are on record in the Council office should address Research Information Service, National Research Council, 1701 Massachusetts Ave., Washington, D. C.

Mexico to Increase Tariff Rates

On January 1 a new tariff schedule will be effective in Mexico which will increase rates on various commodities from 50 to 100 per cent. Candy, leather goods, woollens, furniture, silk, brooms and chemical products are to be taxed 50 per cent more than the present rate, while matches, soap, tobacco and toilet waters have been placed in the 100 per cent list.



PHOTO TAKEN ON STEPS ON WINANTS HALL, RUTGERS COLLEGE

Annual Meeting of the New Jersey Clay Workers' Association

The annual meeting of the New Jersey Clay Workers' Association and Eastern Section of the American Ceramic Society, held at New Brunswick, N. J., Friday, Dec. 16, surpassed in many ways any previous gathering of the organization. The papers were timely, practical and decidedly instructive; the discussions equally illuminating; and the attendance excellent.

Morning and afternoon sessions took place in the Fine Arts Room, Queen's Building, Rutgers College, and the hall was well filled when the meeting was called to order shortly after 10 o'clock, with President Abel Hansen, head of the Fords Porcelain Works, presiding.

CERAMIC SCHOOL WELL UNDER WAY

In his opening address President Hansen made particular reference to the new ceramic school and research station now in course of erection and which is expected to be ready for occupancy in the spring of next year. He said that the completion would mark a new milestone in the history of the ceramic industry of the state, and he urged that every support, financial and moral, be given to the enterprise.

He spoke also of the need for defined quality products in the ceramic field, and said that systematic education was necessary to bring about a full appreciation of American wares as compared with the general run of foreign production.

BRIEF BUSINESS SESSION

Secretary George H. Brown, director, department of ceramics, Rutgers College, presented an interesting report, covering the minutes of the last annual gathering as well as numerous details and features pertaining to the new school building. He mentioned the generous contributions received toward the erection of the structure from different companies in the ceramic industry, and the enterprising work of different committees appointed in this direction.

R. H. Minton, General Ceramics Co., chairman of the committee appointed to draft new bylaws for the association conforming to those of the American Ceramic Society, presented the set of rules as arranged by the committee. These were adopted by a unanimous vote, without change.

COMPOSITION OF PORCELAIN BODIES

The first paper of the technical session was "Notes on the Effect of Composition on the Mechanical Strength of Porcelain Bodies," by Prof. Brown and C. C. Clarke, department of ceramics, Rutgers College.

The treatise set forth the results of a comprehensive series of tests of ten different porcelain bodies to determine the transverse strength of the material. The bodies were fired in regular commercial kilns, maturing at cones 7 and 8. The body compositions were varied with fundamental view of securing definite data as to the effect of the relative contents of flint and feldspar on the mechanical strength of the bodies.

The results of this work go to confirm the theory that a

high flint content is conducive to greater mechanical strength. In this, however, it was pointed out that a high flint content cannot be held as being desirable for all types of porcelain bodies, and primarily, those which are subjected to wide temperature changes in use. In the latter body the gain in mechanical strength is likely to be more than offset by the tendency of the high and irregular coefficient of expansion of the flint, bringing about fracture in heating and cooling.

The high strength developed by the high feldspar body, stated at 55 per cent, has points of merit to warrant more extended investigations, and particularly so in the case of low-fire compositions, such as are used in the production of tableware and kindred specialties, and the high feldspar bodies so popular in the manufacture of vitreous floor tile.

In the high flint end of the different bodies and tests, there did not appear to be a direct relation between porosity and mechanical strength. Accordingly, it would seem that a porcelain body does not necessarily attain its maximum strength when it has developed minimum porosity.

The results of the tests were shown by illustrated references in the form of charts, flashed on the screen, the curves being plotted in a manner for ready comprehension.

MANUFACTURE OF ELECTRICAL PORCELAIN

The next paper was an interesting résumé of electrical porcelain manufacture by T. A. Klinefelter, Atlantic Terra Cotta Co., Tottenville, Staten Island, under the head of "Some Notes on Materials and Processes in Electrical Porcelain Manufacture."

Speaking from notes, Mr. Klinefelter showed his knowledge and intimacy of the subject by taking up each phase of production, from the raw clay to finished article. Considering briefly electrical porcelain for low-tension work, such as sockets, cutouts, fuse blocks, etc., he explained the common methods of quantity production and showed how attractive this field has become to different manufacturers.

Electrical porcelain for high-tension service, he set forth, was an entirely different proposition, requiring great care and attention in manufacture. For voltages up to 70,000 and 75,000 and above he said that $\frac{1}{4}$ -in. material was the usual practice, while for 110,000 v. and even higher, $\frac{3}{4}$ -in. porcelain was being used. For service ranging around 40,000 v., $\frac{1}{2}$ -in. material is the customary thickness.

The material for first-grade electrical porcelain must have such characteristics as great strength, great density, great resistance to impact and resistance to severe temperature changes. Firing is carried out to cones 11 and 12 for such class of material, while for low-voltage service, burning to cones 8 and 9 answers all requirements. The usual clay mixtures for high-tension porcelain average from 40 to 60 per cent of clay, 20 to 25 per cent of feldspar and from 20 to 15 per cent of flint.

Reference was made to the different types of equipment in use. In the plant in question, regular updraft, round kilns are employed, and the speaker pointed out the indicated possibilities of tunnel kilns and compartment kilns for this work. With regard to pug mills, he said that there was great room for improvement, while diaphragm

pumps were recommended strongly for work in connection with the handling of the slip. The modern humidity drier was referred to as a great achievement, permitting the drying of ware in from 60 to 70 hours as compared with from 2 to 3 months in time gone by.

The tests made upon insulators for high line service were explained in an interesting way. In this the high frequency test is carried to voltages considerably in excess of those in standard commercial practice, sometimes running to three times above without "splashing" in attaining the "flash over" point.

An important reference made by Mr. Klinefelter covered a plea for the development of standard specifications for the purchase of clays, flint, feldspar and other raw materials, eliminating the "guess" method now prevailing. Such specifications, he said, arranged in a logical and fair-minded way, would help the purchaser, dealer and clay miner, and other parties concerned.

NICKEL SALT EFFECT UPON COLOR

The concluding paper of the morning session was "The Effect of Nickel Salt on the Color," by G. M. Tucker, New York Architectural Terra Cotta Co., Long Island City.

This was a brief digest of plant experience and experiment, illustrating the uncertain quality of color reproduction in using nickel salt for terra cotta glazes. It was pointed out that it was practically impossible to utilize nickel in certain glazes for a definite color. A number of interesting specimens of work were shown.

ELECTION OF OFFICERS

Just prior to adjournment for luncheon an election of officers was held, and the following recommendations of the nominating committee were approved for the ensuing year:

President, R. H. Minton, General Ceramics Co., Metuchen, N. J.; vice-president, Andrew Foltz, Lambertville Pottery Co., Lambertville, N. J.; councilor, Charles A. Bloomfield, Bloomfield Clay Co., Metuchen, N. J. (re-elected); and secretary and treasurer, George H. Brown, department of ceramics, Rutgers College.

The executive committee will be composed of eighteen members, in addition to the officers noted, including Abel Hansen, chairman, ex-president; August Staudt, Perth Amboy Tile Works, ex-president; and Charles Howell Cook, Cook Pottery Co., ex-president. The terms of five of the remaining fifteen members will expire in 1922; five others in 1923; and the remaining five in 1924.

PROPERTIES OF SOME BALL CLAYS

Following an hour given over to luncheon, the afternoon session was called to order by President-elect Minton close to 2:30. He made a few appropriate remarks, asking for the support of all members during his term of office. He made a plea also for increased membership during the coming year, and prior to the adjournment for the day about twenty names were added to the roster.

The afternoon technical session was opened by H. H. Sortwell, Bureau of Standards, Washington, D. C., with an interesting paper dealing with "The Properties of Some Ball Clays," illustrated with lantern slides showing different test tables.

The speaker explained the investigations now being made by the bureau of different ball clays, both of English and American origin. The properties of Kentucky clays, Tennessee clays, Dorset and other clays were enumerated, with explanation of their behavior under different tests, and the indicated desirability for certain character of manufacture.

FIREBRICK MANUFACTURE

Following this, F. B. Allen, of the M. D. Valentine & Bro. Co., Woodbridge, N. J., read an illuminating paper entitled, "The Manufacture of Soft-Mud Firebrick," describing the different phases of manufacture at the Valentine plant. This factory has been operating since 1865, and has grown from one kiln to nine kilns, with rated production of approximately 600,000 firebricks per month.

Extended reference was made to recent plant improvements for increased efficiency, including the installation of

considerable new machinery, such as clay granulator, disintegrator, soft-mud brick machine, mechanical driers, gravity conveyors, etc.

A DISCUSSION ON KILNS

The illness of the last speaker on the program, T. A. Shegog, ceramic chemist for the Ellis-Foster Co., Montclair, N. J., prevented the presentation of the final paper on the subject of "Principles and Practice of Kiln Firing." Accordingly President Minton gave the meeting over to a general discussion of kilns, and a valuable hour's talk ensued.

Consideration was given to tunnel kilns and compartment kilns primarily, with interesting points brought out by Mr. Minton in opening the discussion, August Staudt, T. A. Klinefelter, Leslie Brown (Lenox, Inc.), C. W. Hill (Atlantic Terra Cotta Co.), and others.

Co-operation Between Universities and Industries Discussed Before Chicago Section, A.C.S.

Dr. John Johnston, chairman of the department of chemistry, Yale University, spoke before the Chicago Section of the American Chemical Society, Dec. 16, on the question of co-operation between universities and industries. His address is outlined in the following paragraphs.

The problem of the universities is to produce men whom the industry wants, and men who will carry into industry the best spirit of advancement. It is a problem of training them to do their part in the world's work, and of developing them to the maximum of their abilities to so carry on. These men must be capable of developing new knowledge and of applying present knowledge to industry.

Teaching of chemistry in the universities does not separate these two phases. It is attempted to give some degree of industrial application of the subject as well as developing the research phase. The student cannot easily grasp a situation without some knowledge of industrial application. Industry needs a continuous supply of well-trained men, and the university is the only source of supply. Of course, industry may train men who have already had previous training, but not in proportion to its needs. Therefore, industry is the consumer.

The university must have the co-operation of industry through financial assistance and fellowships, going just as far as is compatible with the real function of the university. Each proposal to help must be judged as to whether it contributes to the training of men. It is not always possible to tell at a glance about any one proposal, but if there is any merit to it at all, it must be tried out to see if it constitutes a problem. If it is routine, it should not be done by the university.

Industry should use the university teacher as a consultant, if he is qualified by experience and doesn't take too much of his time at this work. It is advisable because it gives him connection and contact with industry and he learns to get along with people. The average college professor is too individualistic. He can never make a decision without reservations. His work as a consultant should be on a rather small scale, and he must have permission to publish his results. Research is often misnamed in industry, and the term is applied to something which is simply an artifice. This sort of research should be carried on by the industry. There is no difference between fundamental research and pure research, for industry. We are sadly lacking in fundamental knowledge as to alloys and the corrosion of metals, for instance. There is no theory now published that is worth a row of pins. The study of the mechanism of catalysis is more important than the discovery of an individual catalytic process.

One of the problems is to induce more students to stay and get a thorough training at the university. It cannot be done by giving them routine analysis as pot boilers. Where consulting work is done, consultant fees should be charged and the student should get a small part of the fee only, the rest going to the maintenance of the university department. That the professor should get part of his salary by outside work is only a partial solution of the financial situation. It does help to keep some in the teach-

ing business, and they should be allowed to consult within reason.

Fundamental research costs a great deal of money, and therefore the universities cannot finance much industrial research. Research is a form of insurance against ignorance. Industry has developed a bad opinion of the research men because many have been recommended for positions who are inadequately trained. One \$10,000 a year man is worth many \$2,000 a year men. So the university must discover and train \$10,000 men. The university can co-operate by training this high type of man which industry needs. Since the subject of chemistry is nearly twice as large as formerly, a man cannot be adequately trained in less than 6 or 7 years at the university.

It is a well-known fact that the technical man is not considered as the highest type of professional man, both socially and otherwise. The best men who come to the universities never think of the technical professions for this reason, but they rather turn to law and medicine. This is mainly because more money is involved; but no more brains are required in law and medicine than in chemistry. The doctor and lawyer are held in much higher social esteem than the chemist.

The technical efficiency of industry is not over 50 per cent, and in many industries not over 10 per cent. Germany gets by well because the heads of concerns are technically trained men. This is true in the United States in the electrical industry only.

It is to be hoped that industry will contribute to fellowships which the universities cannot afford, and will permit them to go on a completely unrestricted basis. The publication of results within a short time is an important essential. Great benefit would be derived by an interchange of men between the industries and the universities. No university should have vocational courses.

DISCUSSION

Dr. Johnston's paper was followed by a warm discussion by both industrial and university members of the section. Dr. Evans, of Northwestern University, suggested that more students might be held in chemistry by giving them a lighter course the first year, and selling them the idea of the great benefit of chemistry in industry. Dr. David Klein, of Wilson & Co., packers, said that if industry was only on a 10 per cent basis, technically, then the universities were operating on less than a 5 per cent basis as educational institutions. He further suggested that the universities might well train their students to some knowledge of the ordinary business conditions which they would meet on leaving the university.

Production Costs in the Lithopone Industry, January-July, 1921

A study of the costs of producing lithopone during the first 6 months of 1921 shows a considerable increase over the costs during the same period of 1919. The results of this investigation, which was made by the Tariff Commission at a request of a committee representing the domestic manufacturers, have recently been published in a report by C. R. DeLong of the chemical division and E. M. Whitcomb of the accounting division of the commission's staff. The report points out that although the manufacturers reported their costs on a more uniform basis than in the previous investigation,¹ there was still a noticeable lack of uniformity in the methods of treating certain cost items. The outstanding differences are principally in the

methods of handling raw material charges, determining sales expenses and in the treatment of administrative expenses.

The weighted average cost of lithopone for all companies during the first 6 months of 1921 are compared with the same 6 months' periods in 1919 in the accompanying table. This table shows also the distribution of total cost to the items—material, direct labor, factory overhead and selling expense. Column 9 shows the average profit for the industry by deducting the total cost from the average net sales price, as shown in column 8.

The increase in total cost is accounted for largely by the increase in factory overhead expense per pound of lithopone, which more than offset the decrease of 0.26 of a cent per pound in direct labor and a slight decrease in selling expense. The total cost of producing lithopone was distributed as follows: 42 per cent for raw materials, 13 per cent for direct labor, 41 per cent for factory overhead, and about 4 per cent for sales expense.

The total quantity of lithopone produced is only about one-half the output during the last half of 1919, when the industry was operating at a maximum capacity. Without doubt this restricted production is mainly responsible for the increase in total unit cost.

Only eight of the thirteen firms previously engaged in lithopone production were in actual operation during this period. Considering existing plants, the industry was in operation only to the extent of one-third of its capacity, and the eight firms which were operating manufactured lithopone equal to only about 40 per cent of their capacity. It is pointed out, however, that this inactivity is not due to competition from imported lithopone, as imports equaled only 2 per cent of domestic sales.

German Labor Situation

From reliable sources in Germany the Department of Commerce is advised that labor unrest is again appearing in that country, concurrently with the sharp decline in the value of the German mark and advancing costs of necessary food and clothing there. Workers in the engineering and steel industries of the Düsseldorf area are now striking for increases in wage rates. It is said to be difficult to maintain operations in the most essential continuous processes of the plants at Düsseldorf. As a general average the striking workers are demanding a 75 per cent increase in wages.

In the Krupp works at Essen, employing about 50,000 men, a formal demand has just been presented to the management for a "living cost bonus" of 2,000 marks per month to each employee. A bonus is required by these workers because of the recent and continuous price advances of necessities in terms of their currency.

It is not expected that this demand of labor will remain disputed long, for it seems clearly recognized, both within and outside Germany, that the profits of manufacturers from exports are enormous, particularly while the mark is on the decline and as long as domestic costs of production lag behind the depreciation of currency.

Costs, other than labor, are already increasing, however, in marks. Railroad freights, which were advanced 30 per cent on Nov. 15, were subjected again to another 50 per cent increase on Dec. 1, thus giving a combined advance of approximately 95 per cent in a fortnight. The price of coal is shortly to be made 150 marks more per ton.

The prices of pig iron and tin plate, as of other steel products, have just been extended greatly to cover depreciation of the mark and growing costs of production. And yet foreign orders are said to be numerous, and the plant managers decline to give delivery promises under 4 months.

WEIGHTED AVERAGE COST OF LITHOPONE FOR 1919 AND FIRST 6 MONTHS 1921

1	2	3	4	5	6	7	8	9
Period	Production (Pounds)	Total Cost	Material Cost	Direct Labor Cost	Overhead Factory	Selling Expense	Average Net Sales Price	Apparent Average Profit
1921 (First six months)	45,150,036	\$0.0626	\$0.0263	\$0.0082	\$0.0258	\$0.0023	\$0.0676	\$0.0050
1919 (First 6 months).....	53,092,739	0.0605	0.0258	0.0102	0.0215	0.0030	0.0671*	0.0066
1919 (Last 6 months).....	89,426,437	0.0600	0.0259	0.0111	0.0199	0.0031	0.0653*	0.0053
1919 (12 months).....	142,519,176	0.0602	0.0259	0.0108	0.0204	0.0031	0.0667*	0.0065

* Sales price for 1919 is gross price.

¹ Barytes, Barium Chemical and Lithopone Industries, Including Costs of Production, 1919," Tariff Information Series No. 18.

Professor Moureu Lectures on Rare Gases at Columbia University

Dr. Charles Moureu, professor of chemistry at the Collège de France, who is now in this country as technical adviser to the French Mission for Disarmament, delivered a very instructive address on "Natural Gases, With Special Reference to the Rare Gases," in Havemeyer Hall, Columbia University, Dec. 20.

After reviewing briefly the history of the discovery of the five rare gases—argon, neon, helium, krypton and xenon—he outlined the results of his studies on these gases as found in the atmosphere, thermal springs, firedamp and natural gases. A special apparatus for the separation and purification of the gases was illustrated and described.

A thorough study of hundreds of French thermal springs has shown an almost universal occurrence of these gases, although the quantity varies greatly with the locality, some springs having only infinitesimal amounts, while the gases from the Source Carnot of Santenay contain over 10 per cent of rare gases, helium predominating. The springs are radioactive as a rule, but the amount of radium emanation present is not proportional to the quantity of rare gases.

From numerous studies it has been shown that the proportion of rare gases in the atmosphere is fairly constant. If the ratio of the quantities of any two of the rare gases in the atmosphere is compared with the ratio for the same gases from the thermal springs, a remarkable similarity is noted. Thus if the ratio krypton:argon in air is taken as 1, the ratio krypton:argon in the gases from thermal springs does not vary much from 1. This constancy is not noted in ratios involving helium, however, because of the fact that helium is being produced by the decomposition of radium in the vicinity of radioactive springs. The ratios involving neon are being studied at the present time. Since the main constituent of the gases from thermal springs is what Prof. Moureu calls "crude nitrogen"—that is, nitrogen plus the rare gases—ratios with nitrogen were also studied and the results were fairly constant considering the relatively greater chemical activity of nitrogen. From all these observations Prof. Moureu concludes that the inert gases occur today in the same relative proportions as when the earth was formed from nebulous material.

Similar studies have been made of firedamp in the various French coal mines and of other natural gases. Prof. Moureu also touched briefly upon the work done with American natural gas and the great practical importance of these studies.

In the evening Prof. Moureu was the guest of honor at a dinner at the Chemists' Club given by the American Section of the Société de Chimie Industrielle.

"Ghosts" and Elongated Structure of Drawn Wires Discussed at Washington Chapter, A.S.S.T.

The elongated structure produced by heavy drafts in wire drawing may be readily removed by suitable annealing, whereas in the case of "ghosts" only a partial removal of this structure is effected and there remain the elongated non-metallic inclusions high in phosphorus and sulphur which pass through the grains producing lines of weakness. At a meeting of the Washington Chapter, American Society for Steel Treating, Dec. 16, the occurrences and differences between these "ghost lines" and the elongated structure produced in wire drawing were discussed by N. B. Hoffman, metallurgist of the Colonial Steel Co., Pittsburgh.

The magnitudes of the effects of "ghost lines" in low-carbon steel wire vary in individual cases, but for the numerous examples presented the tensile properties were reduced by about 26 per cent. Stead's copper reagent may be used to show the outline of the "ghosts" due to the fact that the areas low in phosphorus are first covered with copper. If the samples are washed the "ghost lines" high in phosphorus, to which the copper has not adhered, will then clearly be shown.

The January meeting of the section will be addressed by T. Holland Nelson, steel-works manager of H. Disston & Sons, Philadelphia, who will speak on "A Comparison of American and English Methods of Producing High-Grade Crucible Steel."

Number of Plants Increasing Operations Still Growing

Paper. The International Paper Co., 30 Broad St., New York, has increased production at its different mills about 100 tons daily since the first of the month, bringing the output up to about 1,000 tons per day for all varieties of paper. The company is planning for a gradual increase in manufacture to a maximum of 1,800 tons daily.

The York Haven Paper Co., York Haven, Pa., is maintaining active production at its mills, and is distributing a Christmas bonus to its 300 employees totaling about \$10,000. The fund represents 5 per cent of the employees' earnings during the past 6 months.

Glass. The Scott-Warman Glass Co., East Stroudsburg, Pa., has resumed production at its plant after a considerable period of curtailment. Orders received are said to insure continuous operations for some time to come.

Rubber. The B. F. Goodrich Co., Akron, Ohio, has increased production to a point of 16,000 tires a day, or about twice the number manufactured in recent months. It is planned to advance the output gradually until a maximum of 20,000 tires daily is reached.

The Kelly-Springfield Tire Co., Cumberland, Md., has started a night shift at its local plant.

The Goodyear Tire & Rubber Co., Akron, Ohio, is operating its local plant on a basis of 16,000 tires per day.

Copper. The Raritan Copper Works of the Anaconda Copper Co., Perth Amboy, N. J., has opened a number of departments at the local plant, giving employment to an increased number of operatives.

Iron and Steel. The Logan Iron & Steel Co., Lewistown, Pa., has recently resumed operations at its puddle mills, giving employment to an increased working force.

The Bethlehem Steel Co., Bethlehem, Pa., is resuming operations in a number of departments at its Steelton, Pa., works, following an extended period of curtailment.

The Wheeling Steel Corporation has resumed full operations at its Benwood (W. Va.) tube works, giving employment to a full quota of 1,500 men. The company is also operating its top mill furnaces at 100 per cent capacity.

The Gulf States Steel Co., Gadsden, Ala., is operating at record capacity at its local plant, with full working force. New high production totals are being established.

The United Alloy Steel Corporation, Canton, Ohio, is operating on a basis of more than 50 per cent of normal, and is said to be planning for an early increase.

The American Steel Foundries, East St. Louis, Ill., is increasing production at its different plants and will be running soon at over 60 per cent of normal, as compared with 25 to 30 per cent capacity in September and October. Operations recently were resumed at the Alliance, Ohio, works, following a shutdown for several months.

The United States Steel Corporation, New York, has increased production at its various mills to about 50 per cent of normal.

Tin Plate. The McKeesport Tin Plate Co., McKeesport, Pa., is operating its forty-four mills on full time, giving employment to about 3,000 men.

The American Sheet & Tin Plate Co. has resumed full operations at its Farrell Works, Sharon, Pa., effective Dec. 18, placing six hot mills in service, making a total of thirty mills in active production at the plant.

Work of Chemical Division, Bureau of Internal Revenue

A total of 39,474 samples were analyzed by the chemical division of the Bureau of Internal Revenue during the last fiscal year, the annual report of the Commissioner which was submitted to Congress Dec. 5 shows. These samples comprised butter, oleomargarine, fats, oils, narcotic drugs, fermented beverages, distilled spirits, denatured alcohol and medicinal preparations. The laboratory work of the bureau has been greatly increased by the laws governing the administration of preparations containing alcohol. The extension of the use of alcohol free of tax has also added materially to the work of the industrial alcohol section, the report shows. The number of bonded manufacturers using specially denatured alcohol increased from 1,395 during the previous year to 1,761.

War Department Sells Sodium Nitrate

The War Department has disposed of 81,000 long tons of its reserve of sodium nitrate. The awards were made to the highest bidders for the various lots of the material located at a number of warehouses throughout the country. The prices ranged from \$34.94 to \$46.50 per ton. The purchasers of the larger amounts were: Hercules Powder Co., Wilmington, Del., 20,017 tons; E. I. du Pont de Nemours & Co., Wilmington, 18,600 tons; Wessel-Duval Co., New York, 18,000 tons; G. S. Alexander & Co., New York, 10,167 tons; Merrimac Chemical Co., Boston, 4,408 tons. Other purchasers were: Armour Fertilizer Works, Chicago; Equitable Powder Co., East Alton, Ill.; Senior Powder Co., Cincinnati; Southern Acid & Sulphur Co., St. Louis.

Chicago Chemists Club Night

The first evening social event of the Chicago Chemists Club's winter season occurred Saturday, Dec. 17. After dinner, served in the main dining room, the members and the ladies danced until a late hour. Novel entertainment features between the dances gave a well-rounded program.

Obituary

ROBERT H. MCKEAN, manager of the credit department of the McGraw-Hill Co., Inc., died at his home on Dec. 17, 1921, at 2 a.m. Mr. McKean's services began with *Engineering and Mining Journal* in April, 1902, as assistant in the accounting department. Within 2 years he had been promoted to the position of head bookkeeper and at the time the *Journal* was purchased by Mr. Hill he was in charge of the accounting department. About a year after the purchase of *Engineering and Mining Journal* by the Hill Publishing Co. Mr. McKean was appointed manager of the *Journal*, which position he held until he was elected a director and secretary of the Hill Publishing Co. At this time he assumed the management of the credit department of the company. He was a director and secretary of the Hill Publishing Co. until its consolidation with the McGraw Publishing Co. After the consolidation he became manager of the combined credit departments and held this position until his death. Mr. McKean's loss to the McGraw-Hill Co., Inc., will be a serious one, because of his unusual ability in his chosen work. His ready wit and keen sense of humor will be missed by his associates.

REUBEN L. LINDSTROM, superintendent Point St. Charles plant, Canadian Steel Foundries, Ltd., died on Dec. 12 at his home in Montreal. He left the Bettendorf Company, Bettendorf, Iowa, four years ago to become metallurgist with the Canadian Steel Foundries, Ltd., which position he filled until appointed superintendent of the Point St. Charles works 18 months ago.

Personal

Dr. CHARLES BASKERVILLE, professor of chemistry of the College of the City of New York, gave an address on Science and Civilization: The Rôle of Chemistry," before the members of the Pittsburgh Section of the American Chemical Society on Dec. 13.

LEWIS H. CARLSON has severed his connection with the Frederick Stearns Co. and has organized the Chemicals Sales Co., of which he is president.

HOLLIS H. DANN, recently chief chemist at Central Fe, Cuba, has become associated with the Darco Corporation, of Wilmington, Del., as technical assistant to the sales manager. Mr. Dann will have charge of the development work in connection with the cane sugar industry.

FRED C. HAHN, research chemist at the Marcus Hook plant of the National Aniline and Chemical Co., has been given a leave of absence to complete graduate work at Johns Hopkins University.

P. H. HART has been elected treasurer of the Goodyear Tire & Rubber Co., Akron, Ohio, succeeding H. H. Springfield, who has become assistant to the president.

HUGH M. HENTON has resigned the instructorship in metallurgy at Case School of Applied Science, and has opened an office in the National City Building, Cleveland, Ohio, as consulting engineer in metallurgy and mining.

ARTHUR H. HUISKEN, formerly of the Baltimore Copper Works, is now with the Research Laboratory of the Edgewood Arsenal, Edgewood, Md.

ALBERT E. MARSHALL, formerly chemical engineer for the Davison Chemical Co., has severed his connection with that organization and has opened an office in Baltimore for consulting work.

Dr. H. H. MORRIS has recently resigned from the chemical department of E. I. du Pont de Nemours & Co. to take charge of the research department of the Bond Manufacturing Corporation, Wilmington, Del.

ALBERT W. SMITH, formerly dean of Sibley College, Cornell University, is now a consulting engineer with the firm of Henry R. Kent & Co., New York and Boston. Dean Smith's work will lie particularly in consultation on thermodynamic and mechanical engineering for chemical plants.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, Dec. 24, 1921.

The chemical market during the past week showed no signs of any radical changes and transactions in most cases were limited to small quantities. The movement was somewhat irregular and fully in line with pre-holiday seasons. A great deal of optimism, however, is expressed by leading factors, who stated that outside influences are making for betterment in trade conditions, and with this in mind there are few indeed that do not expect an expansion in business during the early part of next year.

The export situation has also been an encouraging feature to traders and frequent inquiries are still reaching the market from various sections of Europe, the Orient and South American countries. Although actual transactions among exporters were limited, owing to the differential in quotations on spot and the prices given to exporters from their foreign customers, the fact that inquiries were freer is an encouraging sign for future prosperity. The advance in foreign exchange rates is favorable to our industry in many respects. The biggest thing that could be brought about through this advance is the opening up of export channels to permit the absorption of our surplus chemical stocks. There is also no doubt that foreign products imported to this country would bring higher prices with a stronger money market. Importations still continue with unceasing rapidity at relatively low prices and have kept the consumer from paying a price on domestic material. Adjustments are constantly taking place and it is certain that 1922 will find domestic manufacturers ready to compete in a more favorable manner than at any time since the war.

The rise of yellow prussiate of soda still continued to be the feature of the week's activities. This commodity is practically the only one to fall in line with the rise in sterling. Spot stocks seem to be well sold up and domestic producers have been turning away round lot business. Orders on hand are reported to keep factors busy far into January. On the other hand, there is an easier tone prevailing in the market on caustic soda, soda ash and caustic potash. These chemicals have become quite dormant in the past two weeks and a keener state of competition has developed. Glycerine and tin oxide have been advanced by leading makers during the week and trading in general seems to have been very satisfactory on these items. Imported chlorate of potash has also shown a little better tone, although prices are considerably lower than those quoted by domestic manufacturers. Oxalic acid is moderately active, especially in small-quantity orders to regular

consuming channels. Cream of tartar prices eased up somewhat and domestic producers announced a reduction. Quotations on the imported are close to the pre-war level, the present market holding at 25c. per lb., against 24c. for the domestic material during 1919. Yellow prussiate of potash is another item that has fallen in line with prussiate of soda and quotations were considerably higher for spot material. Stocks in resale quarters are very limited and manufacturers seem to be in a well sold up condition.

CHEMICALS

Scattered offerings of *yellow prussiate of soda* are obtainable in the open market and sellers quote from 16@16½c. per lb. The fact that imported shipments which were due to arrive late in November and in the early part of December have not shown up as yet has placed the market in very scant supply. Arrivals were quoted at 15½c. per lb. c.i.f. New York, January-February shipments were held at 15½@15¾c. per lb. The present position of the market is very strong and in all probability will remain so until supplies increase. Sales of *solid caustic soda* for export have gone through at \$3.80 per 100 lb. f.a.s. It was stated some business was transacted down to 3½c. per lb. The irregular condition of the market is keeping spot quotations rather unsettled, but those closely related to the inside workings have no doubt that the market will show signs of real life early in 1922. Producers are taking on contract business over next year at \$2.75 per 100 lb., basis 60 per cent, f.o.b. works. Manufacturers of *bleaching powder* reported sales at \$2.25 per 100 lb., f.o.b. works, in large containers. Textile and paper mills have bought extensively during the past few weeks. The market for imported bleach is very strong and forward shipments are heavily sold as far ahead as February. Spot stocks of imported bleach are quoted at \$2.20 per 100 lb. ex-dock New York. Prices on spot *oxalic acid* have been well maintained at 14½@15c. per lb. Trading is fairly active, with small lot transactions featuring. Producers quote 14@15c. per lb., f.o.b. works, depending upon the brand and quantity involved. Leading factors in domestic *chlorate of soda* quote the market at 7½c. per lb., f.o.b. works. Imported material on the spot market, however, is considerably lower, at prices ranging from 6½@6¾c. per lb. The demand is quite slow and any real business in round lots would undoubtedly bring lower quotations. *Yellow prussiate of potash* is higher and the market reflects to some extent the strength in prussiate of soda. It is very doubtful if better than 23c. per lb. can be done on this commodity, while the majority of sellers are asking all the way up to 24@25c. per lb. for only limited amounts. The red variety is also very scarce and prices range around 29c. per lb. Imported *chlorate of potash* is quoted at prices ranging from 5¼@6c. per lb. In various quarters it was intimated that the market appeared somewhat firmer at the inside quotation. The demand, however, for this chemical has been limited, since the outlet is very narrow in the face of subnormal conditions. This is preventing a rapid distribution of spot stocks, regardless of the attractive prices named. Domestic chlorate remains quotably unchanged at 12c. per lb., f.o.b. works. Imported caustic potash, 88-92 per cent, is moving very slowly and prices are irregular, with offerings heard as low as \$5.40 per 100 lb. Goods on the high seas were obtainable at \$5.35, while shipments were offered at 5½c. per lb. Consumers have not been purchasing any noticeable quantities during the past week and dealers stated that extreme difficulties were found to move any spot stocks. Light *soda ash* has shown very little activity on spot and dealers quote the market for domestic material at \$1.90@\$2 per 100 lb., in single bags, depending upon the quantity. Imported ash on dock was quoted as \$1.70 per 100 lb. and shipment goods at \$1.65. Barrel ash was held at \$2.25@\$2.30 per 100 lb. Producers continue to book contracts over next year at \$1.40 per 100 lb., basis 48 per cent, f.o.b. works, in single bags. Prices on imported *sulphide of soda* have slightly declined. The demand has not shown any marked activity and second hands seemed eager to dispose of stocks at any reasonable price. Sales were reported at 4½@4¾c. per lb., for the 60-62 per cent, fused. Shipment material was held at 4½c. per lb., duty paid, with intimations of lower prices on round lots.

The St. Louis Market

ST. LOUIS, Mo., Dec. 23, 1921.

Trading in the drug and chemical markets shows little real change from the last few weeks, but if anything is a trifle slower. A few small-lot transactions have been recorded, but even in these the movement was irregular and in line with the pre-holiday season. The inventory period and holiday influences have reflected in the market operations, but only to a very small percentage.

Several advances have taken place during the last period on some of the more important items which will give a good stimulating influence for a more stable market. The heavy importations are still of great annoyance to the manufacturers and keep the market very unsettled. However, it is greatly hoped that this obstacle will soon be eliminated, and that the year 1922 will be a prosperous one.

The market on *alkalis* has declined somewhat since our last report. The demand is not great, as the flake has declined from \$5.25 per 100 lb. in single drums to \$4.87½, with the 12½c. differential on 5-drum lots. The carlot material has not changed. The dullness of the market is expected to cause a drop. Solid 76 per cent material is at \$4 per 100 lb. in drums carlots, flakes at \$4.25 per 100 lb. f.o.b. point of production. *Soda ash* has declined somewhat and can now be had at around \$2.90 per 100 lb. barrels, with demand nominal. *Bicarbonate of soda* is moving slowly at about \$2.50 per 100 lb., a decline of 2 to 5c. *Sal soda* is ranging around \$2 per 100 lb., with the market very quiet.

CHEMICAL, DRUGS AND PHARMACEUTICALS

Acetpheneditin is moving in a fair way. Factors have again advanced their price of *acetylsalicylic acid* and a great demand is in evidence. The demand for *bromides* continues to be steady with a very firm market. Demand for *carbon bisulphide* is practically nil. *Creosote* and *guaiacols* are moving in a large way. *Glycerine* has again advanced sharply and now is in good demand at 15½c. in drums. Some contracts are still to be made, and no decline is looked for on this item for some time. Some of the *glycerophosphates* are again coming to life with quite a few inquiries and orders. *Hydroquinone* has taken an upward course and the demand is very brisk. With the rise in the sterling market manufacturers have also revised their prices on *iodides* and a general advance on all *iodide salts* took place on the 10th. *Lithium salts* continues to move quite steadily. The *salicylates* are commanding quite an important position at the present moment. There has been no change in *sulphur* and the market is very dull. *Commercial sulphur*, at \$2 per 100 lb. in 25-bag lots, finds little demand. *Zinc oxide* is moving nicely and maintains the same price level of two weeks previous—that is, 7½c. in barrels, 7¼c. in bags f.o.b. works for standard brands.

ACID

The heavy commercial mineral acids continue to move in a large way. *Citric acid* is not of big importance just at this time. *Pyrogalllic acid* is holding its own. *Tartaric acid* has fallen off quite a bit.

VEGETABLE OILS AND NAVAL STORES

Castor oil is very firm, and the 12½c. price in drums now holds only for quantities of 200 gal. or better; for less than 200 gal. the price is 13c. for the 50-gal. drums. The *linseed oil* market is somewhat firm, and producers are taking contracts only up to May 1, the prevailing price being 70c., basis raw oil. *Turpentine* is gradually climbing and is now 85c. in single barrels, with the usual 4c. differential on 5-bbl. lots.

PAINT MATERIALS

The paint dealers, though usually overly optimistic, are showing signs of life, and some reasonably sized orders have been placed recently. *Barytes* are moving nominally at the old price of \$23.50 per ton. The producers in the St. Louis lithopone market are not turning out much new material as yet, but report all their warehouse stock practically sold up, and are expecting some nice business in the future. *Whiting* can now be had in St. Louis at \$12 per ton, carlots at \$14.50 f.o.b. buyer's door in ton lots.

The Iron and Steel Market

PITTSBURGH, Dec. 23, 1921.

The Steel Corporation's reduction in tubular goods prices, reported a week ago, is followed this week by a reduction in wire products. In each case the reduction was brought about by price shading on the part of independent producers. In each case the reduction made makes market prices somewhat below the average of the cut prices that were ruling.

The reduction in wire products is to a schedule \$5 a ton below the prices ruling prior to the advance of Sept. 12, that advance having been \$2 a ton in plain wire and \$3 a ton in nails and barb wire. The advance held nominally for a time, but it had been preceded by the making of 60-day contracts at the old prices, and when these contracts began to expire, last month, they were found to be renewable. The advance practically slipped away, so that the present reduction is from the old prices, not the advanced prices. The new quotations of the Steel Corporation subsidiary, the American Steel & Wire Co., were first made on Wednesday, Dec. 21, and were of course adopted by independents, being as follows: Plain wire, 2.25c.; galvanized wire, 2.75c.; wire nails, \$2.50; cement coated nails, \$2.15; painted barb wire, 2.65c.; galvanized barb wire, 3.15c.; polished staples, 2.65c.

The average price of wire nails in the 10 years before the war was \$1.80, the low point, struck both in 1911 and in 1914, being \$1.50. Thus nails are now 50 per cent above their previous low point, and it is interesting if not surprising to note that the majority of steel products show quite uniformly at the present time a price 50 per cent above the previous low price. One would, perhaps, expect more variations to be shown between commodities. Bars, shapes and plates are now quotable at 1.50c. in the case of fairly attractive orders, while in December, 1914, the going price on good-sized orders was 1c., the openly quoted market, on lots down to single carloads, being 1.05c.

LIGHT VOLUME OF BUYING

Outside of the price developments in tubular goods and wire products the steel market of the past fortnight has been practically without incident. The volume of buying has been very light, on the whole, and such buying as has occurred has been confined almost entirely to small lots, generally single carloads. All buyers have been particularly conservative in making commitments, not on account of any fresh uncertainties in the situation, but on account of the season of the year. The steel market is always very dull in the second half of December, and that rule holds good even when there is great activity in general.

PRODUCTION RATES

In October production of steel ingots was at the rate of about 23,000,000 gross tons a year, or at about 44 per cent of estimated capacity, and the Steel Corporation and independents respectively operated at very nearly the same percentage rates, in proportion to capacity. In November the Steel Corporation's operating rate increased somewhat, while the independent rate decreased correspondingly. The divergence is now much more marked, as since Dec. 1 the Steel Corporation's operations have been at above 50 per cent, and touched 55 per cent at one time, while the independents have scarcely averaged a 40 per cent rate, and production as a whole is down a trifle from the rate in October and November. A number of mills will probably close the last week of December or the first week of January, partly because they have made a special effort to operate lately, to furnish holiday money to employees. By the latter part of January production is likely to be nearly up to the recent rate, but no very great increase is expected for any time in the first 6 months of the new year.

PIG IRON AND COKE

Pig iron remains quotable at \$20 for bessemer, \$19 for basic and \$19.50 for foundry, at valley furnaces, freight to Pittsburgh being \$1.96.

Connellsville coke is decidedly soft, and market prices might be lower if there were enough inquiry to encourage operators to name their lowest terms. As it is, spot furnace coke is quotable nominally at \$2.90@\$3 and spot foundry at \$3.75@\$4.50, depending on brand.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots		Less Carlots	
Acetic anhydride.....lb.	\$0.12½	\$0.12½	\$0.40	\$0.45
Acetone.....lb.	12½	12½	13	13½
Acid, acetic, 28 per cent.....100 lbs.	2.75	3.00	3.25	3.50
Acetic, 56 per cent.....100 lbs.	5.00	5.25	5.30	5.50
Acetic, glacial, 99½ per cent, carboys, 100 lbs.	10.00	10.50	10.75	11.00
Boric, crystals.....lb.	12½	12½	13	13½
Boric, powder.....lb.	13	13½	14	14½
Citric.....lb.	44	46	44	46
Hydrochloric.....100 lb.	1.25	1.50	1.60	1.75
Hydrofluoric, 52 per cent.....lb.	12	12½	12½	13
Lactic, 44 per cent tech.....lb.	09½	10	10½	12
Lactic, 22 per cent tech.....lb.	04	04½	04½	05
Molybdic, C.P.....lb.	3.00	3.25	3.30	3.75
Muriatic, 20 deg. (see hydrochloric).....	06½	06½	06½	07
Nitric, 40 deg.....lb.	06½	07	07½	07½
Nitric, 42 deg.....lb.	14½	15	15½	16
Oxalic, crystals.....lb.	13	13½	14	18
Phosphoric, 50 per cent solution.....lb.	20	25	27	35
Picric.....lb.	1.65	1.75	1.65	1.75
Pyrogallol, resublimed.....lb.	11.00	12.00	11.00	12.00
Sulphuric, 60 deg., tank cars.....ton	13.00	15.00	13.00	15.00
Sulphuric, 60 deg., drums.....ton	17.00	18.00	22.50	23.00
Sulphuric, 66 deg., tank cars.....ton	21.00	22.00	22.50	23.00
Sulphuric, 66 deg., drums.....ton	21.00	22.00	22.50	23.00
Sulphuric, 66 deg., carboys.....ton	21.00	22.00	22.50	23.00
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	21.00	22.00	22.50	23.00
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	23.00	23.50	24.00	24.50
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	31.00	32.00	33.00	34.00
Tannic, U. S. P.....lb.	55	60	75	85
Tannic (tech.).....lb.	55	60	61	65
Tartaric, imported crystals.....lb.	26½	27	26½	27
Tartaric acid, imported, powdered.....lb.	27	28	27	28
Tartaric acid, domestic.....lb.	27	28	27	28
Tungstic, per lb. of WO.....lb.	1.10	1.20	1.10	1.20
Alcohol, Ethyl.....gal.	4.65	5.00	4.65	5.00
Alcohol, Methyl (see methanol).....gal.	42	43	42	43
Alcohol, denatured, 188 proof.....gal.	43	44	43	44
Alcohol, denatured, 190 proof.....gal.	43	44	43	44
Alum, ammonia, lump.....lb.	03½	03½	04	04½
Alum, potash, lump.....lb.	03½	04	04½	04½
Alum, chrome lump.....lb.	08	08½	08½	09
Aluminum sulphate, commercial.....lb.	01½	02	02½	02½
Aluminum sulphate, iron free.....lb.	02½	02½	03	03½
Aqua ammonia, 26 deg., drums (750 lb.) lb.	07½	07½	08	08½
Ammonia, anhydrous, cyl. (100-150 lb.) lb.	30	30½	31	33
Ammonium carbonate, powder.....lb.	07	07½	08	09
Ammonium chloride, granular (white sal ammoniac).....lb.	07	07½	07½	07½
Ammonium chloride, granular (gray sal ammoniac).....lb.	07	07½	07½	07½
Ammonium nitrate.....lb.	07½	07½	07½	08½
Amylacetate tech.....gal.	2.40	2.50	2.40	2.50
Arsenic oxide, (white arsenic) powdered lb.	06	06½	06½	07
Arsenic, sulphide, powdered (red arsenic) lb.	12	12½	12½	13
Barium chloride.....ton	52.00	53.00	54.00	55.00
Barium dioxide (peroxide).....lb.	20	21	22	23
Barium nitrate.....lb.	06½	07	07½	08
Barium sulphate (precip.) (blanc fixe) lb.	04	04½	04½	05
Bleaching powder (see calc. hypochlorite).....	23	24	25	28
Blue vitriol (see copper sulphate).....	23	24	24.50	28.00
Borax (see sodium borate).....	01½	02	02½	02½
Brimstone (see sulphur, roll).....	2.50	2.60	2.65	3.25
Bromine.....lb.	1.40	1.50	1.40	1.50
Bromine.....100 lbs.	1.75	2.00	1.5	1.6
Calcium carbide.....lb.	04½	04½	05	05½
Calcium chloride, fused, lump.....ton	23.00	24.00	24.50	28.00
Calcium chloride, granulated.....lb.	01½	02	02½	02½
Calcium hypochloride (bleach'g powder) 100 lb.	2.50	2.60	2.65	3.25
Calcium peroxide.....lb.	1.40	1.50	1.40	1.50
Calcium phosphate, tribasic.....lb.	15	16	15	16
Camphor.....lb.	91	95	91	95
Carbon bisulphide.....lb.	06½	06½	07	07½
Carbon tetrachloride, drums.....lb.	10½	10½	11	12
Carbonyl chloride, (phosgene).....lb.	60	75	60	75
Caustic potash (see potassium hydroxide).....	08	09	09½	10
Caustic soda (see sodium hydroxide).....	08	09	09½	10
Chlorine, gas, liquid-cylinders (100 lb.) lb.	08	09	09½	10
Chloroform.....lb.	2.00	2.10	2.00	2.10
Cobalt oxide.....lb.	20	20½	21	21½
Copperas (see iron sulphate).....lb.	20	20½	21	21½
Copper carbonate, green precipitate.....lb.	50	62	50	62
Copper cyanide.....lb.	5.65	5.70	5.75	6.25
Copper sulphate, crystals.....100 lb.	5.65	5.70	5.75	6.25
Cream of tartar (see potassium bitartrate).....	70	80	70	80
Epsom salt (see magnesium sulphate).....	70	80	70	80
Ethyl Acetate Com. 85%.....gal.	95	100	95	100
Ethyl Acetate pure (acetic ether, 98% to 100%).....gal.	10½	11	11½	12
Formaldehyde, 40 per cent.....lb.	2.50	3.00	2.50	3.00
Fusel oil, ref.....gal.	1.50	1.75	1.50	1.75
Fusel oil, crude.....gal.	1.50	1.75	1.50	1.75
Glauber's salt (see sodium sulphate).....	16	16½	16	16½
Glycerine, C. P. drums extra.....lb.	3.80	3.90	3.80	3.90
Iodine, resublimed.....lb.	12	18	12	18
Iron oxide, red.....lb.	15.00	16.00	17.00	20.00
Iron sulphate (copperas).....ton	10½	12½	10½	12½
Lead acetate.....lb.	15	15½	15½	16½
Lead arsenate, powd.....lb.	15	15½	15½	16½
Lead nitrate.....lb.	15	15½	15½	16½
Litharge.....lb.	08	08½	08½	09
Magnesium carbonate, technical.....lb.	07½	07½	08	09
Magnesium sulphate, U. S. P.....100 lb.	2.65	2.70	2.75	3.00
Magnesium sulphate, technical.....100 lb.	1.10	1.75	1.10	1.75
Methanol, 95%.....gal.	62	63	62	63
Methanol, 97%.....gal.	64	65	64	65
Nickel salt, double.....lb.	12	12½	12	12½
Nickel salt, single.....lb.	14	14½	14	14½
Phosgene (see carbonyl chloride).....	45	46	47	50
Phosphorus, red.....lb.	32	35	32	35
Phosphorus, yellow.....lb.	10½	11	11½	11½
Potassium bichromate.....lb.	10½	11	11½	11½

	Carlots	Less Carlots
Potassium bitartrate (cream of tartar).... lb.	\$.25 - \$.27	\$0.25 - \$0.27
Potassium bromide, granular..... lb.	.15 - .16	.15 - .20
Potassium carbonate, U. S. P..... lb.	.04 - .04	.17 - .20
Potassium carbonate, 80-85%..... lb.	.06 - .06	.05 - .06
Potassium chlorate, crystals..... lb.	.06 - .06	.30 - .35
Potassium cyanide..... lb.	.05 - .05	.06 - .08
Potassium hydroxide (caustic potash).... lb.	.07 - .07	2.90 - 3.00
Potassium iodide..... lb.	.16 - .17	.08 - .09
Potassium nitrate..... lb.	.29 - .29	.18 - .22
Potassium permanganate..... lb.	.23 - .23	.30 - .30
Potassium prussiate, red..... lb.		.24 - .25
Potassium prussiate, yellow..... lb.		
Rochelle salts (see sodium potas tartrate)		
Salammoniac (see ammonium chloride)....		
Sal soda (see sodium carbonate).....		
Salt cake (bulk)..... ton	18.00 - 21.00	
Silver cyanide..... oz.	1.10 - 1.20	
Silver nitrate..... oz.	.45 - .46	
Soda ash, light..... 100 lb.	1.75 - 2.10	2.15 - 2.50
Soda ash, dense..... 100 lb.	2.15 - 2.20	2.25 - 2.50
Sodium acetate..... lb.	.04 - .04	.04 - .05
Sodium bicarbonate..... 100 lb.	2.30 - 2.35	2.40 - 2.75
Sodium bichromate..... lb.	.07 - .08	.08 - .08
Sodium bisulphate (nitre cake)..... ton	5.00 - 5.25	5.50 - 6.50
Sodium bisulphite powdered, U.S.P..... lb.	.04 - .05	.05 - .06
Sodium borate (borax)..... lb.	.05 - .06	.06 - .07
Sodium carbonate (sal soda)..... 100 lb.	1.80 - 1.90	1.95 - 2.15
Sodium carb. rate..... lb.	.06 - .07	.07 - .08
Sodium cyanide..... lb.	.27 - .27	.28 - .30
Sodium fluoride..... lb.	.11 - .12	.12 - .14
Sodium hydroxide (caustic soda)..... 100 lb.	3.75 - 3.80	3.85 - 4.25
Sodium hyposulphite..... lb.	.06 - .06	.03 - .03
Sodium nitrite..... lb.	.25 - .26	.07 - .07
Sodium peroxide, powdered..... lb.	.04 - .04	.27 - .30
Sodium phosphate, dibasic..... lb.	.16 - .16	.04 - .05
Sodium potassium tartrate (Rochelle salts) lb.	.19 - .21	.19 - .21
Sodium prussiate, yellow..... lb.	1.60 - 1.65	.16 - .17
Sodium silicate, solution (40 deg.)..... 100 lb.	1.00 - 1.05	1.10 - 1.30
Sodium silicate, solution (60 deg.)..... 100 lb.	2.30 - 2.40	2.45 - 3.00
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	1.30 - 1.50	1.60 - 2.00
Sodium sulphide, fused, 60-62 per cent (conc.) lb.	.04 - .04	.04 - .05
Sodium sulphite, crystals..... lb.	.03 - .03	.04 - .04
Sulphur, nitrate, powdered..... lb.	.11 - .12	.12 - .15
Sulphur chloride, red..... lb.	.05 - .06	.06 - .06
Sulphur, crude..... ton	18.00 - 20.00	
Sulphur dioxide, liquid, cylinders extra..... lb.	.08 - .08	.09 - .10
Sulphur (sublimed), flour..... 100 lb.		2.25 - 3.10
Sulphur, roll (brimstone)..... 100 lb.		2.00 - 2.75
Tin bichloride..... lb.	.09 - .09	.09 - .10
Tin oxide..... lb.	.14 - .14	.39 - .40
Zinc carbonate..... lb.	.09 - .09	.15 - .16
Zinc chloride, gran..... lb.	.42 - .44	.09 - .10
Zinc cyanide..... lb.	.11 - .11	.45 - .47
Zinc dust..... lb.	.07 - .07	.11 - .12
Zinc oxide, XX..... lb.	3.00 - 3.25	.08 - .09
Zinc sulphate..... 100 lb.		3.30 - 3.50

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude..... lb.	\$1.10 - \$1.15
Alpha-naphthol, refined..... lb.	1.25 - 1.30
Alpha-naphthylamine..... lb.	.30 - .32
Aniline oil, drums extra..... lb.	.17 - .19
Aniline salts..... lb.	.24 - .26
Anthracene, 80% in drums (100 lb.)..... lb.	.75 - 1.00
Benzaldehyde U.S.P..... lb.	1.35 - 1.45
Benzidine, base..... lb.	.90 - 1.00
Benzidine sulphate..... lb.	.75 - .85
Benzoic acid, U.S.P..... lb.	.60 - .65
Benzoate of soda, U.S.P..... lb.	.52 - .55
Benzene, pure, water-white, in drums (100 gal.) gal.	.27 - .32
Benzene, 90%, in drums (100 gal.) gal.	.25 - .28
Benzyl chloride, 95-97%, refined..... lb.	.25 - .27
Benzyl chloride, tech..... lb.	.20 - .23
Beta-naphthol benzoate..... lb.	3.75 - 4.00
Beta-naphthol, sublimed..... lb.	.70 - .75
Beta-naphthol, tech..... lb.	.30 - .34
Beta-naphthylamine, sublimed..... lb.	1.65 - 1.75
Cresol, U. S. P., in drums (100 lb.)..... lb.	.15 - .16
Ortho-cresol, in drums (100 lb.)..... lb.	.24 - .26
Cresylic acid, 97-99%, straw color, in drums..... gal.	.70 - .80
Cresylic acid, 95-97%, dark, in drums..... gal.	.65 - .70
Cresylic acid, 50%, first quality, drums..... gal.	.45 - .50
Dichlorobenzene..... lb.	.06 - .09
Diethylaniline..... lb.	.95 - 1.10
Dimethylaniline..... lb.	.40 - .45
Dinitrobenzene..... lb.	.23 - .27
Dinitrochlorobenzene..... lb.	.20 - .25
Dinitronaphthalene..... lb.	.30 - .35
Dinitrophenol..... lb.	.35 - .40
Dinitrotoluene..... lb.	.25 - .30
Dip oil, 25%, car lots, in drums..... gal.	.30 - .35
Diphenylamine..... lb.	.60 - .70
H-acid..... lb.	1.00 - 1.10
Meta-phenylenediamine..... lb.	1.10 - 1.15
Monochlorobenzene..... lb.	.12 - .14
Monoethylaniline..... lb.	1.65 - 1.70
Naphthalene crushed, in bbls..... lb.	.07 - .08
Naphthalene, flake..... lb.	.07 - .08
Naphthalene, balls..... lb.	.08 - .09
Naphthionic acid, crude..... lb.	.70 - .75
Nitrobenzene..... lb.	.12 - .15
Nitro-naphthalene..... lb.	.30 - .35
Nitro-toluene..... lb.	.15 - .17
Ortho-amidophenol..... lb.	3.00 - 3.10
Ortho-dichlor-benzene..... lb.	.15 - .20
Ortho-nitro-phenol..... lb.	.77 - .80
Ortho-nitro-toluene..... lb.	.15 - .20
Ortho-toluidine..... lb.	.20 - .25
Para-amidophenol, base..... lb.	1.40 - 1.45
Para-amidophenol, HCl..... lb.	1.70 - 1.80
Para-dichlorobenzene..... lb.	.12 - .15
Paranitroaniline..... lb.	.77 - .80
Para-nitrotoluene..... lb.	.80 - .85
Para-phenylenediamine..... lb.	1.70 - 1.75
Para-toluidine..... lb.	1.25 - 1.40
Phthalic anhydride..... lb.	.37 - .40

Phenol, U. S. P., drums..... lb.	.11 - .15
Pyridine..... gal.	2.00 - 3.50
Resorcinol, technical..... lb.	1.50 - 1.60
Resorcinol, pure..... lb.	2.00 - 2.25
Salicylic acid, tech., in bbls..... lb.	.20 - .21
Salicylic acid, U. S. P..... lb.	.22 - .23
Salol..... lb.	.70 - .72
Solvent naphtha water-white, in drums, 100 gal. gal.	.25 - .28
Solvent naphtha, crude, heavy, in drums, 100 gal. gal.	.14 - .16
Sulphanilic acid, crude..... lb.	.27 - .30
Tolidine..... lb.	1.30 - 1.35
Toluidine, mixed..... lb.	.43 - .45
Toluene, in tank cars..... gal.	.25 - .28
Toluene, in drums..... gal.	.28 - .31
Xylidines, drums, 100 gal..... lb.	.40 - .45
Xylene, pure, in drums..... gal.	.40 - .45
Xylene, pure, in tank cars..... gal.	.45 - .45
Xylene, commercial, in drums, 100 gal..... gal.	.33 - .35
Xylene, commercial, in tank cars..... gal.	.30 - .35

Waxes

Prices based on original packages in large quantities

Bayberry Wax..... lb.	\$0.21 - \$0.22
Beeswax, refined, dark..... lb.	.24 - .25
Beeswax, refined, light..... lb.	.28 - .30
Beeswax, white pure..... lb.	.34 - .38
Candelilla wax..... lb.	.24 - .24
Carnauba, No. 1..... lb.	.45 - .46
Carnauba, No. 2, North Country..... lb.	.23 - .24
Carnauba, No. 3, North Country..... lb.	.13 - .14
Japan..... lb.	.21 - .21
Montan, crude..... lb.	.04 - .05
Paraffine waxes, crude match wax (white) 105-110 m.p..... lb.	.04 - .04
Paraffine waxes, crude, scale 124-126 m.p..... lb.	.03 - .04
Paraffine waxes, refined, 118-120 m.p..... lb.	.03 - .04
Paraffine waxes, refined, 125 m.p..... lb.	.04 - .04
Paraffine waxes, refined, 128-130 m.p..... lb.	.04 - .04
Paraffine waxes, refined, 133-135 m.p..... lb.	.05 - .05
Paraffine waxes, refined, 135-137 m.p..... lb.	.05 - .05
Stearic acid, single pressed..... lb.	.09 - .09
Stearic acid, double pressed..... lb.	.09 - .09
Stearic acid, triple pressed..... lb.	.10 - .10

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl..... 280 lb.	\$5.30 - 5.35
Rosin E-I..... 280 lb.	5.40 - 5.50
Rosin K-N..... 280 lb.	6.05 - 6.75
Rosin W. G. W. W..... 280 lb.	7.00 - 7.25
Wood rosin, bbl..... 280 lb.	6.25 - .
Spirits of turpentine..... gal.	.81 - .
Wood turpentine, steam dist..... gal.	.79 - .
Wood turpentine, dest. dist..... gal.	.78 - .
Pine tar pitch, bbl..... 200 lb.	6.00 - .
Tar, kiln burned, bbl. (500 lb.)..... bbl.	9.50 - .
Retort tar, bbl..... 500 lb.	9.50 - .
Rosin oil, first run..... gal.	.36 - .
Rosin oil, second run..... gal.	.39 - .
Rosin oil, third run..... gal.	.46 - .
Pine oil, steam dist., sp.gr. 0.930-0.940..... gal.	1.90 - .
Pine oil, pure, dest. dist..... gal.	1.50 - .
Pine tar oil, ref., sp.gr. 1.025-1.035..... gal.	.46 - .
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla..... gal.	.35 - .
Pine tar oil, double ref., sp.gr. 0.965-0.990..... gal.	.75 - .
Pine tar, ref., thin, sp.gr. 1.080-1.960..... gal.	.35 - .
Turpentine, crude, sp. gr. 0.900-0.970..... gal.	1.25 - .
Hardwood oil, f.o.b. Mich., sp.gr. 0.960-0.990..... gal.	.35 - .
Pinewood creosote, ref..... gal.	.52 - .

Solvents

73-76 deg., steel bbls. (85 lb.)..... gal.	\$0.37 - .
70-72 deg., steel bbls. (85 lb.)..... gal.	.35 - .
68-70 deg., steel bbls. (85 lb.)..... gal.	.34 - .
V. M. and P. naphtha, steel bbls. (85 lb.)..... gal.	.23 - .

Fertilizers

Ammonium sulphate, bulk and d. bags..... 100 lb.	\$2.30 - 2.90
Blood, dried, f.o.b., N. Y..... unit	4.00 - .
Bone, 3 and 50, ground, raw..... ton	30.00 - 32.00
Fish scrap, dom., dried, f.o.b. works..... unit	2.90 - 3.00
Nitrate soda..... 100 lb.	2.30 - 2.35
Tankage, high grade, f.o.b. Chicago..... unit	2.75 - 3.00
Phosphate rock, f.o.b. mines, Florida pebble, 68-72 p.c..... ton	4.50 - 6.50
Tennessee, 78-80 p.c..... ton	8.50 - 9.00
Potassium muriate, 80 p.c..... ton	34.00 - 35.00
Potassium sulphate..... unit	.70 - 1.00

Crude Rubber

Para-Upriver fine..... lb.	\$0.23 - .23
Upriver coarse..... lb.	.13 - .14
Upriver caucho ball..... lb.	.13 - .13
Plantation—First latex crepe..... lb.	.18 - .18
Ribbed smoked sheets..... lb.	.18 - .19
Brown crepe, thin, clean..... lb.	.15 - .
Amber crepe No. 1..... lb.	.17 - .

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls..... lb.	\$0.10 - \$0.10
Castor oil, AA, in bbls..... lb.	.11 - .12
China wood oil, in bbls. (f.o.b. Pac. coast)..... lb.	.13 - .13
Cocoonut oil, Ceylon grade, in bbls..... lb.	.09 - .09
Cocoonut oil, Cochinchina grade, in bbls..... lb.	.10 - .10
Corn oil, crude, in bbls..... lb.	.08 - .08
Cottonseed oil, crude (f. o. b. mill)..... lb.	.07 - .07
Cottonseed oil, summer yellow..... lb.	.08 - .09
Cottonseed oil, winter yellow..... lb.	.09 - .09

Linseed oil, raw, ear lots (domestic).....	gal.	.67	—	.68
Linseed oil, raw, tank ears (domestic).....	gal.	.62	—	.63
Linseed oil, in 5-bbl lots (domestic).....	gal.	.70	—	.71
Olive oil, Denatured.....	gal.	\$1.15	—	\$1.20
Palm, Lagos.....	lb.	.07 ¹ / ₂	—	.07 ¹ / ₂
Palm, Niger.....	lb.	.06 ¹ / ₂	—	.06 ¹ / ₂
Peanut oil, crude, tank ears (f.o.b. mill).....	lb.	.08	—	.08 ¹ / ₂
Peanut oil, refined, in bbls.....	lb.	.11	—	.11 ¹ / ₂
Rapeseed oil, refined, in bbls.....	gal.	.82	—	.83
Rapeseed oil, blown, in bbls.....	gal.	.88	—	.90
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.08 ³ / ₄	—	....
Soya bean oil, tank ears, f.o.b., Pacific coast.....	lb.	.07 ¹ / ₂	—	....

FISH

Light pressed menhaden.....	gal.	\$0.43	—	....
Yellow bleached menhaden.....	gal.	.44	—	....
White bleached menhaden.....	gal.	.46	—	....
Blown menhaden.....	gal.	.48	—	....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$23.00	—	23.50
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	15.00	—	17.00
Barytes, crude, 88% @ 94% ba., Kings Creek.....	net ton	10.00	—	12.00
Barytes, floated, f.o.b. St. Louis.....	net ton	23.00	—	24.00
Barytes, crude, first grade, Missouri.....	net ton	6.00	—	7.00
Blanc fixe, dry.....	lb.	.04	—	.04 ¹ / ₂
Blanc fixe, pulp.....	net ton	45.00	—	55.00
Casein.....	lb.	.14	—	.14 ¹ / ₂
Chalk, Precipitated, domestic, extra light.....	lb.	.04 ¹ / ₂	—	.05
Chalk, Precipitated, domestic, light.....	lb.	.04	—	.04 ¹ / ₂
Chalk, Precipitated, domestic, heavy.....	lb.	.03 ¹ / ₂	—	.04
Chalk, Precipitated, English, extra light.....	lb.	.04 ¹ / ₂	—	.05
Chalk, Precipitated, English, light.....	lb.	.04 ¹ / ₂	—	.05
Chalk, Precipitated, English, dense.....	lb.	.04	—	.04 ¹ / ₂
China clay (kaolin) crude, f.o.b. mines, Georgia.....	net ton	6.50	—	8.50
China clay (kaolin) washed, f.o.b. Georgia.....	net ton	9.00	—	10.00
China clay (kaolin) powdered, f.o.b. Georgia.....	net ton	13.00	—	20.00
China clay (kaolin) crude f.o.b. Virginia points.....	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points.....	net ton	13.00	—	20.00
China clay (kaolin), in ported, lump.....	net ton	12.00	—	20.00
China clay (kaolin), in ported, powdered.....	net ton	25.00	—	30.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	net ton	5.00	—	7.50
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27.00	—	30.00
Fullers earth, f.o.b. Me. es.....	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Baltimore.....	net ton	15.00	—	18.00
Fullers earth, powdered, f.o.b. Baltimore.....	net ton	18.00	—	....
Fullers earth, in ported, powdered.....	net ton	22.00	—	24.00
Graphite, Ceylon lump, first quality.....	lb.	.05 ¹ / ₂	—	.06 ¹ / ₂
Graphite, Ceylon chip.....	lb.	.04	—	.05
Graphite, high grade amorphous crude.....	lb.	.00 ³ / ₄	—	.02 ¹ / ₂
Kieselguhr, f.o.b. mines, Cal.....	per ton	40.00	—	....
Kieselguhr, f.o.b. N.Y.....	per ton	55.00	—	60.00
Magnesite, calcined.....	per ton	50.00	—	65.00
Pumice stone, imported.....	lb.	.03	—	.40
Pumice stone, domestic, lump.....	lb.	.05	—	.05 ¹ / ₂
Pumice stone, domestic, ground.....	lb.	.06	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore.....	net ton	....	—	10.00
Quartz (acid tower) 1 ¹ / ₂ @ 2 in., f.o.b. Baltimore.....	net ton	....	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	....	—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange line.....	lb.	.68	—	.70
Shellac, orange superline.....	lb.	.78	—	.80
Shellac, A. C. garnet.....	lb.	.58	—	.60
Shellac, T. N.....	lb.	.68	—	.70
Soapstone.....	ton	15.00	—	17.00
Sodium chloride.....	long ton	12.50	—	13.00
Talc, paper-making grades, f.o.b. Vermont.....	ton	11.00	—	18.00
Talc, roofing grades, f.o.b. Vermont.....	ton	8.25	—	13.00
Talc, rubber grades, f.o.b. Vermont.....	ton	11.00	—	18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	7.50	—	11.00
Talc, imported.....	ton	30.00	—	40.00
Talc, California talcum powder grade.....	ton	18.00	—	25.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	per ton	\$50.00	—	....
Carborundum refractory brick, 9-in.	1,000	1250.00	—	....
Chrome brick, f.o.b. Eastern shipping points.....	net ton	52- 55	—	....
Chrome cement, 40-45% Cr ₂ O ₃	net ton	30- 32	—	....
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in ear lots, f.o.b. Eastern shipping points.....	net ton	33- 35	—	....
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	35- 40	—	....
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	30- 35	—	....
Magnesite brick, 9-in. straight.....	net ton	65- 70	—	....
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	77	—	....
Magnesite brick, soaps and splits.....	net ton	98	—	....
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	40- 42	—	....
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	42- 45	—	....
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	35- 38	—	....

Ferro-Alloys

All f.o.b. Works

Ferrocobalt-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00	—	\$225.00
Ferrochrome per lb. of Cr. contained, 6-8% carbon, earlots.....	lb.	.12	—	....
Ferrochrome per lb. of Cr. contained, 4-6% carbon, earlots.....	lb.	.13	—	....
Ferromanganese, 76-80% Mn, domestic.....	gross ton	58.00	—	60.00
Ferromanganese, 76-80% Mn, Foreign, C. I. F. Atlantic Seaport.....	gross ton	54.00	—	58.35
Spiegeleisen, 18-22% Mn.....	gross ton	25.00	—	27.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.25	—	....
Ferrosilicon, 10-15%.....	gross ton	38.00	—	40.00
Ferrosilicon, 50%.....	gross ton	57.00	—	59.00
Ferrosilicon, 75%.....	gross ton	120.00	—	125.00
Ferrotungsten, 70-80%, per lb. of contained W.....	lb.	.40	—	.45
Ferrouranium, 35-50% of U, per lb. of U content.....	lb.	6.00	—	....
Ferrovandium, 30-40% per lb. of contained V.....	lb.	4.25	—	4.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content.....	net ton	\$8.00	—	\$10.00
Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃	ton	22.00	—	23.00
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard.....	ton	22.00	—	23.00
Coke, foundry, f.o.b. ovens.....	net ton	4.25	—	4.50
Coke, furnace, f.o.b. ovens.....	net ton	3.25	—	3.50
Fluorspar, gravel, f.o.b. mines, New Mexico.....	net ton	12.00	—	....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	20.00	—	22.00
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01 ¹ / ₂	—	.01 ¹ / ₂
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	.23	—	.24
Manganese ore, chemical (MnO ₂).....	net ton	55.00	—	60.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.45	—	.50
Monazite, per unit of ThO ₂ , c.i.f., Atlantic seaport.....	unit	30.00	—	....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport.....	unit	.12	—	.12
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.13	—	.13
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.11	—	.12
Rutile, 95% TiO ₂ per lb. ore.....	lb.	.15	—	....
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	2.50	—	2.75
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	2.75	—	3.00
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	1.25	—	1.75
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.25	—	2.50
Vanadium pentoxide, 99%.....	lb.	12.00	—	14.00
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1.00	—	....
Zircon, washed, iron free, f.o.b. Pablo, Florida.....	lb.	.04 ¹ / ₂	—	.13

Non-Ferrous Metals

New York Markets

Cents per Lb.

Copper, electrolytic.....	13.875
Aluminum, 98 to 99 per cent.....	19.00
Antimony, wholesale lots, Chinese and Japanese.....	4.50
Nickel, ordinary (ingot).....	41.00
Nickel, electrolytic.....	44.00
Monel metal, shot and blocks.....	35.00
Monel metal ingots.....	38.00
Monel metal, sheet bars.....	40.00
Tin, 5-ton lots, Straits.....	32.875
Lead, New York, spot.....	4.70
Lead, E. St. Louis, spot.....	4.375
Zinc, spot, New York.....	5.30 @ 5.35
Zinc, spot, E. St. Louis.....	4.85 @ 4.90

OTHER METALS

Silver (commercial).....	oz.	\$0.65 ¹ / ₂
Cadmium.....	lb.	1.00-1.25
Bismuth (500 lb. lots).....	lb.	1.50 @ 1.55
Cobalt.....	lb.	3.00 @ 3.25
Magnesium (f.o.b. Philadelphia).....	lb.	1.25
Platinum.....	oz.	75.00-78.00
Iridium.....	oz.	150.00 @ 170.00
Palladium.....	oz.	55.00-60.00
Mercury.....	.75 lb.	51.00 52.00

FINISHED METAL PRODUCTS

Warehouse Price
Cents per Lb.

Copper sheets, hot rolled.....	21.25
Copper bottoms.....	28.75
Copper rods.....	19.75
High brass wire.....	17.25
High brass rods.....	14.75
Low brass wire.....	18.75
Low brass rods.....	19.25
Brazed brass tubing.....	25.50
Brazed bronze tubing.....	30.50
Seamless copper tubing.....	21.25
Seamless high brass tubing.....	18.50

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current	Cleveland	Chicago
Copper, heavy and crucible.....	9.75 @ 10.25	9.25	9.50
Copper, heavy and wire.....	9.25 @ 9.50	8.50	8.50
Copper, light and bottoms.....	7.50 @ 8.00	7.50	7.25
Lead, heavy.....	3.50 @ 3.75	3.25	3.25
Lead, tea.....	2.25 @ 2.35	2.25	2.25
Brass, heavy.....	4.25 @ 4.50	4.50	5.00
Brass, light.....	3.25 @ 3.50	3.25	3.50
No. 1 yellow brass turnings.....	4.00 @ 4.25	4.25	4.50
Zinc.....	2.00 @ 2.25	2.00	2.25

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by 1/2 in. and larger, and plates 1/2 in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes.....	\$2.78	\$2.88	\$2.78
Soft steel bars.....	2.68	2.78	2.68
Soft steel bar shapes.....	2.68	2.78	2.68
Soft steel bands.....	3.28	3.48	3.28
Plates, 1/2 to 1 in. thick.....	2.78	2.88	2.78

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

BIRMINGHAM—The Acme Oil Co. of Alabama, recently organized, has had plans prepared for the erection of a local oil works, with initial daily capacity of about 3,000 gal. D. E. Chandler is secretary.

California

SACRAMENTO—The Sacramento Brick Co. is planning for the installation of additional machinery at its plant to develop an annual capacity of about 30,000,000 bricks. The company will also establish a department for the manufacture of roofing tile and other ceramic products. H. H. Bartells is manager.

Georgia

BRUNSWICK—The Ocean Leather Co., 33 New York Ave., Newark, N. J., is perfecting plans for the establishment of a plant at Brunswick for the tanning of shark skins and other fish hides. Alfred Ehrenreich is president.

Florida

JACKSONVILLE—The Florida-Louisiana Refining Co., now being organized with a capital of \$500,000, is planning for the erection of a large oil refinery on local site. H. C. Leete, Jacksonville, heads the organization.

MIAMI—The Pennsylvania Sugar Co., Delaware Ave., Philadelphia, Pa., has acquired a tract of land adjoining its property in this section, totaling about 60,000 acres, and plans to use the portion of the site for a new sugar mill, estimated to cost close to \$500,000, including machinery.

Illinois

HILLSBORO—Fire, Dec. 7, destroyed a portion of the plant of the Schram Glass Mfg. Co., with loss reported at close to \$30,000.

ROCKFORD—The Hess & Hopkins Leather Co. is considering tentative plans for the rebuilding of its 1-story plant, 60 x 115 ft., and proposes to commence work early in the spring. F. L. Morgan is secretary.

CHICAGO—The city of Chicago, architect Charles W. Tallal, is preparing plans for a 2-story pumping station to be erected near Western Ave. and 43d St., in connection with the Western Ave. water tunnel; estimated cost \$3,165,000. The beginning of the work will be dependent upon the appropriation of the 1922 city of Chicago budget.

CHICAGO—The Cole Storage Battery Co., located at 2437 Indiana Ave., is preparing plans for a 1-story addition to its present factory; estimated cost \$30,000.

CHICAGO—The Dental Metal Products Co. is preparing plans for a 2-story mill construction factory, 42x71 ft., and a warehouse 28x42 ft. for the manufacture of dental products. This plant will be located at 7512 Greenwood Ave.; estimated cost \$30,000.

Indiana

INDIANAPOLIS—The Piel Bros. Starch Co., State Life Bldg., is planning for the construction of a 1-story top addition to its plant, 200 x 200 ft. Improvements will be made also in the present plant. The work is estimated to cost about \$50,000. William F. Piel is president.

Louisiana

SHREVEPORT—The United States Sheet & Window Glass Co. is pushing construction on its new local works and expects to occupy the plant at an early date. It is estimated to represent an investment of close to \$1,000,000. It is reported that further additions will be made in the near future.

ALEXANDRIA—W. J. O'Pry, Alexandria, and associates are organizing a new company to establish a local tannery. A building has been purchased for the works, and occupancy will be arranged at an early date.

Maryland

BALTIMORE—The Union Smelting & Refining Co., Charles St., Newark, N. J., has acquired the property at Ostend and Howard Sts., 135 x 155 ft., for a consideration said to be \$31,000. It is proposed to use the site for the erection of a branch plant.

CENTERVILLE—E. S. Valliant & Son, manufacturers of fertilizer products, are arranging for the removal of a portion of their business, now located at Church Hill, and purpose to make Centerville their headquarters. The company operates a large fertilizer plant at Centerville Landing, and will concentrate production to a large extent at this point.

Massachusetts

SALEM—The Park Leather Co., Grove St., has awarded a contract to A. C. Brown, Danvers, Mass., for extensions and improvements in its plant. The work will be commenced at once.

Michigan

SHEBOYGAN—The Union Bag & Paper Co. has work under way on the remodeling of its plant 3-story 60 x 100 ft., estimated to cost about \$100,000. The improvement is being arranged for increased operations and better efficiency in production. G. S. Witham is general superintendent.

DETROIT—The Gagnier Stereotype Foundry Co., 525 Howard Ave., is having plans prepared for the erection of a new 1-story foundry on McKinstry St., estimated to cost about \$50,000. Kasurin Bros., 512 Empire Bldg., are architects. Edmond Gagnier is president.

PONTIAC—The Crodius Steam Pressed Brick Co. has tentative plans under consideration for the construction of a new plant. It is proposed to inaugurate work in the spring of the coming year. C. J. Crawford is president.

OTSEGO—The Mac-Sim-Bar Paper Co. has taken bids for the erection of the proposed new 1-story electric power plant at its mill, to be used for general operating service. It will be 80 x 140 ft., and is estimated to cost close to \$300,000, including machinery. Billingham & Cobb, Press Bldg., Kalamazoo, are architects.

PORT HURON—The Port Huron Sulphite & Paper Co., 1805 Richardson St., has construction under way on a 2-story and basement addition to its plant on Black River St., 70 x 100 ft., estimated to cost about \$50,000. Alfred J. L. Sullivan, 1320 Tenth St., has received the building contract. Edgar Kiefer is president.

Montana

CUT BANK—The Cut Bank Flour Mill Co. is reported to be planning for the rebuilding of the portion of its local plant, recently destroyed by fire with loss estimated at about \$35,000. John Bye is manager.

BAINVILLE—Fire recently destroyed a portion of the flour mill and elevator of the Jennison Mills Co. An official estimate of loss has not been made. It is said that the plant will be rebuilt at once.

New Jersey

METUCHEN—The General Ceramics Co., 50 Church St., New York, has perfected plans for the immediate erection of the proposed addition to its local sanitary ware manufacturing plant, estimated to cost about \$100,000. Dietrich Wertmann, 118 Lexington Ave., New York, is architect.

MATAWAN—Fire, Dec. 16, destroyed a portion of the plant of the Erdman Color Works and the adjoining factory of the Chrome Color Works, operated by the same interests, with loss estimated at about \$85,000, including machinery.

NEWARK—The Miller Oil Products Co., Bloomfield, N. J., has acquired property at 33-39 Ave. A, extending to 135-39 Miller St., for the manufacture of oils, polishes, etc. The lease covers a long term and the company will remove its plant to this location shortly after the first of January. The property comprises a 1-story building, on a lot totaling 100 x 150 ft. A number of improvements are planned.

GARFIELD—Fire, Dec. 12, destroyed a large portion of the plant of the Heyden Chemical Co. of America, Monroe St. and River Road, with loss estimated at close to \$500,000, including machinery. S. H. Chamberlain is president.

ELIZABETH—Fire, Dec. 10, destroyed a portion of the plant of the Darvin Chemical Co., with loss estimated at close to \$75,000. The plant is located on Miller St., and it is proposed to rebuild at an early date.

New York

HUDSON—The Hudson City Steel Co., 233 Broadway, New York, has preliminary plans under way for the erection of a new steel works at Hudson. It is proposed to call for bids early in the spring. Dwight P. Robinson & Co., 125 East Forty-sixth St., New York, are engineers.

North Carolina

LENOIR—T. H. Broyhill and F. H. Coffey, Lenoir, are organizing a new company with capital of \$200,000, for establishment of a local plant for the manufacture of mirrors and other glassware products.

Ohio

CINCINNATI—The Ultra-Marine Co., Huntington, W. Va., manufacturer of bluing, etc., has plans under way for the erection of a 1-story and 2-story plant on site selected at Cincinnati. It is proposed to call for bids late in February. E. C. Baugher is superintendent.

Pennsylvania

JAMISON CITY—The Elk Tanning Co. has construction under way on an addition to its plant, to include a 1-story extension to the beam house. The capacity will be increased.

PHILADELPHIA—F. W. Tunnell & Co., 15 North Fifth St., manufacturers of glue, fertilizers, etc., have filed plans for the creation of a 1-story plant extension.

MARCUS HOOK—The Viscose Co., has work well under way on a 3-story and basement addition to its local plant, estimated to cost about \$150,000. It is planned to occupy the structure for general manufacture at an early date.

Tennessee

CHATTANOOGA—The Independent Glass Co. has awarded a contract to J. W. Pogue, Chattanooga, for the erection of a new 2-story plant, 50 x 195 ft., to be equipped for the manufacture of windshields and other glass products. A. R. Williams is president.

KNOXVILLE—The Knoxville Fertilizer Co. is completing foundations for its new plant in the Vestal section, and will commence the immediate erection of the superstructure. The plant, with equipment, is estimated to cost about \$200,000. J. W. Dean is secretary and treasurer.

BRISTOL—A. D. Reynolds, Bristol and Leroy Park, Greenville, Tenn., are organizing a new company to construct and operate a blast furnace and steel works on a site being selected in eastern Tennessee. It is said that the new plant will cost in excess of \$500,000.

Texas

COLEMAN—J. P. Morris has acquired the local plant of the Brinkley Brick & Tile Co. The new owner purposes to operate the works, and is said to be planning for a number of extensions and improvements.

DALLAS—The O. C. China Novelty & Pottery Co., 1104-6 South Betterton St., has filed plans for the erection of a new 2-story and basement plant, estimated to cost about \$25,000.

HOUSTON—The Humphreys-Pure Oil Co. is reported to be planning for the erection of a new local refinery, with initial capacity of about 30,000 bbl. of oil a day. The refining plant will be operated in connection with the proposed pipe line to be constructed from Mexia, Tex., to the Gulf. The entire project is estimated to cost in excess of \$1,000,000. Col. E. A. Humphreys is president.

CORSICANA—The Corsicana Oil & Refining Co., is planning for the immediate operation of its new local oil refinery, now practically completed. It will be run on a full capacity basis.

Virginia

RICHMOND—The Virginia-Carolina Rubber Co., North Nineteenth Street, will break ground at once for the erection of a new 1-story plant, estimated to cost about \$130,000, and of which amount approximately \$90,000 will be used for the purchase of new machinery and equipment. R. J. Bell is manager.

New Companies

THE PHARMO CHEMICAL Co., Newark, N. J., has been incorporated with a capital of \$50,000, to manufacture chemicals and chemical byproducts. The incorporators are Samuel W. Barlow and Harry S. Neiwirth, 63 New Jersey Railroad Ave., Newark.

THE SOUTH WILLIAMSPORT TANNING Co., South Williamsport, Pa., has been incorporated with a capital of \$24,000, to manufacture leather products. L. R. Plankenhorn, South Williamsport, is treasurer.

THE BOLIVAR REFINING CORP., Bolivar (Allegheny County), N. Y., has been incorporated with a capital of \$350,000, to manufacture refined oil products. The incorporators are H. B. Yerdon, W. E. Sawyer and C. A. Chipman. The company is represented by Bliss & Bliss, Bolivar.

THE CAROLINA FISH & OIL Co., Moorhead City, N. C., has been incorporated with a capital of \$100,000, to manufacture oil products of various kinds. The incorporators are D. W. Wade, E. H. Gorham and J. E. Woodland, Moorhead City.

THE CHICAGO CORE COMPOUND Co., 302 Marquette Bldg., Chicago, Ill., has been incorporated with a capital of \$10,000, to manufacture chemicals, compounds, etc. The incorporators are W. W. Welch, William A. Herron and Thomas G. Lovelace.

THE STANDARD APPROVED PRODUCTS Co., Washington, D. C., has been incorporated under Delaware laws with capital of \$750,000, to manufacture tile, fire-proofing cement and kindred specialties. The incorporators are Albert Pauley, R. J. Michael and Joseph F. Randall, Washington. The company is represented by Horace G. Eastburn, Ford Bldg., Wilmington, Del.

THE NEW YORK FELDSPAR CORP., Rochester, N. Y., has been incorporated with a capital of \$100,000, to operate a feldspar producing and grinding plant. The incorporators are F. G. Kennedy and J. W. B. Bausman. The company is represented by Havens, Mann, Strang & Whipple, attorneys, Rochester.

THE COMMONWEALTH OIL CORP., Union Hill, N. J., has been incorporated with a capital of \$100,000, to manufacture oil products. The incorporators are W. Stanley Coles, George and Herman Koch, 101 Bergenline Ave., Union Hill.

THE MOORE-NORTH RUBBER Co., Fort Worth, Tex., has been organized under state laws to manufacture rubber specialties. The company is headed by J. W. Moore, E. M. North and E. E. Edgar, Fort Worth.

THE MIDWEST GLASS PRODUCTS Co., 112 South Michigan Ave., Chicago, Ill., has been incorporated with a capital of \$500,000, to manufacture glassware of various kinds. The incorporators are O. S. Flath, C. R. W. Peterson and Otto Treulich.

THE ADAMANT RUBBER PRODUCTS Co., New York, N. Y., has been incorporated with a capital of \$500,000, to manufacture rubber goods of various kinds. The incorporators are M. Stabins and B. Weiner. The company is represented by M. P. Schaffer, 1463 Broadway, New York.

THE CITY BRICK Co., Los Angeles, Cal., has been incorporated with a capital of \$100,000, to manufacture brick and other burned clay products. The incorporators are W. R. J. T. and I. L. Simons. The company is represented by Ford & Bodkin, 410 H. W. Hellman Bldg., Los Angeles.

McKECHNIE BROS., INC., Philadelphia, Pa., has been incorporated with a capital of \$150,000, to operate a metal smelting and refining plant. William McKechnie, Bellevue-Stratford Hotel, Philadelphia, is treasurer.

THE ZIRALOY Co., 1227 Calvert Bldg., Baltimore, Md., has been incorporated with a capital of \$50,000, to manufacture metals and metal alloys. The incorporators are Robert E. L. Young and Ferdinand I. Gruebel.

THE NOX-A-MITE CHEMICAL Co., 417 South Dearborn St., Chicago, Ill., has been organized under state laws to manufacture chemicals and chemical byproducts. The incorporators are William F. Ayres, Charles E. Ludington and John F. Gallagher.

THE AMERICAN OIL Co., Hattiesburg, Miss., has been incorporated with a capital of \$100,000, to manufacture petroleum products. The incorporators are A. R. Harbison, J. O. Barron and James A. Swayne, Hattiesburg.

THE NATIONAL FIRREFORM Co., Wilmington, Del., has been incorporated under state laws with capital of \$500,000, to manufacture fiber and pulp products. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington.

THE EVANSVILLE OIL & GREASE Co., Evansville, Ind., has been incorporated with a capital of \$200,000, to manufacture oils, greases and other lubricants. The incorporators are T. H. Meyer, F. C. Enz and E. H. Schmidt, Evansville.

THE SOUTHERN METAL WORKS, INC., Shelby, N. C., has been incorporated with a capital of \$50,000, to manufacture babbitt metal, solders and kindred products. J. S. Williams is president, and Peyton McSwain, secretary and treasurer, both of Shelby.

THE SOAP & CHEMICAL MFG. Co., Secaucus, N. J., has been incorporated with a capital of \$50,000, to manufacture chemicals and chemical byproducts, soaps, etc. The incorporators are Emerson C. McVausland, Charles W. Aschenbach and Percy Meebott, 210 Penhorn Ave., Secaucus.

THE UTILITY OIL CORP., Brooklyn, N. Y., has been incorporated with a capital of \$100,000, to manufacture oil products. The incorporators are M. Slavin and S. Margolies. The company is represented by Schwimer & Gempler, 955 Broadway, Brooklyn.

THE RAINBOW OIL Co., Greenville, Miss., has been incorporated with a capital of \$300,000, to manufacture petroleum products. The incorporators are A. R. Harbison and J. O. Barron, Hattiesburg, Miss.

THE GENERAL SEAMLESS TUBE Co., New York, N. Y., has been incorporated under Delaware laws with a capital of \$1,450,000, to manufacture seamless steel tubing and kindred products. The incorporators are James W. Sanders, New York; H. Russ Van Vleck and William Hotchkiss, Montclair, N. J. The company is represented by the United States Corporation Co., 65 Cedar St., New York.

THE OWENS REFINING Co., Cameron, Tex., has been incorporated with a capital of \$45,000, to manufacture refined petroleum products. The incorporators are John S. Owens, John H. Edwards and E. A. Wallace, Cameron.

THE CHICAGO INSECTICIDE LABORATORY, INC., 3925 Calumet Ave., Chicago, Ill., has been incorporated under state laws with 10 shares of stock, no par value, to manufacture chemicals, insecticides, etc. The incorporators are A. J. Campbell, Albert and Benjamin Heller.

THE CAROLINA SMELTING & REFINING Co., Columbia, S. C., has been organized under state laws to operate a metal smelting and refining plant. A. Morgan is president, and N. Zalmenovitz, secretary-treasurer, both of Columbia.

THE M. C. O. OIL Co., San Francisco, Cal., has been incorporated with a capital of \$2,000,000 under Delaware laws, to manufacture petroleum products. The incorporators are W. R. MacDonald and William H. Jordan, San Francisco. The company is represented by the Corporation Service Co., Wilmington, Del.

THE SHERWOOD PAPER Co., Boston, Mass., has been incorporated with a capital of \$50,000, to manufacture paper specialties. Norman J. MacGaffin, West Medford, Mass., is treasurer.

Industrial Notes

THE QUIGLEY FURNACE SPECIALTIES Co., New York announces that it has added to its staff, as sales manager, Robert L. Warburton, who was formerly associated with the Celite Products Co.

W. LA COSTE NEILSON, heretofore foreign manager for the Norton Co., Worcester, Mass., at London, England, has been elected vice-president and general sales manager of the company. Other officials elected at a recent meeting are: Henry Duckworth as controller and assistant treasurer, Louis E. Saunders as head of the research department and John C. Spence as superintendent of the grinding machine division.

THE EXETER MACHINE WORKS, INC., West Pittston, Pa., makes the following announcements: The appointment of the English Tool & Supply Co. as exclusive sales agent for the Exeter rotary pump line in the Kansas City district; the appointment of Reeves & Skinner Machinery Co. of St. Louis, Mo., as sales agent in the St. Louis district; the appointment of the Hendrie & Bolthoff Mfg. & Supply Co. of Denver, Col., as sales agent in the Denver district; the appointment of the W. P. MacKenzie Co. as sales agent in the Philadelphia and Baltimore districts; the appointment of Buckmaster-Luck-Malochee, Inc., of New Orleans, La., as sales agent in the New Orleans district; the appointment of Vickers & Co. of Seattle, Wash., as sales agent in the Seattle district; the appointment of Hodgeart & Co. of Chicago, Ill., as sales agent in the Chicago district, and the H. M. Stark Machinery Co. of Detroit, Mich., as sales agent in the Detroit district.

Capital Increases, Etc.

THE BINNEY & SMITH Co., 81 Fulton St., New York, N. Y., manufacturer of lamp black, etc., has filed notice of increase in capital from \$250,000 to \$1,250,000.

THE VERNON COTTON OIL Co., Vernon, Tex., has filed notice of increase in capital from \$250,000 to \$300,000.

THE WESTERN PAPER BOX Co., 172 North Green St., Chicago, Ill., has filed notice of increase in capital from \$35,000 to \$100,000.

GODCHAUX SUGARS, INC., 527 Canal St., New Orleans, La., operating a number of sugar refineries, has arranged for a bond issue of \$3,000,000. Charles Godchaux is president.

THE GRAND RAPIDS TIRE & RUBBER CORP., Grand Rapids, Mich., manufacturer of tires and rubber products, has filed notice of increase in capital from \$3,000,000 to \$9,000,000.

THE ROBERT GAIR Co., 350 Madison Ave., New York, manufacturer of paper boxes and other paper products, operating six large plants, has disposed of a bond issue totaling \$4,000,000. George W. Gair is president.

THE TRANSCONTINENTAL OIL Co., 576 Fifth Ave., New York, N. Y., is arranging for a bond issue of \$10,000,000, of which fund about \$7,000,000 will be used for the purchase of new properties, extensions, expansion, etc.

J. G. Leavall has been appointed receiver for the **GENERAL OIL Co.**, Houston, Tex., capitalized at \$20,000,000. The company is said to be solvent but a receivership was deemed advisable.

THE EASTERN MFG. Co., Bangor, Me., operating paper and pulp mills, is arranging for a bond issue to total \$2,500,000, for additional working capital.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE is holding its seventy-fourth meeting at Toronto, Canada. Dec. 26 to 31, 1921.

AMERICAN CERAMIC SOCIETY will hold its twenty-fourth annual meeting at St. Louis, Feb. 27 to March 2, 1922.

AMERICAN CHEMICAL SOCIETY will hold its spring meeting at Birmingham, Ala., April 4 to 7, 1922.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting in Baltimore, April 27, 28 and 29, 1922.

AMERICAN ENGINEERING COUNCIL will hold its next meeting in Washington, Jan. 5-6.

AMERICAN FOUNDRYMEN'S ASSOCIATION will hold its next convention and exhibit at Cleveland, O., during the week of April 24, 1922. Meetings will be held in the spring instead of in the fall as heretofore.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its spring meeting in New York the week of Feb. 20, 1922.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stettens Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

PERKIN MEDAL will be presented to William M. Burton by the Society of Chemical Industry at its meeting Jan. 13 at the Chemists' Club, New York.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

The following meetings are scheduled to be held in Rumford Hall, the Chemists' Club, New York: Jan. 6—American Chemical Society, regular meeting; Jan. 13—Society of Chemical Industry, Perkin Medal; Feb. 10—American Electrochemical Society (in charge), Society of Chemical Industry, Société de Chimie Industrielle, American Chemical Society, joint meeting; March 10—American Chemical Society, Nichols Medal; March 24—Society of Chemical Industry, regular meeting; April 21—Society of Chemical Industry (in charge), American Electrochemical Society, Société de Chimie Industrielle, American Chemical Society, joint meeting; May 5—American Chemical Society, regular meeting; May 12—Société de Chimie Industrielle (in charge), American Chemical Society, Society of Chemical Industry, American Electrochemical Society, joint meeting; May 19—Society of Chemical Industry, regular meeting; June 9—American Chemical Society, regular meeting.

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